INDENT

INDicators of ENvironmental inTegration

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Summary

Based on a review of work on environmental indicators for fisheries in different scientific fora, which in turn was reviewed by STECF, the Commission selected a reduced set of indicators from the list as a preliminary set of indicators to implement an environmental indicator scheme on a pilot basis. This set consisted of 32 indicators covering four policy areas: (1) Conservation measures, (2) Structural measures, (3) Market measures and (4) Horizontal measures.

The INDENT project is the next step in this process, quantifying each of these indicators. The approach taken consisted of three key stages: (1) Quantification: data was compiled and the numerical values of the indicators calculated, (2) Evaluation: insights gained during data compilation and processing were used to determine gaps in data or information and suggest solutions. Performance of indicators was evaluated, the rationale of each indicator re-examined and underlying assumptions made clear. Possible improvements or alternative indicators were subsequently suggested, (3) Interpretation: the historical series obtained were interpreted. Because the aim is that the indicators are representative of the European Community and should be applicable in regional management special attention was paid to representivity and if the information available could be broken down by categories such as geographic regions, fisheries métiers and/or Member States.

Finally an overall evaluation was conducted of all indicators against those screening criteria of a larger suite of criteria that were deemed within the remit of the project. As the main objective of INDENT was to “attribute numerical values” to each of the indicators and “determine gaps in data or information” we focused on the criterion of “Availability of historical data” while considering also “Cost” and “Measurement”. Based on these criteria we followed a formal decision scheme that lead to the characterization of the indicators into the following four classes:

1. Informative indicators which can be made operational with little or no additional effort
2. Informative indicators which require further development before they can be made operational
3. Potentially informative indicators which require further development prior to re-evaluation
4. Indicators which are not informative or redundant

Overall the conservation measure indicators were considered to be informative and easiest to make operational in most, if not all, European regions. They were followed by the Structural measure indicators for which the indicators were deemed potentially informative but data were often not available. Finally, the Market measure and Horizontal measure indicators were considered least well developed. It was often unclear against which objectives they were intended to measure progress, they suffered from lack of definition, e.g. what is considered “environmentally friendly fishing” or when it comes to the evaluation of the fishery inspection or funding of research, to distinguish environmental issues from other issues.

Interpretation of the results paints a grim picture that to a more or lesser extent applies to all European waters: the ecosystem is severely affected by fishing and shows no sign of improvement. One significant problem in the management of the fishery is the lack of reliable international data of fishing impact. To some extent the current situation of the ecosystem and the fishery may have emerged because scientific advice was insufficiently incorporated in decision making.

Guide to the reader:

In this report we distinguish three sections that differ in the amount of detail provided for readers with different levels of interest:

1. The summary is the least detailed
2. More detail is provided in chapter 3
3. The highest level of detail is provided in chapter 2 where each indicator is described in a subsection

1 Introduction

1.1 The role of indicators in fisheries management

Indicators can be valuable tools for tracking change, identifying problems and monitoring implementation of policies and results. They are increasingly used to assess the efficacy of EU policies, including the extent to which environmental concerns are integrated into sectoral policies. A robust set of informative indicators will help policy- and decision-makers to evaluate the performance of management measures, as well as ensure accountability to the public through regular information.

Fisheries by their nature are dependant upon, and can profoundly influence, the aquatic environment. Their dependence on the environment relates primarily to the overall health of the coastal and marine ecosystems and is thus vulnerable to both anthropogenic influences, such as a decline in water quality from pollution, as well as temporal variations in the cycling of natural processes. Fisheries exploitation can also have a major impact on the aquatic environment through the reduction of wild fish populations. This may not only affect the exploited/targeted populations but also non-target species through trophic interactions or competition. Fisheries and aquaculture activities can also have direct or indirect impacts on marine and coastal habitats, which may have further consequences for maintenance of the integrity of marine life, including biodiversity.

1.2 Policy context

1.2.1 Integration of environmental concerns into the CFP

The fundamental legal basis for the environment to be an integral part of EU policy lies in the Treaty. Article 6 contains the principle that '*environmental protection requirements must be integrated into the definition and implementation of Community policies and activities…in particular with a view to promoting sustainable development*'. Furthermore, the process of integrating interactions between fisheries and marine ecosystems into European fisheries management, that is the workings of the Common Fisheries Policy (CFP), has evolved through a series of stages. These include the following:

- Commission Communication: *Fisheries Management and Nature Conservation in the Marine Environment COM (1999) 363*
- Commission Communication: *The Application of the Precautionary Principle and Multi-annual Arrangements for Setting Total Allowable Catches COM (2000) 803.*
- Commission Communication: *Elements of a Strategy for the Integration of Environmental Protection Requirements into the Common Fisheries Policy COM (2001) 143*
- Commission Communication: *Biodiversity Action Plans in the Areas of Conservation of Natural Resources, Agriculture, Fisheries and Development and Economic Co-operation COM (2001) 162*

- Commission Communication: *Setting out a Community Action Plan to Integrate Environmental Protection Requirements into the Common Fisheries Policy COM (2002) 186*.
- The EC's Sixth Environment Action Programme[1] 2001-2010 recognises the need to fully integrate environmental considerations during the reform of the Common Fisheries Policy (CFP), requesting the '*revision of the Common Fisheries Policy after 2002 leading to the greater integration of environmental concerns*'.

1.2.2 The Common Fisheries Policy

The CFP provides *the* framework for European and national fisheries management activities. The CFP framework ('basic') Regulation (2371/2002) sets out the objectives and instruments that can be deployed for fisheries management. This Regulation was the outcome of the 2002 CFP reform, which resulted in a number of changes.

From an environmental perspective, the new basic regulation contains important environmental provisions. It provides for measures that will 'limit the environmental impact of the CFP' and explicitly refers to the application of the precautionary principle and the progressive implementation of an eco-system based approach to fisheries management.

1.2.3 INDENT and the 2005 environmental integration Report

The Action Plan on environmental integration into the CFP (COM(2002)186) contains guiding principles, management measures and a work programme, to move towards an ecosystem approach to fisheries management. It envisaged the development of a system of indicators to monitor the change from the 'old' to the 'new' CFP. These indicators are to assess to what extent the reformed CFP is on the right track towards integrating environmental protection requirements. The Action Plan also foresees that the Commission will issue a progress report on the integration process, based on this system of indicators, before the end of 2005.

A study report was finalised in August 2003 to review work on environmental indicators for fisheries in different scientific fora in order to build on existing knowledge and a proposal for a preliminary set of indicators[2]. This report was reviewed by an STECF expert group on 28-30 October 2003[3] and by the Plenary

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[1] COM(2001)29 Communication on the Sixth Environment Action Programme of the European Community 'Environment 2010: Our future, Our choice'

[2] Jaako Pöyry Infra (Soil & Water), 2003. *Development of Preliminary Indicators of Environmental Integration of the Common Fisheries Policy*; Contract No FISH/2002/08.

[3] SEC(2004)29 *Ad hoc Expert Group on Indicators of environmental integration for the common fisheries policy*. Commission Staff Working Paper. Brussels, October 2003. 8.1.2004 http://europa.eu.int/comm/fisheries/doc_et_publ/factsheets/legal_texts/docscom/en/sec_2004_573_en.pdf

STECF on 3-7 November 2003[4]. Based on this, the Commission selected a reduced set of indicators from the list as a preliminary set of indicators to implement an environmental indicator scheme on a pilot basis on which its first report on the integration process, by the end of 2005, should be based[5]. The INDENT project is the next step in this process, quantifying this preliminary set of indicators**.**

1.2.4 Beyond an environmental report: the 2003 data collection review

Council Regulation 1543/2000 and associated legislation set out a legal and funding framework for the collection of data needed to implement the CFP. Member States are required to collect data on the 'biology of the fish stocks, on the fleets and their activities and on economic and social issues' and submit a National Programme to the Commission by 31 May each year. Apart from a definition of fishing effort in relation to fishing operations under the extended programme, there are no environmental variables.

Article 10 of Regulation 1543/2000 stipulates that by the end of 2003 the Commission will review whether it is appropriate to extend the range of data collected to cover the relationship of fisheries and aquaculture with the environment. A study was therefore commissioned to determine the appropriateness and feasibility of extending the current obligations of Regulation 1543/2000 to include interactions between fisheries and the environment. It reported in July 2003[6]. In particular, the study examined the wide body of information available on (i) the environmental effects of fishing and (ii) the interactions between different elements of the marine ecosystem on fisheries and consumers. As a result of this examination, recommendations were made as to the most appropriate variables to monitor based upon their importance relative to the CFP and practical and technical issues related to their monitoring. Following this, the STECF reviewed the report and identified and prioritised immediate data and research and development needs to support the integration of environmental protection requirements into the CFP[7].

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[4] SEC(2004)573 17th *Report of the Scientific, Technical and Economic Committee for Fisheries* Commission Staff Working Paper 6.5.2004 Brussels, 03-07 November 2003 http://europa.eu.int/comm/fisheries/doc_et_publ/factsheets/legal_texts/docscom/en/sec_2004_573_en.pdf

[5] SEC(2004)892 *Developing a system of indicators of environmental integration for the Common Fisheries Policy*. Commission Staff Working Paper Brussels, 29.06.2004 http://europa.eu.int/comm/fisheries/doc_et_publ/factsheets/legal_texts/docscom/en/sec_2004_892_en.pdf

[6] Huntington, T., C. Frid, I. Boyd, I. Goulding and G. Macfadyen (2003). '*Determination of Environmental Variables of Interest for the Common Fisheries Policy Capable of Regular Monitoring*'. Final Report to the European Commission. Contract SI2.348197 of Fish/2002/13. http://www.consult-poseidon.com/reports/EC%20Poseidon%20Environmental%20Variables.pdf

[7] SEC(2005)*** *Report of the Subgroup On Research Needs (SGRN) on data collection: environmental integration and move towards an ecosystem approach.* Commission Staff Working Paper, Report of the Scientific, Technical and Economic Committee for Fisheries. Brussels 11-14 July, 2005.

It is expected that the experience gained from the preliminary system of indicators quantified by INDENT and the data collection review, together with further knowledge and experience gained in other fora (eg the INDECO project[8]), will together provide a basis for an in-depth revision of the current system after 2006 in the form of a revised data collection Regulation.

1.3 Project Terms of Reference and purpose

1.3.1 Purpose/objectives

The main objective is to build up a system, based on indicators, to monitor the process of environmental integration of the CFP.

1.3.2 Terms of Reference

The terms of reference are:

- to attribute numerical values to the preliminary set of indicators, on which the first report on the environmental integration (2005) should be based, as detailed in (SEC(2004)892);
- to collect data and attribute numerical values to the second order set of indicators as detailed in (SEC(2004)892);
- to determine gaps in data or information and suggest solutions; and
- to interpret the historical series obtained.

1.3.3 Study methodology

In order to build up a system, based on indicators, that can monitor the impact of the CFP and how this is affected by the process of environmental integration, numerical values are attributed to the preliminary set of indicators. Emphasis is placed on the preliminary set of proposed (first-order) indicators. The aim is that the indicators are representative of the European Community as a whole preferably broken down by categories such as geographic regions, fisheries and/or Member States. However, realisation of this aim is largely determined by the availability of data. For the second-order indicators we attempt to quantify them where the necessary datasets are available. However, as this is not always the case, the focus for these indicators is on identifying gaps in data or information and suggesting solutions.

In the approach taken there were three key stages:

- Stage 1 – Quantification: data was compiled and the numerical values of the indicators calculated;
- Stage 2 – Evaluation: insights gained during data compilation and processing were used to determine gaps in data or information and suggest solutions. Performance of indicators were evaluated, the rationale of each indicator re-examined and underlying assumptions made clear. Possible improvements or alternative indicators were subsequently suggested;
- Stage 3 – Interpretation: the historical series obtained were interpreted.

[8] http://www.ieep.org.uk/projectMiniSites/indeco/index.php

The emphasis in the project is on quantification of the proposed first-order indicators. For each of these indicators all three stages were undertaken. For the second-order indicators every effort was made to quantify them where the necessary datasets were available and within the resources available. Where such data was not available however, the focus was on Stage 2.

1.4 Geographic areas

On the 24 October, the Commission adopted a Thematic Strategy on the protection and Conservation of the Marine Environment (COM(2005)504). This was the second Thematic Strategy to be adopted, following the provisions of the 6th Environmental Action programme. The main component of the Marine Strategy is a proposal for a Framework Directive – a Marine Strategy Directive (COM(2005)505) with the aim to achieve 'good environmental status' in the Marine Environment by 2021, at the latest.

Two important deliverables from this process include the production of:

a) a guidance document on the application of the ecosystem-based approach to the marine environment;
b) a study on the identification of European Marine Regions on the basis of hydrological, oceanographic and bio-geographic features to guide implementation of the Strategy.

In the latter the following Marine Regions and their sub-regions were identified:

a) Baltic Sea;
b) North East Atlantic Ocean with sub-regions:
    - Greater North Sea, including the Kattegat and English Channel,
    - Celtic Seas,
    - Bay of Biscay and the Iberian Coast,
    - Atlantic Ocean
c) Mediterranean Sea with sub-regions:
    - Western Mediterranean Sea
    - Adriatic Sea,
    - Ionian Sea
    - Aegean-Levantine Sea,

Another relevant set of divisions of EU waters was established by the EU for Regional Advisory Councils (RACs) and is shown in table 1.4.1 and figure 1.4.1.

Table 1.4.1. RAC boundaries

Name of the Regional Advisory Council	ICES areas, CECAF divisions and General Fisheries Commission for the Mediterranean
Baltic Sea	IIIb, IIIc and IIId
Mediterranean Sea	Maritime Waters of the Mediterranean of the East of line5°36' West
North Sea	IV, IIIa
North Western waters	V (excluding Va and only EC waters in Vb), VI, VII
South Western waters	VIII, IX and X (waters around Azores),

	and CECAF divisions34.1.1, 34.1.2 and 34.2.0 (waters around Madeira and the Canary Islands)
Pelagic stocks (blue whiting, mackerel, horse mackerel, herring)	All areas (excluding the Baltic Sea and the Mediterranean Sea)
High seas/long distance fleet	All non EC-waters

Source: Council Decision 2004/585

It should be noted that there is a large degree of consistency between the RAC areas and the MTS marine regions where the Baltic Sea and the Mediterranean Sea are the same and the MTS-defined North East Atlantic Ocean consists of the RAC-defined North Sea, North-western waters and South-western waters. At the level of sub-regions more differences exist: the MTS distinguishes sub-regions in the Mediterranean Sea and the North- and South Western waters consist of the MTS sub-regions Bay of Biscay and the Iberian Coast and Atlantic Ocean.

For INDENT we use the three major regions identified in both EU geographic divisions e.g. Baltic Sea, Mediterranean Sea and North East Atlantic Ocean. Where we go beyond this we specifically mention which sub-division has been applied.

If data are not presented for a specific indicator in a specific (sub) area this does not necessarily imply that the data were not available. We do not attempt to be comprehensive for each indicator in terms of the areas covered.

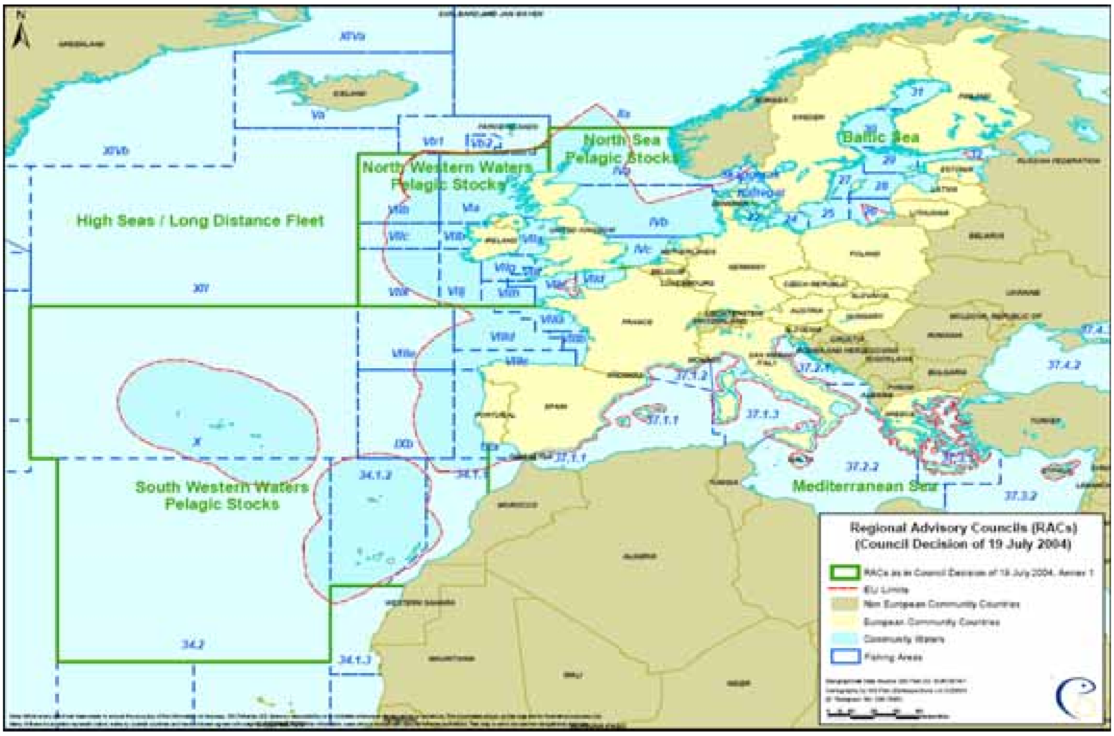

Figure 1.4.1. RAC regions

2 Indicators

The 2003 study (see section 1.2.3) aimed at the compilation of the most recent work on indicators in the fisheries field identified a preliminary suite of indicators covering four policy areas:

- Conservation measures,
- Structural measures,
- Market measures,
- Horizontal measures.

After wide consultation including the scientific, Technical and Economic Committee for Fisheries (STECF), the Commission selected a preliminary set of indicators of environmental integration as a basis for the SEC(2004)892. Based on an appreciation of data availability and an estimation of the time-scale in which their implementation may become effective 1st order and 2nd order indicators were distinguished (table 2.1). Each of these indicators will be dealt with in subsequent sections.

Table 2.1. List of indicators, the four policy areas (C=conservation measures, S=structural measures, M=market measures and H=horizontal measures) and their rating as 1st or 2nd order.

Policy area	Section	Indicator	Rate
C	**1**	Proportion of commercial stocks that are within safe biological limits	1
C	**2**	Relative abundance of a set of populations that are not regularly assessed but which are decreasing in number.	2
C	**3**	Average size (length and weight) in the community	1
C	**4**	Mean trophic level	2
C	**5**	Mean maximum length	2
C	**6**	Biodiversity indicators	2
C	**7**	Trends in abundance of sensitive benthos species.	1
C	**8**	Area coverage of highly sensitive habitats.	2
C	**9**	Total aquaculture production and total area occupied by aquaculture installations	1
C	**10**	Effluent water quality	2
C	**11**	Eco-efficiency of aquaculture	2
C	**12**	Potential impact of aquaculture, and particularly on the impact of reared fish (such as salmon) escaping from fish farms, on the genetic structure of wild (fish) populations.	2
S	**13**	Effective fishing capacity (adjusted fishing effort) and its spatial and temporal distribution	1
S	**14**	Structural support and proportion allocated to promote environmental friendly fishing practices.	2
S	**15**	Mapping of effort distribution over the sensitive areas	1
S	**16**	Use of environmentally friendly gears	1
S	**17**	Oil consumption as a proxy for CO2 production.	2
S	**18**	Unwanted by-catches of protected species and discards	2
M	**19**	Share of fish produced (or consumed) that are eco-labelled.	2
M	**20**	Initiatives to support eco-labelling and use of eco-labels and similar awards	1
M	**21**	Amounts of fish taken out of the market and/or traded on secondary (intervention) conditions.	1
M	**22**	Size of the European market for fish	2
M	**23**	Changes in consumer preferences in relation to environmental issues	2
H	**24**	Number of inspections per landing	1
H	**25**	Number of infringements over number of inspections.	1
H	**26**	Level of imposition of punishment	2
H	**27**	Attitudes and awareness of stakeholders towards CFP environmental goals	1
H	**28**	Total quantity of funds allocated to relevant research and distribution of research funds	1
H	**29**	Scientific advice in decision making	2

H	**30**	Policy makers performance	2
M	**31**	Proportion of landings covered by catch plans	2
H	**32**	Number of violations (assuming that inspection is efficient)	2

2.1 Proportion of commercial stocks that are within safe biological limits

For quantification of this indicator different approaches were applied for the North-East Atlantic (and its sub-regions) and Baltic Sea as opposed to the Mediterranean because the management framework and availability of data differs markedly between these regions.

North-East Atlantic
This indicator can be interpreted as stock biomass should be 'above precautionary reference points for commercial fish species where these have been agreed by the competent authority for fisheries management'. The relevant precautionary reference points are those for "spawning stock biomass (SSB), also taking into account fishing mortality (F), used in advice given by ICES in relation to fisheries management". ICES has established B_{pa} and F_{pa} as the respective precautionary reference points for spawning stock biomass and fishing mortality for use in formulating advice. They are set on a stock-specific basis, and take account of both stock dynamics and uncertainties in the assessment. B_{pa} is the spawning biomass at and above which there is a low probability that true SSB is so low that productivity is impaired. F_{pa} is the fishing mortality at and below which the true fishing mortality has a low probability of leading to stock collapse. To evaluate the performance of fisheries management advice Piet & Rice (2004) identified the state of these stocks using precautionary reference points. Therefore three criteria were used to determine whether a stock was within safe biological limit, and hence that the objective was met:

- SSB was above the precautionary reference point (SSB>SSBpa)
- F was below the precautionary reference point (F<Fpa)
- Both the above (SSB>Bpa and F<Fpa)

The suggested indicator is the proportion of commercial fish stocks within safe biological limits. The objective is that this indicator should be at a target level relative to a reference level which by definition is 100%.

Mediterranean
Mediterranean fisheries have historically been managed with a different philosophy from those of the North East Atlantic. The General Fisheries Commission for the Mediterranean (GFCM) of the FAO, through its Scientific Advisory Committee (SAC), provides a forum for countries to attempt to coordinate assessment and management activities, and is the principal decision-making body. The implementation of the decisions of the GFCM is aided by a series of sub-regional fisheries projects
Stock assessment is at a relative early stage of development judged by the criteria of North Atlantic fisheries, and the development of reference points is still underway.

Management does not use quota control because the high species diversity and multi-gear characteristics of most fisheries, the limited data on size composition and the amounts of discards, the small proportion of the catch that passes through organised markets, and the small scale and dispersion of fleets and ports would make such an attempt administratively cumbersome, and impractical for many species. The relatively modest control of fishing capacity applied over a long term period, is supplemented by seasonal and area restrictions to protect young fish, or by a control on gear type or engine/boat size, and by raising the mesh sizes.

2.1.1 Material and methods

North-East Atlantic and Baltic Sea

For indicators relating to spawning stock biomass (SSB) or fishing mortality (F), the appropriate source of information for the different stocks is the regular assessments by the ICES Working Groups reporting to ACFM (http://www.ices.dk/committe/acfm/comwork/report/asp/advice.asp). Quantification of these indicators was based on the most recent ACFM advice available. Stock estimates are given per ICES area (figure 2.1.1). These ICES areas were attributed to the RAC areas according to table 2.1.1. Where stocks cross boundaries of the RAC areas they will be attributed to the geographical areas based on the following interpretations:

- Stocks in ICES IIIa that are assessed along with stocks in the Baltic will be attributed to the Baltic region;
- Stocks in ICES IIIa that are assessed along with stocks in the North Sea will be attributed to the North Sea region;
- Southern Channel stocks (ICES area VIId) that are assessed along with North Sea stocks will be attributed to the North Sea region;
- Stocks in ICES-area VI of the eastern Atlantic that are assessed along with stocks in the North Sea will be attributed to the North Sea region;
- Stocks in the North/Southern waters that are assessed along with stocks at high seas will be attributed to the Long distance fleets (Blue whiting and Capelin);
- Bay of Biscay stocks that are assessed along with stocks in ICES area VII of the eastern Atlantic will be attributed to the North Western waters (e.g. Megrim);
- Stocks that are assessed throughout the Bay of Biscay, the eastern Atlantic and the North Sea will be attributed to the North Western waters (e.g. Hake).

In additions to the quantification of indicators per RAC geographic area, there is also an indicator for the pelagic stocks (see table 1.4.1), following the same procedure.

When ICES assessments provide values of fishing mortality as F, F_{HC}, F_{disc} and F_{IB}, the general F was used for analysis. Of stocks that fall within the defined areas and for which ICES provides quantitative scientific analysis, stocks were excluded (table 2.1.2) if:

- They are not assessed, and estimates of SSB are not available, even though they may be fished commercially;
- Values of SSB and F were displayed in graphs only;
- No precautionary levels of SSB of F were available.

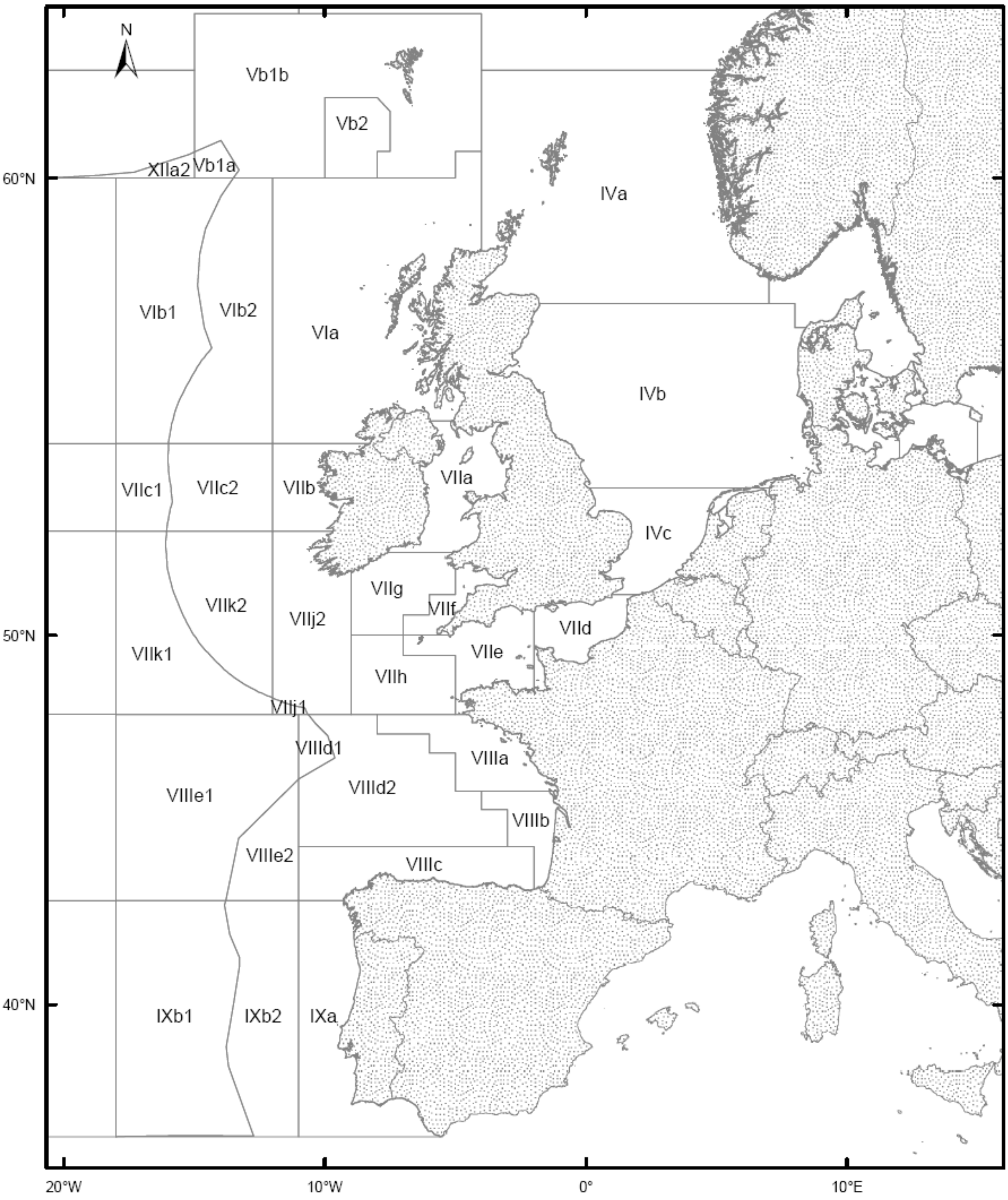

Figure 2.1.1. ICES areas

Mediterranean

Stock assessment of the Mediterranean resources is based mainly on analysis of landing trends, biomass surveys, and the analysis of commercial catch per unit effort (CPUE) data, given the absence of complete or independent information on fishing intensity or fishing mortality. Assessment models have been implemented and applied, using data from commercial fishery or from experimental surveys, the latter limited to the analytical approach, leading to diagnoses of under-, full- or over-exploitation of the resources. (GFCM-SAC, 2003).

2.1.2 Results

North-East Atlantic and Baltic Sea

The historical trajectories of the suggested indicators for the commercial species are shown per RAC area in Figure 2.1.2. The indicator for pelagic stocks is also shown in figure 2.1.2. Fisheries management seems to be most sufficient in the Baltic Sea and the South Western waters, whereas in the North Sea management performance does show shortcomings.

In the Baltic Sea indicators for F, SSB and the combined F&SSB are constantly grouped around 75%. Only in the mid nineties F was below F_{pa} for <30% of the stocks but increased to 75% again in 2000.

In the North Sea between 1990 and 2000 SSB was above SSB_{pa} for about 40% of the stocks, and F was below F_{pa} for <20% of the stocks. The percentage of stocks that meet both criteria was consistently below 10%. For the more recent years a change is observed. Since 2001 SSB was above SSB_{pa} for about 60% of the stocks, and the percentage of $F < F_{pa}$ increased up to 50%. The percentage of stocks that meet both criteria also increased during the last three years.

In the North Western Waters SSB was above B_{pa} for about 50% of the stocks, and F was below F_{pa} for <20% of the stocks. The percentage of stocks that meet both criteria was consistently below 10%, except for the last year.

In the South Western Waters the EcoQO for SSB is met between 1990 and 2000. This indicates that in those years SSB was above SSB_{pa} for 100% of the stocks. After 2000 this value dropped to 65%. The F was consistently below F_{pa} for 37.5% of the stocks with one high outlier in 1993 and one low outlier in 1996. The percentage of stocks that meet both criteria was below 40%.

From 1990 to 1992 the indicator of SSB for the long distance fleet increased from 40% to a level above 60% at which it stabilized. The indicators for F and the combined F&SSB were both above 20%.

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The performance of fisheries management of the pelagic stocks is increasing during recent year. SSB was above SSB_{pa} for about 60%, and F was below F_{pa} for 40% of the stocks. The combined indicator showed a more unstable pattern but was on average above 40%.

Table 2.1.1. Overview of stocks used in analysis

Stock	Subarea	RAC area
Anchovy	VIII	South Western Waters
Blue whiting	I-IX, XII, XIV	Long distance fleet
Cod	25-32	Baltic Sea
	IIIa (kattegat)	North Sea
	IV, VIId, IIIa	North Sea
	I, II (northeast artic)	Long distance fleet
	VIIe-k	North Western Waters
	Vb1	North Western Waters
Haddock	IV, IIIa	North Sea
	I, II	Long distance fleet
	VIa	North Western Waters
	Vb	North Western Waters
Hake	IIIa, IV, VI, VII, VIIIa-b, d	North Western Waters
	VIIIc, IXa	South Western Waters
Herring	IV, VIId, IIIa	North Sea
	Norwegian spring-spawning herring	Long distance fleet
	Subdiv 30	Baltic Sea
	Subdiv 32 (Gulf Riga)	Baltic Sea
	Va	Long distance fleet
Mackerel		
Megrim	VIIc-k, VIIIa-b, d	North Western Waters
Plaice	IIIa	North Sea
	IV	North Sea
	VIIa	North Western Waters
	VIId	North Western Waters
	VIIe	North Western Waters
Saithe	IV, IIIa, VI	North Sea
	I, II	Long distance fleet
	Va	Long distance fleet
	Vb	North Western Waters
Sardine	XIIIa, IXc	Long distance fleet
Sole	IIIa	North Sea
	IV	North Sea
	VIIIa, b	South Western Waters
	VIIa	North Western Waters
	VIId	North Western Waters
	VIIe	North Western Waters
	VIIf, g	North Western Waters
Sprat	22-32	Baltic Sea

Table 2.1.2. Overview of stocks where either F_{pa} or SSB_{pa} is missing (X shows the available data)

Stock	Subarea	RAC area	F	F_{pa}	SSB	SSB_{pa}
Cod	22-24	Baltic Sea	X		X	X
	I, II (norwegian coastal cod)	Long distance fleet	X		X	
	VIIa	North Western waters	X		X	
	Va	Long distance fleet	X		X	
Greenland halibut	I, II	Long distance fleet	X		X	
Haddock	VIIa	North Western waters	X	X	X	
	VIIb-k	North Western waters	X		X	
	Va	Long distance fleet	X	X	X	
Herring	Subdiv 22-24, IIIa	Baltic Sea	X		X	
	Subdiv 25-29, 32	Baltic Sea	X	X	X	
	VIIj	North Western waters	X		X	X
	VIa (north)	North Western waters	X		X	X
L. Boscii	VIIIc, IXa	South Western waters	X		X	
L. whiffiagonis	VIIIc, IXa	South Western waters	X		X	
Norway pout	IIIa, IV	North Sea	X		X	X
Plaice	VIIf, g	North Western waters	X		X	X
Sandeel	IV	North Sea	X		X	X
Whiting	VIIe-k	North Western waters	X		X	X

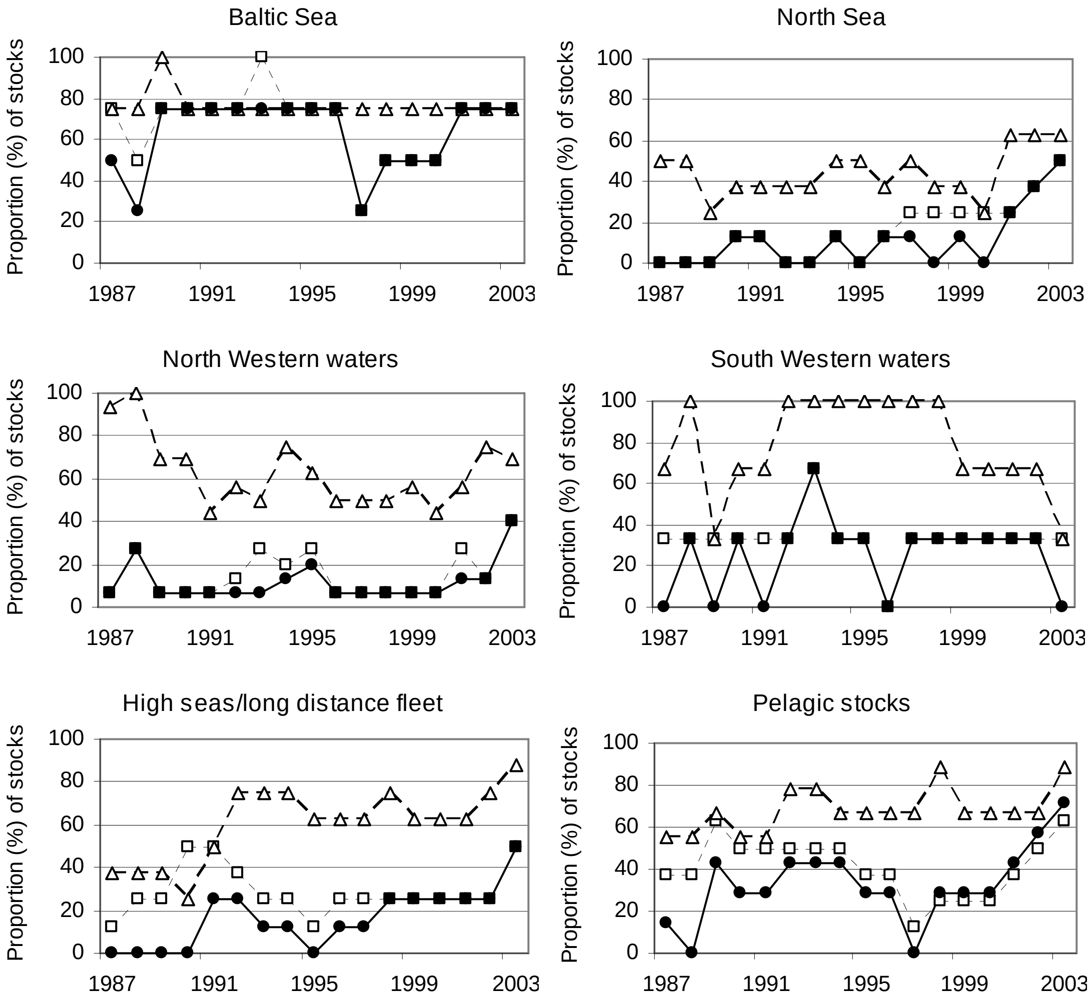


Figure 2.1.2. Proportion of stocks within safe biological limits, based on F (--□--), SSB (--∆--) and SSB&F (−●−)

Mediterranean
Stock assessment coverage and the frequency of their updating is poor.

The exploited demersal fisheries in the Mediterranean (depth range usually from 10 to 800 m, but mainly below 400 m), include shallow shelf coastal species such as grey mullets (*Mugil spp.*), sea breams (*Dentex sp.*, *Sparus sp.*, *Pagrus sp.*, *Diplodus sp.*, *Pagellus sp.*), sea bass (*Dicentrarchus labrax*), some shrimps (*Crangon crangon*), and many molluscs. Continental shelf fisheries are usually dominated by red mullets, (*Mullus barbatus*, *M. surmuletus*), sole (*Solea vulgaris*), gurnards (*Trigla sp*.), poor cod (*Trisopterus minutus capelanus*), Black Sea whiting (*Merlangius melrangus euxinus*), common spiny lobster (*Palinurus elephas*) and the triple-grooved shrimp (*Penaeus kerathurus*). On the upper continental slope (200 – 400 m) there are many species of economic interest such as hake (*Merluccius merluccius*), anglerfish (*Lophius sp.*), flatfishes (*Lepidorhombus boscii*, *Citharus linguatula*), Norway lobster (*Nephrops norvegicus*) and shrimps such as *Penaeus longirostris*. In still deeper waters, from 400 to 600 m, the dominant commercial species are the greater forkbread (*Phycis blennoides*), the blue whiting (*Micromesistius poutassou*) and red shrimps (*Aristeus antennatus* and *Aristaeomorpha foliacea*). Anchovy (*Engraulis encrasicolus*), sprat (*Sprattus sprattus*), sardine (*Sardina pilchardus*) , and horse mackerels (*Trachurus mediterraneus* and *T. trachurus*) form the important small pelagic stocks, but are taken on a smaller scale than in Atlantic fisheries. The most economically valuable pelagic fishery in the area is for bluefin tuna (*Thunnus thynnus*) which is also targeted by distant water vessels flying a number of flags, but progressively nowadays, is also fished as juveniles for cage culture. Swordfish (*Xiphias gladius*), bonito (*Sarda sarda*), and dolphin fish (*Coryphaena hippurus*) are also locally important.

Examining the GFCM-SAC assessments over the past 5 years (2000-2004) (GFCM-SAC, 2003), it is apparent that only a limited number of stocks is assessed and not even in a consistent and systematic manner. An example is given in Table 2.1.3 using two wider areas covering the EU waters of the Western Mediterranean corresponding to FAO's Balearic and Sardinia areas. In the first area only 8 species are assessed and in the latter 6. Assessment of demersal species is poor in the first area and in the second assessment of pelagics is missing. In Sardinia demersal stocks in sub-areas are characterised either as Overfished or Fully fished. Finally, only for *Mullus barbatus* there are assessments for all years in both areas.

Deriving a time-series for the status of stocks is therefore dubious. However using only the stocks for which data (even fragmentary) exist the following time-series can be created.

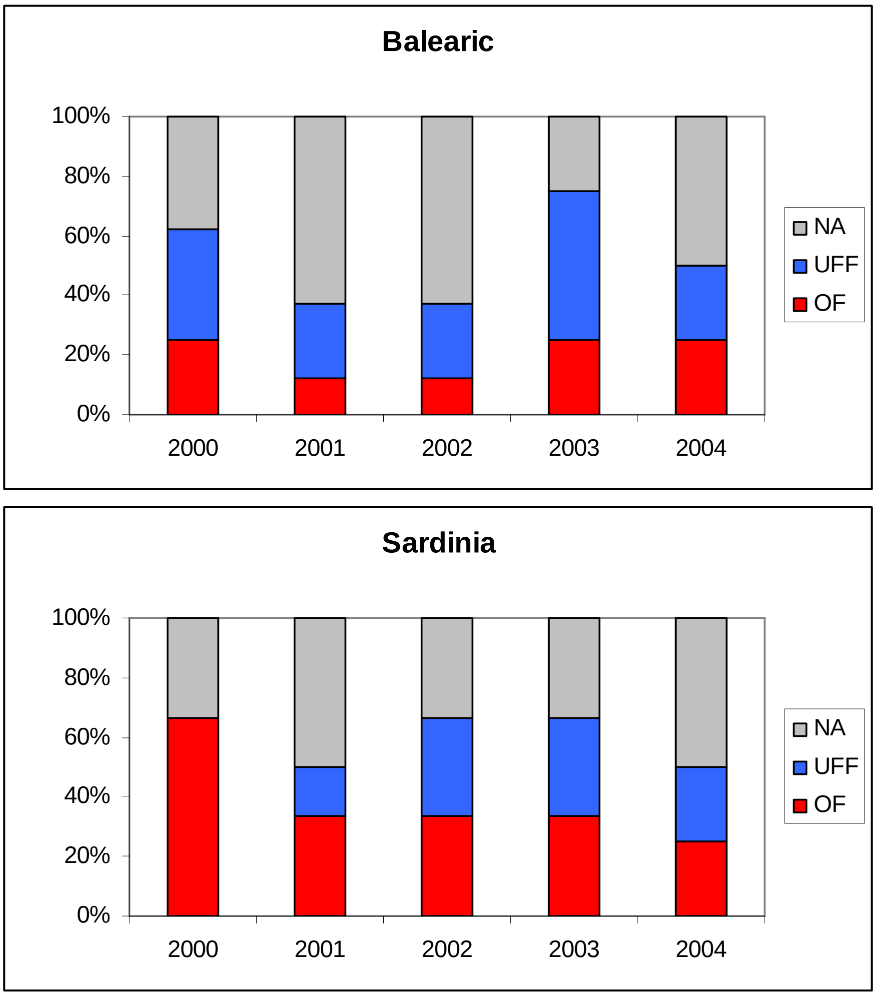


Figure 2.1.3. Time-series for two areas in the Mediterranean. OF: Overfished
UFF: Underfished or Fully fished, NA: No Assessment in particular year

Note: In Sardinia where stocks have been assessed both as OF and FF we considered them Overfished

Table 2.1.3. GFCM –SAC Stock Assessment (derived from GFCM-SAC, 2004).

Stock	***FAO Area*** GFCM Units									
	Balearic 1,5,6					*Sardinia* 8,9,10,11				
	2000	**2001**	**2002**	**2003**	**2004**	**2000**	**2001**	**2002**	**2003**	**2004**
Aristeomorpha foliacea	-	-	-	-	-	NA	NA	UF	UF	UF
Aristeus antennatus	FF	OF	OF	OF	NA	OF	NA	NA	NA	NA
Engraulis encrasicolus	FF	FF	FF	FF	NA	-	-	-	-	-
Merluccius merluccius	OF	NA	NA	NA	OF	OF-FF	OF	OF-FF	OF	NA
Micromesistius poutassou	-	-	-	-	-	OF	NA	NA	NA	NA
Mullus barbatus	OF	NA	NA	OF	OF	OF-FF	OF	OF-FF	OF-FF	FF
Mullus surmuletus	NA	NA	NA	NA	UF	-	-	-	-	-
Nephrops norvegicus	-	-	-	-	-	NA	UF	UF	UF	NA
Parapenaeus longirostris	NA	NA	NA	FF	FF	-	-	-	-	-
Sardina pilchardus	UF	UF	UF	UF	NA	-	-	-	-	-
Trachurus trachurus	NA	NA	NA	FF	NA	-	-	-	-	-

OF: Over Fished
FF: Fully Fished
UF: Under Fished
NA: No Assessment in particular year
- : No assessment for this area

GFCM Management Units 1: Northern Alboran
5: Balearic Island
6: Northern Spain
9: Ligurian and Northern Tirrenian Sea
10: South and Central Tirrenian Sea
11: Sardinia

2.1.3 Evaluation and interpretation

North-East Atlantic

Care must be taken in interpreting this indicator. In the past, some stocks dropped out of the assessment system when they fell to very low biomass (e.g. North Sea mackerel). Also, several commercial stocks were depleted to a fraction of their former abundance (e.g. spurdog *Squalus acanthias*, thornback ray *Raja clavata*), but are not assessed regularly by ICES. As the value of the indicator depends on the stocks included in estimating the percentages, rigorous criteria should be used to determine the stocks that should be included, and this list should be clearly stated when using the indicator.

When evaluating the historical performance of this indicator, the 2004 results were not included in the analysis, because the assessments had not converged enough to be confident what the true estimates of SSB and F were in that year. This argument, however, may apply to the last few years.

Because of the theoretical assumptions made (F, F_{pa}, SSb and SSB_{pa} must be defined for the analysis), stocks were excluded if just one of the precautionary values was lacking (table 2.1.2). In practice this meant that large stocks for which regular assessments are made were excluded, e.g. herring in area VIa (north) because F_{pa} is not known.

A comparable indicator “Percentage of the total catches taken from stocks considered to be outside 'safe biological limits'” is already quantified (see http://epp.eurostat.cec.eu.int) for all EU Member States and stocks for which ICES provides management advice to the Community. The data cover the fishing areas of the Northeast Atlantic which are managed autonomously or jointly by the EU. The criteria that were used to determine whether or not a stock is outside 'safe biological limits' (SSB>Bpa) were less precautionary than the criteria used for the indicator ‘Proportion of stocks within safe biological limits’ (SSB>Bpa and F<Fpa). The indicator “Percentage of the total catches taken from stocks considered to be outside 'safe biological limits'” is considered a structural indicator.

Mediterranean

Despite GFCM attempts to harmonise and push forward the assessment process, both stock assessment coverage and the frequency of their updating is poor. Stock assessment databases are fragmentary, and not very suitable as a basis for indicator series, though they may provide benchmarks for use in trend analysis or ‘extent-of-decline’ indicators. According to GFCM-SAC, (2003) assessments in the Mediterranean have been hindered primarily by the general lacking of a systematic collection of data series on the main aspects of the fishery and to some extent on the scarcity of information on species natural life history. Evaluation of stock status is seldom based on assessments that account for the specific features and complexity of the ecosystems. Regarding the commercial data, current systems provide poor coverage of vital fleet, catch and effort statistics.

2.1.4 Recommendations

North-East Atlantic

The indicator requires information on SSB, Bpa, F and Fpa. For most stocks that are assessed by ICES this information is available but for others not. If the definition of “within safe biological limits” is going to be based on these parameters then it should become mandatory that for all regularly assessed species this information becomes available as part of the assessment process.

Mediterranean

With the data that are currently available it is difficult to quantify this indicator. Therefore the recommendation is that these data become available for the Mediterranean. In an attempt to improve the management and the assessment of resources GFCM has been promoting and coordinating programs at a local/national level for the collection of fishery independent data (trawl-surveys, echo-surveys, eggs and larvae surveys) for estimating biomass and obtaining biological data.

2.2 Relative abundance of a set of populations that are not regularly assessed but which are decreasing in number

Two approaches were followed to quantify this indicator. The first approach is a fairly straightforward method where a number of vulnerable species were combined at a higher taxonomic level. For this we used the elasmobranchs as these are known to be one of the most vulnerable groups to fishing because of their life-history characteristics.
For the second approach an indicator for assessing and reporting the threat status of a suite of marine fishes is developed (Dulvy et al. 2006). The suite of species represents the section of the fish fauna likely to be most vulnerable to the effects of fishing and also to represent a key area of public concerns for the larger bodied more charismatic megafauna. Relative abundance is converted to an internationally recognised measure of threat for each species over time by applying the World Conservation Union (IUCN) A1 decline criteria to fisheries-independent survey abundance data. A composite threat index is derived from averaged weighted species threat scores in each year.

2.2.1 Material & methods

There are several bottom trawl surveys conducted in the North Sea suited to assess the relative abundance of populations that are not regularly assessed. We chose three surveys that deploy different gears: one beam trawl survey (BTS) and two otter trawl surveys International Bottom Trawl Survey (IBTS) and the English Ground Fish Survey (EGFS) to create time-series for the indicators.
The IBTS survey covers the whole North Sea, Skagerrak and Kattegat, within the 200 m isopleth. We have only used 1st quarter data from 1980 onwards, the year when the same survey gear, a GOV-trawl (Grande Ouverture Verticale), was adopted by all participating nations and excluding Skagerrak and Kattegat. For gear specifications see ICES (1999).
The BTS was initiated in 1985 to estimate the abundance of the dominant age groups of plaice and sole including pre-recruits. The survey is carried out in the south-eastern North Sea by RV Isis and in the central and eastern North Sea by RV Tridens. Both vessels use a pair of 8 m beam trawls rigged with nets of 120 mm and 80 mm stretched mesh in the body and 40 mm stretched mesh cod-ends. A total of 8 tickler chains are used, 4 mounted between the shoes and 4 from the groundrope. RV Tridnes is also equipped with a flip-up rope. The survey was designed to take between one and three hauls per ICES rectangle (boxes of 0.5^{o} latitude by 1^{o} longitude). The stations are allocated over the fishable area of the rectangle on a “pseudo-random” basis to ensure that there is a reasonable spread within each rectangle. No attempt is made to return to the same tow positions each year. Towing speed is 4 knots for a tow duration of 30 minutes and fishing occurs during daylight only.

The North Sea English groundfish survey (EGFS) fishes a survey grid of 75 stations annually. Stations were fished with a Granton demersal trawl until 1990, but from 1991 a Grand Ouverture Verticale (GOV) demersal trawl was used. Tow duration up to 1991 was 60 min, for 1992 onwards the tow duration was 30 min (B. Harley pers. comm.). The Granton trawl gear was fitted with a cod-end liner of 14 mm stretched mesh and the GOV trawl was fitted with a cod-end liner of 20 mm stretched mesh. Both gears were towed at a speed of approximately 4 knots. All fishes caught were identified and measured. Catch rates were raised to numbers or biomass caught per 60 min tow. Not all stations in the survey grid are fished every year due to poor weather, equipment damage or ship failure, and in the earlier surveys more stations were sometimes surveyed (for more details see Maxwell & Jennings, 2005).

As these species are not regularly caught we will explore different types of indicators: e.g. the relative abundance expressed as mean number per haul or the number of hauls in which elasmobranchs were present. At this moment time-series are only available for the latter. For this we calculated two indicators: all elasmobranchs or all elasmobranchs excluding *Raja radiata*. The latter indicator was developed because *R. radiata* is the most abundant elasmobranch with life-history characteristics that make it the least vulnerable to fishing and hence could disturb the sensitivity of the indicator to the effects of fishing.

Quantification of the indicator for assessing and reporting the threat status of a suite of marine fishes was based on the North Sea English groundfish survey (EGFS). The EGFS data were used as a measure of abundance of adult fishes. A survey grid of 75 stations is fished annually. Stations were fished with a Granton demersal trawl until 1990, but from 1991 a Grand Ouverture Verticale (GOV) demersal trawl was used. Tow duration up to 1991 was 60 min, for 1992 onwards the tow duration was 30 min (B. Harley pers. comm.). The Granton trawl gear was fitted with a cod-end liner of 14 mm stretched mesh and the GOV trawl was fitted with a cod-end liner of 20 mm stretched mesh. Both gears were towed at a speed of approximately 4 knots. All fishes caught were identified and measured. Catch rates were raised to numbers or biomass caught per 60 min tow. Not all stations in the survey grid are fished every year due to poor weather, equipment damage or ship failure, and in the earlier surveys more stations were sometimes surveyed (for more details see Maxwell and Jennings 2005).

Species were excluded if they were known to be poorly sampled by the gear, rare or found in peripheral North Sea habitats and had a maximum length of <40 cm (Sparholt 1990; Knijn et al. 1993; Maxwell and Jennings 2005). Specifically, species were excluded if <150 individuals had been caught in the history of the survey, or if morphology, behaviour and habitat preference was expected to lead to very low and variable catchability. Individuals <40 cm have increased in abundance in recent years, possibly as a result of the depletion of their larger predators, so we restricted this analysis to species with a maximum size greater than 40 cm total length (Daan et al. 2005). The twenty-three species retained for analysis were representative of the breadth of morphology, life histories, ecology and taxonomic diversity of the larger bottom dwelling fishes sampled on the English groundfish survey in the North Sea. The average age of maturity of all species in this suite of fishes was 4.9 years

Threat was assessed using IUCN A decline criteria which are based on the reduction in population size over the greater of 10 years or three generations where causes are reversible, understood and have ceased (IUCN 2004). The qualifying decline thresholds are *Critically Endangered* - ≥90% decline, *Endangered* - ≥70%

decline and *Vulnerable* - ≥50% decline. We measured threat retrospectively over the time series using the 'extent of decline'. Extent of decline was calculated by comparing subsequent changes in abundance to a fixed start date of 1982. A linear model was fit to the first 10 years of data, $t_1 – t_{10}$ and to each successive year, i.e. $t_1 – t_{11}$, $t_1 – t_{12}$,…, $t_1 – t_{maximum}$. The percent change in abundance was calculated from the start (t_1) and end (t_{10} to $t_{maximum}$) abundances as predicted from the least squares linear model fit (IUCN 2004). Species that had met one of the decline criteria qualifying as threatened (Critically Endangered, Endangered, Vulnerable) in any year were not delisted (categorized as not threatened) unless their abundance had increased beyond a preset threshold. As an example, we chose a preset threshold of the mean catch rate averaged over the first three years of the time series. This 'baseline' is a compromise, as the real baseline is unknown and also a three year span was chosen simply to provide a reasonable estimate of threshold abundance, as individual annual abundance estimates can be highly variable (Maxwell and Jennings 2005).

The composite threat indicator was calculated for each year as the average of weighted species threat scores. Individual species threat categorisations were weighted as *Critically Endangered* = 3, *Endangered* = 2 and *Vulnerable* =1 (following Baillie et al. 2004), and allocated to the final year of the period over which the decline was measured. A composite threat indicator was calculated as the average threat score of all species for each year. This indicator is readily interpreted, the scores can vary from 0 to 3, such that a score of 0 is equivalent to no species meeting any of the threat criteria to a score of 3 is equivalent to each species being *Critically Endangered*.

2.2.2 Results

Time-series of the two elasmobranch indicators based on BTS and IBTS showed no distinct trend in either time-series, and lots of variation (Figure 2.2.1).

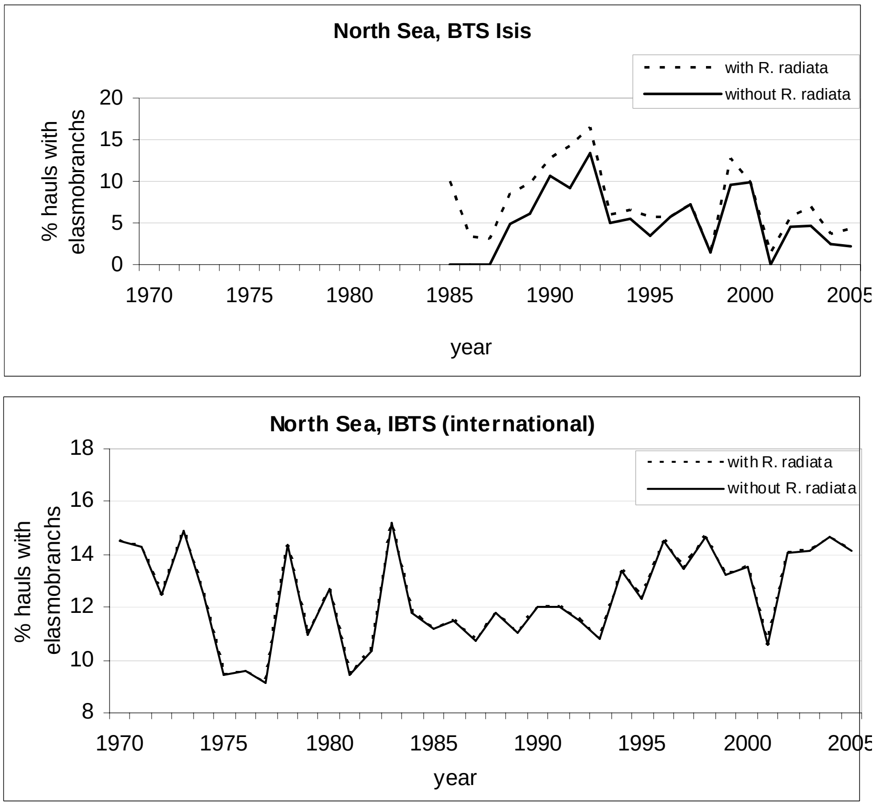


Figure 2.2.1. Time-series of the number of hauls per year with elasmobranchs in it. We distinguished between hauls with any of the elasmobranch species or excluding *R. radiata*.

The composite threat score exhibits consistent year-on-year increases in threat score until the end of the time series (Figure 2.2.2). Large-bodied species consistently met one of the threat criteria, including: wolfish, cod, rays and spurdog (Figure 2.2.3). The proportion of species declining by ≥70% and ≥50%, qualifying as *Endangered* and *Vulnerable* respectively, increased over time, (Figure 2.2.4). There is a continuing increase in the proportion of *Vulnerable* and *Endangered* species and a slight, but highly variable increase in the number of species declining by ≥90% meeting the *Critically Endangered* criterion, with around 5% of species qualifying (Figure 2.2.4).

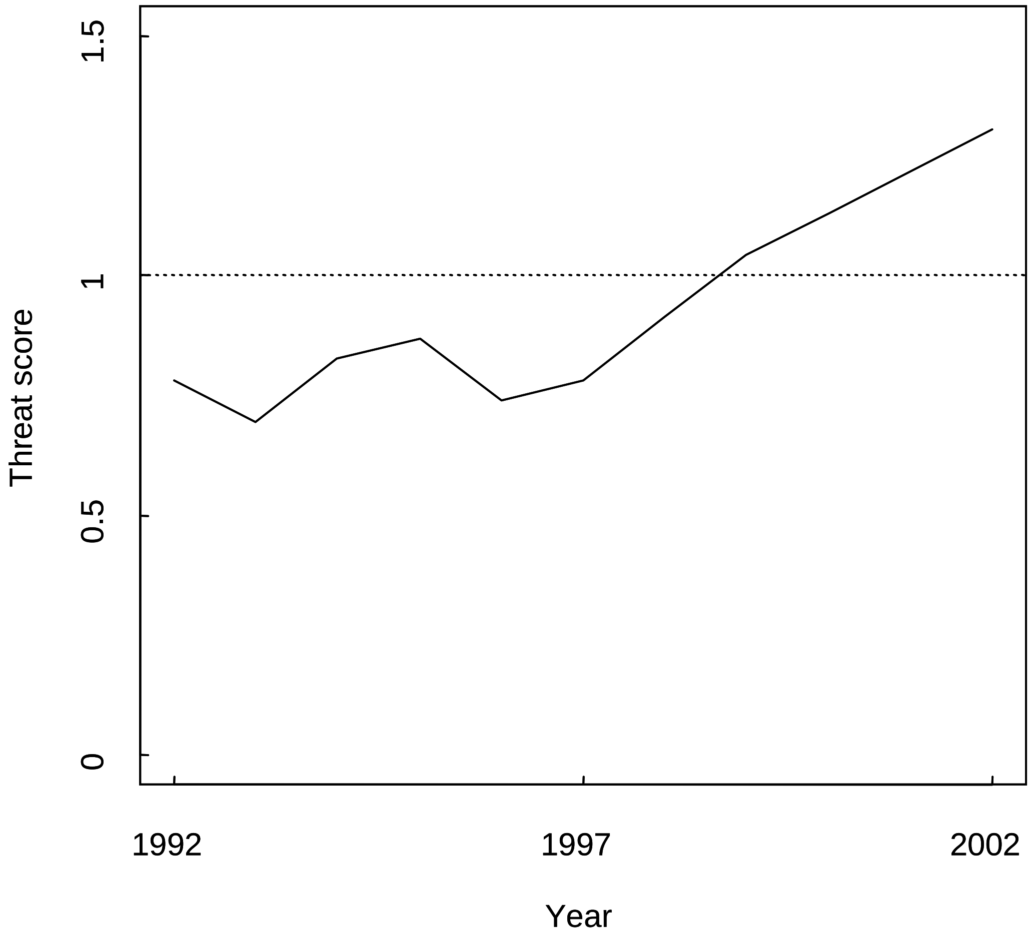


Figure 2.2.2. An indicator of threat over time for a suite of 23 North Sea demersal fishes measured as ‘extent of decline’ from the start of the time series. A score of 1 is equivalent to each species meeting the *Vulnerable* criterion and is indicated with a dotted line.

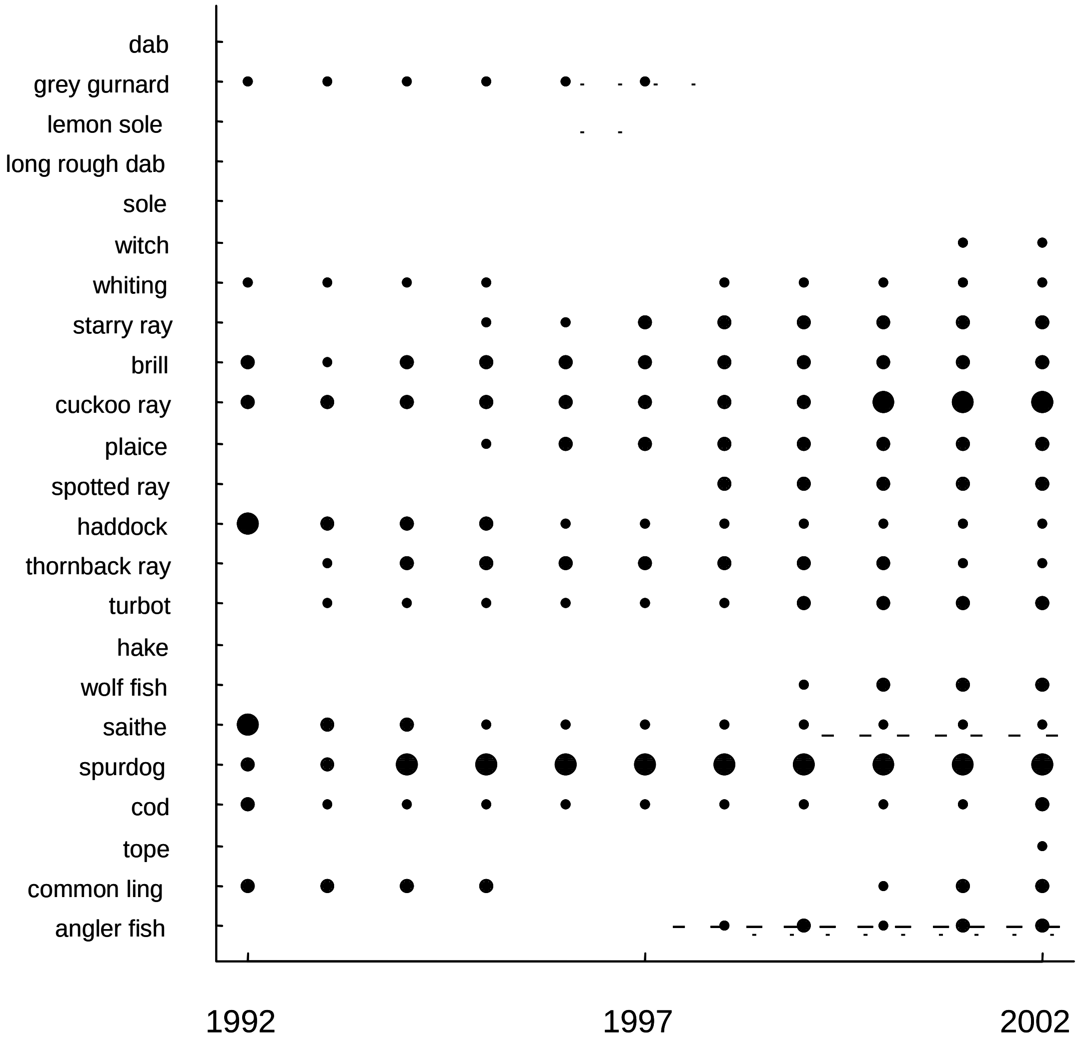


Figure 2.2.3. Species threat scores in each year measured as ‘extent of decline’ from the start of the time series. Species are plotted in descending rank order of body size, with smallest species at the top. Point size is proportional to threat scores, with the largest, intermediate and smallest symbols representing declines over time of ≥90%, ≥70% and ≥50% respectively.

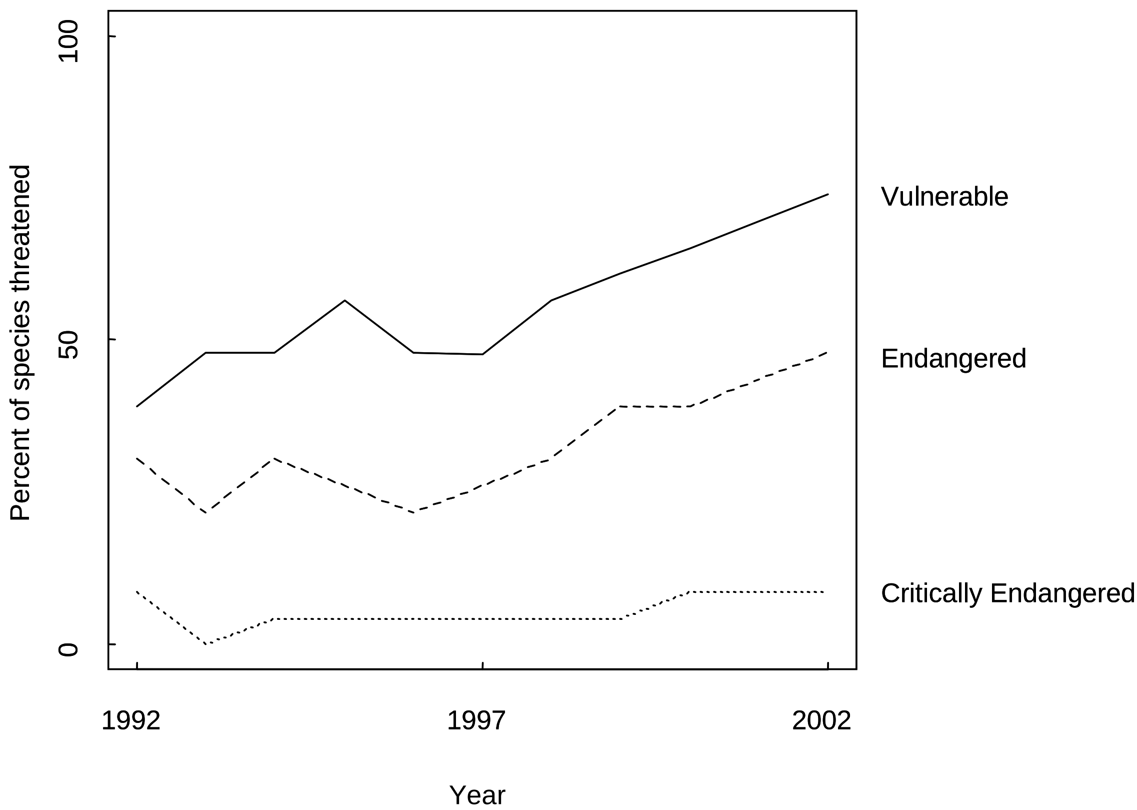


Figure 2.2.4. Proportion of North Sea fishes (n=23) meeting each of the three IUCN threatened categories, *Critically Endangered* – dotted line, *Endangered* – dashed line and *Vulnerable* – solid line, measured as 'extent of decline' from the start of the time series.

2.2.3 Evaluation and interpretation

The increase in threat as measured by the composite threat indicator over time is consistent with overall declines in the combined abundance of this suite of species and individual species abundance (Maxwell and Jennings 2005). This is also consistent with changes in size-based metrics, such as average size and mean maximum size in the North Sea fish assemblage (Nicholson and Jennings 2004; Jennings and Dulvy 2005; Piet and Jennings 2005). In the North Sea, the overall abundance of the suite of species declined by ~34%. This relatively modest decline belies a high degree of threat for individual species. Thus the composite threat indicator suggests that, on average, all species were threatened from the late 1990s onwards. This analysis suggests that using an index of relative abundance where individual abundance trends of a suite of species runs the risk of underestimating threat – the steep declines of individual species can be attenuated by relatively unimportant shallower declines rates or even increases in the abundance of other species (Dulvy et al. 2000; Daan et al. 2005).

1. Availability of historical data
This index can be applied to any large-scale survey dataset that captures as much of the entire range of the populations as possible. The method appears to be robust to major changes in survey design and survey implementation. As a result is can be applied to the long time series offered by the routine groundfish survey conducted in support of stock assessments. This method as applied to the North Sea EGFS has sufficiently long time series to enable interpretation and the theory is sufficiently well-developed to allow the setting of reference points and directions.

2. Measurement
These types of indices rely on routinely collected data (English Groundfish Survey or IBTS) that are widely accessible. It is relatively easy to measure but species selection requires some consideration. At present it is not possible to objectively assess the accuracy or precision of this indicator but its trend is at least consistent with our knowledge of changes in the North Sea fish assemblage.

3. Cost
This is a relatively cheap indicator, in the sense that it relies on routinely collected data (English Groundfish Survey or IBTS) that are widely accessible. The only real cost is the initial exploratory analysis required to select an appropriate species list and the writing of software code to calculate the indices.

2.2.4 Recommendations

The composite threat indicator has a number of advantages. First, unlike conventional diversity indices this index is calculated across a number of years, and thus is robust to changes in survey duration and changes in survey gear. Second, it is consistent with other threat-based indicators used to report on the status of mammals, birds and amphibians, which are likely to be used to report on progress toward achieving the Convention on Biological Diversity target of, "halting the rate of biodiversity loss by 2010" (Butchart et al. 2004; Butchart et al. 2005). Third, the measures of threat are entirely consistent with precautionary principle and the fisheries limit reference points used to assess the status of targeted assessed fish stocks with in the EU by the International Council for the Exploration of the Seas (ICES). Populations and species that meet these simple but widely used threat criteria are also, without exception, likely to be exploited beyond safe biological limits (Dulvy et al. 2005). Forth, as consequence of the tight link between IUCN decline criteria-based measures of threat and safe exploitation limits it is possible to set target and limit reference points and in the interim reference directions for this composite threat indicator (Dulvy et al. 2005; Jennings and Dulvy 2005). In summary a composite threat indicator is:

- consistent with other community indicators and single-species fisheries management indicators,
- robust to sampling problems
- consistent with and can support other key policy drivers and targets.

2.3 Average size (length and weight) in the community

This indicator is suggested by various fora as the most appropriate indicator to describe the size-structure of the fish community. In the past few years there have been numerous studies on size-based indicators and their use in management frameworks, many of them presented at a Symposium on Quantitative Ecosystem Indicators for Fisheries Management which was held in Paris in 2004. The proceedings are published in the ICES Journal of Marine Science Vol. 62(3). There are a number of articles exploring the utility of size-based indicators (Shin *et al*., 2005; Jennings & Dulvy, 2005; Rochet & Rice, 2005).

Shin *et al*. (2005) carried out an extensive review of the use of size-based indicators (SBI) to evaluate the ecosystem effects of fishing and concluded that: *"SBIs are sensitive to variations in fishing intensity. Reference directions of change can be established on the basis of theoretical, empirical, and modelling studies. In some cases, response time may be improved by suitable selection of the most informative size classes, and by improving survey design (increased standardization and replication within strata). Although a slow response to changes in exploitation limits their use in the context of short-term, tactical fisheries management, the failure of conventional management systems to sustain fisheries has led to a strong movement towards strategic (5–10 year) approaches to managing fisheries (Butterworth and Punt, 1999; Geromont et al., 1999; Smith et al., 1999). In this context, SBIs score high for inclusion in the suite of indicators required for an ecosystem approach to fisheries (EAF)."*

Furthermore: *"no single SBI can serve as an effective overall indicator of heavy fishing pressure. Rather, suites of SBI should be selected and reference directions may be more useful than reference points. Further modeling and worldwide comparative studies are needed to provide better understanding of SBIs and the factors affecting them. The slow response to fishing pressure reflects the complexity of community interactions and ecosystem responses, and prohibits their application in the context of short-term (annual) tactical fisheries management. However, movement towards longer-term (5–10 years) strategic management in an ecosystem approach to fisheries (EAF) should facilitate their use."* (Shin *et al*., 2005)

In their study, Jennings and Dulvy (2005) stated that *"Practical issues preclude the development and adoption of firm reference points for size-based indicators. However, an appropriate target to support ecosystem approach to fisheries management (EAFM) would be a reference direction that is consistent with a decline in the overall human impact of fishing on the community, and thereby on the ecosystem."*

Piet & Jennings (2005) showed that although the indicators for slope of biomass-size spectra, mean weight and mean maximum length showed broadly consistent responses to fishing effort, only the slope of biomass-size spectra showed a response to the spatial management measures carried out at traditional time and spatial scales.

Daan *et al.* (2005) have explored size- and L_{max}-spectra to identify the indirect effects of fishing on the North Sea fish community. They showed, based on trawl surveys, that the abundance of small fish and the abundance of fish with a low L_{max} have steadily and significantly increased during the past 30 years. They identified a time lag from the time at which fishing effort was highest in the mid-80s to the present day, which supports the earlier conclusions made on responsiveness of SBI for management.

Greenstreet and Rogers (2006) analysed Scottish groundfish data from 1925-1997 in order to identify potential reference levels for an ecosystem approach to management.

The authors consider a variety of different indicators of the fish community – size composition metrics, life history characteristic metrics, species richness and diversity metrics and trophic level metrics, as well as their interactions. For the metrics ‘percentage of large fish’, ‘average fish weight’ and ‘average L_{inf} of the community’, the authors demonstrated a definitive effect of fishing and they suggest potential reference levels, specific to the Aberdeen 48 ft trawl gear and for the NW North Sea, of 10%, 125 g and 48 cm, respectively.

Mediterranean

The Mediterranean fisheries are highly diverse in terms of species and fishing gears used. Bottom trawling fisheries are essentially multi-species, and they are carried out in a wide range of depths and affect different bottoms and communities. Bottom trawl fleets predominate in many Mediterranean fisheries, being responsible for a high share of total catches and, in many cases, yielding the highest earnings among all the fishing sub-sectors. The high profitability of this fishing practice is largely due to its low selectivity with respect to sizes and species caught, and to the high harvests generated.

Trawlers have dramatic effects on the ecosystem including physical damage to the seabed and the degradation of associated communities, the overfishing of demersal resources, and the changes in the structure and functioning of marine ecosystems derived from the depletion of populations and the huge amount of by-catches and associated discards. From a total of 300 species in the eastern Mediterranean about 60% are always discarded and mean discarded proportions reach 45% of the total catches (Machias et al., 2001). The latter underlines the necessity to gather relevant information and develop indicators contributing to track the impact of trawling on stocks, communities and finally the ecosystem. On the other hand, due to their multispecific nature and the large number of landing harbours involved, it has been traditionally difficult to gather long and reliable series of trawl fisheries data in Mediterranean countries.

For the Mediterranean two case studies are provided, one for the Aegean and the other for the Ionian Sea, on the basis of a monitoring program gathering data on a broad number of both target and non-target species on-board commercial trawlers during an eleven year period from 1995 until 2005. Observers conducting data recording on-board vessels were experienced personnel of the Institute of Marine Biological Resources of the HCMR.

2.3.1 Material & methods

North Sea

Time-series of the two indicators “mean length of the community” and “mean weight of the community” for the North Sea are based on two surveys: IBTS and BTS. These surveys are described in section 2.2.

Next, we explored how the choice of the size range affects the indicators. We calculated size-based indicators from North Sea trawl survey data, and the power to detect reference directions is used to guide choice of indicator. We emphasize the interaction between the size range used in the calculations, the retrospective trend in the metric, the interannual variance in the metric, and the power to detect trends in future years. The size range used will influence trend and variance, because survey gears do not sample all size classes with equal efficiency, and because large and small size classes respond differently to fishing. Larger size classes will be depleted by the direct effects of fishing (Daan *et al.*, 2005; Dulvy *et al.*, 2004), whereas smaller size classes may proliferate because predators have been depleted. Therefore, an indicator biased towards larger fish will reflect the direct effects of fishing more strongly than an indicator based on data for smaller fish.

To investigate how the selection of different size ranges could affect the power of a survey to detect trends in a reference direction, we used data from the North Sea International Bottom Trawl survey (Knijn *et al.*, 1993). Community metrics were calculated from species-size-abundance data (number per hour fishing) for 107 rectangles sampled in every year from 1982 to 2000. Mean values of the metrics were then calculated among rectangles within years. Further details of the IBTS data and metric calculations are provided in Jennings et al. (2002a), and Nicholson and Jennings (2004).

As well as on magnitude and pattern of trend, sampling scheme, and significance level of the test, power depends on the residual variance, Ψ^2 (Nicholson & Fryer, 1992). To identify the size range that optimised power, and hence the trade-off between trend and variance, we calculated the power to detect future trends in the community metrics, based on the difference-based variance estimation method recommended by Gasser et al. (1986), and following the approach of Fryer and Nicholson (1993). When the projected trend in slope, b, is $\neq 0$, then power depends on the number of data points in the time-series, and the signal to noise ratio b/ψ. Projected trends in slope were assumed to correspond to the recorded trends (1982–2000). Mean body mass of an individual in the catch was calculated as the weight of the catch divided by the number of individuals.

Celtic Sea

Size-abundance data by species from the annual CEFAS Celtic Sea groundfish surveys were used to calculate size-based metrics (Warnes & Jones, 1995). Only locations sampled with the standard Portuguese high-headline trawl in >90% of years for the temporal analyses were used. The resultant time-series spanned 1987–2003 for 47 stations. Winter and summer sea surface temperatures (SST; mean values January–March and June–August) for each year were obtained from http://www.cdc.noaa.gov/coads/. Spatial data in a grid of 1˚ longitude by 0.5˚ latitude were obtained from the ICES database for SST and near-bottom temperature (NBT) for winter and summer. Multi-species fishing mortality indices (F) were calculated as the biomass-weighted mean F for (i) all species assessed, and (ii) demersal species only. Spatial fisheries surveillance data were standardized for sightings effort (aircraft visits per ICES rectangle per unit time) (Jennings *et al.*, 2000).

Average weight of an individual fish in the catch was calculated as the sum of the catch weights divided by the total number of fish caught. The original data were standardized catch numbers by length category. Individual lengths were transformed to weights using species-specific length-weight regression coefficients, where possible (Bedford *et al.*, 1986; Coull *et al.*, 1989; Dorel, 1985); otherwise, a standard equation was used ($W = 0.01L^3$). All metrics were calculated for all species caught and for demersal species only, and analyses were carried out separately for each group.

Mediterranean
From 1995 to 2005, on a seasonal basis i.e. in October for autumn, in February for winter, and in May for spring, (summer trawling is prohibited in Greek waters) observers on board commercial trawlers followed fishing operations and recorded data from hauls stratified in three different depth strata in the central Aegean and in the Ionian Sea, considered to be among the most important fishing grounds for trawl fisheries in Greece.

In a representative sample from each haul, the various species were identified; the number of individuals per species and their total weight were recorded as well as the total length of each individual. From this, mean length and mean weight, of the Aegean and Ionian demersal assemblages were calculated. Mean length was calculated as

$$\overline{L_{mean}} = \sum_j (L_{mean\,j} N_j) \Big/ N$$

where L_{meanj} is the mean length of species j, N_j is the total number of individuals of species j and N is the total number of individuals of all species. Mean individual weight in the catch was calculated as the sum of the catch weights divided by the total number of fish caught.

Due to unbalances in sampling stations among seasons/depth zones in the various years of the surveys, the effects created by the aforementioned factors were tested using General Linear Model Analysis of Variance (GLM ANOVA) using SPSS version 11 for Windows statistical package. Since those effects were found to be significant ($p<0.05$) it was decided to proceed in adjustments by producing marginal means of the yearly indicators' values.

Possible trends in the indicators' time series were extracted through GLM ANOVA, using the time t (year) as the covariate and the slope of the linear model as the metric of the series' trend. In all GLM ANOVAs The *partial eta squared*, the *noncentrality parameter* and the *observed power* were also estimated. Partial eta squared is the ratio of the variation accounted for by an individual independent variable to the sum of the variation accounted for by the independent variable and the variation unaccounted for by the model as a whole. The estimated non-centrality parameter is used in determining the observed power under the alternative hypothesis for the two tailed test F test and it is the absolute value of the t statistic. The observed power gives the probability that the F test will detect the differences between groups equal to those implied by the sample difference and it was calculated at a=0.05 significance level. In the GLM ANOVA Tables presented below, the observed power concerns differences from zero (the null hypothesis of a zero parameter: intercept, slope). Alternative (other than zero) hypotheses about the slope can also be tested through power analysis (Fox 2001, Trenkel & Rochet 2003, Nicholson & Jennings 2004, Rice & Rochet 2005). In the present study various hypotheses about the slope (≤ 1%, 2%, 3%, 4% and 5% of the mean series value) were tested after transforming the original series to their relative form (dividing by their mean). Graphs of power versus sample size (in years) as well as of power versus slope at the given sampling size of the 11 years were produced for the evaluation of the indicator's performance.

2.3.2 Results

North Sea
Both the mean length (Figure 2.3.1) and mean weight (Figure 2.3.2) show a decreasing trend for each survey.

Mean individual mass decreased faster over time when smaller mass classes were included, but also inter-annual variance appeared to be larger (Figure 2.3.3a). Changing the upper size class, while holding the lower size class at 128 g, did not have such marked effects on trends in the metric (Figure 2.3.3b). The calculations show that metrics calculated from a range starting with intermediate body mass classes provide the greatest power to detect future trends (Figure 2.3.4). For mean mass, the power is maximized when x = 32 g.

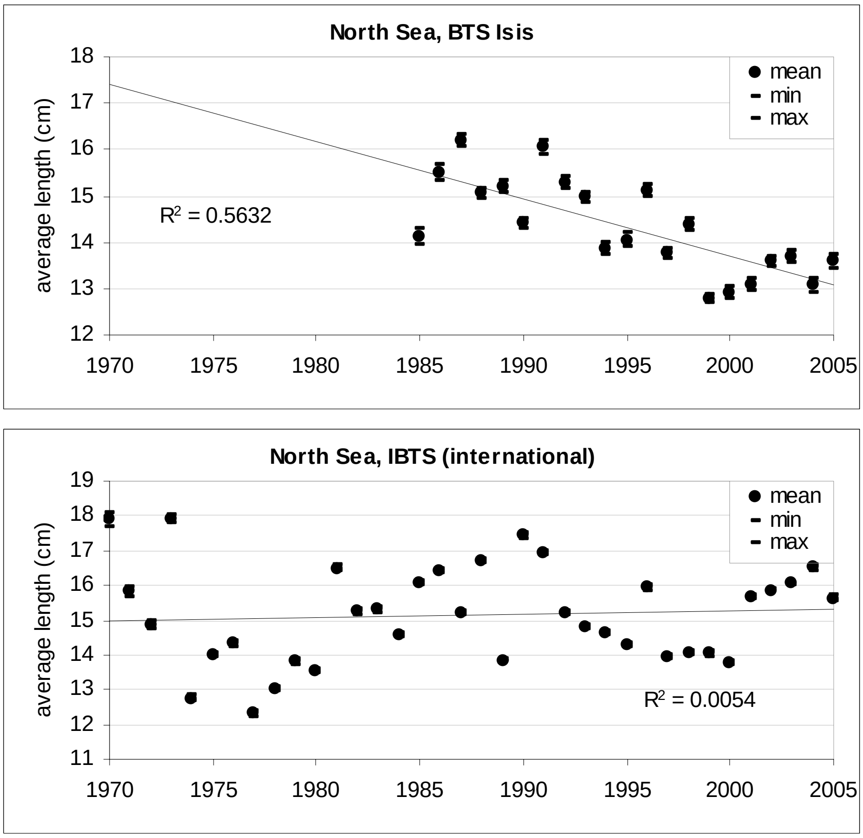
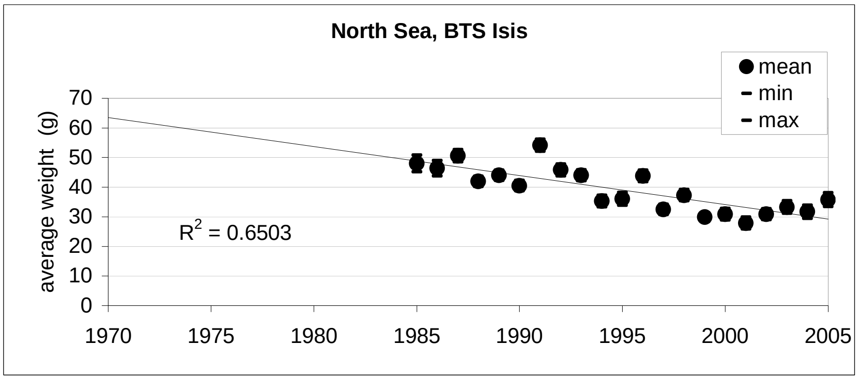


Figure 2.3.1. Mean length and standard deviation per year of the North Sea fish community based on BTS and IBTS.



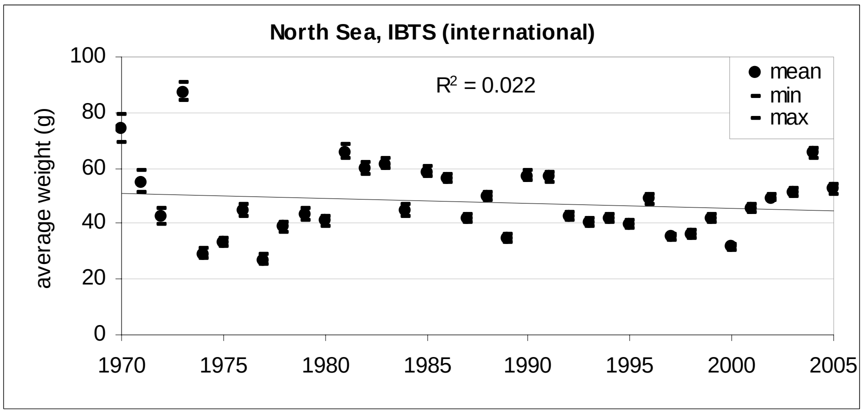


Figure 2.3.2. Mean weight and standard deviation per year of the North Sea fish community based on BTS and IBTS.

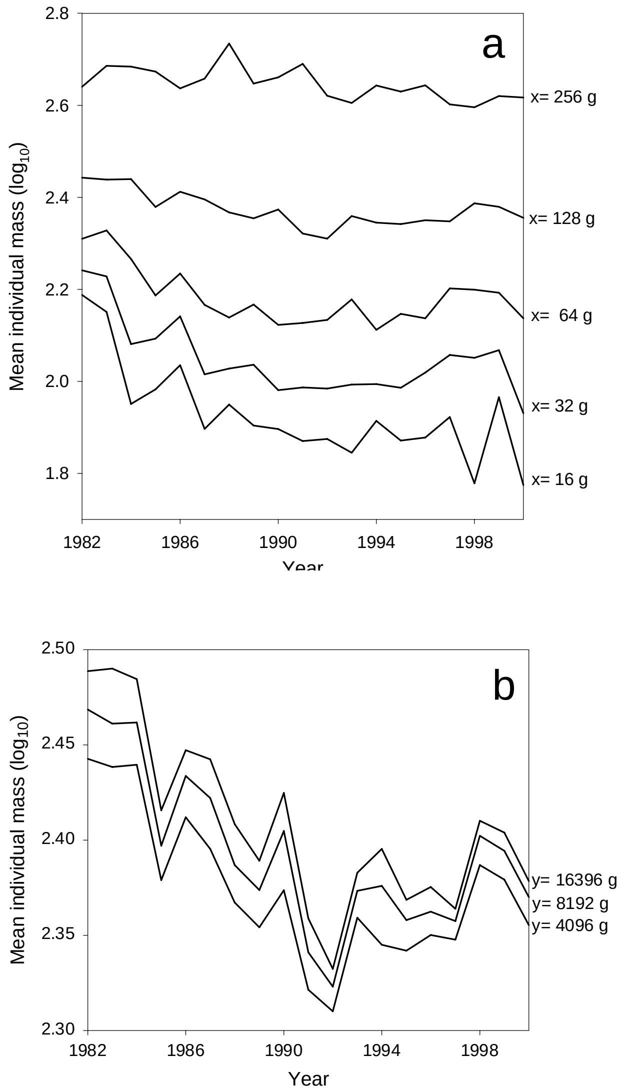


Figure 2.3.3. North Sea demersal fish (IBTS data): temporal trends in mean body mass as a function of (a), the minimum body mass class (x) included in the analysis (range x – 4096 g), and (b) the maximum body class mass (y) included in the analysis (range 128 g – y).

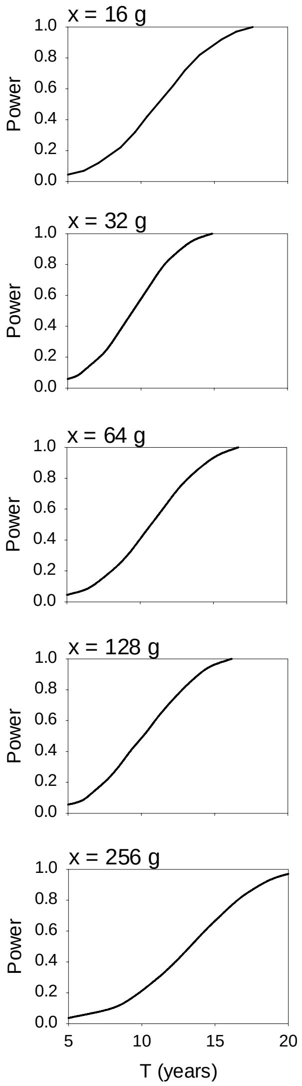


Figure 2.3.4. Power to detect future temporal trends (based on observations for the years 1982–2000) in the mean mass of the mature component of North Sea demersal fish, as a function of the number of years for which data are available, and of the minimum body mass class (x) included in the analysis (range x – 4096 g).

Celtic Sea

For the Celtic Sea trends over time in average weight (r_s = –0.57, $p<0.05$) were negative (Figure 2.3.5). However, the trend exhibited a "dip" during the years 1993–1996. Metrics based on demersal fish only exhibited similar declines in average weight (r_s = –0.54, $p<0.05$).

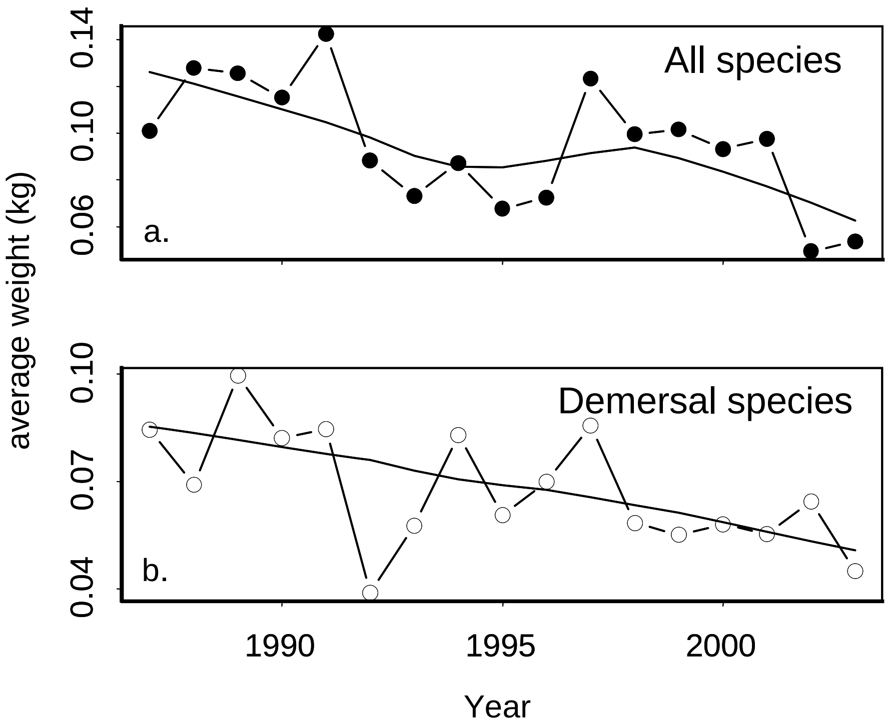
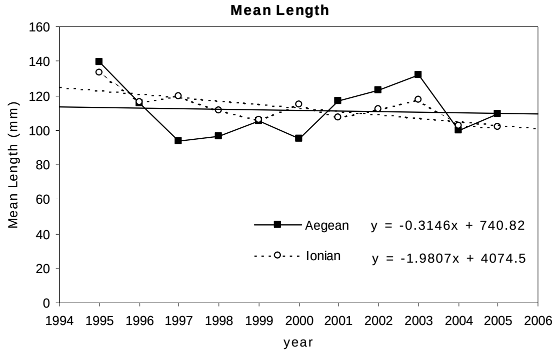


Figure 2.3.5. Time-series plots of average weight of all species combined and demersal species separately in the Celtic Sea (line fits are LOESS local smoother for visualization purposes only)

Mediterranean

Values of mean length and weight per haul were calculated and time series graphs of the two indicators are shown in Figure 2.3.6. Although both series appeared to have a negative trend, this trend was not significant (Table 2.3.1) and its power was found to be very low for the Aegean Sea, while for the Ionian the trend was significant and the power was high for mean length but not adequate (i.e.<0.8) for mean weight.



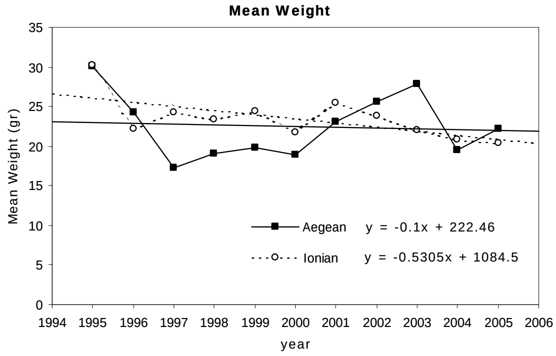


Figure 2.3.6. Time series of the size indicators (mean length and weight) in the Aegean and Ionian Sea, along with their linear trendlines against year (from 1995 to 2005).

Table 2.3.1. Parameter estimates of a general linear model of the size indicators (mean length and weight) in the Aegean and Ionian Sea, against time (from 1 to 11 years). The estimated parameter value is denoted as *B* and the *t* statistic as *t*.

INDEX	AREA	Parameter	B	Std. Error	t	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Mean Length	Aegean	Intercept	113.4910	10.425	10.887	.000	89.908	137.074	.929	10.887	1.000
		Time	-.3146	1.537	-.205	.842	-3.792	3.162	.005	.205	.054
	Ionian	Intercept	124.9461	4.244	29.443	.000	115.346	134.546	.990	29.443	1.000
		Time	-1.9807	.626	-3.166	.011	-3.396	-.565	.527	3.166	.804
Mean Weight	Aegean	Intercept	23.1096	2.779	8.315	.000	16.822	29.397	.885	8.315	1.000
		Time	-.1000	.410	-.244	.813	-1.027	.827	.007	.244	.056
	Ionian	Intercept	26.7103	1.384	19.302	.000	23.580	29.841	.976	19.302	1.000
		Time	-.5305	.204	-2.600	.029	-.992	-.069	.429	2.600	.640

a. Computed using alpha = .05

Power analysis was conducted to evaluate the utility and robustness of mean size (length and weight) of animals as indicators of exploitation status for Aegean and Ionian demersal assemblages. Results showed that in all cases larger sampling sizes were needed to detect smaller changes (Fig. 2.3.7). For example in the Aegean at a power level of 0.8 a 1% rate of change of the mean needs more than 27 years, while 11 years are enough for a 5% rate of change. The fact that the Ionian time series exhibited a higher power in relation to the Aegean resulted in less years needed to detect a trend in the respective indices. With the given sampling size, a much higher slope would be necessary for the Aegean to allow detection of trends. Comparing the performance of the two size indicators it is obvious that in both study areas mean length is more powerful than mean weight in terms of detecting a linear trend.

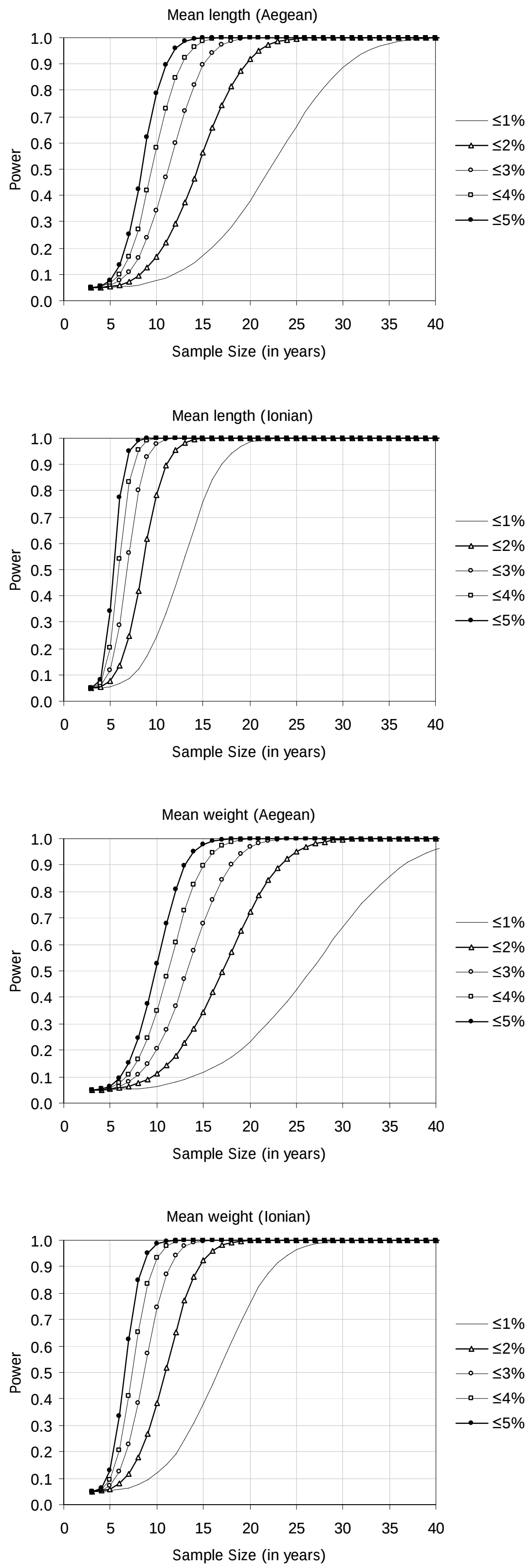


Figure 2.3.7. Power versus sample size (in years) of the size indicators (mean length and weight) time series in the Aegean and Ionian Sea. The hypotheses tested a detection of a linear trend (in terms of absolute value of slope) ≤ 1%, 2%, 3%, 4% and 5% of the mean value of the series.

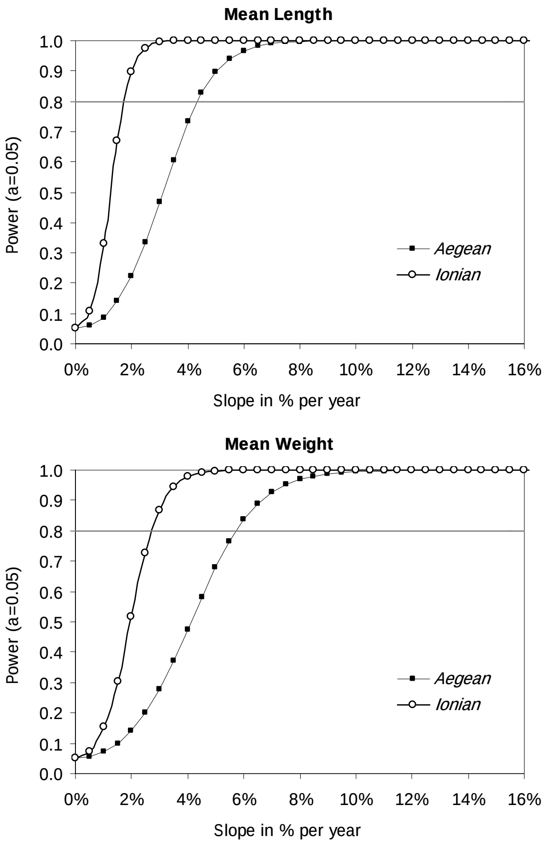


Figure 2.3.8. Power versus slope of the size indicators (mean length and weight) time series in the Aegean and Ionian Sea. The hypotheses tested a detection of a linear trend in % of the mean value of the series at the given sampling size (11 years).

2.3.3 Evaluation & Interpretation

In their recent review, Shin et al (2005) suggest that the use of size-based indicators within a management framework aimed at mitigating the effects of fishing on the broader fish community has some drawbacks. Like many others, these indicators are not specific to fishing. Rather, environmental and density dependent effects on growth and recruitment rates may also affect metrics of fish size regardless of fishing activity levels (Ricker 1995; Ottersen & Loeng 2000; Lekve et al 2002). Poor recruitment may cause the average size of fish in a community to increase as populations become progressively more dominated by older individuals (Wilderbuer et al 2002). Conversely, increased rates of recruitment may cause the mean size of fish to decline even in the absence of over-exploitation by fisheries. In situations where over-exploitation has been followed by remedial action (e.g. fishery closure), coincidental increases in recruitment rate may delay the anticipated increase in size-based metric values (Badalamenti et al 2002). These biological considerations make size-based indicators often insensitive on annual or near-annual time scales. However on time scales appropriate for applying indicators of ecosystem health (usually half-decadal or more) only persistent periods of recruitment failure, steady increases in recruitment strength, or similar persistent changes in growth rate, would render these size-based indicators uninformative about changes in fishing mortality that had been implemented during the interval. The same monitoring necessary to produce any of the size-based indicators could be expected to inform analysts about any such persistent changes in recruitment or growth rates.

Fishing induced changes in the life-history trait composition of fish communities may also need to be taken into account when considering the use of size-based metrics as indicators. Stoberup et al (2005) suggest that metrics of fish community size structure may be poor indicators of over-exploitation in fish communities characterised by fast growth rates, small body size and early age at maturation. Thus, because of the well documented changes in community life-history character composition caused by fishing (Jennings et al 1999; Piet & Jennings 2005; Greenstreet & Rogers 2006), as communities become dominated by species with small (perhaps < 30 cm) L_{max}, metrics of fish community size structure may become less effective as indicators of short-term responses to reduced fishing. Species with relatively larger L_{max} need to become re-established in the community before the size-based indicators will reflect improving ecological status for the community. However, continued over-fishing of communities dominated by species with small L_{max} will still lead to further reduction of size-based indicators.

This discussion serves to make the point that, despite their apparent advantages, metrics of size in fish communities should still be used with care. The potential for processes other than fishing mortality to influence trends in metric value needs always to be considered. Size-based indicators are likely to perform most weakly in situations where over-fishing has been chronic for some time. Under such circumstances, debate about the need for action ought not depend critically on the current values of the indicators in question. It is also likely to take longer to detect improvements in indicator values following the implementation of remedial management action (Nicholson & Jennings 2005) then if appropriate action had been taken before the community became severely altered by fishing. Under such circumstances, because of the extent of improvement required, remedial action is likely to take longer anyway.

In most studies where metrics of size in fish communities have been applied, the anticipated results have been observed (eg Zwanenburg 2000; Bianchi et al 2000; Piet & Jennings 2005; Daan et al 2005; Blanchard et al 2005). Blanchard et al (2005) consider possible confounding effects caused by environmental variation, but conclude that fishing had the stronger effect on community size structure. Greenstreet & Rogers (2006) conclude that variation in fishing effort was the principal cause of differences in the size structure of the groundfish assemblage.

The size window that provides the greatest power to detect fishing effects may be expected to change with the history of fishery development. In a new fishery, larger size classes should be depleted more rapidly at first, but progressively smaller size classes may show the greatest response to fishing as effort continues to increase, if only because of higher noise/signal ratio, as the larger fish become more rare. In the power analyses, it was assumed that the estimate of variance from retrospective analysis applies in future years, an assumption that will be violated when fishing mortality and/or the environment change. Therefore, when fishing mortality rises, the age and size structure of the population becomes more sensitive to annual recruitment events, leading to greater relative changes in abundance. Conversely, when fishing mortality falls and abundance rises, interannual variance in abundance is likely to fall, because effects of annual variations in recruitment will be buffered by the increasingly extended age structure of the population, possibly augmented with effects of density dependence. Consequently, true power will be lower than predicted when abundance is declining, and higher than predicted when abundance is increasing.

For the Celtic Sea, declines observed over time in mean weight are associated with a reduction in the abundance of large fish and an increase in small fish. F did not explain a significant amount of the variance in average weight, addition of F with winter SST (1-year lag, with interaction term) or summer SST (2-year lag) did. For the demersal component of the fish community, F had a weaker effect on the size-based metrics, possibly reflecting the lower demersal species F and the partial sampling of interacting pelagic and demersal communities. In general, the results for the whole community demonstrate that fishing has a relatively large and consistent impact on mean weight over time. Even in the Celtic Sea, where environmental forcing is unusually strong (Southward *et al.*, 1988), fishing effects on size-based metrics can be disentangled from environmental effects. Changes in F and temperature will affect the size structure of communities on a range of time scales. Changes in F reflect the direct effects of mortality, but this analysis provide evidence for longer-term indirect effects, because the biomass of fish in small size classes increased with F, consistent with studies of the response of size spectra to fishing in the North Sea (Daan *et al.*, 2005) and Fiji (Dulvy *et al.*, 2004). Changes in temperature at a given sampling location may lead to changes in the size structure because of (i) immigration and/or emigration of species with different temperature preferences, (ii) temperature effects on the life history of resident species, and (iii) indirect effects on biological processes that support the fish community. These effects on size structure may emerge on a range of time scales, and moreover, different size classes may be affected on different time scales. For example, good recruitment of an abundant species as a consequence of improved conditions for larval survival may affect the size spectrum within one year, whereas the effects of temperature on asymptotic body size may not be manifest for several years. Therefore, any attempt to link changes in size-based metrics to changes in temperature assuming an instantaneous response or a fixed lag is a crude one, but this is unavoidable given the lack of detailed information on biological responses of all species and size classes to temperature. Moreover, it is questionable whether the temporal and spatial scales over which the explanatory variables were tested best reflect the effects of fishing and temperature: spatial data on fishing intensity were incomplete, and the annual set of spatial temperature data was not entirely adequate.

The body size distribution of animals in food webs reflects patterns of energy use and acquisition, so the slopes of size spectra are remarkably constant in many ecosystems (Boudreau and Dickie, 1992). Although temperature will have a marked effect on biomass turnover and energy flux in the system, the slope is an emergent property that is largely temperature-independent (Brown *et al*., 2004). This implies that the slopes of time-averaged size metrics for the entire food web are sensitive to size-selective mortality rather than to temperature, and should be reliable indicators of fishing impacts at the scale of the food web. In practice, however, trawls sample specific assemblages within the food web and the size compositions of the samples reflect (i) gear selectivity, (ii) spatial distribution of individuals, (iii) short-term dynamics of populations, as well as (iv) part of the underlying structure of the food web. Theoretical understanding of the responses of size-based metrics to fishing is based primarily on changes in the underlying structure of the food web (iv) owing to effects of size-selective mortality, but these effects are increasingly more difficult to resolve at progressively smaller spatial and temporal scales because the environment affects factors (i)–(iii). This may explain the failure of size-based metrics to provide an effective indicator of fishing effects at small spatial and temporal scales (such as an ICES rectangle), even though they may be reliable indicators of fishing effects at larger scales.

Average size indicators appear to provide useful information about existing trends in the state of the demersal fish assemblage in the two Mediterranean study areas. The fact, however, that these results are derived from a limited time series and a rather restricted spatial coverage prevents us from drawing strong conclusions for the whole Mediterranean. It would be useful to compare these results with outcomes on the same indicators that will be provided in the near future based on the MEDITS research project (Bertrand *et al.,* 2002; Bertrand *et a.,* 2000). The latter project is based on the carrying out of yearly standardised bottom trawl surveys on the shelves and upper slopes in the Mediterranean Sea. For the time being, the project covers mainly the North Mediterranean, from Gibraltar to the Aegean Sea, with one survey (about 1100 hauls) every year since 1994. Hence although the length of the MEDITS time series is comparable to that provided in the present study, a considerably larger area is covered making it more representative to describe the status of the Mediterranean demersal fish resources.

On the other hand, the fact that fishing effort acts differentially on individual species, depending on their life history characteristics (Ault *et al*., 2005), is a reason that changes in community size structure should be considered with caution in areas of high species diversity such as the Mediterranean. In fact, Stoberrup *et al*. (2005) stated that size indicators do not seem to be suitable for studying the effects of fishing in the tropics, which are characterised by faster growth rates, small sizes, high species diversity, and complex interrelationships. Moreover, the power of surveys to detect trends consistent with reference directions depends on the range of body size classes included in the analysis. According to Jennings & Dulvy (2005) selection of different size ranges may weight metrics to respond to the release of small fish from predation, the depletion of larger individuals as a consequence of exploitation, or both; such weightings, however, may not be consistent over time and much of the interannual variance in indicators may be attributable to sampling inefficiency, and to the relatively large effects of interannual recruitment variation, if poorly sampled small size classes are included. Both mean and median body size in overfished populations are heavily influenced by recruitment variations (Mason, 1998; Rochet and Trenkel, 2003; Trenkel and Rochet, 2003).

2.3.4 Recommendations

Previous studies show that the mean weight indicator is clearly linked to fishing. As such it is a useful state indicator and a good measure of this aspect of ecosystem health. Even though the indicator may also be affected by e.g. variation in recruitment, over the time periods relevant to assess ecosystem health it is relatively robust. Even though the indicator is considered to reflect the status of the fish community it is important to realise that essentially it reflects the status of the assemblage as determined by the monitoring programme (i.e. dependent on gear, area, season) and as such should be clearly defined.

2.4 Mean trophic level

Aggregate fishing-induced changes in the size and species composition of multi-species communities have been described using relationships between abundance and body mass (size spectra) (Duplisea *et al.*, 1997; Gislason & Rice, 1998). Within size-spectra, biomass and production decrease with body mass, owing to the inefficient energy transfer from prey to predators (Kerr & Dickie, 2001; Sheldon *et al.*, 1972). This implies that larger individuals in the trophic continuum feed at higher trophic levels, a pattern demonstrated empirically for plankton, benthic invertebrate and fish communities (Fry & Quinones, 1994; Jennings *et al.*, 2001). Since fishing intensity is positively correlated with the slopes of size-spectra (Pope *et al.*, 1988; Rice & Gislason, 1996), we would expect changes in slope to reflect changes in the mean trophic level of the community.

Pauly et al. (1998), in a global analysis of landings data, assigned trophic-level estimates to species groups from Ecopath mass-balance models and demonstrated significant declines in the trophic level of landings from most oceans between 1950 and 1993. Pauly et al. (2001) subsequently applied Ecopath estimates of trophic level to demonstrate a decline in the trophic level of Canadian landings. However, the existing analyses of fishing impacts on trophic level have considered the effects of changes in species rather than size composition, and assumed that the trophic level of species or species-groups was fixed. This approach overlooks the significant impact of fishing on the size structure of populations (Beverton & Holt, 1957) and overlooks changes in trophic level with body size (Jennings *et al.*, 2002b). For example, many species will switch from being plankton feeders to being piscivores as they grow in mass by 4–5 orders of magnitude. It is also conceivable that trophic level could decrease with increasing body size. Some flatfishes, for example, shift from feeding on predatory polychaetes to deposit- or filter-feeding bivalves as they grow.

The effect of intra-specific changes in trophic level is that the real trophic response of an exploited community is likely to differ from that predicted when trophic level is not treated as a function of body size (Caddy *et al.*, 1998). The main impediment to the quantification of relationships between body size and trophic level is the absence of size-related trophic-level estimates for many species. Gut-content data have been used to estimate the trophic levels of the main North Sea fish species and, for a few species, to examine relationships between body size or age and diet (Yang, 1982). However, short-term dietary data may not provide a good assessment of the trophic level of species that switch diet frequently, prey on species that are digested at different rates, and have gut contents that cannot be identified (Polunin & Pinnegar, 2002). An alternative method for assessing trophic level is nitrogen stable-isotope analysis, because the abundance of $\delta^{15}N$ in the tissues of predators is typically 3.4 times greater than that in the tissues of their prey (Jennings *et al.*, 2002b; Owens, 1987; Post, 2002). Therefore, if the $\delta^{15}N$ of organisms at the base of the food chain is known, and these organisms can be assigned to a trophic level, the trophic level of organisms higher in the food chain can be predicted.

Long-term changes in the trophic structure of the North Sea fish community have been examined using two time series of species–size–abundance trawl-survey data: the International Bottom Trawl Survey (IBTS) and the beam trawl survey (BTS). Rather than assigning fixed trophic levels to species that can vary in size by orders of magnitude during their life history, relationships between trophic level and body size for each species were determined and applied to the species–size–abundance data to estimate the mean trophic level of the community. In order to interpret the utility of mean trophic level the relationships between mean trophic level, mean body size, mean maximum body size and the slopes and intercepts of biomass size-spectra are considered.

The Celtic Sea is an intensively fished ecosystem yet major fisheries developed only recently, when good fishery monitoring and survey systems were in place. This offers a good opportunity for interpretation of the trophic changes in community structure as a result of fishing, against a background of strong climate-driven variability (Blanchard *et al.*, 2005).

2.4.1 Materials and methods

North Sea

Time-series of the "Trophic level" indicator for the North Sea is based on two surveys: IBTS and BTS. These surveys are described in section 2.2.

The trophic levels of individuals were estimated from their length, using relationships between length and trophic level as determined by nitrogen stable isotope analysis (Jennings et al., 2002). Trophic level versus length relationships were only available for 31 species, but these accounted for more than 90% of the total weight of fish caught. The mean trophic level (*TL*) was calculated per haul as:

$$\overline{TL} = \frac{\Sigma(TL_{ij}.W_{ij})}{\Sigma W_{ij}}$$

where W_{ij} and T_{ij} are respectively the mass and trophic level of species i in length class j.

Celtic Sea

Individual species were sampled in the Celtic Sea from the research vessel *Cirolana* using the standard bottom trawl gear utilized for annual ground-fish surveys. This gear consisted of a modified Portuguese High-Headline Trawl (Warnes & Jones, 1995), and tows of 30-min duration were made at a speed of approximately 4 knots. The relative abundance of Celtic Sea demersal fishes has been monitored since 1981 (Warnes & Jones 1995). Species-abundance data were derived from spring surveys (March-April) from 1982 onwards giving a time-series of 18 years. Mean trophic level of catches was estimated as mean TL weighted by abundance of each species.

A species-specific estimate of trophic level was estimated by selecting, where possible, three fish of each species (between 60% and 80% of their maximum-recorded size) from the survey hauls and dissection out ~2 g of white muscle from the dorsal musculature of each fish for stable isotope analysis. Sixty-one standard survey stations were fished throughout the Celtic Sea during February and March 2000.

Mediterranean

Time-series of the "Trophic level" indicator for the Mediterranean is based on the same monitoring program running in the Aegean and the Ionian, which follows the operation of commercial trawlers. These surveys are described in section 2.3.

The trophic levels of individuals were estimated from their length, using relationships between length and trophic level as determined by Stergiou and Karpouzi (2002) using TrophLab (Pauly et al., 2000d) applied to data from Mediterranean fish species. Trophic level versus length relationships were available for 110 out of the 166 species appearing in our original data set.. The mean trophic level (*TL*) was calculated per haul according to the formula used for the North Sea. Existing trends of the time series as well as their power were estimated following the procedure presented in Chapter 2.3.

2.4.2 Results

North Sea

The mean $\delta^{15}N$ of the whole fish community sampled on the IBTS decreased between 1982 and 2000, but the decrease was not significant (Figure 2.4.1; Mann–Kendall nonparametric test of slope, P>0.05). The mean $\delta^{15}N$ of the demersal fish community decreased significantly in the same period (Figure 2.4.1; Mann–Kendall test P<0.05). For the combined pelagic and demersal community, the fall in $\delta^{15}N$ with time that was apparent in the demersal community (Figure 2.4.1) was masked by the effect of changes in the abundance and mean size of herring. There was a highly significant negative relationship between body mass and $\delta^{15}N$ for herring, and herring dominated the abundance of the sampled community in the late 1980s and early 1990s. At this time, the mean body mass of herring was also high. These trends in the herring stock reduced the mean $\delta^{15}N$ of the community during the middle years of the time-series, and masked the significant negative trend in $\delta^{15}N$ that was apparent in the demersal community. When the analyses of trends in $\delta^{15}N$ were repeated using fixed trophic-level estimates for species neither trend was significant.

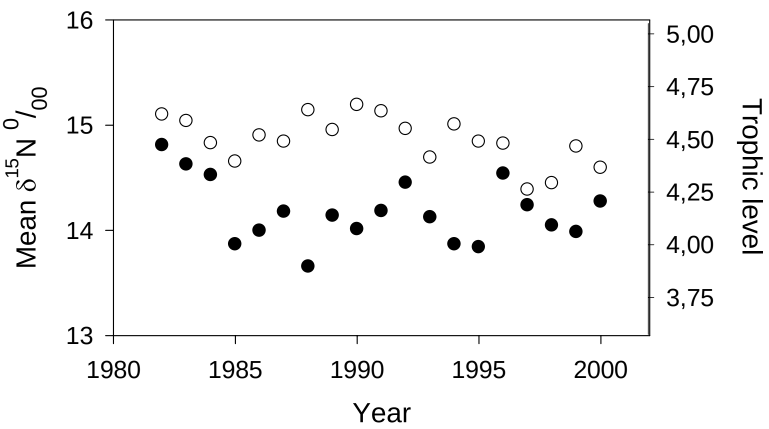


Figure 2.4.1. Long-term trends in the mean δ15N and equivalent trophic level of the North Sea fish community, as sampled by the International Bottom Trawl Survey. *Filled circles* Pelagic and demersal species; *open circles* demersal species

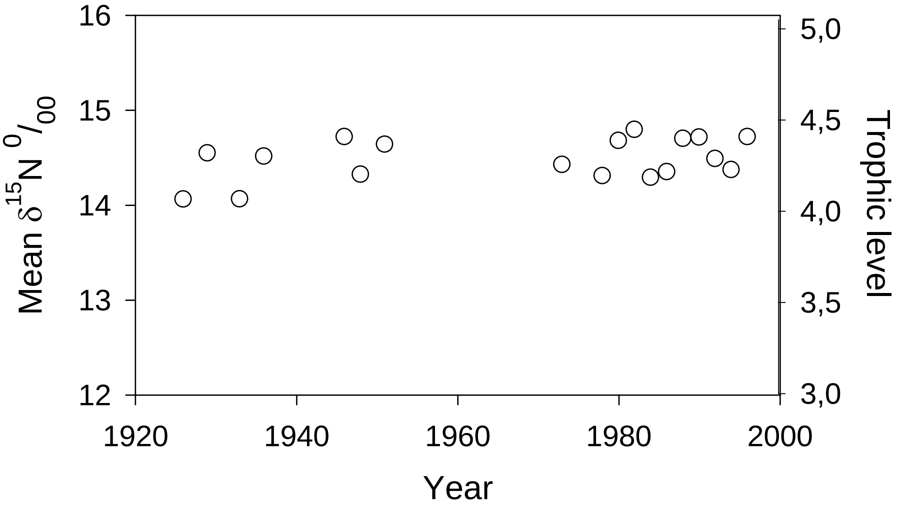


Figure 2.4.2. Long-term trends in the mean δ15N and equivalent trophic level of the North Sea demersal fish community, as sampled by the Scottish August Groundfish Survey.

Celtic Sea

Nitrogen stable isotope compositions were determined for 48 fish species, which represented 99·7% of the biomass in the year 2000 groundfish survey. There was a significant decline in the mean (weighted by species abundance) trophic level of the fish caught in trawl surveys from 1982 to 2000 (Mann–Kendall Z = -2·01, P = 0·04; Figure 2.4.3). The average rate of trophic level decline was around 0·04 year (Pinnegar *et al.*, 2002)

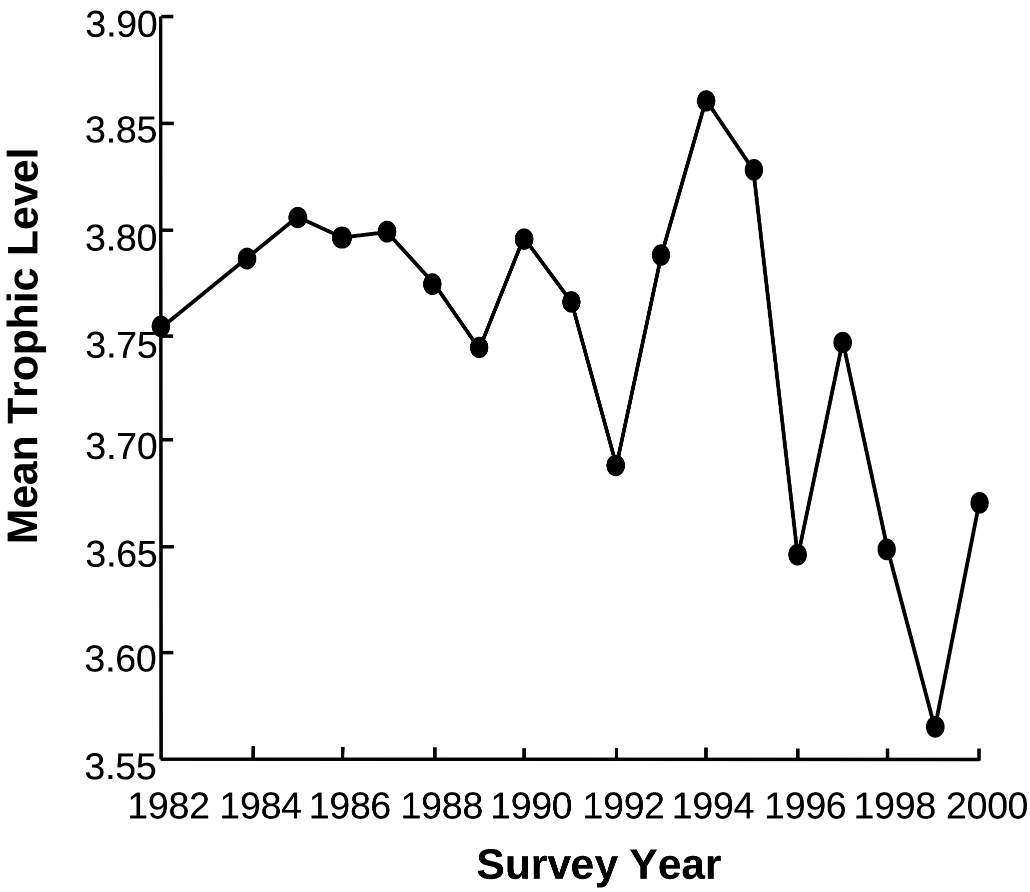


Figure 2.4.3. Patterns of changing trophic level of the fish assemblage sampled by fishery-independent survey data for the Celtic Sea

Mediterranean

Values of mean trophic levels per haul for the Mediterranean fish assemblages were calculated and the respective time series for the Aegean and the Ionian Seas are given in Figure 2.4.4. Mean trophic level indicator values ranged between 3.59 and 3.77 for the Aegean and between 3.60 and 3.81 for the Ionian. Again a negative trend appears in both time series, but this trend is not significant for the Aegean, while it is significant for the Ionian (Table 2.4.1). Power to detect trends is very low (0.05) for the Aegean time series, and higher but still inadequate (<0.8) for the Ionian.

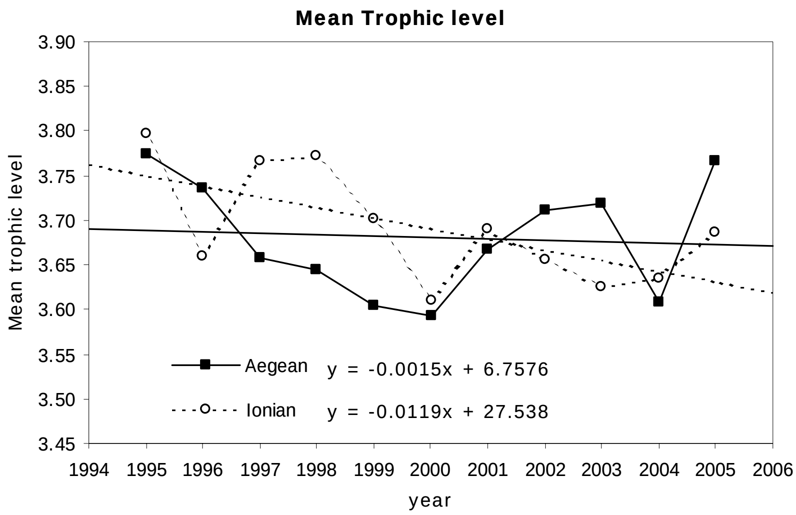


Figure 2.4.4. Time series of the mean trophic level in the Aegean and Ionian Sea, along with linear trendlines against year (from 1995 to 2005).

Table 2.4.1. Parameter estimates of a general linear model of the mean trophic level in the Aegean and Ionian Sea, against time (from 1 to 11 years).

AREA	Parameter	B	Std. Error	t	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Aegean	Intercept	3.690	.044	83.505	.000	3.590	3.790	.999	83.505	1.000
	Time	-1.539E-03	.007	-.236	.819	-1.628E-02	1.320E-02	.006	.236	.055
Ionian	Intercept	3.762	.033	113.222	.000	3.687	3.838	.999	113.222	1.000
	Time	-1.192E-02	.005	-2.434	.038	-2.301E-02	-8.402E-04	.397	2.434	.583

a. Computed using alpha = .05

Mean trophic level has a small variability in relation to the mean value between years (i.e. it ranges between 97.6 and 102.5% for the Aegean and between 97.8 and 102.9% for the Ionian) and hence a much smaller sampling size (i.e. years) is needed to powerfully detect a change (Fig. 2.4.5). In relation to the two study areas, the Ionian seems to have a slightly higher power than the Aegean (Fig. 2.4.6).

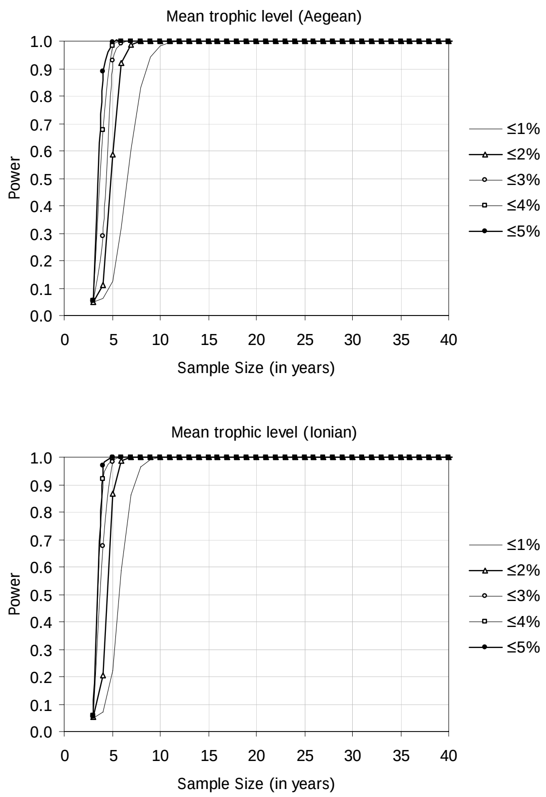


Figure 2.4.5. Power versus sample size (in years) of the mean trophic level indicator time series in the Aegean and Ionian Sea. The hypotheses tested a detection of a linear trend (in terms of absolute value of slope) ≤ 1%, 2%, 3%, 4% and 5% of the mean value of the series.

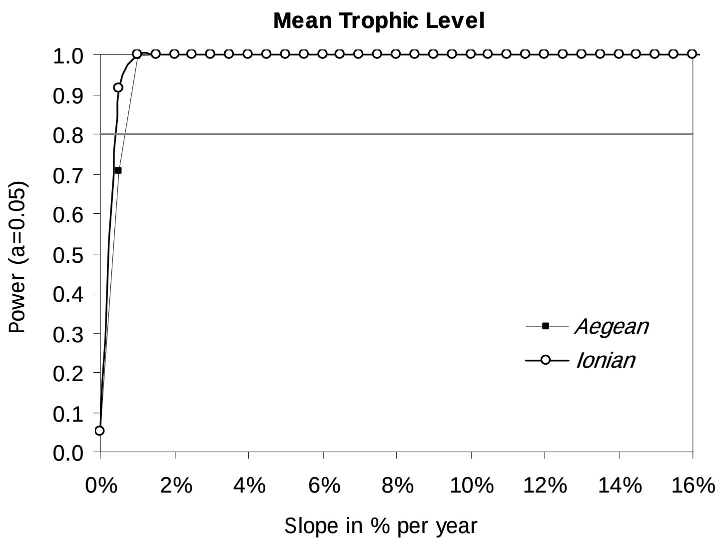


Figure 2.4.6. Power versus slope of the mean trophic level time series in the Aegean and Ionian Sea. The hypotheses tested a detection of a linear trend in % of the mean value of the series at the given sampling size (11 years).

2.4.3 Evaluation and interpretation

North Sea

The correlations between mean trophic level, the slopes and intercepts of size-spectra and mean $\log_2$ body mass and mean maximum log2 body mass (Table 5), show that the size-based metrics of community structure are not consistently informative about the trophic structure of the same community. For all species sampled by the IBTS, mean $\delta^{15}N$ was weakly correlated with the slopes and intercepts of the size-spectra, but the correlations with the other size-based metrics were weak and opposing. For the demersal community sampled on the IBTS, the correlations between metrics were usually stronger than for the whole community, with an increasing slope in the size-spectra and decreasing mean or mean maximum $\log_2$ body mass reflecting the decline in trophic level. Trends in the mean body size and abundance of the herring stock accounted for the weakness in the relationships between $\delta^{15}N$ and the mean mass, mean maximum mass and slope of the size spectra of the combined pelagic and demersal community. For the demersal community sampled by the SAGFS, the changes in weight-based metrics and size spectra were correlated, but the correlations between $\delta^{15}N$ and these metrics were weak and in opposing directions.

Celtic Sea

The decline in mean trophic level coincided with a marked decrease in the proportion of high trophic level species such as horse mackerel (trophic level = 3.94) 'cods and hakes' and 'sharks and rays' and increases in abundance of lower trophic level species: mackerel, 'seabasses, redfishes, congers' and boarfish (TL=2.94). The mean trophic level of the community was stable until 1988, but in subsequent years it became more variable largely due to variation in abundance of horse mackerel and mackerel, due to low catches in 1993-5 (Pinnegar *et al.*, 2002).

These changes were interpreted as consistent with fishery expansion and market development over the past fifty years. The changes reflect a switch away from high trophic level high price species to greater demand for low trophic level, low price species.

Mediterranean

The trends of the trophic level in the Mediterranean are comparable with those observed in other EU waters, i.e. no change or a slight decrease.

2.4.4 Recommendation

North Sea

These analyses suggest that the trophic level of the North Sea demersal fish community has decreased between 1982 and 2000. The decrease was significant only when we accounted for changes in the size structure of the community. For the demersal community, changes in the size structure of the community resulting from the differential vulnerability of species to fishing can, but do not necessarily, reflect changes in trophic level. Indeed, cross-species comparisons show that species with larger body size do not necessarily feed at higher trophic levels (Jennings et al. 2001). As a result, changes in the size structure of fish communities due to fishing may be decoupled from changes in trophic structure. In the present study, this decoupling was even more pronounced when pelagic species were included in the analysis, because the most abundant pelagic species, the herring, fed at a lower trophic level as it increased in size.

This approach could be rolled out year on year to provide annual estimates of mean trophic level of the community, however this would probably be based on the same trophic level – body size relationships. Thus new index values would vary solely as a function of species and size composition of trawl surveys. In effect the index would simply represent size or abundance indices rescaled by fixed factors (TL-body mass relationships). Unless the TL-body size relationships could be recalculated each year, which would be a costly exercise, then it is likely that size- and or abundance-based indices would be more informative.

Celtic Sea

Similar to the recommendation for the North Sea trophic level index, this approach could be rolled out year on year to provide annual estimates of mean trophic level of the community, however this would probably be based on the same trophic level – body size relationships. Thus new index values would vary solely as a function of species abundance of trawl surveys. In effect the index would simply represent size or abundance indices rescaled by fixed factors (species-TL value). Unless the TL-body size relationships could be used and be recalculated each year, which would be a costly exercise, then it is likely that size- and or abundance-based indices would be more informative. However it will be difficult to provide indicators for the Celtic Sea in the near future as this trawl survey ended in 2002.

Mediterranean

According to Gascuel *et al*. (2005), length is an essential factor determining ecosystem dynamics, whereas trophic length may appear rather as an emergent result of these dynamics, providing an a posteriori metric of the trophic processes involved. No single trophodynamic indicator, however, can track the complexity of the observed changes in fisheries and ecosystems. Although they appear useful for understanding ecosystem and fisheries dynamics, such indicators tend to be conservative, because they respond quite slowly to structural change (Cury, 2005). Trends are sensitive to calculated trophic level values, emphasising a need to improve data collection to better understand fish feeding behaviour. Long-term retrospective analyses are needed to interpret trends and values correctly, and to avoid shifting baselines. Any change in the temporal dynamics or trajectory of an indicator must be interpreted in the light of other, complementary indicators, as well as general ecological knowledge.

2.5 Mean maximum length

Mean maximum length describes an important aspect of species composition, i.e. its composition in terms of the life-history characteristics. There is extensive theoretical literature that distinguishes K-strategists from r-strategists, that is, species whose life history characteristics adapt them to living in undisturbed, stable environments vs. those adapted to living in frequently disturbed, variable environments. Particular life history characteristics can be used to place species somewhere along this continuum, and thus provide an indication of vulnerability to disturbance by additional fishing mortality. Correspondingly, the life history character composition of communities may provide a metric of the past impact of fisheries on that community. Values for one or more of the parameters are available for many species from the literature. This list, however, is far from comprehensive and for several of the parameters, values are available for only a few species. Therefore, unless we have much better tabulations of life history traits for large numbers of species, establishing the relationship with fishing impact may suffer from circularity. Community metrics based on these parameters are calculated per year by weighting the community species' biomasses with the value of that particular life history parameter. Potential metrics might be derived from sex ratio, lifetime reproductive output, or growth rates.

2.5.1 Material & methods

Mean maximum length was chosen as the indicator for the composition of the fish community in terms of life history types and was calculated per haul as: $\overline{L_{\max}} = \sum_j (L_{\max j} N_j) \Big/ N$ where $L_{\max j}$ is the maximum length obtained by species j, N_j is the number or biomass of individuals of species j and N is the total number or biomass of individuals.

Time-series for this indicator were generated from the same surveys as the indicator "average size in the community" (section 2.3). Performance was also assessed in the same manner as that indicator.

2.5.2 Results

North Sea

Time-series of Mean maximum length in the North Sea based on two surveys, BTS and IBTS are shown in figure 2.5.1.

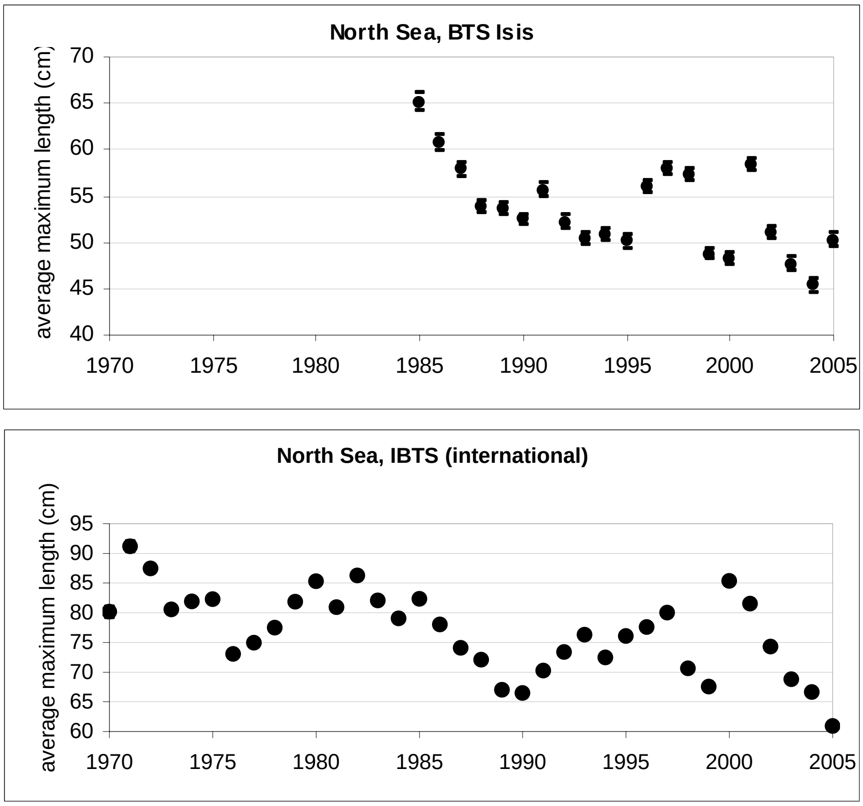


Figure 2.5.1. Mean maximum length based on BTS (top) and IBTS (bottom)

Mediterranean

Values of mean maximum length per haul for the Mediterranean fish assemblages were calculated and the respective time series are given in Figure 2.5.2. This indicator's time series in both study areas appeared to follow the exact same pattern as that of mean length. A negative trend also appears in both time series of mean max length, but this trend is not significant for the Aegean, while it is significant for the Ionian (Table 2.5.1). Power to detect trends is either very low (i.e. 0.05 for the Aegean time series), or inadequate (i.e. <0.8 for the Ionian).

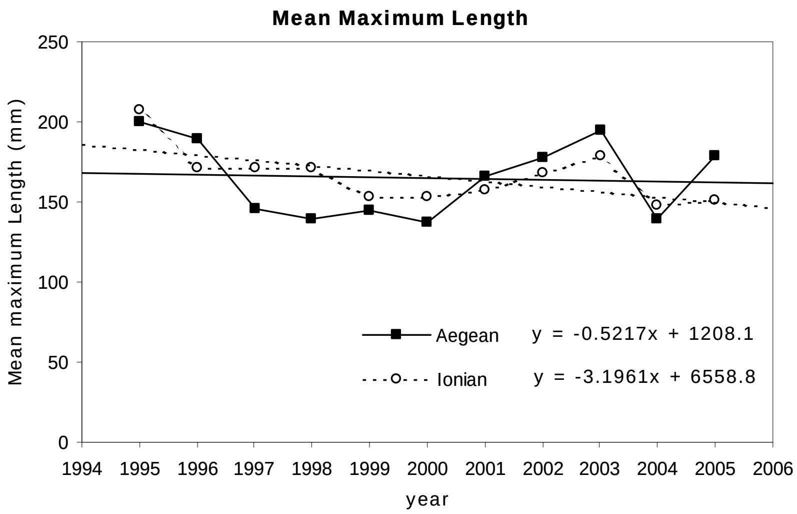


Figure 2.5.2 Time series of the mean maximum length in the Aegean and Ionian Sea, along with linear trendlines against year (from 1995 to 2005).

Table 2.5.1 Parameter estimates of a general linear model of the mean maximum length in the Aegean and Ionian Sea, against time (from 1 to 11 years).

						95% Confidence Interval				
AREA	Parameter	B	Std. Error	t	Sig.	Lower Bound	Upper Bound	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Aegean	Intercept	167.895	16.489	10.182	.000	130.594	205.196	.920	10.182	1.000
	Time	-.522	2.431	-.215	.835	-6.021	4.978	.005	.215	.054
Ionian	Intercept	185.681	8.993	20.647	.000	165.337	206.025	.979	20.647	1.000
	Time	-3.196	1.326	-2.410	.039	-6.196	-.197	.392	2.410	.575

a. Computed using alpha = .05

Results of power analysis showed that the Ionian time series exhibited a higher power in relation to the Aegean resulting in less years needed to powerfully detect a trend in this indicator in the former area (Fig. 2.5.3). With the given sampling size, a much higher slope (i.e.change) would be necessary for the Aegean to allow powerful detection of trends (Fig. 2.5.4).

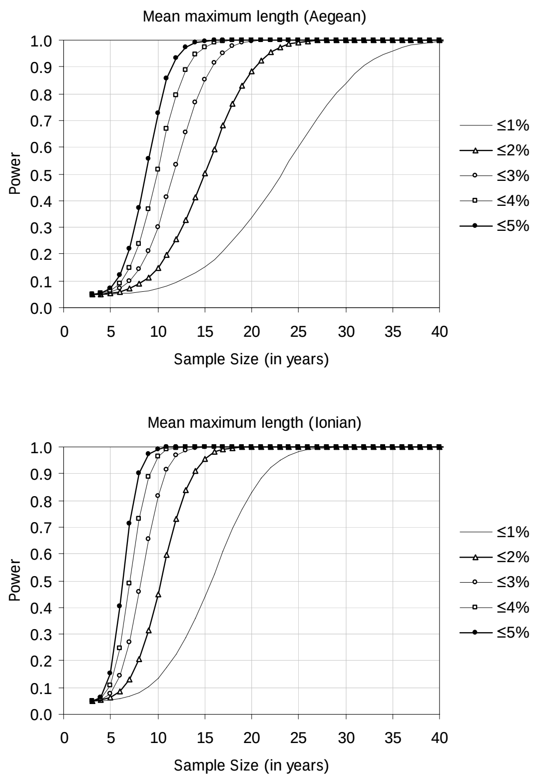


Figure 2.5.3. Power versus sample size (in years) of the mean maximum length time series in the Aegean and Ionian Sea. The hypotheses tested a detection of a linear trend (in terms of absolute value of slope) ≤ 1%, 2%, 3%, 4% and 5% of the mean value of the series.

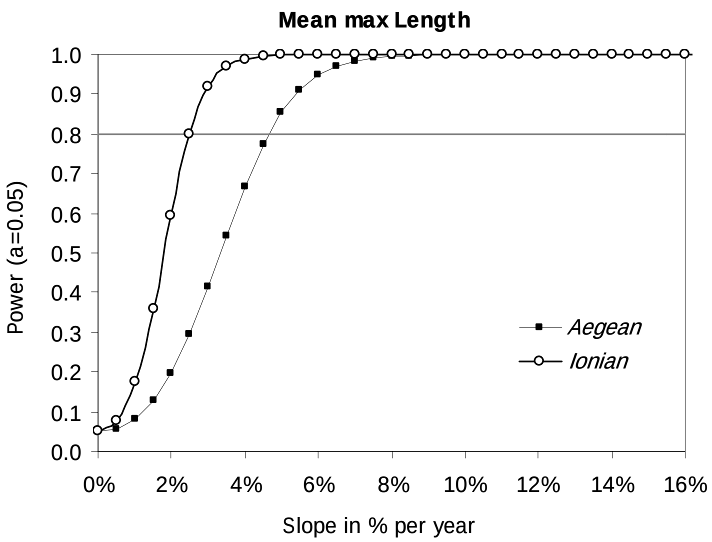


Figure 2.5.4. Power versus slope of the mean maximum length time series in the Aegean and Ionian Sea. The hypotheses tested a detection of a linear trend in % of the mean value of the series at the given sampling size (11 years).

2.5.3 Evaluation

This indicator of mean maximum length covers a feature of the fish community not covered by other indicators. Note, however, that the way it is calculated it reflects changes in the species composition towards more r-selected species, not a change within species towards earlier maturation and a smaller maximum length. This indicator of mean maximum length shows in all regions a trend consistent with the expected effects of fishing.

2.5.4 Recommendation

This is a useful indicator that can be easily calculated from existing survey data and is clearly linked to fishing. As such it is a useful state indicator and a good and relatively robust measure of this aspect of ecosystem health. Even though the indicator is considered to reflect the status of the fish community it is important to realise that essentially it reflects the status of the assemblage as determined by the monitoring programme (i.e. dependent on gear, area, season) and as such should be clearly defined.

2.6 Biodiversity

At present biodiversity can be defined as the quantity, variety and distribution of genes and genotypes, populations and species as well as communities and ecosystems (MEA, 2005). The concept of species diversity has a long history in the ecological literature; countless different metrics have been devised and utilised in numerous different studies covering taxa from just about every phylum in the plant and animal kingdoms (Brown, 1973; Connell, 1978; Davidson, 1977; Death and Winterbourn, 1995; Eadie and Keast, 1984; Heip *et al.*, 1992; Huston, 1994; MacArthur and MacArthur, 1961; Magurran, 1988; May, 1975; Rosenzweig, 1995; Washington, 1984). Despite this long tradition, and perhaps in part due to the proliferation of different metrics, species diversity as a concept has been questioned (Hurlbert, 1971). Hill (1973), however, argued that much of the perceived difficulty with the concept lay in the fact that it combined the two characteristics of richness and evenness. The theoretical underpinning of the concept has been discussed (May, 1975; 1976). The ability of the different indices to actually detect environmental and anthropogenic influences has on occasion been questioned (e.g., Robinson and Sandgren, 1984; Chadwick and Canton, 1984), however, in general these problems have usually been associated with inadequate sample size (Soetaert and Heip, 1990). It might be reasonable to assume that measures of diversity – the distribution of species abundance and richness – would capture a major dimension of biodiversity, but it should be recognised that additional measures are required to capture the wider definition of biodiversity (MEA, 2005). As a first step we focussed on species diversity for which several metrics will be considered as candidate indicators.

In addition to protecting species diversity there is a need to maintain or restore the abundance variety and distribution of genes and alleles. Genetic diversity is reflected in the differences among individuals for many characters, from DNA sequences and proteins to behavioural and morphological traits. This diversity allows populations to evolve by changing relative frequencies of different alleles to cope with environmental changes such as new diseases, pests, parasites, competitors, predators and anthropogenic drivers. Species lacking genetic diversity usually have difficulty adapting to environmental or other changes and face an increased risk of extinction because any change that harms one individual is likely to harm other individuals of the same genetic make-up to the same extent (Reed et al. 2003). There are at least two reasons for preserving genetic diversity: (1) to facilitate current and future 'bioprospecting' for pharmaceutical products and (2) to ensure resilience and capacity to respond in face of large-scale threats such as climate change.

Genetic change in the marine environment was inferred from two sources of evidence:

1. changing growth and maturation schedules of fish stocks
2. changes in population substructure and genetic diversity

Changes in growth and maturation schedules have been inferred in salmon, Atlantic cod and plaice (Ricker 1981; Law and Grey 1989; Rijnsdorp et al. 2005). It is argued that these changes are consistent with the elevated mortality imposed by fisheries exploitation on larger size and older age classes. High adult mortality, due to predation or fishing, tends to select for faster growth and earlier maturation to maximise the probability of breeding and reproductive lifespan. Experimental evidence from guppies and Atlantic silverside have corroborated the theoretical and field results (Conover and Munch 2002; Reznick and Ghalambor 2005). While the most parsimonious explanation for such changes is that they are evidence for long-term genetic change, fish have high phenotypic plasticity and thus it is difficult to determine the degree to which the observed change can be attributed to (1) genetic change and (2) fisheries exploitation. While an indicator of the maturation schedules of target species may be a useful indication of pheno- or genotypic changes (potentially due to fishing), it is unlikely that such an indicator would directly represent changing genetic diversity.

Modern genetic tools have sufficient resolution to discern significant population differentiation and sub-structuring in marine populations (Ruzzante et al. 2000). While hard to gather, there is increasing evidence that fishing has driven morphologically and genetically distinct subpopulations, particularly of herring and cod, to extinction (Jakobsson 1980; Smedbol and Stephenson 2001). Historic studies of the genetic diversity of archived otoliths has shown significant reduction in the genetic diversity of cod and plaice in the North Sea (Hutchinson et al. 2003; Hoarau et al. 2005). In the case of cod, one of the four North Sea subpopulations was inferred to have been driven to extinction by exploitation in the early 1970s (Hutchinson et al. 2003)

One approach to measuring genetic diversity would be to routinely survey the genetic diversity (Allelle frequencies) of target fish populations or fish catches, particularly those for which historic genetic structure can be inferred, e.g. cod and plaice. This approach is likely to have fairly high precision and accuracy and is technically and logistically feasible. However this may prove to be expensive to implement on an annual basis. One approach could be to undertake comprehensive sampling over a longer time interval, e.g. 3-5 years. At present there are no data available for generating an indicator of the status and change of genetic biodiversity. Therefore this will not be further addressed in this chapter.

2.6.1 Material & methods

Hill (1973) suggested that several of the most commonly used diversity indices were mathematically related, forming a family of indices varying in their sensitivity to species richness and species evenness (Peet, 1974; Southwood, 1978). N_0 is species richness, a simple count of the number of species in the sample, N_1 is the exponential of the Shannon-Weaver diversity index (Shannon and Weaver, 1949, sometimes referred to as the Shannon-Wiener index), H, computed as $H = -\sum p_i . \ln(p_i)$, effectively the number of abundant species, and N_2 is the reciprocal of Simpson's diversity index, d, computed as $d = \sum p_i^{\ 2}$, effectively the number of very abundant species. These indices are all affected by sample size, which is a major disadvantage with regard to monitoring change in marine ecosystems where sampling is logistically difficult and expensive. As the Hill number notation increases, the index moves from being a measure of species richness to one of species dominance. Low N number metrics, e.g., N0 and N1, are consequently the most affected by variation in sample size. When the problem of variable sample size can be addressed, these metrics have been used to demonstrate long-term temporal and spatial trends in species diversity that have been associated with differences in fishing activity (Greenstreet and Hall, 1996; Greenstreet *et al.*, 1999).
For the North Sea the same surveys as described in section 2.3 were used to quantify this indicator.

2.6.2 Results

North Sea

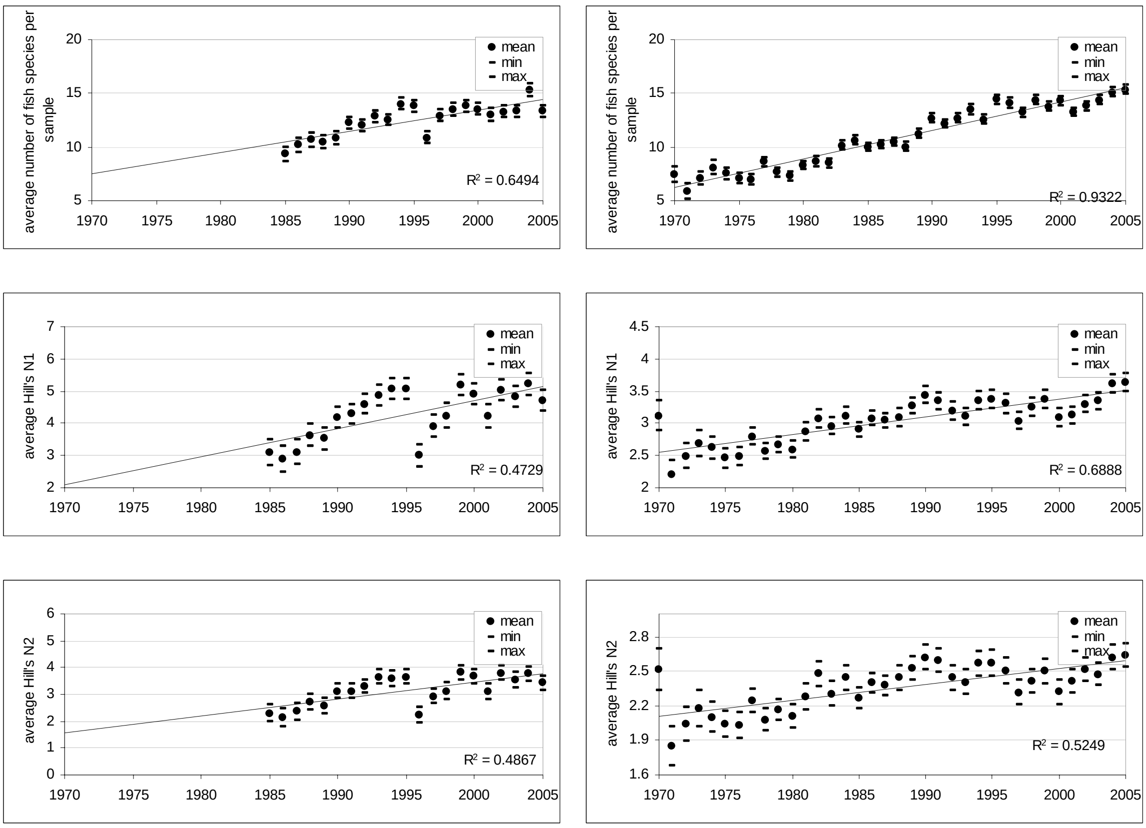


Figure 2.6.1 Biodiversity indices Hill's N0 (top), Hill's N1 (middle) and Hill's N2 (bottom) based on BTS (left) and IBTS (right).

Mediterranean

Values of Hill’s N1 and N2 per haul for the Mediterranean fish assemblages were calculated and the respective time series are given in Figure 2.6.2. Although these two indicators appear to have a similar pattern within each area, they appear to differ between areas where in the Ionian Sea biodiversity appears to increase albeit not significantly while no trend is observed in the Aegean (Table 2.6.1).

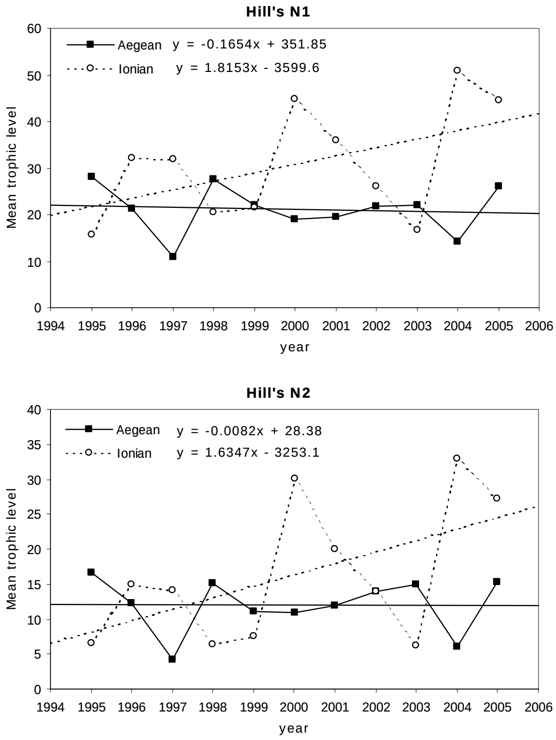


Figure 2.6.2 Time series of the biodiversity indices (Hill’s N1 and N2) in the Aegean and Ionian Sea, along with linear trendlines against year (from 1995 to 2005).

Table 2.6.1 Parameter estimates of a general linear model of the biodiversity indices (Hill’s N1 and N2) in the Aegean and Ionian Sea, against time (from 1 to 11 years).

							95% Confidence Interval				
INDEX	AREA	Parameter	B	Std. Error	t	Sig.	Lower Bound	Upper Bound	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Hill's N1	Aegean	Intercept	22.134	3.559	6.219	.000	14.082	30.185	.811	6.219	1.000
		Time	-.165	.525	-.315	.760	-1.352	1.022	.011	.315	.059
	Ionian	Intercept	20.048	7.139	2.808	.020	3.899	36.197	.467	2.808	.706
		Time	1.815	1.053	1.725	.119	-.566	4.196	.248	1.725	.338
Hill's N2	Aegean	Intercept	12.102	2.669	4.535	.001	6.066	18.139	.696	4.535	.980
		Time	-8.163E-03	.393	-.021	.984	-.898	.882	.000	.021	.050
	Ionian	Intercept	6.544	5.677	1.153	.279	-6.299	19.387	.129	1.153	.178
		Time	1.635	.837	1.953	.083	-.259	3.528	.298	1.953	.415

a. Computed using alpha = .05

Much greater sampling sizes are needed to powerfully detect even relatively great changes in both study areas (Fig. 2.6.3). For these two indicators the Aegean time series appear to have a slightly higher power than the Ionian (Fig. 2.6.4).

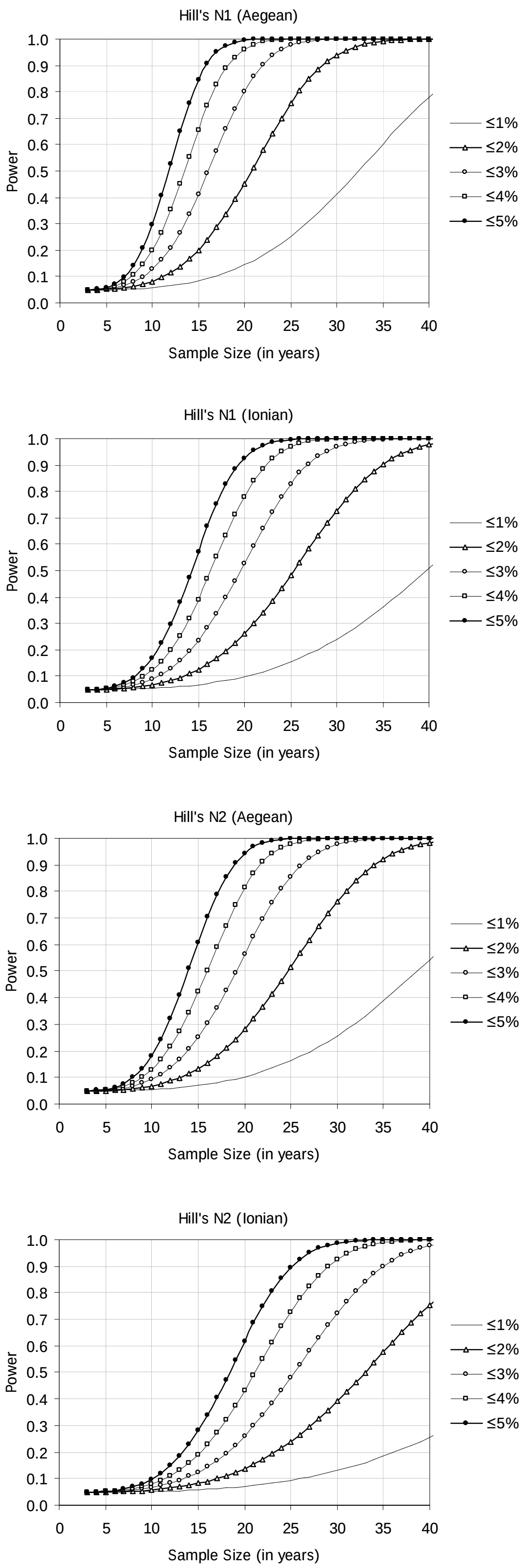


Figure 2.6.3. Power versus sample size (in years) of the diversity indices (Hill's N1 and N2) time series in the Aegean and Ionian Sea. The hypotheses tested a detection of a linear trend (in terms of absolute value of slope) ≤ 1%, 2%, 3%, 4% and 5% of the mean value of the series.

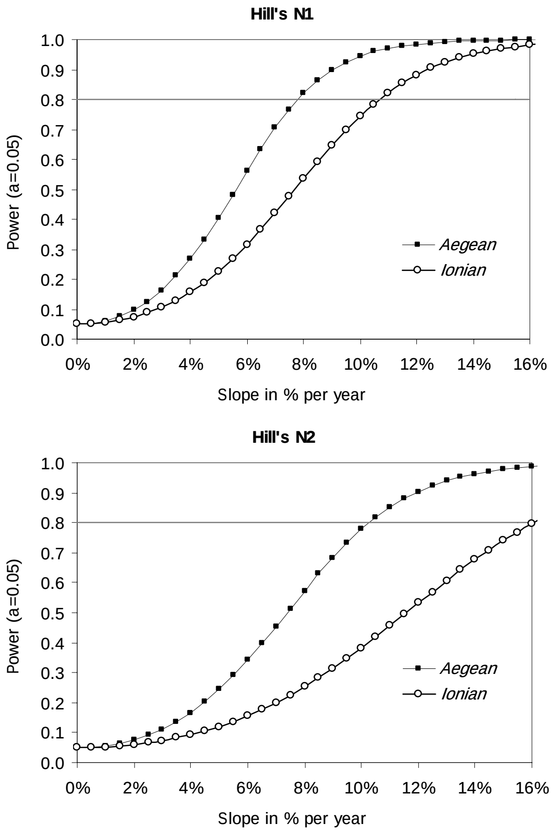


Figure 2.6.4. Power versus slope of the diversity indices (Hill's N1 and N2) time series in the Aegean and Ionian Sea. The hypotheses tested a detection of a linear trend in % of the mean value of the series at the given sampling size (11 years).

2.6.3 Evaluation and Interpretation

All indices show the same trend for different surveys and in different areas, i.e. an increase in biodiversity. The problem with some of these measures of biodiversity (N1 and N2) is that they are determined by both the number of species, which can be expected to decrease as a result of fisheries and evenness which usually increases. The overall result may therefore be an increase or decrease in biodiversity as expressed in these measures. Hill's N0 is very sensitive to sampling effort.
Thus, there the main problems with the use of diversity indices as indicators are that:

1. the indices are sensitive to sampling effort
2. difficult to link to a manageable activity

2.6.4 Recommendation

Even though biodiversity does provide some insight in changes in the community and as such may be a useful indicator of state, interpretation of the observed trend is difficult.
One option would be to use the composite threat indicator to report on an aspect of biodiversity of public concern. The threat index is not representative of the wide definition of biodiversity outlined above, but captures a key aspect of biodiversity– the status of marine megafauna. This is broadly the sense in which the Red List Indices for birds are used to report on the state of the world's biodiversity.

2.7 Trends in abundance of sensitive benthos species

There have been extensive critiques of proposals for the development of indicators for the benthic systems ((ICES, 2000, 2001b, 2002, 2003b). In answer to these critiques ACE established the Study Group on Ecological Quality Objectives for Sensitive and for Opportunistic Benthos Species (SGSOBS) in 2003.

SGSOBS used the following definitions:

- *Sensitive species* – A species easily depleted by human activity and, when affected, is expected to recover over a long period or not at all. As such, the term “sensitivity” takes into account both the tolerance to and the time needed for recovery (largely species dependent) from the stressor.
- *Fragile species* are considered to be especially susceptible to physical/mechanical disturbance.
- *Opportunistic species* Species (second and first-order, based on Borja *et al.*, 2000, ecological groups IV and V) that follow the reproductive (*r*) strategy (*sensu* Pianka, 1970), with short lifecycle (<1 year), small size, rapid growth, early sexual maturity, planktonic larvae through the year, and direct development.

These species proliferate after intense disturbance or pollution episodes. Surface or subsurface deposit-feeders dominate. In 2003 the ICES Working Group on Ecosystem effects of fishing (WGECO, ICES, 2003), based on the data for the North Sea soft sedimentary environments provided by the North Sea Benthos Survey database, recorded a total of 180 taxa as meeting the criteria for sensitive species, this includes biogenic structure-forming species as well as those with fragile morphological features, and 69 taxa as meeting the criteria for opportunists, this includes the opportunistic scavengers. WGECO considered this to be an initial and incomplete list. SGSOBS identified 242 sensitive species in genera beginning with the letter “A” alone and 54 taxa as 1st order opportunistic species and 119 as 2nd order opportunistic species (i.e., 173 opportunistic taxa). As previously stated by WGECO and SGSOBS, there remains a massive literature and incomplete knowledge of many species such that these estimates still remain conservative. However, they further serve to illustrate the problems of attempting to manage benthic systems using an indicator based on the density of individual sensitive and/or opportunistic taxa.

2.7.1 Material & methods

In the North Sea there are a few beam trawl surveys that sample part of the benthic invertebrate community (macro-epibenthos) on a regular basis. For one of these surveys BTS conducted by two Research Vessels: RV Tridens and RV Isis, timeseries of a few selected species are shown.

2.7.2 Results

Figure 2.7.1 shows the time series of six epi-benthic species in the North Sea based on two RV beam trawl surveys.

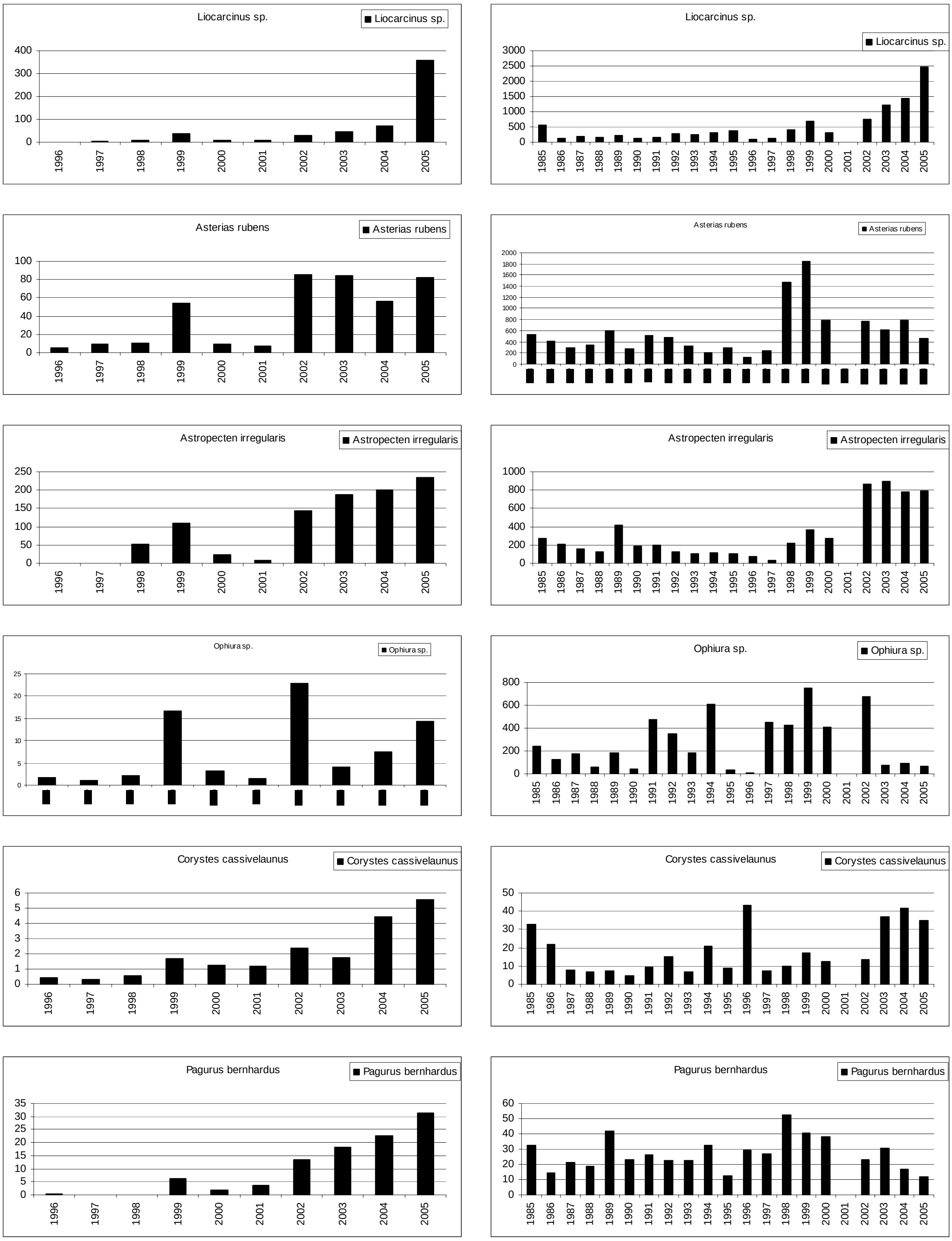


Figure 2.7.1. Timeseries of 6 epibenthic species based on beam trawl surveys conducted by RV Tridens (left) and RV Isis (right)

2.7.3 Evaluation

Most of the species that are considered sensitive, however, are not regularly caught in these surveys thereby preventing the use of single-species indicators. No indicators at higher taxonomic level or community level have been developed yet.

2.7.4 Recommendation

The design of benthic monitoring schemes will need to account for the close interaction between the physical habitat and the benthos it supports. Sampling the North Sea according to areas or grids which have no biological references such as ICES rectangles may not provide high quality information about population and distribution trends in the species to be monitored, as the underlying cause of species distribution is not addressed. However, this approach does simplify the monitoring process.
As the surveys do not appear to be able to deliver single-species indicators we suggest that indicators at higher taxonomic level or community level should be developed.

2.8 Area coverage of highly sensitive habitats

Three main issues were considered: what are the highly sensitive habitats, are data on their spatial extent and occurrence available and is the spatial information of the habitats on a spatial scale comparable to that of fishing effort data (which is essential for the development of indicator 15).
The first issue addressed was to identify highly sensitive habitats. The term 'highly sensitive' was not defined. A number of different definitions of "sensitive habitats" exist, including that given in McDonald *et al.* (1997), along with a range of classification systems for habitat sensitivity (Gundlach and Hayes, 1978; Anderson and Moore, 1997; Cooke and McGrath, 1998). For the purposes of quantifying this indicator we chose to define a "sensitive habitat" as one which is "easily adversely affected by a human activity, and/or if affected is expected to only recover over a very long period, or not at all" (OSPAR/TexelFaial).
To what extent the spatial information is available and adequate is dealt with below.

2.8.1 Materials & methods

There are two policy-relevant categorizations of marine habitats in EU waters: EU Habitats Directive Annex I protected habitats:

- Coastal and halophytic habitats
- Open sea and tidal habitats
- Sandbanks which are slightly covered by sea water all the time
- *Posidonia* beds (*Posidonion oceanicae*)
- Estuaries
- Mudflats and sandflats not covered by seawater at low tide
- Coastal lagoons
- Large shallow inlets and bays
- Reefs
- Submarine structures made by leaking gases

and the Oslo-Paris Convention (OSPAR) threatened habitats (Table 2.8.1).

Table 2.8.1. Al list of OSPAR threatened habitats, the OSPAR region of occurrence and the OSPAR region where the habitat is threatened or declining

Habitat	**OSPAR Regions where the habitat occurs**	**OSPAR Regions where such habitats are under threat and/or in decline**
Carbonate mounds	I, V	V
Deep-sea sponge aggregations	I, III, IV, V	All where they occur
Oceanic ridges with hydrothermal vents/fields	I, V	V
Intertidal mudflats	I, II, III, IV	All where they occur
Littoral chalk communities	II	All where they occur
Lophelia pertusa reefs	All	All where they occur
Maerl beds	***All***	***III***
Modiolus modiolus beds	***All***	All where they occur
Intertidal *Mytilus edulis* beds on mixed and sandy sediments	***II, III***	All where they occur
Ostrea edulis beds	***II, III, IV***	***All where they occur***
Sabellaria spinulosa reefs	All	II, III
Seamounts	I, IV, V	All where they occur
Sea-pen and burrowing megafauna communities	***I, II, III, IV***	II, III
Zostera beds	I, II, III, IV	All where they occur

A comprehensive evaluation of species and habitat sensitivity has also been developed as part of the UK MarLIN programme www.MarLIN.ac.uk (TylerWalters *et al.*, 2001) administered by the Marine Biological Association of the UK. This gives biology and sensitivity key information on habitats, biotope complexes and biotopes found within Annex I habitat types in the UK candidate marine SACs or addressed under the UK Biodiversity Action Plan. Key problems with these data are that while the habitats are clearly of high biodiversity value and of key policy relevance, the habitats tend to be small in aerial extent and extremely patchily distributed and generally found in either very shallow (lagoons, large shallow inlets and bays, submerged or partly submerged sea caves, intertidal mud flats, seagrass *Zostera* beds, littoral chalk communities) or very deep waters (deepwater coral *Lophelia pertusa* reefs and sponge aggregations, oceanic ridges with hydrothermal vents/fields, seamounts).
In order to quantify the area coverage of sensitive habitats it is necessary to have good information on the spatial distribution of these habitats in EU waters. This can only be achieved if these sensitive habitats can be attributed to an existing habitat classification system. The EUNIS system of classification has been adopted by other organisations, most notably OSPAR and the World Wildlife Fund, who have in turn compiled listings of marine habitats congruent with EUNIS.

One other option is to use marine landscapes, which are broad habitat classifications based on geophysical attributes (e.g. bathymetry, seabed sediments, bedforms, and maximum near-bed stress (Figure 2.8.1). While such landscapes are not necessarily 'sensitive' they can be related to biological habitats of interest and also are mapped on scales similar to the distribution of fishing effort (Mills *et al.*, 2004) (see section 2.15).

2.8.2 Results

For a number of potential "sensitive habitats" WGECO (ICES 2003) reviewed the readily available information for each habitat type.

Carbonate mounds
EUNIS Classification: A5.1/A5.2.
This habitat is recognised by both OSPAR and WWF as being sensitive. Carbonate mounds are biogenic in nature and were nominated in a joint submission of the Contracting Parties to OSPAR citing decline, rarity, sensitivity and ecological significance, as well as information on threat. While the full distribution of such mounds within the ICES area is not fully known, they are thought to be widely distributed on the eastern margin of the North Atlantic from the Iberian Peninsula to offshore Norway (Masson *et al.*, 1998). A number of precise locations are available, but information on the precise location of seamount habitats exists only for a few cases, and so is incomplete. WWF has proposed that a Marine Protected Area (MPA) should be created in the Rockall Trough and Channel adjacent to the Rockall Bank, where a number of carbonate mounds are known to exist.

Seamounts
EUNIS Classification: A6.4.
Seamounts were nominated for the OSPAR list in a joint submission by three Contracting Parties citing decline, sensitivity and ecological significance with information provided on threat. Seamounts occur along the MidAtlantic Ridge in chains and are large features, as wide as 100 km across the base. Their general location is well known and documented from the west of Portugal on the MaderiaTore rise and the Milne seamounts to the east of the MidAtlantic Ridge going northwards up past the Rockall Bank (Gubbay, 1999). Some specific sites are known and the Banco Gorringe Site has been listed by WWF. WGECO considered that, while adequate information regarding the physical location of seamounts within the ICES area exists from bathymetric charts, knowledge as to flora and fauna that inhabit them and their sensitivity to fishing exists in only a limited number of cases.

Deepsea sponge aggregations
EUNIS Classification: A5.1/A5.2.
This habitat is recognised by OSPAR in its latest list of threatened and declining habitats. In limited areas they occur in very high densities and can make up more than 90% of the catch biomass, excluding benthic fish. It has been reported that one study off the coast of northern Norway took grab samples from an area of less than 3 m2, yielding 4,000 sponge specimens belonging to 206 species, 26 of which were not described (Konnecker, 2002). They are recognised as sensitive habitats by both OSPAR and WWF. Precise locations are known for a limited number of examples of this habitat close to the shelf break around the Faroe Islands (Klitgaard and Tendel, 2001), along the Norwegian coast up to West Spitzbergen and Bjørnya (Blacker, 1957; Dyer *et al.*, 1984; Fosså and Mortensen, 1998) and from the Porcupine Seabight (Rice *et al.*, 1990), however they have not all been mapped.

Hydrothermal vents

EUNIS Classification: A6.3.

The animal communities associated with hotwater vents caused by hydrothermal activity are particularly unusual. They derive their energy under conditions where photosynthesis is not possible, as well as resisting extreme temperatures and potentially toxic concentrations of various heavy metals (Tunnicliffe *et al.*, 1998). Hydrothermal vent habitats occur in areas of deepsea tectonic activity. In the ICES area, they are confined to the MidAtlantic Ridge, and at the present time the locations of four vent fields to the southwest of the Azores are known. They are the Menez Gwen, Lucky Strike, Saldanha and Rainbow Vents. They are recognised as sensitive habitats by both OSPAR and WWF. WGECO considered that, while adequate information exists regarding the geographical location of a number of hydrothermal vent habitats, the overall distribution of this habitat and its precise location within the ICES area remains incomplete.

Lophelia pertusa reefs

EUNIS Classification: A5.1.

OSPAR received three nominations for *Lophelia pertusa* reefs to be included on its list of threatened and declining habitats. The habitat is also recognised as being sensitive by the WWF and JNCC, and it is the subject of a specialist study group within ICES, the Study Group on Mapping the Occurrence of ColdWater Corals (SGCOR). *L. pertusa* is a reefforming coldwater coral with a wide distribution ranging from 55oS to 71oN (Dons, 1944; Cairns, 1994). While the largest concentrations currently appear to be off the coast of Norway on the Sula Ridge, there are other outcrops off the Iberian Peninsula, around the Rockall Bank off Ireland and the Faroe Islands. WGECO considered that adequate information exists regarding the geographical location of an incomplete number of *Lophelia pertusa* reef habitats. The full extent of this habitat within the ICES area remains unknown.

Sabellaria spinulosa

EUNIS Classification A3.234.

MarLIN lists this habitat as being covered by the UK Biodiversity Action Plan and the EU Habitats Directive. This is a rare habitat with two records from northeast England and one from the Gower peninsula, Wales. MarLIN states that this habitat is highly sensitive to substratum loss, smothering and physical abrasion, with low evidence of recovery in the latter case. WGECO considered that adequate information exists regarding the geographical location of the few *Sabellaria spinulosa* habitats that exist around the UK coastline. Knowledge of the full extent of this habitat within the ICES area, however, remains incomplete.

Sabellaria alveolaat

EUNIS Classification A1.261.

MarLIN describes this habitat as restricted to the south and west coasts of the UK, with the eastern limit in Lyme Bay and the northern limit in the Solway Firth, and it is also found in the southwest and west of Ireland. MarLIN states that this habitat is highly sensitive to substratum loss and physical abrasion. WGECO considered that adequate information exists regarding the geographical location of *Sabellaria alveolata* reef habitats around the UK coastline. Knowledge of the full extent of this habitat within the ICES area, however, remains incomplete.

Serpulid reefs on very sheltered circalittoral muddy sand

EUNIS Classification A4.652.

MarLIN describes this habitat as being extremely rare. In Britain, *Serpula vermicularis* reefs are known from Loch Creran in Scotland. The only other known sites in Britain and Ireland for these reefs are at locations in County Galway. MarLIN also states that these reefs are very sensitive to substrate loss, abrasion and displacement. WGECO considered that adequate information exists regarding the geographical location of Serpulid reef habitats around the UK coastline. Knowledge of the full extent of this habitat within the ICES area, however, remains incomplete.

Maërl beds

EUNIS Classification A4.6. *2003 WGECO* 112 *Report*

MarLIN lists two maërl habitats under the EU Habitats Directive and the UK Biodiversity Action Plan featuring the species *Phymatolithon calcareum* and *Lithothamnion glaciale*. The latter species is commercially dredged. Both species occur within the photic zone along the west coasts of Scotland and Ireland. Both species are listed as being highly sensitive to substratum loss and smothering, with very low rates of recovery. WGECO considered that adequate information exists regarding the geographical location of maërl bed habitats within the ICES area.

Ampharete falcate

EUNIS Classification A4.741.

Ampharete falcata forms dense stands of tubes which protrude from muddy sediments, creating a physical habitat for both itself and a range of other species. It is especially common with *Parvicardium ovale* on cohesive muddy very fine sand near margins of deep stratified seas. MarLIN describes this habitat as being highly sensitive to substratum loss and smothering, although the rate of recovery is suggested as being high. MarLIN lists occurrences of this habitat from the west coast of Scotland and in the Irish Sea. WGECO considered that adequate information exists regarding the geographical location of the *Ampharete falcata* habitats that exist around the UK coastline. Knowledge of the full extent of this habitat within the ICES area, however, remains incomplete.

Modiolus modiolus beds

EUNIS Classification A3. 643.

Modiolus beds form a physical habitat in tideswept areas for a number of other species including hydroids, sponges, tubeworms and barnacles. This habitat is highly sensitive to substratum loss and abrasion with a low rate of recovery. MarLIN shows a number of locations of this habitat, ranging from the west coast of Scotland to Wales and Northern Ireland. WGECO considered that adequate information exists regarding the geographical location of the *Modiolus* bed habitats that exist around the UK coastline. Knowledge of the full extent of this habitat within the ICES area, however, remains incomplete.

Littoral muds

EUNIS Classification: A2.3.

Intertidal mudflats are characterised by high biological productivity and abundance of organisms, but low diversity with few rare species (Anon., 2000). They are recognised as sensitive habitats by both OSPAR and MarLIN. The largest continuous area of intertidal mudflats in the ICES area borders the North Sea coasts of Denmark, Germany, and the Netherlands in the Wadden Sea and covers around 499,000 hectares. WGECO considered that adequate information exists regarding the geographical location of littoral muds in the ICES area.

Seapens and burrowing megafauna

EUNIS Classification: A4.3.

This habitat was nominated for the OSPAR list by one Contracting Party with reference to decline and sensitivity, and with information on threat. It is also recognised by MarLIN and the JNCC as a sensitive habitat. There has been no detailed mapping of this biotope in the OSPAR Maritime Area and therefore no quantifiable information on changes in extent. WGECO therefore considered that geographical information on this habitat is incomplete.

Littoral chalk communities

EUNIS Classification: A1.

The marine communities associated with littoral chalk habitats are generally tolerant of a high degree of turbidity. The most sensitive elements of the marine communities in these habitats are likely to be the algae found in the splash zone. This habitat is recognised as sensitive by OSPAR, MarLIN and JNCC. Coastal exposures of chalk are rare in Europe, with the greatest proportion occurring around the coast of England. There is, however, around 120 km of chalk coastline on the French coast of upper Normandy and Picardy and some chalk exposures at the coast in Denmark. WGECO considered that sufficient information exists regarding the location of this habitat within the ICES area.

Ostrea edulis beds

EUNIS Classification: A4.

Ostrea edulis beds were nominated for the OSPAR list by two Contracting Parties on the grounds of sensitivity and decline, with additional information on threat. The habitat is also listed on the MarLIN website as having high sensitivity to substratum loss and smothering. Information on the historic distribution of *O. edulis* beds appears good, particularly for the North Sea (Korringa, 1976) and the UK (Edwards, 1997). WGECO considered that adequate information exists regarding the location of this habitat within the ICES area.

Zostera beds

EUNIS Classification: A. 2. 71.

Zostera beds were nominated by two OSPAR Contracting Parties on the grounds of decline, ecological significance and sensitivity, with information also provided on threat. This habitat is also recognised by MarLIN for two species, *Zostera marina* and *Zostera noltii*. This habitat is the subject of several local recovery plans around the UK coast. Distribution of *Zostera* beds within the ICES area is well known (Davison and Hughes, 1998).

Irish Sea

The distribution of Marine landscapes in the Irish Sea is shown in figure 2.8.1.

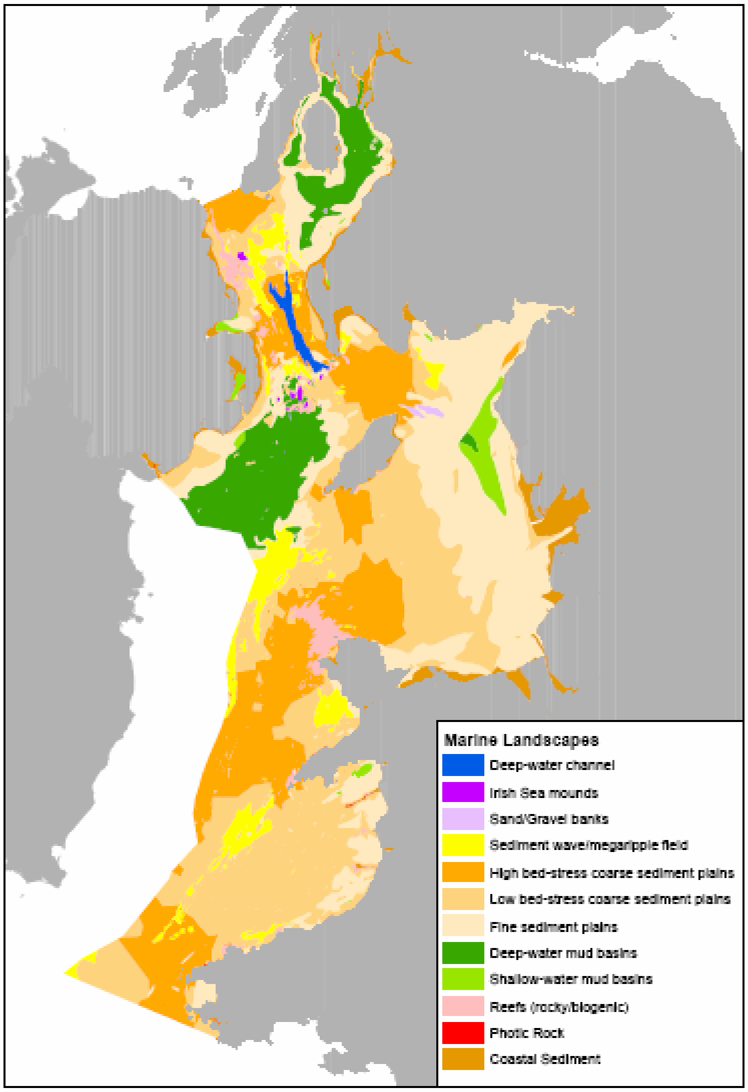


Figure 2.8.1. Marine Landscapes in the UK territorial waters of the Irish Sea.

2.8.3 Evaluation

The key issues when interpreting marine habitat maps is that measures of extent tend to be composite, such that data are derived from a number of point sources potentially over a period of time. As such the aerial extent of marine habitats and landscapes tends to represent a static composite snap-shot compiled over a number of years. Marine habitat maps and landscape maps are not updated on a regular basis and can therefore not be used to provide estimates of the changing extent of each habitat or landscape, as can be derived for the major terrestrial vegetations types, such as tropical forest cover. As a result the impact of human activities upon on marine habitats can only be assessed the degree of overlap of human activities or the overlap and intensity of human impacts on habitats

2.8.4 Recommendations

This indicator is directly linked with the indicator "mapping of effort distribution over the sensitive areas" (section 2.15) and to a lesser extent with the indicator "abundance of sensitive benthos species" (section 2.7) as specific benthic species may have a strong preference for certain habitats. Although we think that this could be an informative indicator of the ecological status of sensitive habitats, the fact that currently in most EU waters there is no information on the location and area coverage of most of these habitats let alone that there are regular monitoring programmes that make it possible to identify changes in the area covered make it unlikely that this indicator may become operational in the medium or even in the longer term. Such a monitoring programme would come at a considerable cost. As such, the indicator "mapping of effort distribution over the sensitive areas" that can describe the pressure caused by fishing on these habitats is more likely to become operational in the short to medium term.

2.9 Total aquaculture production and total area occupied by aquaculture installations

This indicator consists of two parts: Total aquaculture production and Total area occupied by aquaculture installations.

2.9.1 Material & methods

Total aquaculture production within the European Union was estimated using the FAO database: Aquaculture production: quantities 1950-2003. This database was released in March 2005**.** The database is publicly available and can be accessed via the Internet (http://www.fao.org/fi/statist/fisoft/fishplus.asp#Download).
The database contains data on the aquaculture production volume detailed per country, species, environment (freshwater culture, brackish water culture and mariculture) and area (e.g. Europe – Inland waters or Atlantic, North East).
A time series was constructed for the period 1983-2003 (twenty-one years). An overview of possibilities of data presentation is given. As there are numerous ways to present available data, this overview can only be incomplete.

The total area occupied by aquaculture installations can be estimated as:
Total area = Total production / Production per unit of area.

The productivity of aquaculture operations depends on many factors such as:

- Species cultured
- Culture system
- Local climate conditions
- Genetic strain
- Size at harvest
- Stocking densities
- Type and quality of feed
- Water quality
- General farm management
- State of the art of farming technology
- Availability of juveniles

As a result actual productivity will vary between individual farms and years and an accurate figure for a given species and culture system is not readily available nor easily established.
The factors ‘species’ and ‘culture system’ can be taken into account by considering only the limited number of species that account for the larger part (90%) of the total production and by only considering the one or two culture systems that account for the larger part of the total production of a given species. Depending on the objective (e.g. only conservation of marine ecosystems) against which this indicator is supposed to measure progress, the number of species taken into account can be further reduced by ignoring species produced in freshwater.
Geographic areas can be distinguished and local climate conditions can be taken into account by considering the production and productivity for a given species and culture system for individual EU member states or regions within the EU. This is possible as aquaculture production data are available for individual member states.

Productivity likely changed over the years as a result of e.g. faster growth due to genetic improvement of species, improved culture systems that allow higher stocking densities or development of new, more productive production technologies and systems. This means that productivity needs to be determined from year to year (or clusters of years). If only one productivity figure is used for a given species and culture system it is likely to be inaccurate and, more importantly, the indicator ‘total area occupied by aquaculture installations’ will follow the exact same pattern as the indicator ‘total aquaculture production’ and therefore does not provide additional information or insight.
In conclusion the assessment of total area occupied by aquaculture installations via total production and productivity is complex because accurate productivity data are hard to determine. In addition, it does not provide extra information or insight compared to the indicator ‘Total aquaculture production’ in case productivity has not been determined accurately. Finally, due to the many underlying factors determining productivity, it is hard to single out one factor responsible for these changes and quantify it.

2.9.2 Results

From the database it is clear that over a hundred aquatic species are cultured within the EU. This includes fish, shellfish, crustaceans, other invertebrates and seaweeds. Fish and shellfish are dominant with respectively 42.8% and 56.9% of the total aquaculture production within the EU in 2003. Fish culture is dominated by five fish species which accounted for 90% of the total fish production in the EU in 2003 as illustrated by figure 2.9.1. These five species include rainbow trout, Atlantic salmon, gilthead seabream, European seabass and common carp. Shellfish culture is dominated by four shellfish species which accounted for 96% of the total shell fish culture production in de EU in 2003 as illustrated by figure 2.9.2. These four species include blue mussel, pacific cupped oyster, Mediterranean mussel and Japanse carpet shell.

Figure 2.9.1 Relative contribution of fish species to the total fish culture production volume in the EU in 2003.

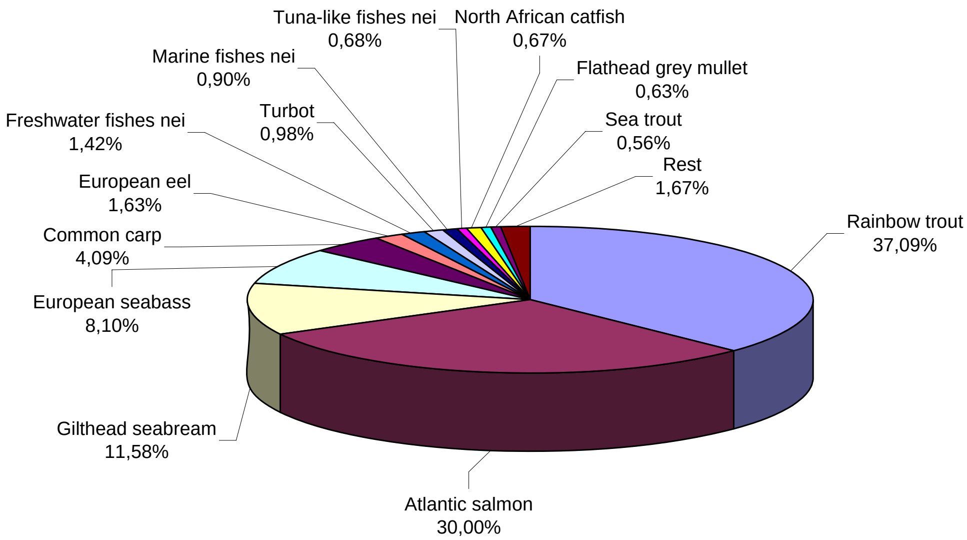


Figure 2.9.2 Relative contribution of shellfish species to the total fish culture production volume in the EU in 2003.

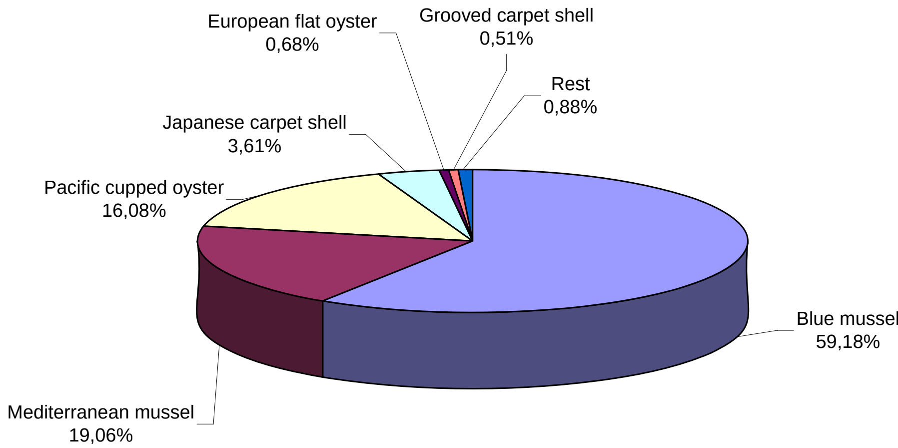
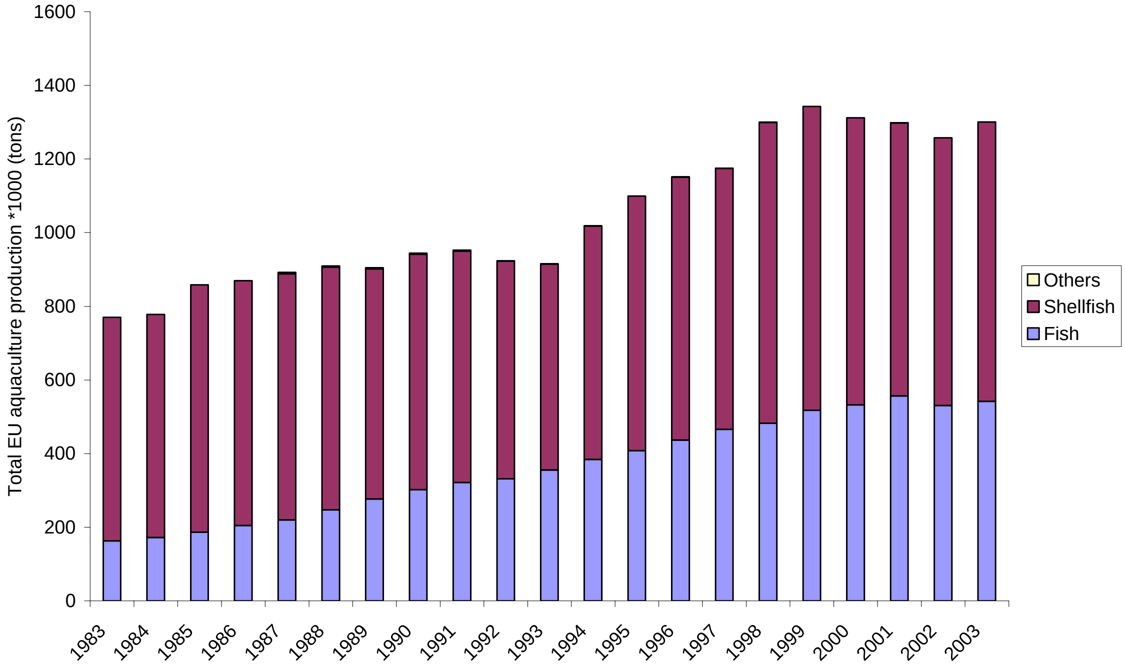


Figure 2.9.3 presents the total EU aquaculture production volume for the period 1983-2003. For each year the total aquaculture production in the EU member states was determined. Total aquaculture production consists of the categories fish, shell fish and others. The category others contains aquatic organisms such as crustaceans, other invertebrates and seaweeds.

Figure 2.9.3 Total aquaculture production volume in the EU in the period 1983-2003.



The production volume of the category 'Others' is small compared to fish and shellfish and it can be hardly distinguished in Figure 2.9.3.

From figure 2.9.3 it is clear that fish and shellfish production volumes in the EU have developed differently during the period 1983-2003. In order to use production volumes as indicator it may therefore be better to present the production volumes over time in separate figures for fish and shellfish. This is done in respectively figure 2.9.4 and 2.9.5.

Figure 2.9.4 Total fish culture production volume in the EU in the period 1983-2003.

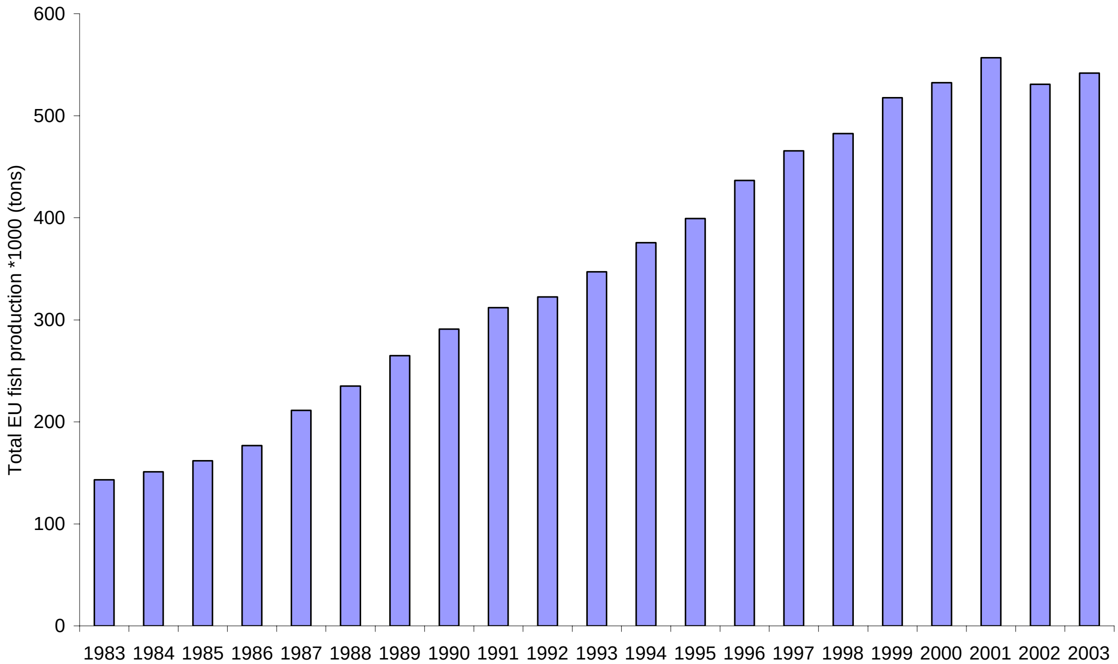
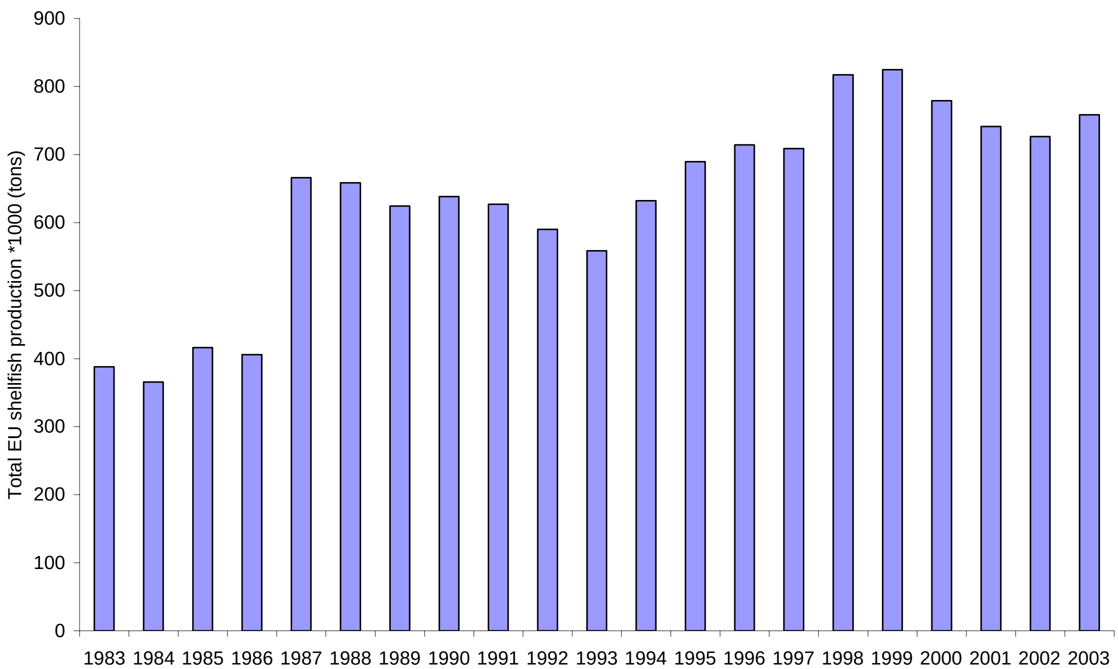


Figure 2.9.5 Total shellfish culture production volume in the EU in the period 1983-2003.



Part of the changes in aquaculture production volumes are caused by the introduction of new EU member states. This especially applies to the difference in shellfish production between 1986 and 1987 which results from Spain and Portugal becoming EU member states in 1986 and Austria, Sweden and Finland in 1995. To avoid that the time-series of the indicator is affected by changes in the suite of member states on which the indicator is based the production volumes of fish and shellfish were determined for all the states that were EU member in 2003 indicating the production in non member states at any particular year. This results in Figure 2.9.6 and 2.9.7 for respectively fish and shellfish. This is especially relevant for a times series beyond 2004 when ten new member states were added.

Figure 2.9.6 Total fish culture production volume in the EU member states in 2003 for the period 1983-2003

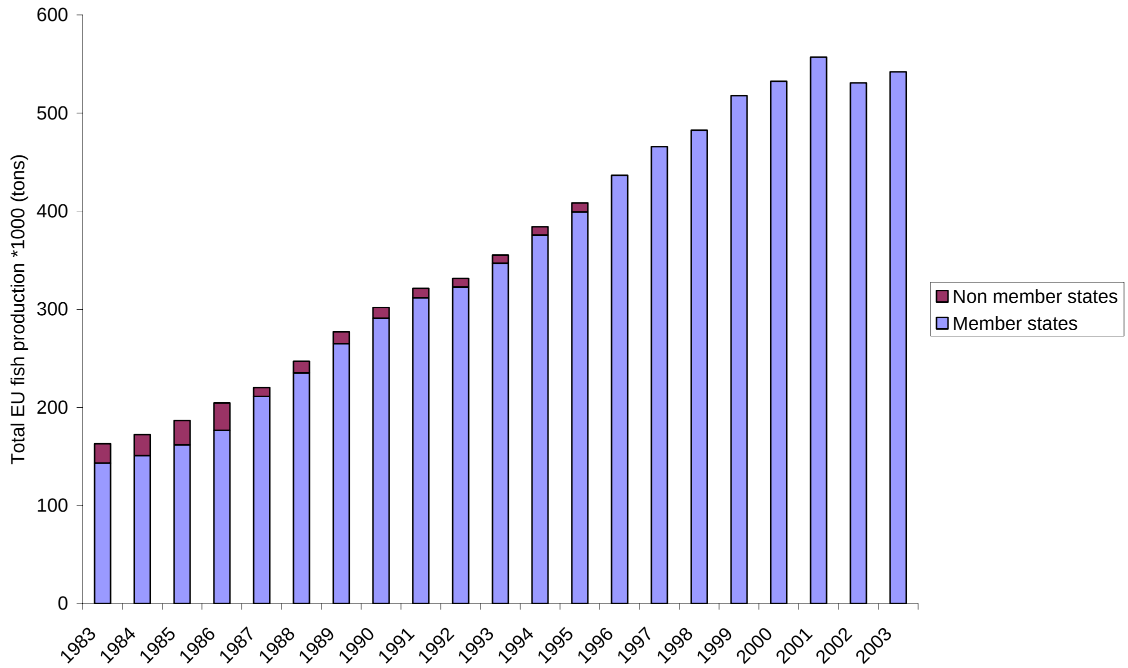
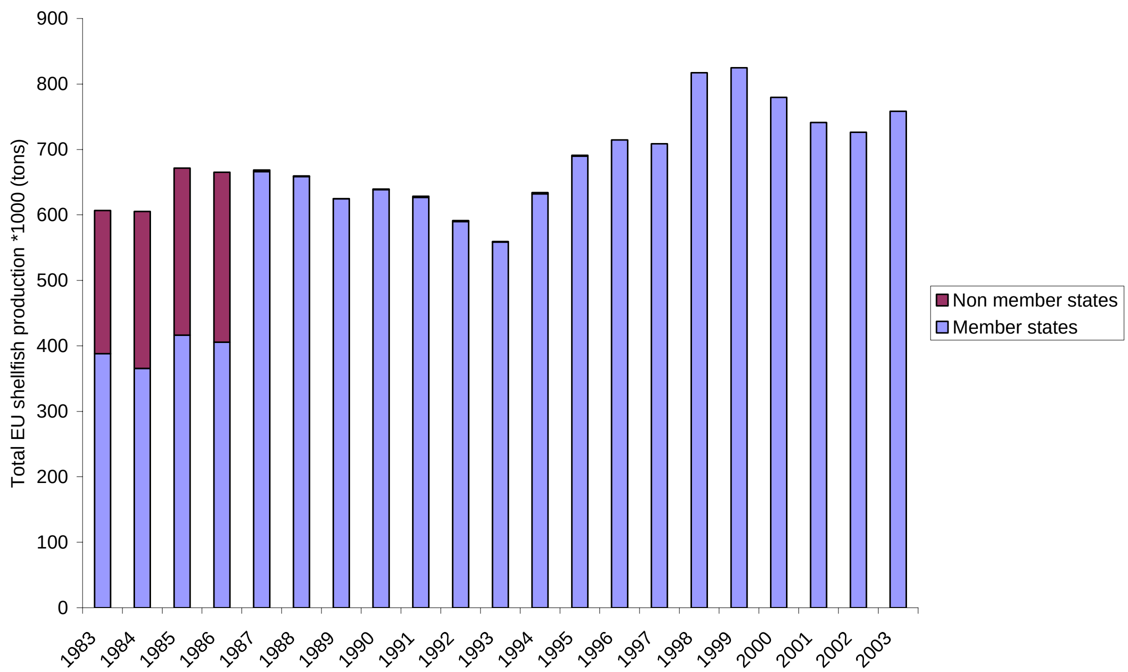


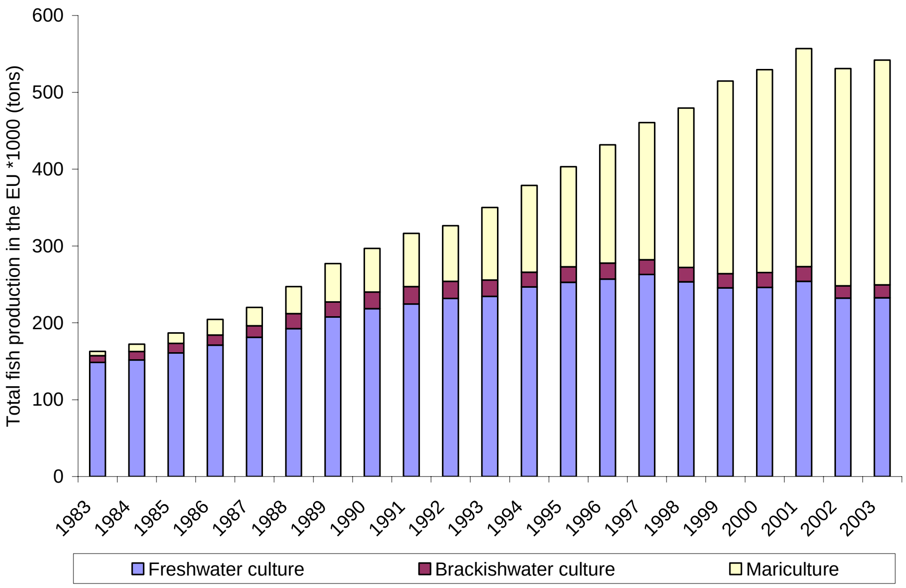
Figure 2.9.7 Total shellfish culture production volume in the EU member states in 2003 for the period 1983-2003



As the indicator 'Total aquaculture production volume' had been proposed to monitor environmental

impact of aquaculture on marine ecosystems, the aquaculture in freshwater or inland ecosystems is not relevant. This has consequences for the fish culture production volume as the five major species include both marine and freshwater species. The shellfish production on the other hand only concerns marine species.
For this purpose the total fish culture production volume is given by production environment (marine, freshwater, brackish water). As certain species are cultured in more than one environment, most notably rainbow trout, detailing on species level is not an option. Figure 2.9.8 presents the total EU fish production detailed for production environment. For each year only the EU member states in that year are considered, similar to Figures 2.9.3, 2.9.4 and 2.9.5.

Figure 2.9.8 Total EU fish culture production volume in the period 1983-2003 distinguished by environment



It should be mentioned that the FAO database on aquaculture production volumes provides numerous opportunities for data presentation and indicators as the aquaculture production data are detailed on species, country, area and environment level.
Aquaculture production data can be determined per geographic area. For example the total aquaculture production in France, allows a distinction between production in the Mediterranean and in the North Atlantic. To determine what extend the areas that are distinguished in the FAO database equal RAC areas or MTS eco-regions further investigation is needed.

2.9.3 Evaluation

For this indicator there are sufficient and high-quality data available to create time-series and make this indicator operational, even on a regional basis. However, before this decisions need to be made on the species included in the indicator, if fish- and shellfish need to be distinguished, how to deal with expansion over time of the number of EU member states, etc. Also it is unclear what the objective is against which this indicator is supposed to measure progress. Is more aquaculture an indication of CFP becoming more environment friendly as it partly releases the wild stocks from pressure through exploitation? Or does the opposite apply as this indicates an increasing pressure of aquaculture effluent, fish escaping etc. on the environment? If the latter applies then the

location of the aquaculture installations becomes relevant as some environments may be more sensitive to impact of nearby aquaculture than others.
Finally, this and other indicators that describe aquaculture and its impact on the environment (i.e. indicators 9, 10, 11, 12) should fall under structural measures instead of conservation measures.

2.9.4 Recommendation

The indicator as it is worded for this study can be easily made operational with the data available. However, as the concerns above have not been addressed we feel this indicator is not fully developed yet.

2.10 Effluent water quality

2.10.1 Introduction

Effluent water quality is determined by the concentration of nutrients in the discharge water and hence by the amount of nutrients produced that will be discharged and the flow rate of the effluent. The largest part of the aquaculture production in the EU takes place in cages for which effluent is hard to determine. Therefore effluent water quality cannot be assessed for a large part of the EU aquaculture production. Instead the production of nutrients by an aquaculture production system that will be discharged can be estimated. This however, is the same approach as has been proposed for the eco-efficiency of aquaculture (see section 2.11). It is therefore proposed to use nutrient discharge per unit of actual production of market sized fish to express indicator 11 Eco efficiency of aquaculture. Nitrogen has been chosen as indicator nutrient as nitrogen is the limiting nutrient in most marine eco systems. The nitrogen discharge of aquaculture installations was assessed and this covers both the indicator for "Effluent water quality" and "Eco-efficiency of aquaculture". As production and subsequent discharge of nutrients only occurs at aquaculture operations in which the animals are fed artificial feeds instead of or in addition to naturally occurring feed sources in the system, all shellfish production can be excluded.
As shown in section 2.9, more than 90% of the total EU fish production can be attributed to five species: Atlantic salmon, rainbow trout, gilthead seabream, European seabass and common carp. These five species will be considered for both the indicator for "Effluent water quality" and "Eco-efficiency of aquaculture".

2.10.2 Materials and methods

Nitrogen mass balance
The actual nitrogen discharge was estimated by modelling the nitrogen production by aquaculture operations. The nitrogen discharge can be assessed by making a nitrogen mass balance for aquaculture production. The nitrogen balance can be defined as:

Feed nitrogen = Fish nitrogen + Discharged nitrogen

Basically all nitrogen introduced in the production system via the feed (Feed nitrogen) that does not leave the production system as fish (Fish nitrogen) is considered nitrogen that will somehow be discharged to the environment (Discharged nitrogen). As a result the nitrogen that will be discharged is simply calculated as the difference between Feed nitrogen and Fish nitrogen

Fish nitrogen and Feed nitrogen are calculated as:

Fish nitrogen = Total fish production * Protein level in fish/6.25
Feed nitrogen = Protein level /6.25 * Amount of feed
Amount of feed = Total fish production * Feed conversion rate

Key variables are therefore:

- Total fish production
- Feed conversion rate
- Protein level in the feed
- Protein level in the fish

Changes over time in the total nitrogen discharge by aquaculture are therefore a result of changes in either Total fish production, Feed conversion rate and protein level in the feed. In order to establish a time series for nitrogen discharge the changes of these key variables over time need to be established. As these key variables and their changes over time will vary among cultured fish species, they need to be established for individual species.
As mentioned above five species account for more than 90% of the total EU fish production. The total nitrogen discharge is estimated as the sum of the estimated nitrogen discharge of these five major species and the estimated nitrogen discharge by other cultured species. The latter is estimated based on the total production of other species and average nitrogen production as determined for the five major species.

Total fish production
The total EU production of the five major species is determined using FAO statistics as described for indicator 9. The production of other fish species is determined as the difference between the total fish production and the production of the five major species.
The increased total fish production over the years (indicator 9) has resulted in an increased total nitrogen discharge by aquaculture.

Feed conversion rate
Changes over time in feed conversion rates (FCR) for different fish species have not been systematically documented but could probably be collected among fish feed manufactures. As historic data are currently lacking, assumptions have been made in relation to the improvement of FCR over time to illustrate its effect on nitrogen discharge.
It is expected that the utilization of feed in aquaculture has improved over the years as a result of the development of better feeds, farming practices etc. As a result the key variable Feed conversion rate can be expected to have decreased in time, which contributes to a lower nutrient discharge per unit of production.

Protein level in the feed
Changes over time in protein levels in fish feeds for different fish species have not been systematically documented but could probably be collected among fish feed manufactures. As historic data are currently lacking, assumptions have been made in relation to the development of the protein level over time to illustrate its effect on nitrogen discharge.
Current protein levels in fish feeds for different species were estimated based on the information on websites and other promotional materials of fish feed manufacturers. Table 2.10.1. presents the currently used protein levels in the feeds of different fish species.

Table 2.10.1. Current protein levels in commercial fish feeds

Species	Protein level range (g/kg)	Currently used value (g/kg)

Atlantic salmon	400-460	430
Gilthead seabream	430-500	460
European Seabass	430-500	460
Rainbow trout	400-500	450
Common carp	440-450	450

It is expected that protein levels in aquaculture diets increased over the years, which may contribute to a higher nitrogen discharge per unit of production. Data are however currently lacking. Therefore the current (2005) protein levels were applied for all years in the time series.

Protein level in the fish

Of these factors only the protein level in the fish can be considered relatively constant over time, although genetic improvement of fish may have resulted in higher fillet yields and subsequently higher protein levels in fish but this is neglected. Table 2.10.2 provides an overview of the protein levels used for the different species. Whole body protein content varies among species, diet and body size (Rasmussen, 2001). Within species differences related to diet and size (post juvenile) are relatively small. Data on whole body protein level of market sized fish are scarce. Data are available for fish below market size from scientific publications on experimental work in which the whole body protein level was determined in relation to dietary treatments. In this study averages of values obtained from scientific literature were used. More exact determination of protein content of market size fish may be required but it is expected that values will differ less than 5% from the currently used data.

Table 2.10.2 Whole body protein level of the five most important fish species for the EU aquaculture production

Species	Whole body protein level (g/kg)		Source	Currently used value (g/kg)
	Range	Average		
Atlantic salmon	172-174 178-180	173 179	Kroghdahl et al. (2004) Azevedo et al. (2004)	176
Gilthead seabream	167-189 176-186	178 182	Lupatsch & Kissil (1998) Perreira & Oliva-Teles (2004)	180
European Seabass	152-208	183	Peres and Oliva-Teles (1999)	183
Rainbow trout	157-168 165-170	162 168	Rasmussen (2001) Kroghdahl et al. (2004)	165
Common carp	142-156	149	Hancz et al. (2003)	149

Breakdown of nitrogen discharge

Nitrogen discharge can potentially be further detailed. Within the culture system three important sources for nitrogen discharge exist:

- Feed loss nitrogen: This is the nitrogen in feed that remains uneaten by the fish and is highly dependent on farm management. It is in solid form.
- Faecal nitrogen loss: This is Nitrogen associated with fish faeces, it comes from not digested nitrogen sources in the feed and is mostly dependent on protein digestibility. It is in solid form.

- Non faecal nitrogen loss: Opposed to mammals, fish utilize mainly proteins as dietary energy source. The nitrogenous end product of their protein metabolism is ammonia which is excreted to the surrounding water via the gills. This is dissolved.

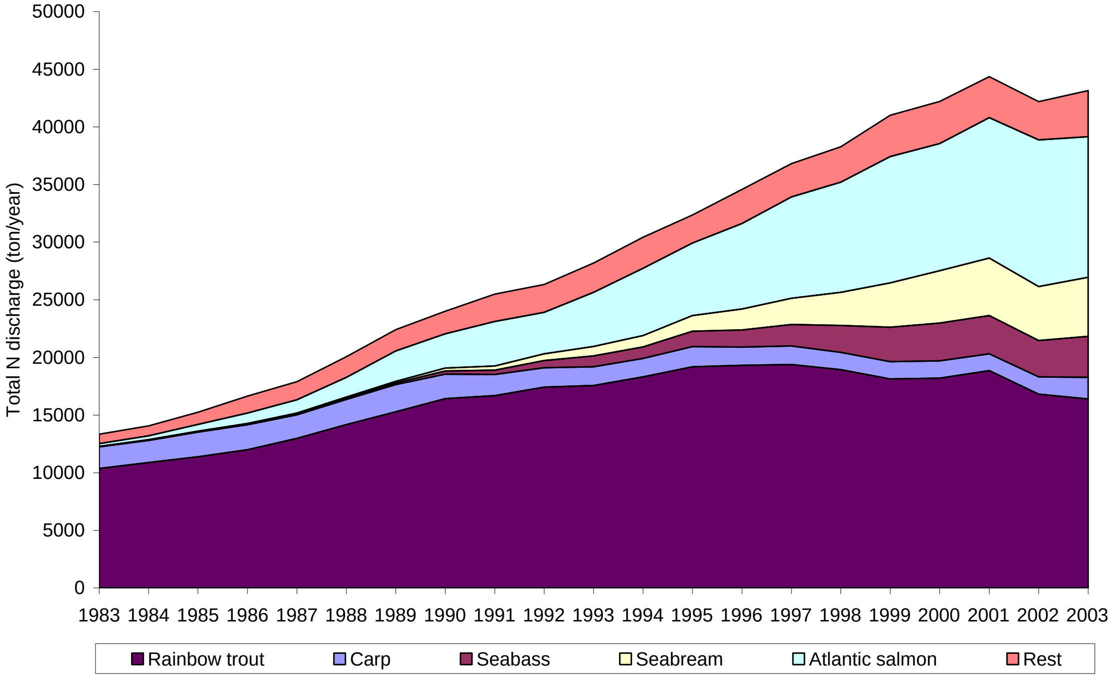
The different chemical and physical forms in which nitrogen will be discharged by the fish production system depend on the conversion processes taking place in the culture system prior to discharge. This is highly dependent on the culture system. Inside open seacages no conversion processes take place and nitrogen will be discharged in the same forms as it is produced. In contrast, partial conversion of ammonia to nitrate and from nitrate to nitrogen gas can take place in recirculation systems and ponds. Gaseous nitrogen is discharged to the air and therefore reduces the total amount of nitrogen discharged to the surrounding water. Specification of nitrogen discharge requires detailed information on the conversion processes in different culture systems for each relevant species. The relative contribution of each culture system to the total fish production should be taken into account when calculating a total nitrogen breakdown.

2.10.3 Results

Total Nitrogen discharge in relation to total fish production

Figure 2.10.1 illustrates the effect of the increased fish production on the total nitrogen discharge. For this purpose the other key variables are kept constant. The feed conversion rate is fixed at 1.5, protein levels in feed and fish are as mentioned in respectively tables 2.10.1 and 2.10.2 and do not necessarily represent correct values. For this reason the indicator should be considered a relative measure. As FCR and protein level in the feed are constant the nitrogen discharge per ton production is constant as well.

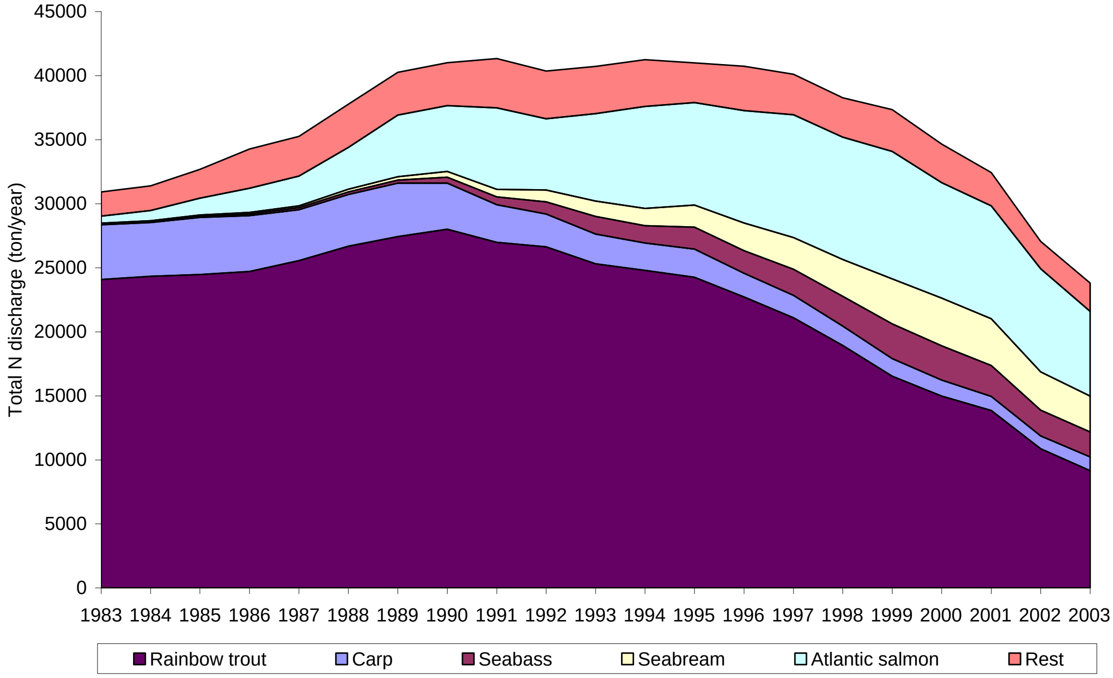
Figure 2.10.1 Total nitrogen discharge by EU fish culture as a function of the production increase during the period 1983-2003. FCR is fixed at 1.5 for all species. Protein levels in the feeds are in accordance with average levels in commercial feeds in 2005.



Total Nitrogen discharge in relation to total fish production and FCR

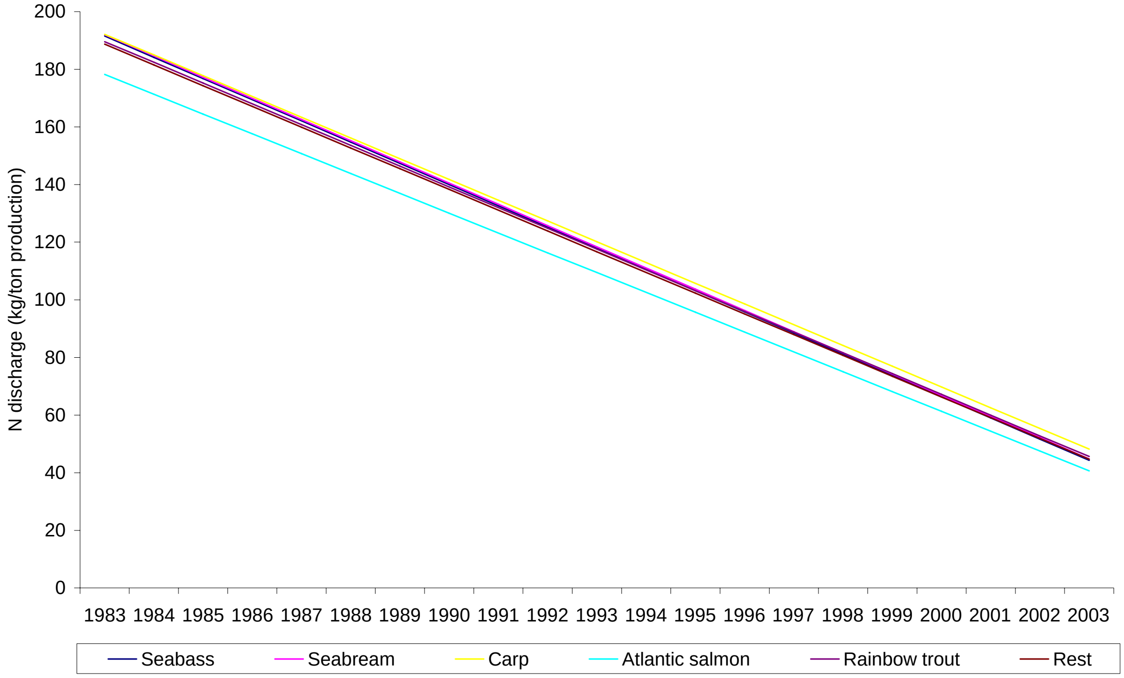
An improvement of feed utilization over time results in a decrease of FCR. As historic data on FCR for different species are currently not available, it is not possible to take this into account. An exploration of the effect of a reduction of FCR over time is shown in figure 2.10.2 where FCR decreased linearly from 3 to 1 from 1983 to 2003 for all species. To what extent such a reduction in FCR is realistic remains uncertain but figure 2.10.2 does indicate that the time-series of the indicator is strongly affected by changes in FCR.

Figure 2.10.2. Total nitrogen discharge by EU fish culture as a function of the production increase during the period 1983-2003. FCR is assumed to linearly decrease from 3.0 in 1983 to 1.0 in 2003 for all species. Protein levels in the feeds are in accordance with average levels in commercial feeds in 2005.



In order to separate the effect of the increased production and the decreased FCR on the total nitrogen discharge, the nitrogen discharge is calculated per ton of fish production (see 2.11 Eco efficiency of aquaculture). The results are presented in Figure 2.10.3.

Figure 2.10.3. Nitrogen discharge per ton production by EU fish culture as a function of the production increase during the period 1983-2003. FCR is assumed to linearly decrease from 3.0 in 1983 to 1.0 in 2003 for all species. Protein levels in the feeds are in accordance with average levels in commercial feeds in 2005.



The differences between species results from differences in protein level in their feeds. In reality differences in FCR between species should also exist.

2.10.4 Evaluation

The time-series of this indicator depends to a large extent on assumptions pertaining to the FCR and how it developed over time. As it is not possible to obtain reliable information to estimate the FCR this indicator can not be quantified at present.

2.10.5 Recommendation

In order for this indicator to be informative more information, notably on the FCR, is needed than is currently available. Therefore the suggestion is to re-evaluate the usefulness of this indicator when more information becomes available.

2.11 Eco-efficiency of aquaculture

As this indicator is strongly linked to that of the indicator “Effluent water quality” the same problems (notably data on feed conversion rate) apply when quantifying this indicator. Therefore see section 2.10.

2.12 Potential impact of aquaculture on the genetic structure of wild (fish) populations.

Potential impact of escapees on the genetic structure of wild fish populations may apply to situations were fish species are farmed in areas where wild populations of their wild counterparts occur and are farmed in culture systems which are prone to escaping.

This applies to Atlantic salmon, European seabass and gilthead seabream.
The total production of these species in areas where populations of their wild counterparts occur may serve as an indicator for potential impact.

There are no records of numbers of farmed fish escaping from fish farms.

2.13 Effective fishing capacity (adjusted fishing effort) and its spatial and temporal distribution

When implementing an Ecosystem Approach to Fisheries Management (EAFM), indicators are required to describe the pressures affecting the ecosystem, the state of the ecosystem, and the response of managers. Such indicators can be used to support management decision making, track progress towards meeting management objectives and to aid communication with non-specialist audiences (Garcia et al. 2000, Rice 2000, Rochet and Trenkel 2003). Many indicators have been proposed (e.g. (Rice 2000, Link 2002, Link et al. 2002, Rochet and Trenkel 2003), but few (if any) of those that track changes in the "state" of the marine environment or of different ecosystem components (e.g. fish, benthos, habitat) can support management directly (Rice 2000). This is largely because the precise causes of any changes in "state" may be poorly understood, making it difficult to identify appropriate management action. To implement an EAFM successfully therefore, it is not only necessary to have a suite of indicators that accurately and comprehensively portray the "state" of various ecosystem components, but it is also critical that we have indicators that describe changes in the level of different manageable anthropogenic activities, and which indicate the impact of each activity on the various ecosystem components. Only by adequately covering both aspects will the mechanistic links between "cause" and "effect" be well enough understood so as to provide the advice required (Daan 2005).

Several frameworks have been proposed for classifying environmental management indicators on this basis, for example, the pressure state response (PSR) system (Garcia and Staples 2000). This framework uses pressure indicators (P) to measure the pressure impacting an ecosystem component, state indicators (S) to measure the state of the ecosystem component and response indicators (R) to measure the response of managers to the change in state. This is in line with traditional fisheries management where they report for each stock what is considered the best state indicator (SSB=Spawning Stock Biomass) and best pressure indicator (F=fishing mortality) while the response indicator is usually the Total Allowable Catch (TAC) set by managers. Since policy commitments and associated objectives generally relate to "state", for example to conserve biodiversity, or restore biodiversity in regions where this has been degraded (OSPAR Annex V), reference points, targets, or trend trajectories needed to measure progress towards meeting management objectives tend most frequently to be set for "state" indicators. However, the "state" of different components of marine ecosystems can rarely, if ever, be managed directly. All managers can realistically hope to achieve is to manipulate "pressure" such that "state" indicators are kept within, or moved towards, acceptable limits. "Pressure" and "response" indicators are clearly essential in this process. Such indicators also often have the desirable properties of ease of measurement and rapid response times. Consequently, guidance for year-on-year management decision making is often better based on pressure and response indicators, with changes in state assessed less frequently to confirm that pressure and response are affecting state as predicted (Nicholson and Jennings 2004).

The development of pressure indicators for fisheries has in the past tended to be hampered by confusion over the difference between the actual ecological impact of fishing (mortality and habitat change) and the community level changes that are later seen as a consequence of this impact (for example a change in the size structure of the community). The ecosystem components for which most information is available on the direct effects of fishing are fish and benthic invertebrates (For reviews see: (Dayton et al. 1995, Jennings and Kaiser 1998, Hall 1999, Collie et al. 2000, Kaiser and de Groot 2000) and many indicators have been proposed that describe the state of these components at different hierarchical levels (e.g. population and community levels, see (Frid et al. 2005, Piet and Jennings 2005). However, the state of the individual components is not only determined by the effects of a particular anthropogenic activity such as fishing, but by a combination of all the intrinsic and extrinsic factors that combine to structure populations and communities. These include a combination of biotic (e.g. competition, predation and larval dispersal) and abiotic factors (e.g. climatically driven changes in temperature and productivity) (Murawski 1993, Clark and Frid 2001, Kröncke 2001). In theoretical ecology terms, impact or disturbance is the mortality caused by perturbations to the ecosystem and fisheries impact is an anthropogenic source of mortality. Clearly, to be able to realistically predict the response of ecosystem components to fisheries impact, one must first establish the level of mortality experienced by these components before inputting this to an overall model of the factors that structure them.

In terms of indicators required to implement an EAFM, ideally pressure indicators should account for mortality to an ecosystem component that results directly from fishing, state indicators for the overall state of that component and response indicators for the response of managers required to alter the level of pressure where unacceptable changes in state have occurred. In case management objectives are set for populations of ecosystem components other than the target fish species (e.g. threatened and declining species, sensitive benthic species) or at the community level (e.g. mean length or mean weight of the fish community), the known mortality estimates of a few target fish species that come from stock assessments may not be adequate to link pressure with such state indicators. For those cases the mortality of all ecosystem components can be calculated following the swept-area method introduced simultaneously by (Pope et al. 2000) for fish and Piet et al. (2000) for benthos. This method is based on an estimate of fishing intensity, the chance of individuals of a species coming into contact with the fishing gear and the encounter mortality which is the proportion mortality caused by the singular passing of the gear.

Starting from the premise that fishing mortality is the most accurate measure to describe fishing impact but acknowledging that data limitations often force us to use less-informative proxies, we introduce a framework (Figure 2.13.1) that encompasses the most common pressure indicators. The main objective of this paper is to describe this framework and how the different existing pressure indicators compare to one another, by incrementally adding information to the most basic pressure indicator, ultimately leading to indicators that describe the actual ecological impact of fishing, i.e. the level of mortality inflicted on a particular ecosystem component. This approach makes explicit the assumptions that are made at lower levels of information content and how these bias the pressure indicator.

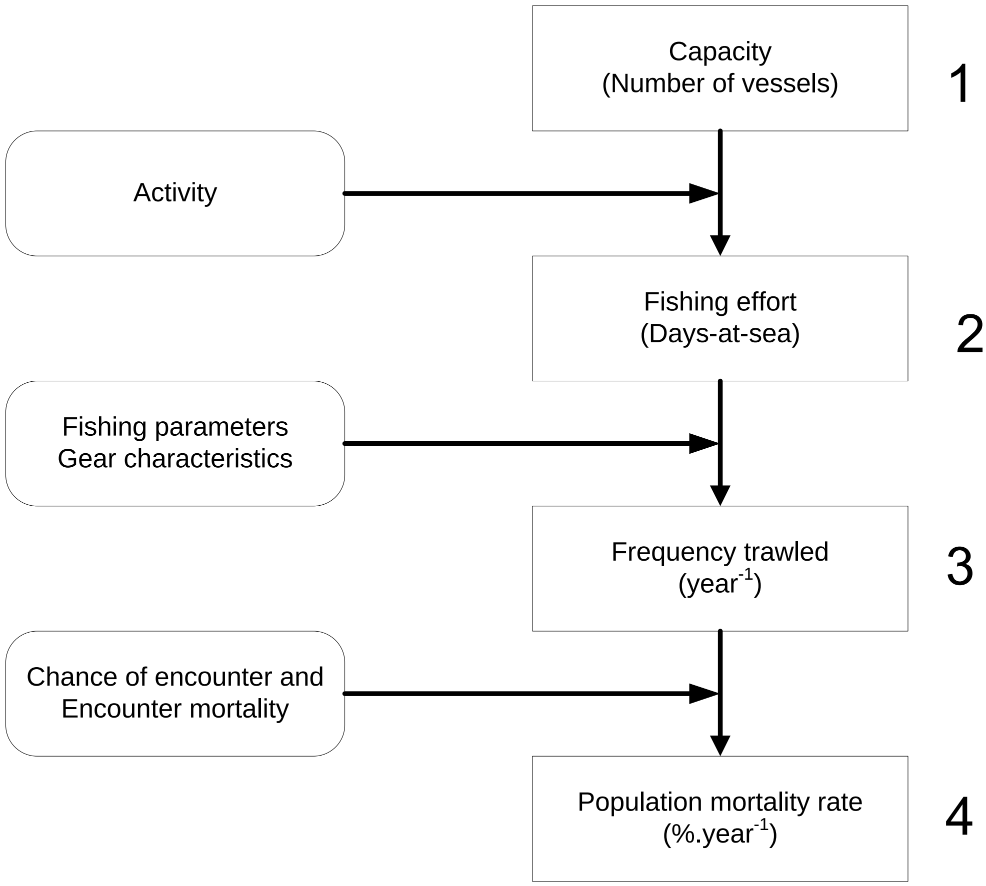


Figure 2.13.1. Schematic representation of Fishing Pressure indicators at different levels of information content. Activity indicates the number of fishing hours or days at sea per vessel. The fishing parameters and gear characteristics determine how much area is covered by a unit of fishing effort which translates into the frequency with which a specific area is trawled. The chance of encounter determined by the spatial distribution of the population relative to that of the fishery gear and the encounter mortality, expressed as the proportion mortality of individuals in the path of the gear determine the extent to which a population is actually affected by the fishery (i.e. the population mortality rate).

To exemplify this we chose the Dutch beam trawl fishery in the southern North Sea as a case study. Beam trawling accounts for a high proportion of all fishing activity, particularly in the southern North Sea (Jennings et al 1999), and the Dutch beam trawl fleet is responsible for more than 70% of total beam trawl effort. Furthermore, this fishery has been intensively studied in recent years, resulting in a high level of knowledge regarding the precise operation of the fleet (Rijnsdorp et al., 1998;(Rijnsdorp et al. 2000a, Rijnsdorp et al. 2000b); (Piet et al. 2000). Mortality is only known for the two target species of the beam trawl fishery, plaice and sole, despite the fisheries potential to cause collateral damage to other components of the marine ecosystem. Although more detailed data are available, the impact of beam trawling on the North Sea ecosystem is still reported using one of the least informative measures of effort (i.e. days-at-sea) at a spatial scale of ICES rectangles (approximately 30x30 Nm). Such measures take little account of species-specific encounter mortality rates, or how these are influenced by the micro-scale (sub ICES rectangle) spatial distribution of fishing effort.
The consequences of these findings for the collection of data needed to support an EAFM are discussed.

2.13.1 Material & methods

Because beam trawl fishing has such high potential to cause collateral damage to other components of marine ecosystems, including fish and benthic invertebrate communities as well as the seabed habitat, it has long been the focus of considerable attention from fisheries scientists. This has lead to the collection of a diverse range of data, including information on the capacity, spatial coverage and behaviour of different types of vessel within the fleet, and temporal and spatial variation in these at several different scales (see Rijnsdorp et al., 1998; Piet et al., 2000). Two databases that differ in their spatial resolution were analyzed in this study:

1. Low spatial resolution. The VIRIS database, which contains information on fishing activities of the entire Dutch fleet at a spatial resolution of ICES rectangles (approximately 30x30 Nm) stored in individual fishers' EC-logbooks. Data were extracted for the years 1994 to 2004. The database distinguishes different segments of the fleet based on their engine-power, contains information on the time of the start and end of the fishing trip, the gear used, the ICES rectangles fished and the landings by fish species. The database is designed for quota management purposes but available for research purposes and similar databases are available for other EC countries.
2. High spatial resolution. The APR/VMS database consists of Automated Position Registration (APR) and Vessel Monitoring through Satellite (VMS) data at a resolution of 1 minute latitude x 2 minute longitude squares (approximately 1x1 Nm). APR data are based on a sample of about 10% of the Dutch beam trawl fleet that was equipped with APR equipment for the period 1993-2000 during which the position of the vessels was recorded every 6 minutes (see (Rijnsdorp et al. 1998). The VMS data became available from 2000 onwards when positions of all EU vessels >24 m were recorded for enforcement purposes. From September 2003 onwards this was extended to vessels >18 m and subsequently from the 1st of January 2005 to vessels >15 m. Positions are recorded approximately every 2 hours. Although these data are collected by all EC countries for enforcement purposes, not all countries have access to VMS data for research purposes. For the Dutch beam trawl fleet VMS data from only a subset of the vessels are available for research purposes. In addition to detailed data on track positions, some of the vessels provided data on a haul-by-haul (HBH) basis of the catch of the target species, the trawling speed and the times of shooting and hauling of the gear.

The ecological impact of fishing by the Dutch beam trawl fleet was described by pressure indicators at four levels of increasing information content (Figure 2.13.1). Level one quantifies fleet capacity, i.e. the number of vessels in a fishery, where different fishing métiers (defined by the target species, the fishing gear used and the area visited, (Laurec et al. 1991) may be defined as necessary. Level two is the measure most commonly referred to as fishing effort, calculated as fleet capacity (usually in number of vessels but this may also take account of vessel tonnage or engine-power) multiplied by their activity (e.g. number of fishing hours or days at sea). At level three, pressure is described by the trawling frequency and includes information on fishing practice and gear characteristics, enabling for example, the total area of seabed swept by the gear, or the volume of water filtered, in a given period of time to be calculated. At this level it becomes relevant if information on the spatial distribution of effort exists and when this information is available, at what spatial resolution. We evaluated this by distinguishing between: (1) No spatial information available, (2) Low spatial resolution, or (3) High spatial resolution. Finally, at level 4 we have the ultimate measure of fishing impact: annual population mortality. For the target species of the beam trawl fishery, plaice and sole, this is available from the stock assessments.

Level 1: Fleet capacity

Two principal fishing métiers were identified within the Dutch beam trawl fleet; "Large vessels" with horsepower of 300Hp or more that are not allowed to fish inside the 12 nm zone or the "Plaice box" and "Eurocutters", vessels of less than 300Hp. The number of registered Dutch beam trawl vessels belonging to each métier was determined for each year from the VIRIS database.

Level 2: Fishing effort

Total annual fishing effort, in terms of the number of days-at-sea was determined for each métier within the Dutch beam-trawl fleet based on the VIRIS database.

Level 3: Frequency trawled

The total area of seabed swept by the Dutch beam-trawl fleet in any given year (*SA* in $m^2.y^{-1}$) was estimated by:

$$SA = E * HF * S * 1852 * 2W \qquad 1.$$

where *E* is the measure of effort, i.e. the number of days recorded at sea by the entire fleet ($d.y^{-1}$); *HF* is the mean number of hours fished in a day ($h.d^{-1}$); *S* is the mean trawling speed (knots, converted to $m.h^{-1}$ by multiplying by 1852); and *W* is the width of the beam (m) with two beam-trawls towed by each vessel. These parameter values, determined using information held in both databases, varied between the different métiers in the fleet, *SA* therefore needed to be calculated for each métier independently. Summing the estimates of *SA* for each métier produced the estimate of *SA* for the entire Dutch beam-trawl fleet. In addition to the EC-logbook data trawling speed was recorded by a sample of fishing vessels in the HBH data, allowing the determination of the range of possible fishing speeds. Vessel speed could also be calculated from the APR data by calculating the distance between subsequent positions and dividing by 0.1 hour (i.e. 6 minute time intervals). The VMS database provided the measured speed at each position for most records. The number of hours spent fishing in each day (*HF*) required fishing activity to be distinguished from other vessel activity, i.e. steaming, shooting or hauling the gear, or laying still. This distinction was made on the basis of vessel speed where for each métier in the fleet the mean proportion of records per 24h period that lay within the fishing speed range was equal to the proportion of the time spent fishing. The mean time per day that was spent fishing was calculated from the HBH data that contained the times of shooting and hauling of the gear.

The APR/VMS database holds registration data recorded at different time intervals. In order to combine these data sets the number of hours fishing per year was calculated for each set as follows:

$$E * HF = \frac{FR * TI}{PD} \qquad 2.$$

where *FR* is the number of fishing registrations, Time interval (*TI*) is equal to 0.1 hour (6 minutes) for APR and approximately 2 hours for VMS and *PD* is the proportion of the fleet in the APR or VMS sample (i.e. for which data are recorded in the database). Note that the left hand side of this equation can be substituted directly into equation 1. The mean trawling frequency (*TF*) within the area of Dutch beam-trawling operations was calculated as:

$$TF = \frac{\sum_{i=1}^{SU} \left(SA_i / A_i \right)}{SU} \qquad 3.$$

where SA_i is the area of seabed swept by the Dutch beam-trawl fleet in (sub)area A_i. The area A_i was calculated using GIS (projection UTM-1983, zone 31). Whether or not spatial information on fishing activities was available and if so at what resolution determined the number of Spatial Units (*SU*). The North Sea was defined as ICES area IV minus the area deeper than 200m and if no spatial information was available *SU*=1 and A_1 equal to the area of the North Sea as defined. If based on the VIRIS database or APR/VMS database *SU* equalled respectively the number of ICES statistical rectangles or 1x2 minute squares in which Dutch beam trawl activity had been recorded in that year.

Level 4: Annual population mortality
Ideally, the effect of a fishery on any ecosystem component should be expressed as a annual population mortality (i.e. percentage number of deaths per year to population abundance). In traditional fisheries science the instantaneous mortality rate F is usually calculated as part of the stock assessment process and can be easily converted to the more easily understood concept of Annual Population Mortality (%) through:

$$APM = 100*(1-exp^{-F}) \qquad 4.$$

F can be expressed as catchability * effort, where catchability refers to the chance that an individual in the population is killed by the gear (Beverton and Holt 1957). This depends on (1) the chances of individuals of a species coming into contact with the fishing gear, which is determined by the distribution of the species in relation to the distribution of the fleet, and (2) gear efficiency which is the proportion of the population in the path of the gear that is retained by the gear (Ricker 1975). Catchability therefore integrates all aspects of the distribution of the population in relation to that of the fishing fleet, crew skills, vessel characteristics and gear efficiency (Rijnsdorp et al.).
The main target species of the Dutch beam trawl fishery for which F was available from the stock assessments are plaice and sole. For plaice F is based on both landings and discards, for sole on landings only. As the stock assessments for these species are known to underestimate mortality in the last few years, the values for the final year were not presented.

2.13.2 Results

Level 1: Fleet capacity

According to the VIRIS database the total number of registered beam-trawl vessels declined over the last decade from 378 in 1995 to 224 in 2004 (Figure 2.13.2). The reduction in the number of “Large vessels” was much smaller in relative terms than the reduction in the number of “Eurocutters”, consequently the proportion of “Large vessels” within the fleet increased from 55% in 1995 to 63% in 2004 (Figure 2.13.2).

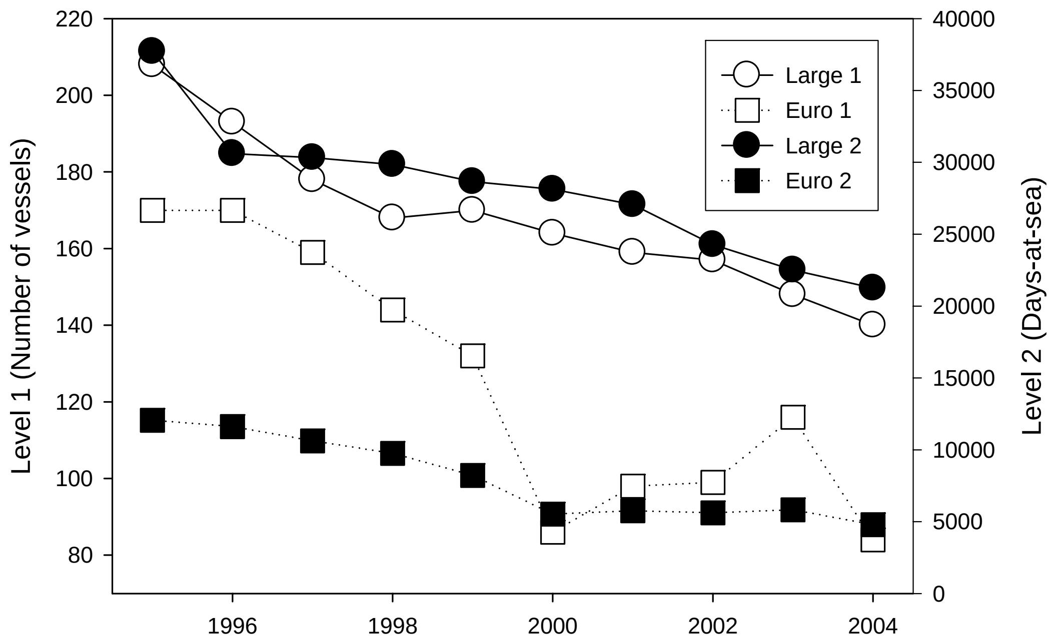


Figure 2.13.2. Time-series of the pressure indicator at Level 1 (fleet capacity - open symbols) and Level 2 (fishing effort - shaded symbols) for two métiers within the Dutch beam trawl fleet. (Large 1: Level 1 indicator for “Large vessels”; Euro 1: Level 1 indicator for ”Eurocutters”; Large 2: Level 2 indicator for “Large vessels”; Euro 2: Level 2 indicator for “Eurocutters”).

Level 2: Fishing effort

Based on the VIRIS database the activity per vessel (=days-at-sea.year^{-1}) varied considerably within and between métiers (Figure 2.13.3). 87% of the “Large vessels” spent 150-250 days-at-sea.year^{-1}, with an average of 170 days-at-sea.year^{-1}. For “Eurocutters”, mean activity was much less with an average of only 67 days-at-sea.year^{-1}, but the distribution was skewed because 25% of “Eurocutters” registered less than 10 days-at-sea.year^{-1}, with many registering only 1 days-at-sea.year^{-1}. For both métiers, activity per vessel decreased by about 1.5 days-at-sea.year^{-1} per year. Total Dutch beam-trawl effort decreased from 49765 days-at-sea.year^{-1} in 1995 to 26034 days-at-sea.year^{-1} in 2004. Over the same period the proportion of total Dutch beam trawl fishing effort that was undertaken by “Large vessels” increased from 76% to 82% (Figure 2.13.2). The spatial distribution of fishing effort at low, ICES statistical rectangle, spatial resolution (i.e. based on the VIRIS database, aggregated over all years) is shown in Figure 2.13.4.

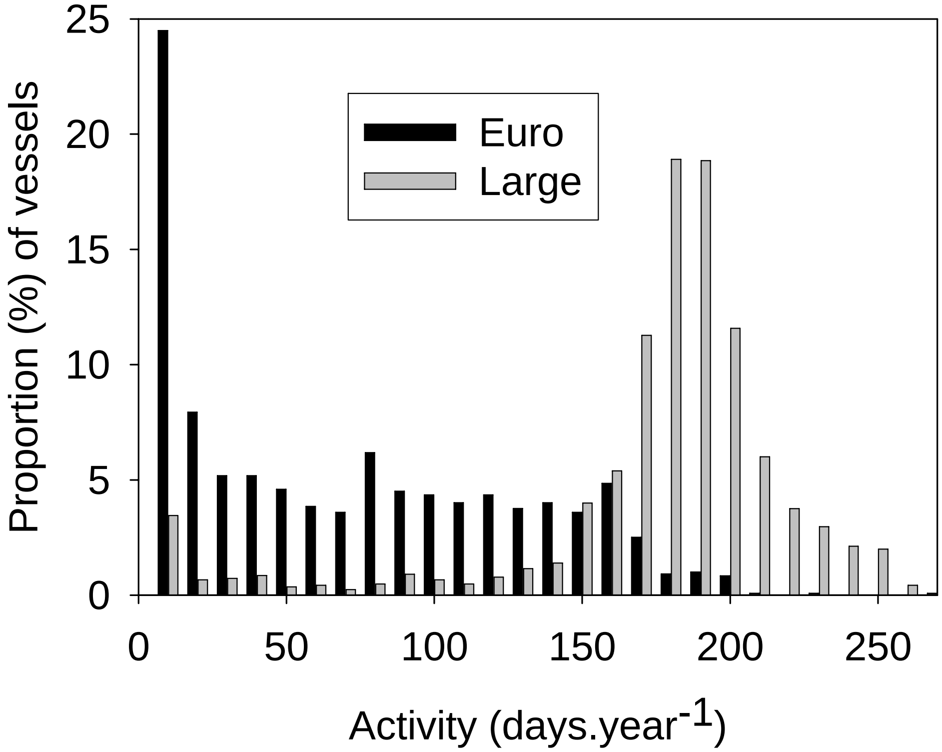


Figure 2.13.3. Vessel activity frequency distributions determined over the period 1995 to 2004 for each métier of fishing vessels within the Dutch beam trawl fleet.

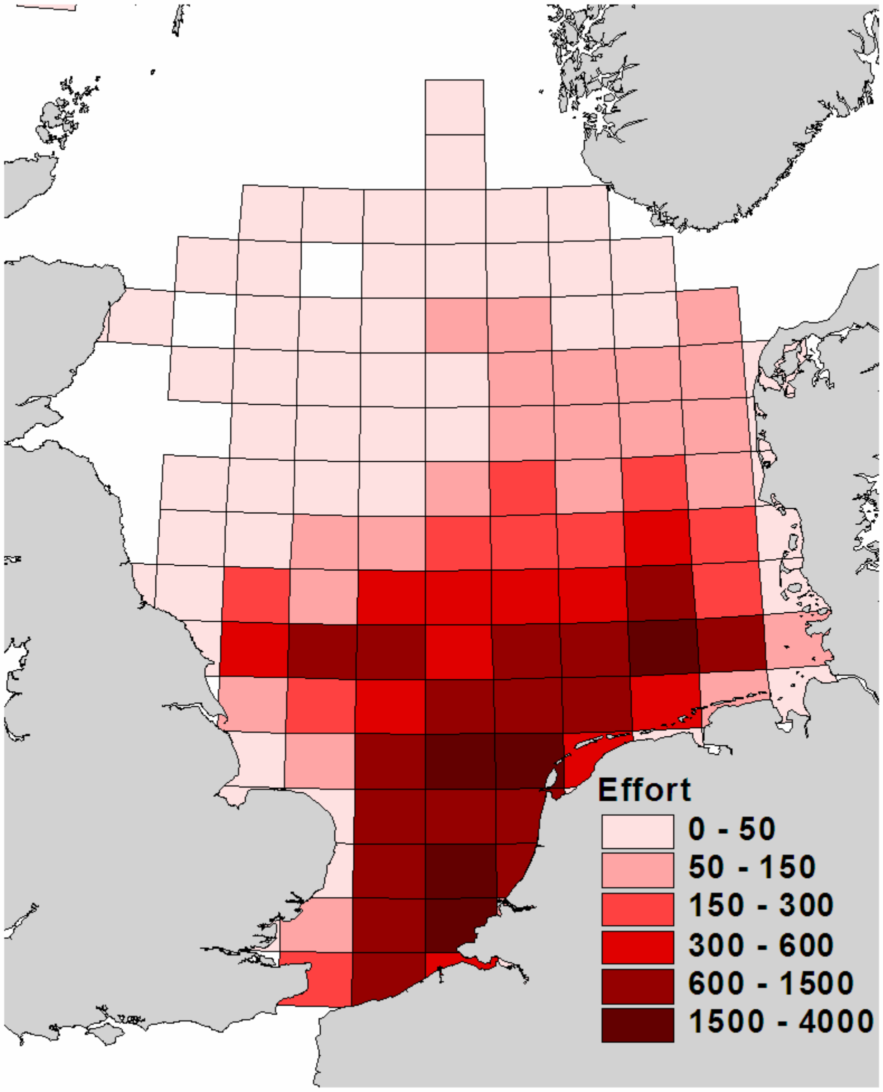


Figure 2.13.4. Spatial distribution of total fishing effort by the whole Dutch beam trawl fleet (recorded as days-at-sea in the VIRIS database). Plot shows all data averaged over the period 1995 to 2004.

Level 3: Frequency trawled

The two métiers within the Dutch beam trawl fleet differ markedly in fishing practice and gear characteristics. Typically "Eurocutters" deploy two beam trawls each of 4 m width, while "Large vessels" deploy two beam trawls each of 12 m width. For each of the fishing métiers frequency distributions of the estimated vessel speed for all APR and VMS registrations were compared with frequency distributions of recorded trawl speeds in the HBH data (Figure 2.13.5). From this we deduced that fishing speeds ranged from 3 to 6 knots for "Eurocutters" and from 5 to 8 knots for "Large vessels". APR and VMS records giving speed estimates within these ranges were considered to be "fishing" records, and the proportion of records falling into this category provided an estimate of the proportion of time spent fishing, enabling the number of hours spent fishing by each métier in an average 24h period to be calculated (Table 2.13.1). There was little difference between the estimated fishing speeds or the proportion of time spent fishing derived from either the APR or the VMS databases (Table 2.13.1), so the values derived from the VMS database were used in equation 1 to estimate the area of seabed swept per day by a fishing vessel belonging to each métier. “Eurocutters” swept an area of 1.2 km^2 on average each day, while “Large vessels” swept an area of 5.3 km^2. Multiplying these values by the total number of days at sea recorded for each métier in the VIRIS database completes the calculation of equation 1, giving estimates of the total area swept by each métier within the Dutch beam-trawl fleet. The area swept by the total Dutch beam-trawl fleet (*SA*) is the sum of these two values.

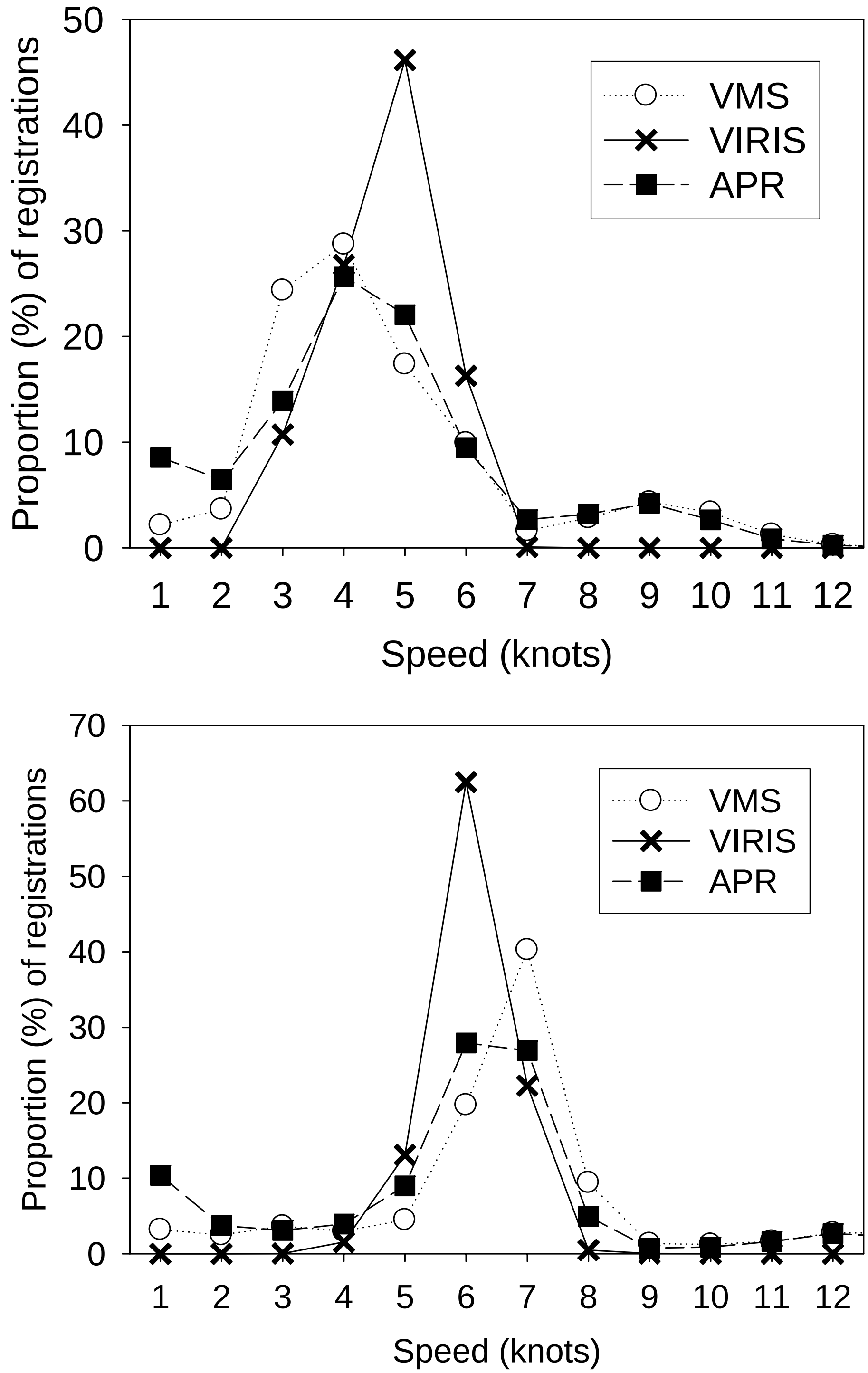


Figure 2.13.5. Estimates of trawling speed derived from each of the three database sources for both the "eurocutter" (upper panel) and "Large vessel" (lower panel) métiers within the Dutch beam-trawler fleet.

Table 2.13.1. Fishing parameters of two métiers of the Dutch beam trawl fleet based on different data sources

Métier	Datasource	Speed	Hours	Proportion of	Area (km^2)

		(knots)	fishing per 24h	the day spent fishing (%)	swept per day
Euro-cutters	HBH	4.7	19.4	80.9	1.3
	APR	4.4	17.1	71.1	1.1
	VMS	4.2	19.3	80.4	1.2
Large vessels	HBH	6.1	20.4	85.1	5.5
	APR	6.1	16.3	67.8	4.4
	VMS	6.7	17.7	73.9	5.3

The VIRIS database provided information that identified all the ICES rectangles in which Dutch beam-trawlers were recorded fishing in each year. Likewise the APR/VMS database identified the fished squares. Knowing the area of each rectangle or square, and summing over all rectangles or squares in which fishing occurred, allowed the total area of Dutch beam-trawling operations in each year (*A*) to be estimated depending on the spatial resolution of the data (Figure 2.13.6a). The low resolution data indicated that just over one hundred ICES rectangles, amounting to about 58% of the North Sea, was fished at the start of the time series, declining to about 50% at the end. In contrast, the high resolution data indicated that approximately 20% of the North Sea (about 26.000 squares) was fished at the start of the period declining to 14%. Figure 2.13.6b illustrates the final result of calculating equation 2 to determine the level three indicator value for each year, the frequency fished (*TF*). The difference in frequency distribution between the VIRIS and APR/VMS datasets is reflected in Figure 2.13.7, which shows the occurrence of spatial units with specific trawling frequencies ($year^{-1}$). Frequencies above 20 $year^{-1}$ were only observed for the micro-scale data. The actual spatial distribution of fishing is shown in Figure 2.13.8. This shows that fishing effort of the eurocutters is mainly concentrated in coastal waters, whereas the larger vessels fish in offshore waters outside the 12 mile zone and the plaice box.
The degree to which the subset of the Dutch bottom trawling fleet, for which APR/VMS data were available, is representative of the entire fleet differs considerably between the period when APR data were used and that when VMS data became available (Figure 2.13.9). In the first period (before the year 2000) mainly large beam trawlers (15-24) and a few eurocutters (1-6) were included in the sample. From 2000 onwards this was increased to 66-143 large vessels and 17-37 eurocutters.

Level 4: Annual population mortality
The annual population mortality (%) of the two commercial species that are targeted by the beam trawl fishery is estimated as part of the stock assessment process (ICES 2005) (figure 2.13.10). The time-series show that over the last decades annual population mortality has increased and contrary to what was observed for the lower level indicators the time-series of both species do not show a decrease in annual population mortality over the last decade but rather a slight (but not significant) increase of 0.04% for sole and 0.55% for plaice (table 2.13.2).

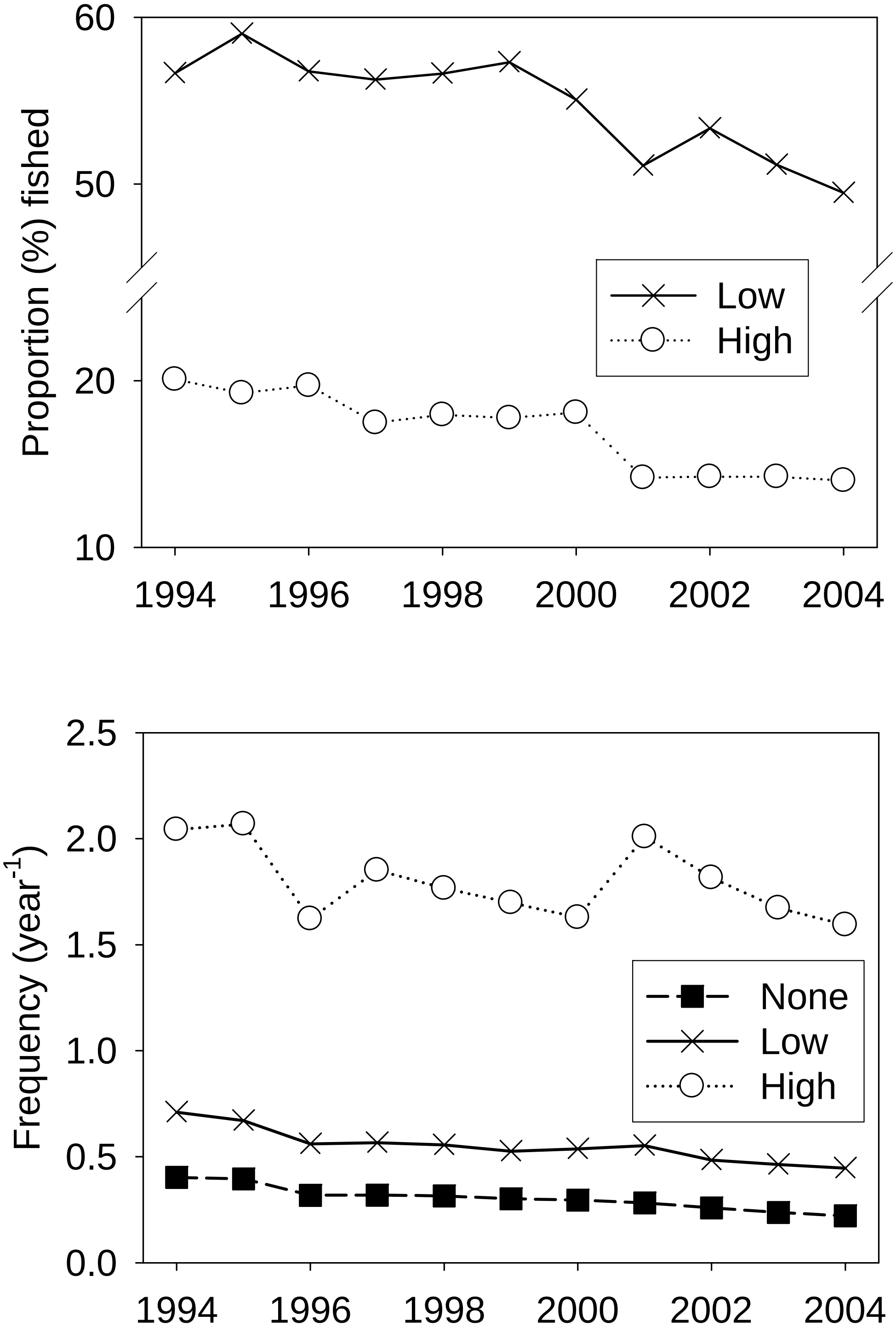


Figure 2.13.6. Time-series of the pressure indicator at Level 3. The figures show the variation in the proportion of the total area of Dutch beam trawl operations fished in each year (upper panel) and the mean frequency that the "fishable" area was trawled each year (lower panel) depending on whether or not information on the spatial distribution is available and at what resolution (High or Low), If no spatial information was available the proportion of the area fished is by definition 100%.

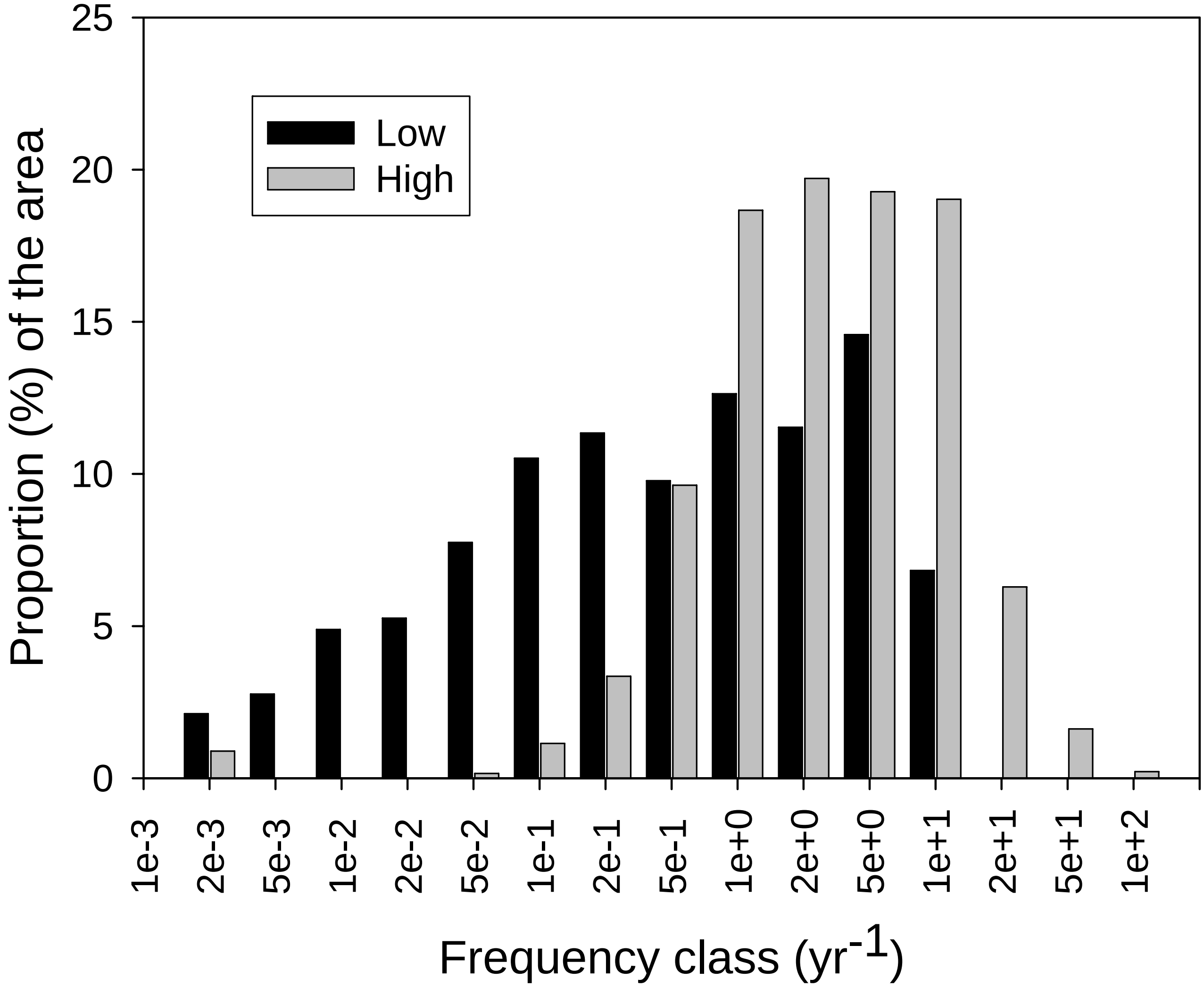


Figure 2.13.7. The distribution of fishing frequencies of the individual fished spatial units across the whole area of Dutch beam trawl operations at two spatial resolutions: Low (ICES rectangles (30x30Nm) based on VIRIS) and High (1x1 Nm squares based on APR/VMS).

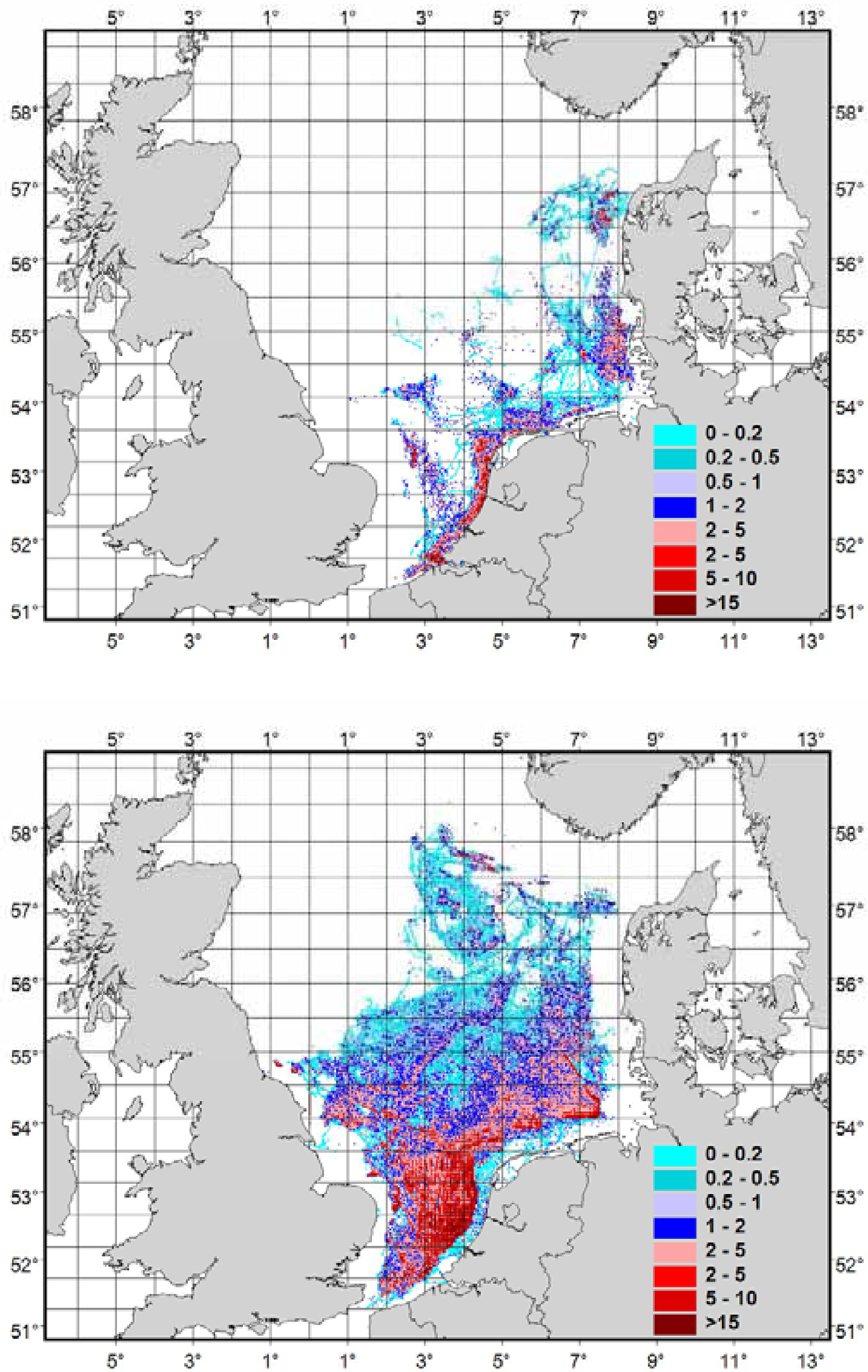


Figure 2.13.8. Spatial distribution of fishing activities of two segments of the Dutch beam trawl fleet expressed by the number of registrations per year based on the period 1994-2003. Upper graph are the eurocutters (enginepower < 300 Hp), lower graph are the large vessels.

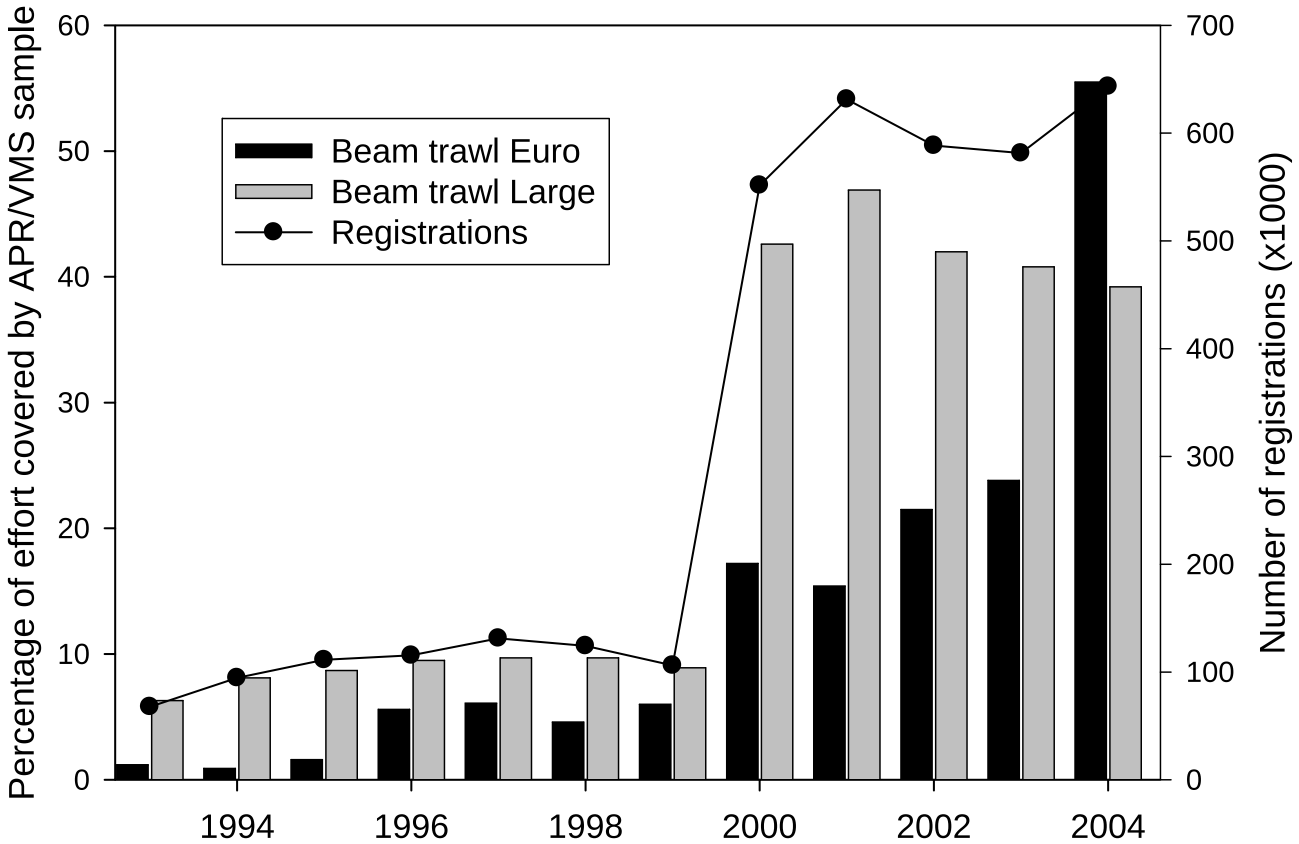


Figure 2.13.9. Representativity and composition of the subset of the Dutch beam trawl fleet in the APR/VMS database. Distinguished are subsets of the fleet based on the type of gear (Otter-, Beam- and Shrimp trawl) and engine-power (Large ≥ 300 Hp and Eurocutter). The number of registrations is standardized to a one-hour interval.

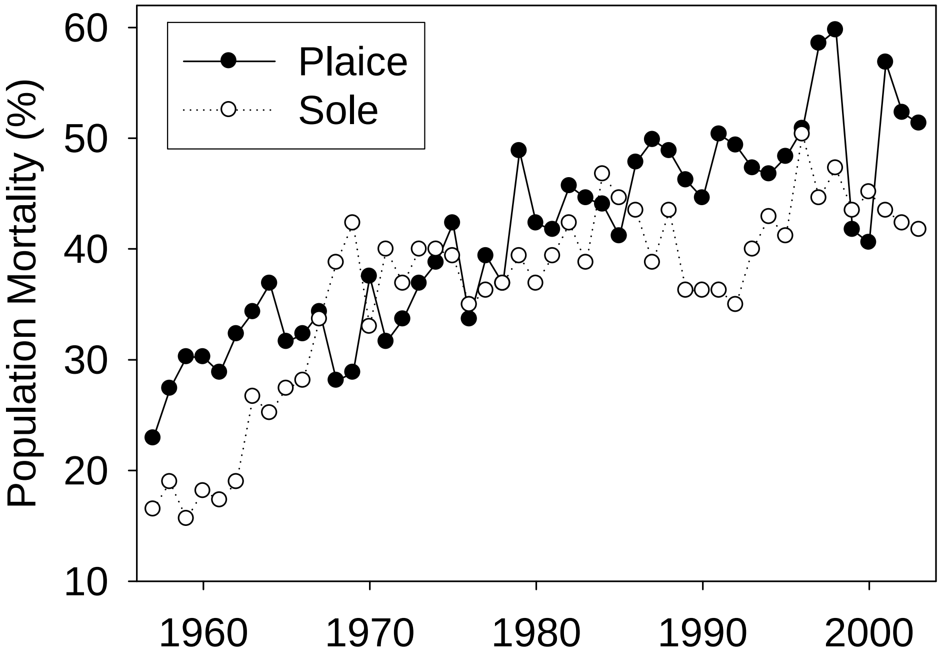


Figure 2.13.10. Time-series of the pressure indicator at Level 4 expressed as population mortality rates of the two target species of the Dutch beam trawl fishery: plaice and sole. The values are for age-classes 2-6 and are based on the 2005 ICES stock assessments.

Table 2.13.2. Summary of absolute values and trends of the pressure indicators at different levels of information content and for populations that differ in vulnerability to that fishery. Level 1 is the fleet capacity, Level 2 the effort in days-at-sea, Level 3 the frequency trawled ($year^{-1}$) and Level 4 the annual population mortality (%) for the two target species of the beam trawl fishery.

Level	Spatial Resolution Target species	Value in 2000	Relative change (%)
1		276	-6.5
2		34829	-6.8
3	NS	0.3	-5.7
	Low	0.4	-4.1
	High	1.8	-1.6
4	Plaice	50.9	0.5
	Sole	43.9	0.0

2.13.3 Evaluation and interpretation

We have used data from the Dutch beam trawl fleet to illustrate how known pressure indicators differ in their representation of fishing impact. When more assumptions need to be made (e.g. the composition of the fleet, fishing practices or modifications of the gear) and hence the level of information content decreases, the indicator becomes more biased. We now address some considerations regarding the implementation of these pressure indicators to support an EAFM, the interpretation of the indicators time-series and the data required to minimize bias.

Level 1: Fleet capacity

When using fleet capacity as the pressure indicator it is important to distinguish between métiers, where each métier is considered to have a relatively homogeneous impact on the ecosystem and its components and where there are considered to be differences between métiers. The fishery in a specific region can be divided into increasingly smaller and more homogeneous métiers. Figure 2.13.11 exemplifies how the beam trawl fishery could fit into such a hierarchy for the North Sea fishery and that it could be further sub-divided beyond the métiers that were distinguished in this paper. With the information currently available however, it is not possible to parameterize these (sub)-métiers in terms of their gear characteristics, fishing speed and fishing area. Characterization of métiers is always arbitrary and increasingly smaller sub-units can be created. Considering that every variation in (rigging of) the gear may alter the impact on the ecosystem, subdividing the fishery into many subdivisions (métiers) potentially allows the most accurate assessment of the ecosystem effects of the fishery. However, if effort data and information on the impact per unit of effort by métier are not available there is no point in subdividing beyond the limitations of the data.

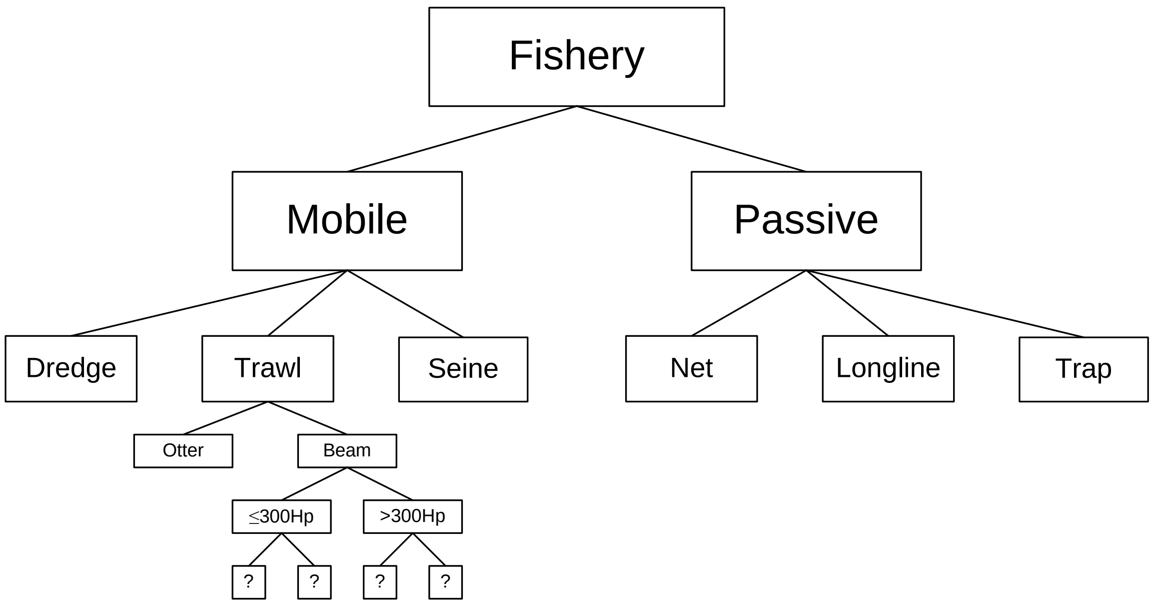


Figure 2.13.11. Example of hierarchy of increasingly more homogeneous and smaller métiers.

Level 2: Fishing effort

Activity varies considerably between vessels, even within one métier. This may be for administrative reasons, for example when vessel quotas are transferred. Alternatively, in the métier where the differences are largest (i.e. the eurocutters), vessels engage in different types of fishery at different times of year using different gears (e.g. shrimp-trawl, otter-trawl) so that for those trips they are not registered as a beam-trawl vessel. The result of this is that measures like decommissioning that appear to have a large effect at level 1 may not have reduced the actual pressure of a specific métier by the same proportion at level 2. For example a reduction in capacity of 19% of the least active eurocutters results in a reduction of just over 1% of effort in days-at-sea.

Level 3: Frequency trawled

For two segments of the Dutch beam trawling fleet, fishing parameters and gear characteristics were determined and used to estimate pressure at indicator level 3, the frequency of trawling. Indicator values at this level may vary by more than a factor of 4 depending on the gear characteristic and fishing parameter values used. The datasets that were used to estimate the fishing parameters provided markedly different estimates of the main parameters, "trawling speed" and "proportion of the day spent fishing", which are inversely related and depend on the speed range chosen. An explanation for this discrepancy is that the calculated speed according to the APR data is underestimated because (1) the vessel does not follow a straight line between the two registrations and (2) if the vessels starts hauling between two registrations the calculated mean speed will decrease. These points will become increasingly important and result in an underestimation of the speed as the time interval between registrations is increased. Thus in order to use speed to distinguish fishing registrations from other activities that do not impact the ecosystem it is necessary to obtain information on the activity of a vessel (e.g. HBH) and combine this with real speed measurements (i.e. not calculated from intervals between registrations). If this needs to be based on calculated speed values the interval should be set as short as possible. This approach to use speed to distinguish fishing from other activities will never be 100% perfect as vessels may engage in activities other than fishing at speeds within the fishing speed range resulting in spurious fishing position registrations and thus an overestimation of the impact.

If available, information on the spatial distribution of the fishery at the highest possible resolution needs to be incorporated when assessing the pressure on the ecosystem. We used two sources of data that differed in their spatial resolution: VIRIS data are at a relatively low resolution of ICES rectangles (approximately 30x30 Nm) while the APR/VMS data were aggregated at a relatively high resolution of 1x2 minute squares (approximately 1x1 Nm). Comparison of the frequency distributions of these datasets shows that the resolution used makes a big difference. According to low resolution data more than 50% of the North Sea is fished of which one third of the ICES rectangles are fished more than once a year and maximum frequency is about 5 $year^{-1}$. According to the high resolution data only about 20% of the North Sea is fished of which two thirds is fished more than once a year and the maximum frequency is up to 100 $year^{-1}$. In this example the proportion of the area fished according to the high resolution data may be slightly underestimated as not all beam trawl vessels are part of the APR/VMS database. The calculated frequency was not affected by this as it was weighted by a factor that raises the frequency of the sample to that of the entire fleet. The important take home message here is that as the spatial resolution of fishing activity data increases, the proportion of the area fished declines, while the trawling frequency within the fished area increases on average.

Level 4: Annual population mortality

The time-series of annual population mortality of plaice and sole show that pressure on these stocks in the past decade has probably increased. This becomes even more likely when considering the systematic underestimation of mortality in the last few years by the stock assessment process. The parameters that describe the annual population mortalities of plaice and sole fall within the range that is observed for the different populations at high spatial resolution thereby confirming that a higher spatial resolution provides more accurate estimates.

These large differences show that within an EAFM, target levels for mortality can only be set realistically at the highest level of information content and that when mortality needs to be calculated (e.g. for non-target species) the spatial resolution is important. It is therefore recommended that a standard spatial resolution is used and as long as this is not achieved the spatial resolution should at least be reported whenever level 3 frequencies are used.
The consequences of this for the use of pressure indicators as part of an EAFM is that the best pressure indicators (i.e. population mortality) will differ between species both in terms of their absolute value and trend and that this in turn may respond differently to management measures than the lower level pressure indicators. Considering this difference between species, the pressure expressed as population mortality of one or two commercial species will not be representative for the whole community. Thus, if management objectives are set for community level indicators such as mean weight, mean maximum length or biodiversity (Piet and Jennings 2005) the community mortality will need to be determined as an integrate of all the population mortalities. For this the swept-area method introduced simultaneously by (Pope et al. 2000) for fish and Piet et al. (2000) for benthos is probably most appropriate.

The swept are method involves the lower level pressure indicators together with the chance of individuals of a species coming into contact with the fishing gear and the encounter mortality which is the proportion mortality caused by the singular passing of the gear. For the benthic community, encounter mortality has been determined (for review and meta-analysis see Collie 2000 and (Kaiser et al. 2005) as there are sampling techniques that allow the determination of absolute pre- and post-haul abundances and in Piet et al. (2000) the fishing-induced population mortality was determined for a limited number of benthic species in the Dutch sector of the North Sea. For fish there are no estimates of the encounter mortality caused by the passing of the gear. In fishery science catchability and gear efficiency are known concepts (e.g. (Dickson 1993)). It is easy to measure the amount caught but as long as there are no reliable estimates of the true abundance before the passing of the gear it is difficult to determine catchability. The main problem is that any gear that is used to determine the initial (pre-hauling) abundance will suffer from the same or similar limitations that prevented the determination of the catchability in the first place; any gear will only catch a gear-dependent subset of a population or community. Several studies exist that at least identified some of the factors involved i.e. herding (Engås and Godø 1989, Engås 1994), swimming speed (Wardle 1975, 1977, He 1993) or other behaviour aimed at escaping the net (Bublitz 1996, Albert et al. 2003) and finally selectivity (Myers and Hoenig 1997, Reeves et al. 1992) for those fish that end up in the net. To further complicate the matter, encounter mortality consists not only of mortality of animals caught in the net (i.e. catchability) but also mortality due to contact with the gear (e.g. after passage through the net).

Determining the encounter mortality of a species in the gear used by a specific métier may be difficult as almost every vessel will fish with gear with slightly different characteristics and rigging (e.g. for a beam trawl the mesh-size, number of ticklers, use of chain mat or flip-up rope etc.), which could affect encounter mortality. It might seem appropriate therefore to distinguish each of these gear types, but the amount of work required to estimate encounter mortality would be prohibitive. We suggest a limited number of métiers be distinguished with "standard" gear types assumed for which encounter mortality can be determined.

The usefulness in an EAFM of this framework of pressure indicators becomes apparent when the minimum level of information content can be identified that is required to evaluate a particular type of management measures. Effort control through decommissioning is already reflected at the lowest level while it will show at the 2nd level if it is implemented through a reduction of the days-at-sea. Technical measures may show up at the 3rd level if it involves changes in the gear characteristics that determine the area fished in relation to effort (e.g. if the width of a beam trawl is reduced) but usually only affect the encounter mortality and will therefore only show up at level 4. Spatial measures such as marine protected areas (MPAs) can only be evaluated at level 4.

This case study demonstrates that it is possible to develop pressure indicators that describe the impact induced by fishing activities on the ecosystem, and which are appropriate for use as part of an EAFM. However, the best Pressure indicators are currently only available for a few commercial species or need to be estimated using the swept area method. In both cases this comes with extensive data requirements which at present are only marginally available even in one of the most data-rich marine environments in the world. An EAFM can only be successfully implemented and monitored if the fishing pressure can be described at a level of information content that is adequate to guide management decision making.

2.13.4 Recommendations

The above example has shown how the different pressure indicators differ in their representation of the actual impact i.e. mortality on one or more of the ecosystem components. The preferred pressure indicator is the mortality of that ecosystem component (or those ecosystem components) for which objectives were set. For most commercial species these are known from the assessment process, for all other components these can be measured through observer programs or modelled (e.g. using the swept area method). All other (lower level) indicators are at best proxies of the actual fishing impact on the ecosystem component(s) that are increasingly biased if more assumptions need to be made on how the fishery interacts with these component(s).

2.14 Structural support and proportion allocated to promote environmental friendly fishing practices.

The proportion of FIFG funds that are allocated to environmental protective measures will give a monetary indication of the extent to which EU structural policy is supportive of environmental goals. At present, detailed statistics on the structural support to the fishing sector and in particular activities aiming at the promotion of environmentally friendly fishing practices are not readily available on project basis. Information on the distribution of the FIFG budget over different areas (“measures”) has been obtained from DG FISH. However, environmentally friendly fishing practices do not form a separate category in the FIFG budget. Due to lack of information about separate FIFG projects, only a very rough estimation of this indicator can be calculated.

2.14.1 Material and methods

The main instrument for structural support in Europe is FIFG, the Financial Instrument for Fisheries Guidance. Structural support is also given by national governments of the Member States. Here the analysis will be limited to FIFG structural support. However, in principal, the same approach can be followed for structural support by Member States governments.

The FIFG budget is divided over different areas (measures). However, “environmentally friendly fishing practices” is not one of the areas. Before we can calculate an indicator, we should define what FIFG measures can be regarded as promoting environmentally friendly fishing practices.

Here two approaches are proposed and consequently two indicators are calculated. The first approach (indicator A) is based on a narrow view of “environmentally fishing practices”. It includes only the structural support that is dedicated directly to measures concerning the environment. The second approach (indicator B) includes also the budgets for scrapping of vessels and for temporary cessation of fishing. Less fishing and less fishing capacity will benefit the environment but it is disputable whether it can be seen as promoting environmentally fishing practices.

Indicator A includes just the three categories of measures listed below.

- Measure 31: protection and development of aquatic resources
  action 1, indicator 1: surface of marine protected areas
  indicator 2: nombre de projets d'autres types

- Measure 44: Operations by Members of the trade
  action 3, indicator 3: number of actions concerning aquaculture or the protection of the environment (or integrated coastal zone management)"

- Measure 46: innovative measures
  action 1: pilot / demonstration projects
  - (indicator 1: experimental fishing)
  - indicator 2: No of other pilot/ demonstration projects" (maybe this could include more environmentally friendly fishing gear etc. ?!)

Even these three measures or actions within measures may contain also projects that cannot be seen as promoting environmentally friendly fishing practices. However the budgets of individual projects are not available on central level

Indicator B includes the budgets for indicator A as well as the FIFG budgets for scrapping and temporary cessation of fishing.

Necessary data

- FIFG budget by area (measure) per Member State per year
- Annual expenditures by area (measure, action, project) and by Member State.

Data availability

Since 2002 Member States are compelled to provide DG Fish with data on annual expenditure on the different FIFG measures. However they don't provide data by project, which makes it difficult to decide which part of the budget was spent on environmentally friendly fishing practices. Data on total FIFG budget are only available for the whole period, not by year.

Data available in Brussels:

- FIFG Budget per Member State and per Member state for each measure (not by action or indicator) for the whole period 2000 – 2006 (not by year)
- Annual expenditure by Member State and by area (measure, action, not by project).

The Source of data is DG Fish, Unit C1, General aspects of structural policy. The Time series is 2000 – 2006 / 2004 and the geographic area is EU 25, breakdown by Member State

2.14.2 Results

Table 2.14.1 Proportion of FIFG structural support allocated to promoting environmentally friendly fishing practices

	Budget 2000 - 2006	Expenditure 1-1-2000 to 31-12 2004	
	FIFG budget 2000 – 2006 (Mio €)	Indicator A	Indicator B
Austria	4.80	1%	1%
Belgium	36.80	1%	10%
Cyprus	3.40	0%	44%
Czech Rep.	7.30	0%	0%
Germany	218.00	4%	7%
Denmark	213.30	6%	27%
Estonia	12.50	0%	16%
Spain	1787.50	3%	22%
Finland	41.70	6%	12%
France	280.60	4%	15%
Greece	223.60	1%	31%
Hungary	4.40	0%	0%
Ireland	67.80	0%	8%
Italy	399.70	3%	31%
Lithuania	12.10	0%	0%
Luxembourg	0.00	0%	0%
Latvia	24.30	0%	0%
Malta	2.80	0%	0%
Netherlands	38.40	0%	9%
Poland	201.80	0%	41%
Portugal	215.20	3%	18%
Sweden	76.80	70%	90%
Slovenia	1.80	0%	0%
Slovak Rep.	1.80	0%	0%
UK	222.30	3%	25%
PEACE II UK-IRL	3.50	0%	0%
Total	4102.20	4%	23%

Source: DG Fish, Unit C1, General aspects of structural policy

2.14.3 Evaluation and interpretation

Problems with data availability:

- Due to limited data availability it's only possible to calculate the ratio of expenditures to the total budget for the whole period. This means that a good indicator will not be available before the end of the FIFG period (2006) when expenditures will cover the whole period 2000 – 2006. It will also not be possible to calculate relevant time series of annual values of the indicator.
- In theory, it would be possible to extend the time series to the period before 2000 by including previous FIFG programmes. However, the definition of the indicator would have to be adjusted because categories in subsequent FIFG programmes are different.

The proportion of structural support allocated to promoting more environmentally fishing methods is certainly a relevant indicator for environmental integration of the CFP. At present, however, data on national support for environmentally friendly fishing practices by the Member States are not available in Brussels. Moreover, data on allocation of FIFG structural support are only partly available, which makes it impossible to calculate the exact value of this indicator for the present FIFG programme.

The proportion of FIFG support allocated to environmental protection differs substantially by Member State. The proportion spent on indicator A is on average 4% but varies from o% in several Member States to 70% in Sweden. The proportion spent on indicator B is much larger (average 23%) due to relative large budgets for scrapping of vessels and temporary cessation of fishing in most Member States with a marine fishing sector. The proportion of the total budget varies from 90% in Sweden to 8% in Ireland 9 (just considering Member States with a marine fishing fleet).

2.14.4 Recommendation

If this indicator is to be calculated on a yearly basis it would be advisable to:

- distinguish "promotion of environmentally friendly fishing methods" as one of the categories in the new FIFG programmes
- one value per FIFG period (i.e. 2000-2006) is not sufficient to make this a useful indicator, if FIFG support is to be used for this indicator then FIFG budget should be available by measure per Member State and per year
- oblige Member States to provide annual data on total expenditures on FIFG measures as well as expenditures on promotion of environmentally friendly fishing.
- oblige Member States to also supply annual data on national support to the fishing sector as well as on the proportion spent on environmental measures.

2.15 Mapping of effort distribution over the sensitive areas

This indicator is effectively a combination the information necessary for the indicators presented in sections 2.8 and 2.13, where fishing effort is overlaid on maps of marine habitat extent. As this is only relevant when an impact of the fishing practices on the habitat is expected we used a matrix (table 2.15.1) to cross-reference them.

An example of the mapping of effort distribution over marine landscapes (not necessarily sensitive areas) is shown for the Irish Sea.

Table 2.15.1. Matrix of fishing gear/habitat type and fishing activity, X indicates a potential impact (after ICES, 2000; Gubbay, 2001).

	Sensitive Habitat Type (from Gubbay, 2001)						
Fishing Activity	Deep-water biogenic habitats[1]	Structural benthic epifauna[2]	Benthic infauna[3]	Mollusc beds[4]	Nearshore communities[5]	Intertidal mudflats	Maerl beds
Otter trawling	X	X	X	X	X		X
Beam trawling		X	X	X	X	X	X
Pelagic trawling							
Drift/gill netting	X						
Bottom long-lining	X?	X				X	
Pelagic long-lining							
Tangle netting	X?	X?			X	X	
Pot fisheries		X			X		
Dredging (Epibenthic)		X	X	X	X	X	X
Dredging (Hydraulic)		X	X	X	X	X	

Key to sensitive habitat types:

1 Deep-water biogenic habitats: Lophelia pertusa reefs, carbonate mounds, oceanic ridges with hydrothermal vents, seamounts and deep-water sponge communities.

2 Structural benthic epifauna: Sabellaria spinulosa reefs.

3 Benthic infauna: Seapens and burrowing megafauna communities.

4 Shellfish beds: Ampharete falcata sublittoral community, Ostrea edulis beds, Modiolus modiolus beds and intertidal mussel beds.

5 Nearshore communities: Zostera beds and littoral chalk communities.

2.15.1 Materials & methods

At present there are insufficient biological data to define habitats. The Irish Sea Pilot project has classified 18 distinct marine landscapes based on geophysical and hydrographical information (Roff and Taylor 2000; Vincent et al. 2004). The main types of data used for landscape classification were depth, substratum type, current strength (sea bed stress), and topography (slope). The sensitivity of each landscape to trawling impact was assessed on the basis of whether the biotope complexes characteristic of the marine landscape would survive a one-off impact (Golding et al. 2004).

VMS fishing effort data were spatialised within the GIS package ESRI ArcGIS version 8 (Mills et al. 2004). The UK VMS database logs the geographical position, speed, bearing and identification number of European vessels over 24m in length within UK waters. In this study, VMS data were used from 1st January 2000 to 31st December 2004 for all UK and non-UK beam, dredge and otter trawling vessels over 24 m in the Irish Sea (ICES Division 7a). Approximately 98% of the vessels operating in the Irish Sea were British, French, Belgian and Irish, and these were used in all subsequent analyses. A small proportion of the gear type descriptors were missing from UK vessels, and on those occasions other national fisheries databases containing vessel registration and type were used to fill the gaps. A larger proportion (75%) of the non-UK vessel VMS returns were not attributed with gear type information. As detailed gear type databases for these international fleets were unavailable, a different approach was adopted. The gear types used by French, Belgian and Irish vessels were inferred by examining the location of the fleets by nation of origin, and applying expert knowledge of the local patterns of fisheries exploitation from throughout the Irish Sea. Using this method it was concluded that the Belgian fleet in the Irish Sea consisted almost entirely of beam trawlers while the French vessels were mainly otter trawlers. The Irish fleet, however, consisted of both beam trawlers and otter trawlers. Due to the known spatial distribution of the Irish fleets, which broadly separated the trawlers in the eastern Irish Sea from those exploiting the Nephrops fishery by otter trawlers in deeper muddy grounds, it was possible to distinguish the few remaining unclassified Irish vessels. Transmitted vessel speeds of UK vessels were used to differentiate among possible vessel behaviours: stationery, fishing, or steaming. The distribution of vessel speeds associated with active fishing was derived from UK vessels known to have been fishing based on logbook records. The frequency distribution of vessel speeds was then used to determine thresholds for fishing speeds of each of the three gear categories. The frequency distribution for beam trawlers suggested that fishing was likely to occur took place at speeds of between 2-8 knots inclusive. Data for dredgers and otter trawlers suggested that fishing occurred at speeds between 1-4 knots inclusive. We summarised fishing effort by calculating average daily counts of VMS fixes over the entire region and individual marine landscapes in each year.

In order to calculate the spatial distribution of fishing activity by each of the gear types, the VMS database was incorporated into a GIS. To estimate vessel density, we used a kernel density estimation (KDE) technique within ArcView Spatial Analyst. A 1 km grid was created covering the entire Irish Sea, and vessel positions were allocated to a search radius surrounding each cell. We used a radius of 14 km based on the least squares cross-validation technique that produced a surface that described local variation in fishing intensity with minimal over-smoothing (Silverman 1986). The vessel density per 1 km^2 cell was calculated from the total number of records and the area of the search, with each vessel position weighted using an adapted Gaussian distribution so that recorded vessel positions close to the cells had a greater weighting. The distribution of VMS fishing effort over each marine landscapes was summarised by comparing the fishing effort density surface outputs with the marine landscape map beyond 6 nm from shore (Mills et al. 2004). The total number of VMS location records for active fishing vessels in each year was calculated for each marine landscape.

2.15.2 Results

The most frequent fishing activities were otter trawling and scallop dredging with 20.2 ± 2.3 and 18.3 ± 3.6 VMS registrations day^{-1} $year^{-1}$ respectively, compared to beam trawling (8.1 ± 2.7 VMS registrations day^{-1} $year^{-1}$).

Otter trawling activity has been consistent over the past four years, with a slight reduction in 2001 (Figure 2.15.1a). Scallop dredging activity increased up to a peak in 2002 and remained stable for the next two years (Figure 2.15.1b). Beam trawl effort has remained consistently low until effort doubled in the last two months of 2004 (Figure 2.15.1c).

Otter, dredge and beam trawling occurs in just 12 of the 18 marine landscapes, and most fishing activity (98%) occurred in just six landscapes (Table 2.15.2). Most fishing activity occurred over low bed stress coarse sediment plains (49.7%), followed by high bed stress coarse sediment plains (13.9%), and fine sediment plains (13.8%), mud basins (deep = 8.6%; shallow = 5.7%) and sediment wave megaripple fields (6.4%).

There have been increases in fishing activity in three sensitive landscapes. Dredging activity has increased three-fold in low bed stress coastal sediment plains (Figure 2.15.2a). Otter trawling has almost doubled in shallow water mud basins (Figure 2.15.2b). Beam trawling has increased 7-fold in fine sediment plains (Figure 2.15.2c). Beam trawling has also increased in sediment wave megaripple fields (Figure 2.15.2e), which have relatively low sensitivity to the impacts of trawl gears.

2.15.3 Evaluation

Availability of historical data

This analysis demonstrates that historic data are available for 2000-2004 for otter, dredge and beam trawlers >24m in the Irish Sea. There is good scope to extend the fleet and habitat coverage of this indicator. All vessels >15m have been included in the VMS since 2004. The marine landscapes habitat classification is currently being extended, which will allow this indicator to be calculated for all UK waters to the median line.

Measurement

This analysis shows that it is possible to generate an indicator to show how fishing activity varies over sensitive marine landscapes over time. Ideally the indicator should represent the impact on biological habitats and as currently formulated there are two problems with this index. First, it is difficult to relate this measure of fishing activity (VMS vessel activity ‘pings’ day^{-1} $year^{-1}$) to the mortality of benthic organisms or change in benthic secondary production, or some other direct measure of change in biodiversity or ecosystem function. It may be fruitful to develop further methods of swept area estimation from such low resolution VMS data (Eastwood et al. submitted; Mills et al. submitted). Second, the marine landscapes used are derived from physical features and thus are not a direct representation of biological value or sensitivity.

The continued development of this indicator is contingent upon the development of a Pan-European VMS database.

Cost

Cost is low and currently confined to the staff time required to analyse VMS vessel distributions.

Table 2.15.2. Irish Sea marine landscapes subject to fishing activity. The size of each landscape is presented in areal extent (km^2) and expressed as a proportion of Irish Sea Pilot project study area. Sensitivity to trawling is scored categorically from 3 = highest to 1 = lowest sensitivity, NA indicates insufficient information on seabed habitats to assess sensitivity. Fishing activity is expressed as VMS registrations expressed as a percent of total.

Marine landscape	Landscape area (km^2)	Landscape area (%)	Sensitivity to trawling	Otter trawl activity	Dredge trawl activity	Beam trawl activity	Average trawl activity
Low bed-stress coarse sediment plain	15186	25.1	3	27.6	82.9	40.1	49.4
High bed-stress coarse sediment plain	11760	19.4	3	21.4	4.0	12.9	13.9
Fine sediment plain	13218	21.9	3	13.1	11.3	22.8	13.8
Deep-water mud basin	5024	8.3	2	16.8	0.2	0.9	8.6
Sediment wave/megaripple-field	6630	11	1	5.7	0.8	23.1	6.4
Shallow-water mud basin	980	1.6	2	11.1	0.4	<0.1	5.7
Deep-water channel	234	0.4	NA	3.4	0.0	0	1.7
Sand/ gravel-banks	540	0.9	3	<0.1	0.2	<0.1	0.1
(Irish) Sea Mounds	74	0.1	3	0.1	0.0	0	<0.1
Photic reef	278	0.5	3	0.1	0	<0.1	<0.1
Coastal sediment	3606	6	3	<0.1	<0.1	<0.1	<0.1

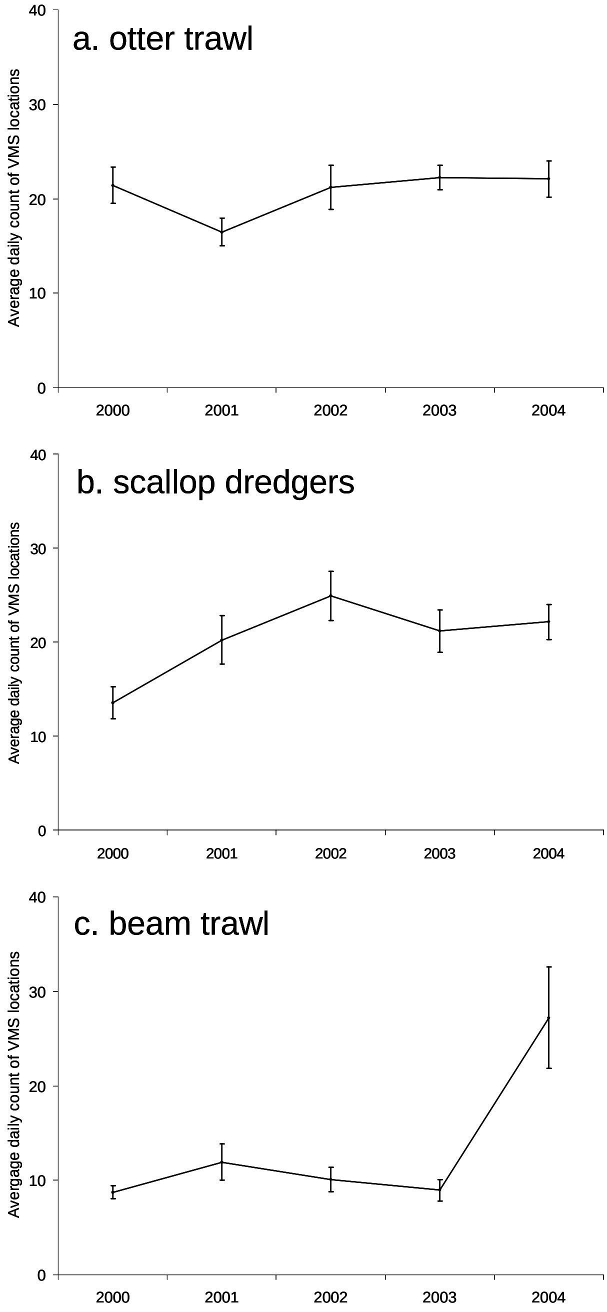


Figure 2.15.1. Annual variation in activity of (a) otter trawlers, (b) scallop dredgers, (c) beam trawlers and in the Irish Sea based on VMS locations. Error bars represent 95% confidence intervals

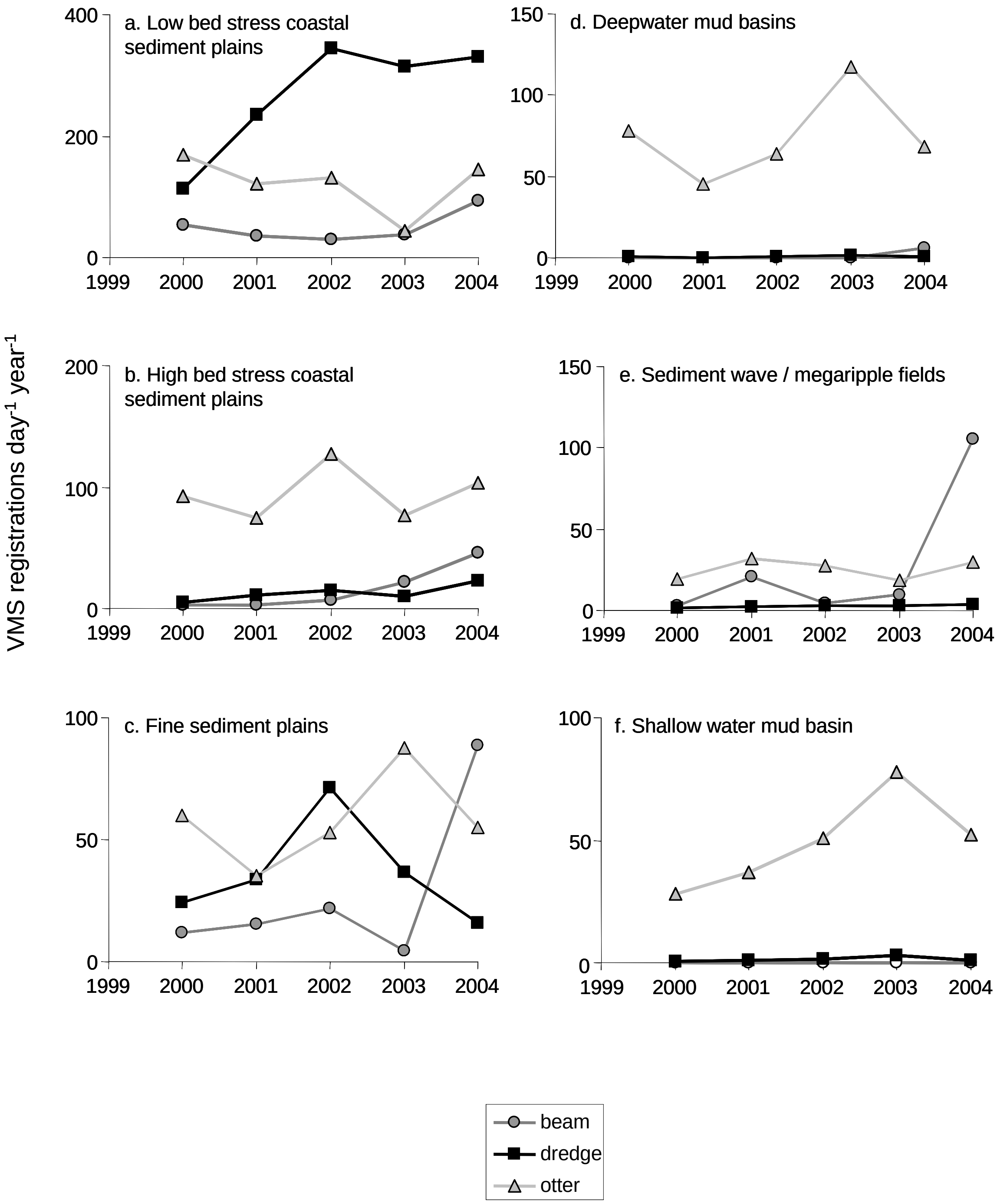


Figure 2.15.2. Annual variation in fishing activity of over six marine landscapes in the Irish Sea based on VMS locations.

2.15.4 Evaluation & interpretation

The possibility to quantify this indicator suffers from the same problems as were already identified in sections 2.8 en 2.13, i.e. the lack of high-resolution data on the spatial distribution of sensitive habitats and the fishing activities that impact them. It is only these data that will allow us to advice on the spatial extent of fishing activity, and the potential impacts of these gears on demersal habitats.

2.15.5 Recommendation

For this indicator to become operational we need consistent definitions of sensitive habitats and high-resolution data that mark their spatial distribution. For the distribution of fishing VMS data should become available.

2.16 Use of environmentally friendly gears

In general the overall impact of CFP policies and in particular the FIFG structural policy is documented. However, at present there is no information readily available in national general statistics on the structural support to the fishing sector and in particular activities aiming at the promotion of environmentally friendly fishing practices. In addition there is no internationally agreed definition available of the notions of: “environmentally friendly measures” or “environmentally friendly gears” as a common understanding of what constitutes an “environmentally friendly” overall structural policy. This indicator can therefore not yet be considered a useful indicator for environmental impact.

2.16.1 Material & methods

Sources of data
The most useful source of data would be the effort statistics collected as part of the European Data Collection (EDC). Ideally it should be possible to characterize the gears in this database based on their “environmentally friendliness” and develop an index by combining this with information on the number of days-at-sea or hours fished per gear-type. However, at present there is no definition of “environmentally friendly gears” and there is insufficient distinction between gear-types in the EDC database for such an exercise.

One could assume that production methods in MSC certified fisheries and other eco-certified fisheries and organic aquaculture includes environmentally friendly gears. This, however, is not a useful criterion as it is possible that some not certified fisheries also make use of “environmentally friendly gears”.

At the centre of the MSC is a set of *Principles and Criteria for Sustainable Fishing* (MSC executive 2002) which may be used as a standard in a third party, independent and voluntary certification programme. The third principle counts various criteria among them also operational criteria relating to gear.

The fishery is subject to an effective management system that respects local, national and international laws and standards and incorporates institutional and operational frameworks that require use of the resource to be responsible and sustainable (MSC principle 3).

Operational Criteria

Fishing operation shall:

- make use of fishing gear and practices designed to avoid the capture of non-target species (and non-target size, age, and/or sex of the target species); minimise mortality of this catch where it cannot be avoided, and reduce discards of what cannot be released alive;

- implement appropriate fishing methods designed to minimise adverse impacts on habitat, especially in critical or sensitive zones such as spawning and nursery areas;

- not use destructive fishing practices such as fishing with poisons or explosives;

- minimise operational waste such as lost fishing gear, oil spills, on-board spoilage of catch, etc.;

The EU is currently working on standardizing EU organic seafood norms.
Article 10 in a Proposal for a Council regulation on organic production and labelling of organic products (Brussels 21.12.2005. COM (2005) 671 final) states that production rules applicable to organic aquaculture will be established. This regulation will become effective in 2009 and Member states shall transmit statistical information necessary for the implementation and follow up of this regulation. This statistical programme will be defined within.the context of the Community Statistical Program.

2.16.2 Recommendations

In order for the suggested method to derive an indicator for the use of environmental friendly gears we suggest the following:

- A definition of "environmental friendly gears" needs to be formulated.
- A framework needs to be developed that categorizes all the gear types used in European waters and allows characterisation of these gear types in terms of e.g. "environmentally friendliness".

When only "environmental friendly gears" are allowed in eco-labelled fisheries, statistical knowledge on eco-labelled fisheries and aquaculture could give information on the use of these gears.

2.17 Oil consumption as a proxy for CO2 production.

The oil consumption by fishing fleets can be considered a proxy for their contribution to CO2 production and can therefore be considered a useful indicator for environmental impact of structural measures.
At present the data collection regulation does not oblige Member States to provide data on fuel consumption by fishing vessels. Therefore these data are not readily available for all Member States.
However, it is possible to estimate fuel consumption on the basis of fuel costs and fuel prices. An attempt has been made for the Dutch fishing fleet and a 5-year time series

is presented in this chapter. A longer time series (1990-2003) is presented for the Dutch cutter fleet, excluding the pelagic freezer trawlers.

2.17.1 Material and methods

Sources of data
Number of vessels, engine power, crew, fuel costs (data for Dutch fleet): LEI

Calculation of indicator
Oil consumption has been calculated on basis of fuel costs and fuel prices.

Comments on indicator
Total oil consumption can be considered a useful indicator for environmental impact of fisheries. However, it is influenced by both the fleet capacity (number of vessels, engine power), fishing effort (number of sea-days) and fishing techniques. In order to reveal more information about development of the fishery, *oil consumption per vessel* has been included as a second indicator. O*il consumption per kg of landed fish* is presented as a third related indicator and can be considered an indicator for environmental efficiency of production. The fourth indicator presented is the ratio of fuel costs and value of landings. This can be seen as an economic indicator for the incentive to change to less energy intensive fishing methods.

Availability of data
Oil consumption in litres is not readily available for EU Member States and for EU total fleet. However, according to data regulations, Member States are obliged to provide data on fuel costs. Oil consumption can be estimated on basis of fuel costs and estimated fuel prices. Fuel prices will differ by Member State and by fleet and are not available for all fleets. Therefore in this report only indicators for the Dutch fleet have been calculated.

2.17.2 Results

Table 2.17.1 Oil consumption by Dutch cutter fleet (1990 – 2003)

	Number of vessels	Engine power (1000 kW)	Crew	Oil Consumption (Mio litres)	Oil cons per vessel (Mio litres)
1990	553	559	2,486	320	0.58
1991	512	521	2,292	305	0.60
1992	482	492	2,195	323	0.67
1993	473	491	2,184	353	0.75
1994	469	493	2,159	369	0.79
1995	458	489	2,108	368	0.80
1996	444	477	2,037	332	0.75
1997	427	457	1,923	332	0.78
1998	412	439	1,858	326	0.79
1999	403	430	1,826	319	0.79
2000	401	427	1,829	321	0.80
2001	401	422	1,775	306	0.76
2002	397	404	1,746	283	0.71
2003	383	380	1,572	269	0.70

Table 2.17.2 Oil consumption by total Dutch fishing fleet (1999 – 2003)

	1999	2000	2001	2002	2003
Number of vessels	417	428	413	410	388
Fuel consumption (mio ltrs)	415.6	410.1	405.4	391.9	385.8
Fuel costs (mio €)	53.3	97.1	92	78.6	79.8
Fuel consumption per vessel (mio ltr)	0.997	0.958	0.982	0.956	0.994
Fuel consumption / volume of landings	0.946	0.875	0.795	0.876	0.737
Fuel costs / value of landings	0.129	0.239	0.216	0.207	0.203

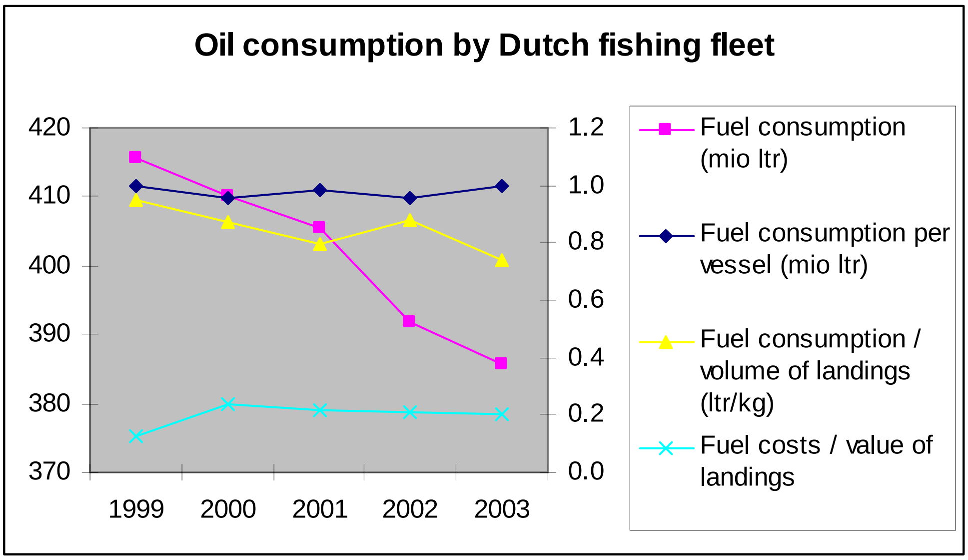


Figure 2.17.1 Time-series of Oil consumption by the Dutch fleet

2.17.3 Evaluation and interpretation

Within this indicator four possible indicators have been investigated, these informative indicators could meet a variety of objectives and can be made operational if data on oil consumption become available. Total oil consumption can be considered a useful indicator for environmental impact of fisheries. However, it is influenced by both the fleet capacity (number of vessels, engine power), fishing effort (number of sea-days) and fishing techniques. In order to reveal more information about development of the fishery, *oil consumption per vessel* has been included as a second indicator. O*il consumption per kg of landed fish* is presented as a third related indicator. This can be considered an indicator for environmental efficiency of production. This third indicator can make use of the method fuel use intensity (litres/tonnes) in which distinction has been made between type of fisheries (fishery purpose and primary targets), gear type, year and country (EP 2004). The fourth indicator presented is the ratio of fuel costs and value of landings. This can be seen as an economic indicator for the incentive to change to less energy intensive fishing methods.

Total fuel consumption by the Dutch fleet has decreased between 1999 and 2003 more or less proportionally to the decrease in number of vessels. Fuel consumption per vessel has remained approximately constant (around 1 million litres per vessel). However, when considering a longer time series (1990-2003) for just the Dutch cutter fleet (which excludes the pelagic freezer trawlers) (table 1), oil consumption per vessel has increased considerably.
The fuel consumption per kg of landed fish has decreased between 1999 and 2003 from 0.95 to 0.74 litres oil/kg fish indicating that the fleet has become less energy intensive, although there are large differences by fleet segment. For instance the shrimp fishery has become more energy intensive.
The ratio of fuel costs and value of landings has increased from 13% to 24% in 2000 and decreased slightly in the following years to app. 20% in 2003. The recent increase in fuel prices, which is not yet visible in these data, will increase this indicator considerably for 2005, indicating an increased incentive for changing to less energy-intensive fishing methods.

2.17.4 Recommendations

If oil consumption and/or one of the related indicators mentioned above will be chosen as one of the official indicators for environmental impact of fisheries and fisheries policies, it would be advisable to include oil consumption as mandatory data in the EU data collection regulation.

2.18 Unwanted by-catches of protected species and discards

Discarding is the throwing overboard of unwanted fish or benthic animals that have been caught by fishing vessels. Discarding has been frequently criticised for wasting a valuable source of protein-rich food, at a time when many fish stocks are declining. Annual estimates of the amount of fish discarded globally have varied during the last 20 years between 6.7 and 39.5 million tonnes (Alverson et al. 1994; Pascoe 1997; Kelleher 2004). The species composition in the discard fraction and amount discarded is highly variable and depends on the type of fishery, with considerable spatial and temporal variability. Therefore, after innumerable analyses of the causes of discarding, and many research projects aimed at reducing the levels of discards, the discard problem remains a serious issue facing fisheries managers. Indices of discarding would provide a means to assess and track the nature and degree of the discarding problem and to guide management.

2.18.1 Materials and method

Even though discards data have been collected under the EC Data Collection Regulations 1543/2000 and 1639/2001 (EC 2000, 2001) from 2002 onwards in all European countries, the availability of suitable discard data for e.g. stock assessments (ICES 2005a, b) or ecosystem evaluations (ICES 2003) has been rather limited. In most stock assessments with discards data incorporated, discards from one or two fleets have been used to estimate discards for fleets from which no discards data were available. Onboard sampling is expensive and as a result the fraction of sampled vessels within a fleet is low, and for some fleet segments sampling has not been done annually (e.g. when within a fleet there are several different mesh size segments), which results in difficulties when raising the data to fleet level.

The ICES working group on ecosystem effects of fishing activities (WGECO) has previously been charged with, "reviewing the data collected by the ICES Study Group on Discard and By-catch Information and, as far as is practicable, conduct analyses that can be used as a basis for the formulation of ICES advice on ecosystem effects of fisheries". Despite the existence of the EC DRC regulations to collect discards data, WGECO have twice lamented that analysis of these data "was hampered by the lack of timely and comprehensive data sets that could be the subject of analysis" (ICES 2002, 2003). To show results of discards indicators, data on the quantity of species discarded have to be available for all major fleet segments for an area concerned.

These data are currently lacking at the appropriate scales, so we have restricted this work to (1) discussion of potential discards indicators and (2) discard patterns of the Cefas NW North Sea discard survey programme.

(1) Potential indicators of discards and bycatch

The nature of any indicator depends entirely upon the desired ecosystem objective. If the ecosystem objective was to minimise the impact of fishing on non-target and undersized fish species, then total weight (or number of individuals) of all discards per unit of effort or raised to total fleet segment could be used as an indicator. A potential limitation of this indicator is that it does not make any distinction between fish species or between fish and benthic organisms, and therefore the impact of a fishery on the populations of protected or declining species through discarding will remain unknown. Clearly different sub-indicators could be constructed to report on each element of the wider ecosystem objective.

A range of discards indicators could be calculated using subsets of species chosen by managers and stakeholders, the suite of species used would depend on the desired ecosystem objective(s). This list could include a variety of species, depending on the status:

- target species
- species subject to recovery plans
- threatened and declining species
- functionally important species

A species-based discards indicator should include data on the quantity (number or biomass) of a species discarded as well as on the effort of the fleet discarding this species. With a discards indicator showing the quantity of discards expressed as unit of effort, the influence between separate fleet segments can be compared, however the effect of the different fleet segments on the stock remain unknown. A small fleet segment showing higher quantity of discards per unit of effort can have less effect on a population than a large fleet segment with lower quantity of discards per unit of effort.

Expressing the quantity of discards raised to fleet seems a better indicator. To raise discards to total fleet, the quantity of discards in the sampled discards trips have to be multiplied by the ratio of effort in sampled trips to total effort of the fleet, with effort being e.g. number of trips or hours fished. However exact total effort per fleet segment per area cannot always be obtained, for example due to the combining of different gears into one gear type in the logbooks or area misreporting. Raising by the ratio of landings weight in sampled trips to total landings weight of the fleet can also be used, but is only suitable for species that are landed, and not for most non-target species that are not landed.

Discards could also be expressed as percentage of the total catch, but for an indicator this is less useful. When a species is not landed, in case of many non-target species, discarding will always results in a 100% discarding rate, even if only one specimen is discarded. The actual impact of the fishery remains unknown. Also for species that are landed, a change in discards percentage could be either a result of increased discarding or decreasing in the fraction retained fish.

(2) The Cefas NW North Sea discard survey programme

The Cefas discard sampling program has begun in 1994 with the purpose of monitoring discards of key gadoid species (cod, haddock and whiting) off the north-east coast of England by the English and Welsh commercial fleet landing to England and Wales since 1994. All fish species caught by the entire English and Welsh fleet landing anywhere except Scotland have been sampled since 2002.

Sampling strategy was varied slightly over the time. Initially sampling was non-random choice from lists of amenable vessels >12m. Random selection has been performed since May 1997. In August 1999, sampling was refined to a quarterly replacement random draw system extending to all sea areas and gears and to include all vessels over 10 metres from October 2001. Finally, from 2002, sampling was performed with reference to the EU Data Collection Directive (EC Regulation 1639/2001), again with a quarterly replacement random draw system, now with sampling groups based on fleet metiers relating to area, gear type and target species.

On-board observers collect two forms of data aboard commercial fishing vessels: (1) counts, lengths and take otoliths of the retained and discarded portion of catches and (2) details to allow raising of catches, such as vessel length and power, details of hauls (location and shooting and hauling times), sea state, weather and gear details. .

We have calculated time series of catch numbers of discarded fish per hour fished of (1) all three gadoids combined and (2) for each individual species and (3) we have summarised the records of discards for threatened and declining species. We restricted our analysis to ICES subdivision IVb from 1994 to 2005. Though when interpreting our findings it should be borne in mind that the first full year of random draw selection is in 2000, and prior to this sampling was less random. We choose to consider numbers, as numerical abundance is more pertinent to the status of threatened and declining species.

Gears were grouped as beam trawls, demersal trawls (all otter trawl nets including twin and triple except finer mesh *Nephrops* gear), *Nephrops* trawls (finer mesh otter trawls including twin and triple) and seine nets (anchor, Danish, pair fly and purse seine).

A list of species known or listed as threatened or declining was summarised from scientific literature and major policy documents (ICES 2004; Dulvy et al. 2005). We have included species likely to be listed and also those species already listed under IUCN Red List criteria, OSPAR, Bern Convention, EU Habitats Directive Annex II (Table 2.18.1). We searched the Cefas discards database for discard records of 26 threatened or declining species for North Sea ICES divisions IVb & IVc.

2.18.2 Results

Discard survey sampling effort was greatest on demersal and *Nephrops* trawl vessels (Table 2.18.2). Over the 12-year period 215 demersal trawl and 159 *Nephrops* trawl trips were sampled, which constituted 94% of all trips and 80% of hours fished that were sampled by discards surveyors. Beam trawls seine netters and another unspecified gear comprised the remainder and are not considered further in this analysis. (Table 2.18.2)

Discard survey sampling effort on trawl vessels varied considerably over time. Demersal trawl discard sampling effort rose in 1997 to peak in 1998, and thereafter declined from ~40 trips sampled each year to ~10 trips year^{-1} (Figure 2.18.1a). The number of hauls sampled and hours fished on sampled vessels correspondingly exhibit similar temporal patterns to trips sampled year^{-1}. Discard sampling effort on *Nephrops* trawlers was highly variable over time, with between and 1 (2000) and 30 trips sampled each year (Figure 2.18.1b).

The total number of gadoids discarded by demersal trawls was relatively constant over time, varying between 200-400 individuals discarded hr^{-1} fished. Whiting comprised half (48%) of gadoid discards with 70-210 individuals discarded hr^{-1} fished. Cod and haddock comprising 25% and 26% of gadoid discards respectively, with 40-140 and 24-200 individuals discarded hr^{-1} fished by demersal trawls in North Sea division IVb (Figure 2.18.2a).

The total number of gadoids discarded by *Nephrops* trawls was relatively constant over time, varying between 150-800 individuals discarded hr^{-1} fished. Whiting comprised most (84%) of gadoid discards with 120-340 individuals discarded hr^{-1} fished. Cod and haddock comprising 6% and 10% of gadoid discards respectively, with 8-44 and 7-150 individuals discarded hr^{-1} fished by *Nephrops* trawls in North Sea division IVb (Figure 2.18.2b).

Discard rates vary among individual gadoid species over time. Cod discards increase to a peak in 1998, thereafter declining to 40 individuals hr^{-1}; from 2000 to 2005 the numbers discarded increases steadily to 63 individuals hr^{-1} (Figure 2.18.3a). Cod discards of *Nephrops* trawls are generally low (15 individuals hr^{-1}) but peak at rate of ~40 individuals hr^{-1} in 1997-8 and also in 2002 (Figure 2.18.3b). Haddock discards increase to peak in 2000 and 2002 for both demersal and Nephrops trawlers (Figure 2.18.4). Discarding rates of demersal trawls average 76 individuals hr^{-1}, approximately twice that of *Nephrops* trawls (41 individuals hr^{-1}). Whiting discard rate of both demersal and *Nephrops* trawlers were variable over time (Figure 2.18.5). Discarding rates of *Nephrops* trawls average 340 individuals hr^{-1} - at least twice that of demersal trawls (132 individuals hr^{-1}).

Very few of the sampled hauls contained threatened and declining species and few such species were captured in these gears. The most frequently captured threatened and declining species were hake and spotted ray. Hake were found in ~12% of sampled seine nets and *Nephrops* trawls and spotted ray were found in 3-7% of trawls sampled (Table 2.18.3). The four gears surveyed in this area captured a total of six out of the list of 26 threatened and declining species.

2.18.3 Evaluation and Interpretation

The availability of discards data has to be improved. In order to implement any form of discards indicator, discards data on target and non-target species for all fleet segments for the area of interest have to be made accessible. As a start a Commission funded project will start in 2006 to review and assess the discard sampling programmes under the Data Collection Regulation. In this project an overview of the discards data will be made with special reference to how representative these data are. We recommend the commissioning of a project to collate, database and make available all existing discard information. The ICES trawl survey database (DATRAS) could provide a useful template.

In the absence of a comprehensive data set we have provided some preliminary analysis from one particular discards sampling programme - the England and Wales NE North Sea discards survey run by Cefas. A number of conclusions can be drawn from this preliminary analysis, including:
an index of discarding of target species and species subject to recovery plans is likely to be feasible, particularly for assessed gadoid species, and
an indicator of the discarding of threatened and declining species is likely to have low power to detect changing discard rates and may not be widely representative of all threatened and declining species.

1. Availability of historical data
Time-series of gadoid discards are likely to provide the longest consistent, reliable historic dataset. For other species data quality will be low except for 2000 onwards. There is sufficient length of time series to begin to interpret the sources of variation in discarding rates of gadoid species. This preliminary analysis suggests discard rates reflect the abundance of juvenile fishes in the environment, to some degree. The peak discard rate of cod is in 1998, coinciding with good recruitment and high abundance of age 1 cod in 1997 and age 2 cod in 1998. For haddock, the peak discard rates in 2000-2002 coincide with the large 1999 year-class.

2. Measurement

There are two problems that mean that an index of unwanted by-catches of protected species and discards may not be as informative as initially envisaged. This preliminary analysis suggests that any index of unwanted by-catches of protected species and discards may not be widely representative and have very low power to detect change. First, relatively few threatened and declining species were captured by any of the four gears considered, and for this reason any indicator of discards of threatened and declining species will be limited to representing the changing fishing impact on only a small sub-set of threatened and declining species. Second, threatened and declining species are, by definition, rare and infrequently captured by any of these gears. Thus any index is likely to have very low power to detect a significant change in discard rate (Maxwell and Jennings 2005).

3. Cost
This is a particularly costly indicator, the organisation and staffing of a large number of discards surveys is expensive. The development of a pan-EU discards database of existing data collected under EC Data Collection Regulations will also take time and is likely to incur some costs.

Table 2.18.1. List of threatened, declining and protected fish species in European waters

Common name	Location	Latin name	Reference
Cod	North Sea, Eastern Baltic Sea, Norway coast, Irish Sea, West Scotland & Kattegat	*Gadus morhua*	IUCN Red List 'Vulnerable'; OSPAR threatened and declining species (draft 2004); Dulvy et al. 2005
Haddock		Melanogrammus aegelfinus	IUCN Red List 'Vulnerable'
Greenland Halibut	NE Arctic	Reinhardtius hippoglossoides	Dulvy et al. 2005
Herring	Icelandic spring-spawning, SW Scotland, W Baltic, E Baltic	Clupea harengus	Dulvy et al. 2005
Norwegian lobster	North Galicia, West Galicia & N. Portugal, Bay of Biscay, South Portugal	Nephrops norvegicus	Dulvy et al. 2005
Hake	Iberian, Northern	Merluccius merluccius	Dulvy et al. 2005
Sole	Baltic	Solea solea	Dulvy et al. 2005
Sturgeon		Acipenser sturio	CITES Annex II, EU Habitats Directive Annex II; OSPAR threatened and declining species (draft 2004)
Seahorses		Hippocampus spp. (H. guttulatus & H. hippocampus)	CITES Annex II; OSPAR threatened and declining species (draft 2004)
Angel shark		Squatina squatina	Bern Convention Annex III; IUCN Red List 'Vulnerable'
Basking shark		Cethorinus maximus	Bern Convention Annex II
White shark		Carcharodon carcharias	Bern Convention Annex II
Mako shark		Isurus oxyrinchus	Bern Convention Annex III

Porbeagle shark		Lamna nasus	Bern Convention Annex III
Blue shark		Prionace glauca	Bern Convention Annex III
Tope		Galeorhinus galeus	IUCN Red List 'Vulnerable'
White skate		Rostroraja (Raja) alba	Bern Convention Annex III
Common skate		Raja or Dipturus batis	IUCN Red List 'Endangered'; OSPAR threatened and declining species (draft 2004)
Long-nose skate		Raja or Dipturus oxyrhinchus	Dulvy et al. 2000
Spotted ray		Raja montagui	OSPAR threatened and declining species (draft 2004)
Devil fish		Mobula mobular	Bern Convention Annex III; IUCN Red List 'Vulnerable'
River lamprey		Lampetra fluviatilis	Bern Convention Annex III; EU Habitats Directive Annex II
Sea lamprey		Petromyzon marinus	Bern Convention Annex III; EU Habitats Directive Annex II
Allis shad		Alosa alosa	Bern Convention Annex III; OSPAR threatened and declining species (draft 2004)
Twaite shad		Alosa fallox	Bern Convention Annex III
Whitefish		Coregonus oxyrhynchus	Bern Convention Annex III, EU Habitats Directive Annex II

Table 2.18.2. The sum, proportion (%) and annual average number of trips, hauls and fishing hours surveyed as part of the England and Wales discards sampling programme in North Sea ICES division IVb from 1994 – 2005.

Gear	Sum			Percent			Yearly average		
	Number of trips	Number of hauls	Number of hours fished	Number of trips	Number of hauls	Number of hours fished	Number of trips	Number of hauls	Number of hours fished
Demersal trawl	214	1264	7647	54	54	61	18	105	637
Nephrops trawl	159	407	2359	40	17	19	13	34	197
Beam trawl	16	519	1770	4	22	14	2	74	253
Seine net	6	164	651	2	7	5	2	41	163
Other gear	1	3	18	~0	~0	~0	1	3	18

Table 2.18.3. Number of hauls, by gear, in which each threatened and declining species was recorded in the Cefas NE North Sea discard survey programme in ICES divisions IVb&c. Total number of hauls sampled is shown for comparison.

Threatened and declining species	Demersal trawls	Nephrops trawls	Beam trawls	Seine nets
hake	25	55	47	20
spotted ray	81	14	43	-
sea lamprey	-	-	2	-
twite shad	21	6	5	-
Allis shad	13	7	-	-
common skate	2	-	-	-
total hauls	1473	407	642	164

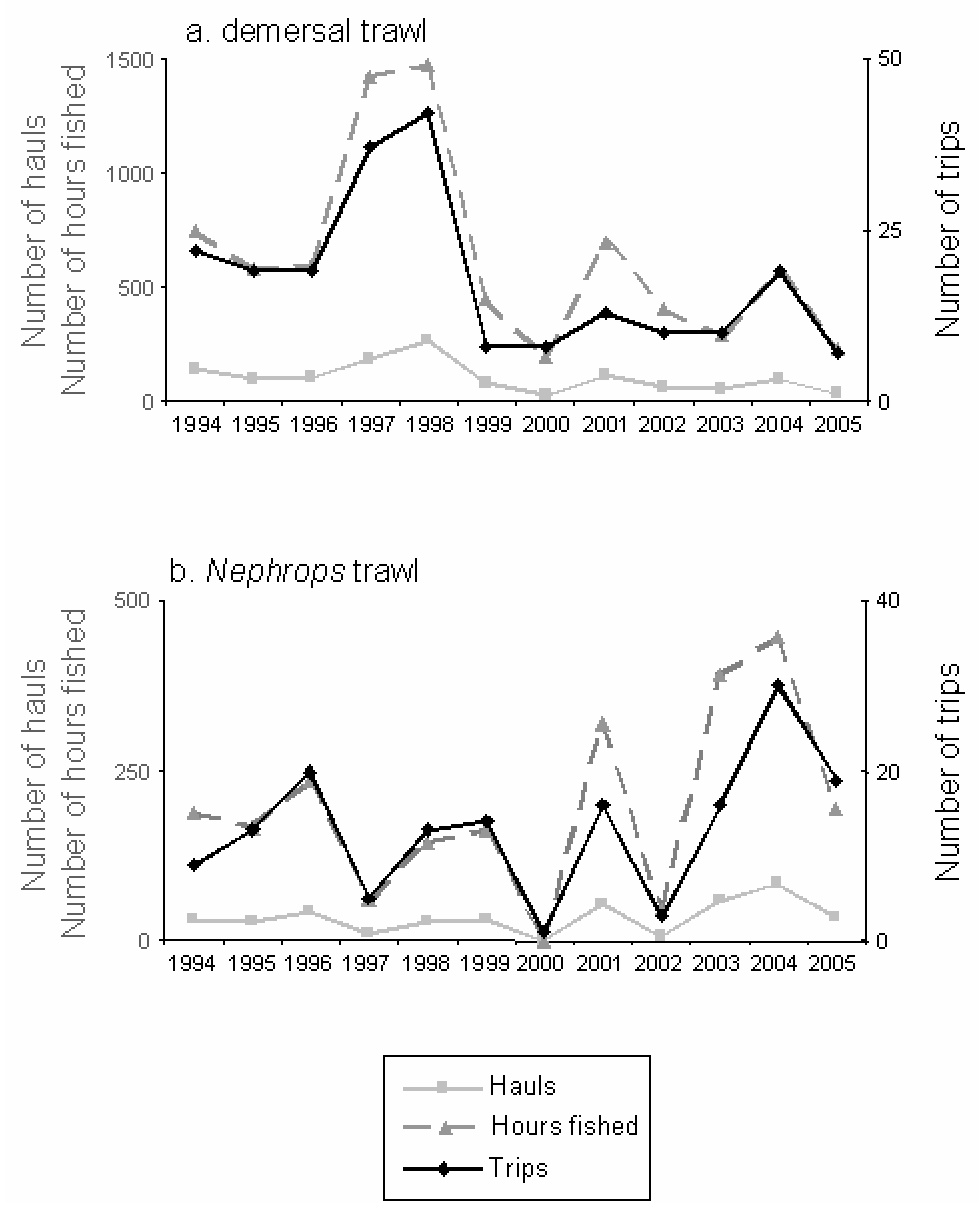


Figure 2.18.1. Discard sampling effort on (a) demersal trawls, and (b) *Nephrops* trawls in North Sea ICES division IVb.

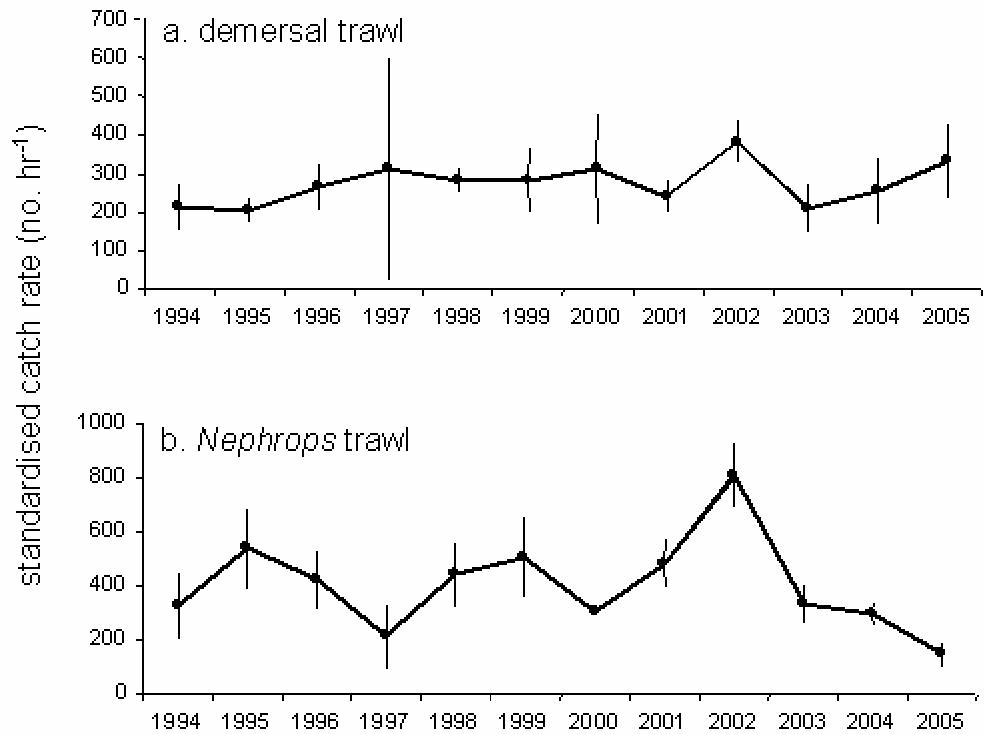


Figure 2.18.2. Discards of gadoids by (a) demersal trawls, and (b) *Nephrops* trawls in North Sea ICES division IVb.

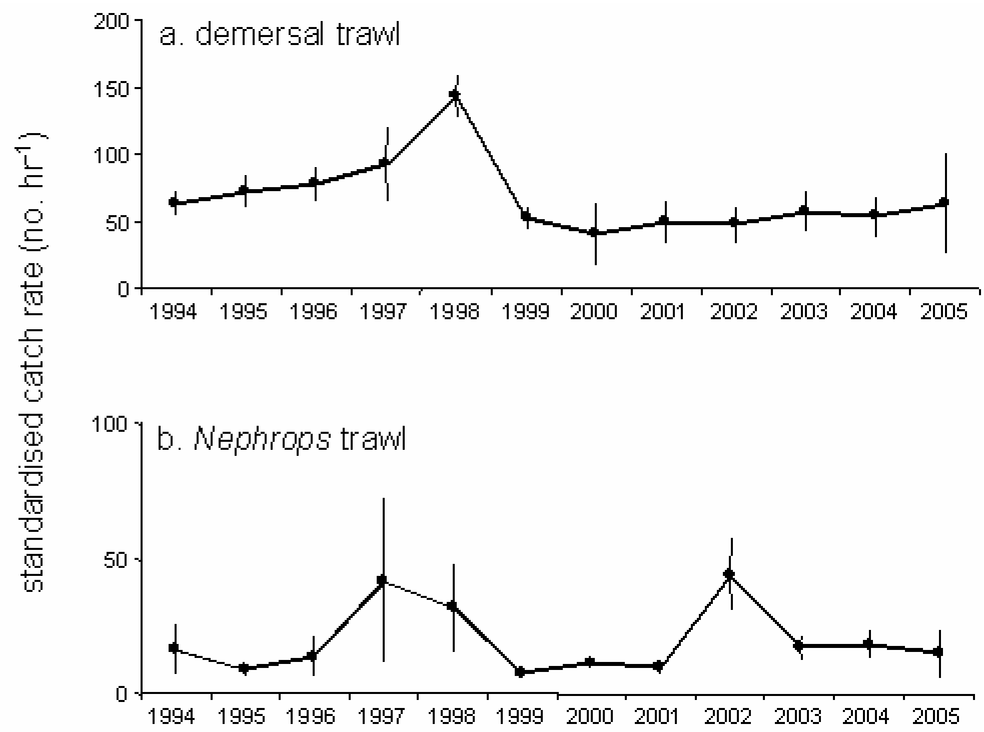


Figure 2.18.3. Discards of cod by (a) demersal trawls, and (b) *Nephrops* trawls in North Sea ICES division IVb.

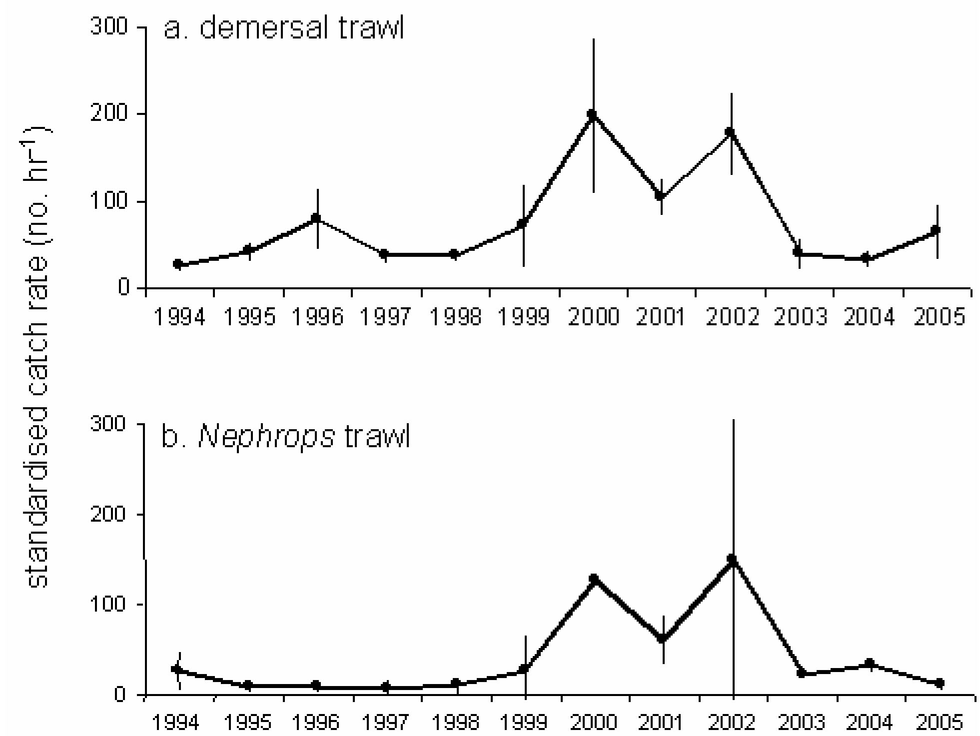


Figure 2.18.4. Discards of haddock by (a) demersal trawls,and (b) *Nephrops* trawls in North Sea ICES division IVb.

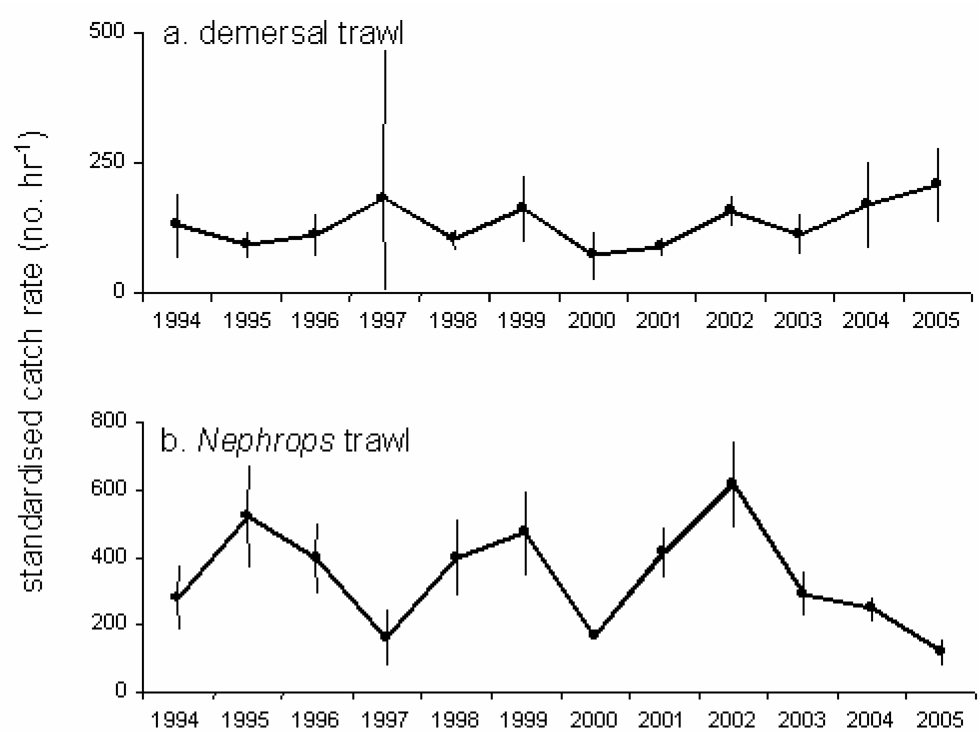


Figure 2.18.5. Discards of whiting by (a) demersal trawls, (b) *Nephrops* trawls in North Sea ICES division IVb.

2.18.4 Recommendation

In order for this indicator to be made operational, information on discards per métier needs to become available with sufficiently high coverage to make this information representative for the métier. Preferably all species should be sampled, identified and measured. As this involves a high number of observer trips and hence costs an alternative could be to develop models that can estimate this from the fishing effort information. This approach is described in section 2.13.

2.19 Share of fish produced (or consumed) that are eco-labelled.

It is considered that when eco-labelling of marine products is well developed and labelling criteria are stable over time this indicator will reflect the progression of environmental friendly fishing practices in detriment of less environmentally friendly fishing practices. This assumption will have to be corroborated (EU, 2003). An indicator of the size of the "eco-market" compared to the "traditional market" could be the share of fish produced (or consumed) that are eco-labelled. The certification of a fishery with an eco-label is granted when a number of sustainability standards or criteria have been fulfilled. (EU, 2002). In 2005 the FAO formulated guidelines for the eco-labelling of fish and fishery products from marine capture. The Commission drew up five EU minimum requirements for voluntary eco-labelling schemes (EU, 2005).

2.19.1 Material & methods

The demand for organic products in the EU is growing. Organic agricultural production methods have been developed for the last 25 years and have recently been extended to products of animal origin.
Organic fish standards can be applied for aquaculture and wild fish production for 'closed' areas (e.g. mussels) (CBI, 2005).

At consumer level, eco-labelling, and organic certification, remain small but evidently growing issues in the marketing of seafood products. With organic certification focused essentially on aquaculture, eco-labelling is oriented towards wild fisheries sustainability and the impact of fisheries on the ecosystem. The growing importance of eco-labelling in seafood marketing is reflected in the increasing interest by European retail chains in the topic. However the approach by individual retailers to this area is varied as is the retail penetration of certified products at a geographical level (O'Sullivan, 2005)

Data availability
At present, general statistics on (fish) consumption and production are not detailed to the extent that a distinction can be made between labelled and non-labelled produce.
Figures on production or consumption of eco-label fish and fish products are hardly available. An exception is MSC labelled fish sold by Unilever in Europe.
Due to the absence of an internationally agreed definition of organic aquaculture products, figures have to be considered as approximate indications. Due to very limited data availability, it is not (yet) possible to calculate time series.

2.19.2 Results

First the production of eco-labelled fish was identified. The following sources were distinguished:

Eco-labelled wild fish production in the EU
At present, there are a number of eco-labels for fish in the market. Perhaps the most long established and well known is the single issue 'dolphin-safe' tuna label, which has been on the EU market since the early 1990's (Brown, 2005). The more recently

established Marine Stewardship Council (MSC) however is generally considered the most comprehensive certification system in place, being a third party standard against which fisheries are certified.
In terms of production, four EU (wild) fisheries are certified by the MSC. While the amount of EU catch certified by the MSC accounts for only 0.6 per cent of the total, EU production and consumption of eco-label products is only set to increase with an increasing number of fisheries seeking MSC certification and Alaskan Pollack in the final certification stages.(EP, 2004)

Timetable MSC certified catches in the EU.

before 2000	2004
0 %	0,6 %

Eco labelled wild fisheries

One European fishery that is directly managed under CFP is MSC labelled:
- Loch Torridon Nephrops (UK)

Three other (non CFP) European fisheries (managed by DEFRA, UK) are MSC labelled:
- Burry Inlet Cockles (UK)
- South West Mackerel Handline (UK)
- Thames Herring (UK)

Three EU fisheries are under MSC assessment:
- Hastings fishing fleet Dover sole fishery (UK)
- Hastings fishing fleet pelagic fishery (UK)
- North Sea Herring (will probably be certified in the course of 2006)

Other non European MSC Certified fisheries:
- Alaska Pollock - Bering Sea and Aleutian Islands
- Alaska salmon
- New Zealand Hoki
- Mexican Baja California Red Rock Lobster
- South African Hake
- South Georgia Toothfish
- Western Australian Rock Lobster

Details CFP Fishery that is MSC certified

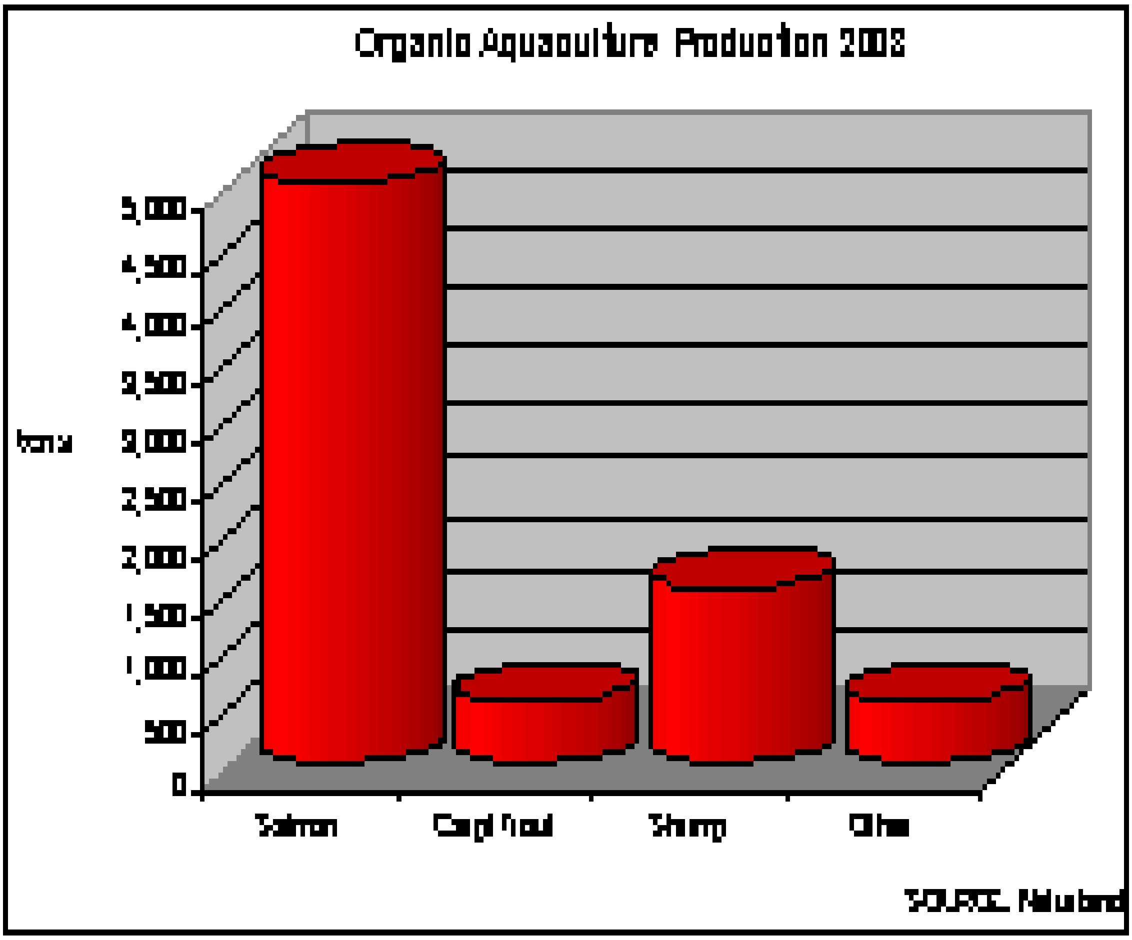
Loch Torridon Nephrops
Nephrops are also known as Dublin Bay Prawns, Langoustine and Norwegian Lobster.

Location:
Loch Torridon and the Inner Sound of Rona "Closed Area" on the North West Coast of Scotland, United Kingdom.
Fishing Method:
The method of capture is baited creels/pots deployed on lines.
Management:
The Torridon Management Plan is a voluntary management plan implemented within the 'Closed Area'. The management is directed ultimately by the European Union (EU) through the Common Fisheries Policy which is controlled by the Member States of the EU. The Scottish Executive, through a Subject Specific Concordat with the UK Department of the Environment, Food and Rural Affairs (DEFRA) enforce legislation and quota management through the Scottish Executive Environment and Rural Affairs Department (SEERAD).
In 1984, the Inshore Fishing (Scotland) Act removed the three-mile limit that banned the use of mobile gear within a three-mile limit of the shore. This opened the fishing grounds to the trawlers and a period of conflict between the creel fishers and trawlers ensued.
Loch Torridon creel fishers actively sought to have an area closed to the mobile fishing gear. On the 1st November 2000 an area closed to all mobile fishing gear was established. This 'Closed Area' is for an initial period of five years and extends between Red Point, including Loch Torridon, and the south end of the BUTEC Range in the Inner Sound of Rona. The Total Allowable Catch is set between 100 to 150 tonnes.
Main commercial market:
Most of the catch is exported weekly to Spain.
Assessment details:
The assessment process began in January 2002 and the certificate was awarded in January 2003.

"Friend of the Sea" approved sustainable fisheries (Underlined species also caught in Europe):
- Argentine anchovy (Engraulis anchoita)
- European anchovy (Engraulis encrasicolus)
- Dungeness crab (Cancer magister)
- Edible crab (Cancer pagarus)
- Shallow water Cape hake (Merluccius capensis)
- Deep water Cape hake (Merluccius paradoxus)
- Atlantic herring (Clupea harengus)
- Pacific herring (Clupea palliassi)
- Chub mackerel (Scomber japonicus)
- Silver salmon (Oncorhynchus kisutch) (Little in Europe)
- Frigate tuna (Auxis thazard)
- Skipjack tuna (Katsuwonus pelamis)
- Yellowfin tuna (Thunnus albacares) (only South Portugal and Spain)
- Longtail tuna (Thunnus tonggol)

Eco labelled or organic labelled EU aquaculture production
Market studies forecasted that the market share of organic products in general will be approximately 2.5% by the year 2000 for Europe as a whole. As organic standards for fish farming have only recently been developed in a few countries and are still being developed at EU-level, there are no exact figures about the market share of organically farmed fish. Although organic production and consumption is increasing fast, this share is (still) very small (CBI, 2005).

Figure 2.19.1. Total Organic aquaculture production 2003:



Source: (Franz, 2004)

According to an estimate of the German Naturland - Association for Organic Agriculture, organic aquaculture production in 2003 reached a total of about 7,500 tons. Victor Hilge, Institute of Fishery Ecology in Hamburg, estimated in 2005 that world production is at least 25,000t with 14,000t in Europe worth around 70m euro. The main species are salmon and trout (EU2005a).

However, due to the absence of an internationally agreed definition of organic aquaculture products, these figures have to be considered as approximate indications. Up to now, salmon, shrimp, carp and trout have been the most important species for organic aquaculture production. However, also some organic sea bream, sea bass, tilapia, mussels, char and sturgeon is being produced. New species monitored for future organic aquaculture production include scallops, cod and pangasius/basa fish. (Franz, 2004)

Organic salmon

Currently, about 50 percent of the total organic salmon production takes place in Ireland. It is mostly exported to other European countries, primarily to France, Germany and Switzerland. A first farm in Ireland has recently received certification according to the strict French 'Agriculture Biologique' (AB) regulations and a second farm in Clifden will follow by the end of the year. This salmon is traded under the brand 'Nature Océan' on the French market. The Irish Salmon Producers Group predicts a production share of 10 percent for organic salmon in Ireland by 2010.

In 2001, the first salmon farm in France obtained certification by EcoCert and is selling its product since July 2002. The Ferme Marine de l'Aber-Wrac'h has received also certification according to the national 'AB' standard. Standards for organic salmon farming have been developed for example by Naturland (Germany), Soil (UK), KRAV (Sweden), TÚN (Iceland), AIAB (Italy) and BioGro (New Zealand). Organic salmon is offered on the German market under the brand 'Teichgut'. The product range includes frozen fillets, breaded frozen cuts as well as smoked and graved salmon slices. Frozen organic salmon fillets, as well as graved or smoked salmon slices originating from Ireland are now a permanent part of German seafood distributor Deutsche See's product range.

Dennis Overton, Aquascot Ltd, estimated that organic salmon production in Europe could rise from around 10,000t based on the 2005 smolt levels to around 17,000t (gutted weight), worth 91m euro, based on likely 2008 smolt levels (EU2005a).

Organic carp and trout

Organic carp, brown trout and rainbow trout are farmed mainly in Germany, France, Switzerland, UK, Ireland and Austria, but some organic carp production takes place also in the new EU-member country Hungary. The Hungarian production is up to now limited to two farms covering an area of 120 ha, but additional 4,600 ha will be ready for certification by the end of 2004.

Carp, an herbivorous fish, is considered to be a perfect species for organic aquaculture. In Austria, already 10 percent (300 ha) of the total area used for carp production has been converted to organic production. The average farm gate price for organic carp, which is sold mainly fresh, in Austria, Germany and Switzerland is about 3.00-3.50 €/kg.

Ireland and UK are also important organic trout producers. According to the British certifier Soil Association, the farm gate value of organic trout production in the UK has increased by 20 percent to £ 0.9 million in 2003.

The Spanish company 'Sierra Nevada' is producing fresh, frozen and smoked organic trout. Certification is based on the standards of the Andalusian Committee on Organic Agriculture (C.A.A.E.).

Some organic trout production takes place also in France, Norway (about 3 tons in 2003), Denmark and in Northern Italy.

Next the consumption of eco-labelled fish was identified. The following areas of consumption were distinguished:

Eco-label fish consumption in the EU
Unilever estimates that just over half the fish sold in Europe (>90% of Unilever's fish sold) is sourced from sustainable fisheries and Unilever expect this to rise to 60% in 2005. The use of MSC-certified fish will then jump from 4% to around 50% in Europe in 2005, with the introduction of products using US Alaskan pollock.

Timetable Unilever MSC certified fish sold in Europe:

Before 2000	+/- 2000	2005
0%	4%	45-50%

Timetable Unilever MSC certified fish (IGLO fish fingers) sold in the Netherlands:

Before 2005	2005
0-4%?	43%

Number of MSC labelled fish products in EU market

2000	2002	2005
1 MSC labelled product (1 fishery)	100 MSC labelled products	260 MSC labelled products

2.19.3 Evaluation and interpretation

Eco-labelling is a relatively new development in the fish markets. Although there has been sustainable fish consumption and production before eco-labels even came into existence, the development of the share of eco-label fish in total production and in total consumption can be regarded as an important indicator for the extent to which environmental fishing practices are applied. The variety of eco-labels in the market, however, makes it necessary to decide on unambiguous criteria for which eco-labels to include in this indicator. Moreover, as eco-labelling is still in development, an increase in eco-labelled production or consumption may not always indicate a change toward more environmentally fishing but merely reflect the development of eco-labelling schemes as such.
On basis of the incomplete data presented here we can draw the following conclusions:
Only a few minor fisheries in the EU have been MSC labelled. In the course of 2006 North Sea Herring will become MSC certified. The share of eco-labelled fish has been estimated at 0.6% of total production in 2004. The interest of eco-labelling is, however, expected to increase due to growing demand for organic food.
Sales of eco-label fish by Unilever have increased substantially, but this increase is almost completely due to MSC certified fisheries outside the EU (Alaska pollock).
Organic aquaculture production increased substantially. It is estimated in 2005 that world organic aquaculture production is at least 25,000t with 14,000t in Europe worth around 70m euro. The main species are salmon and trout (EU2005a).

2.19.4 Recommendation

At present no systematic data on eco-labelling are available. In order to calculate an indicator for the "share of fish produced (or consumed) that are eco-labelled" it is necessary to have a formal procedure for data collection of eco-label fish produced and consumed and unambiguous criteria for which eco-labels to include in this indicator.

2.20 Initiatives to support eco-labelling and use of eco-labels and similar awards

The underlying idea of eco-labelling is that if consumers are properly informed, their choice could possibly stimulate the promotion and consumption of environmentally friendly products. Thus, consumers can influence the behaviour of producers and policy makers.

The industrial and forestry sectors of today possess a large variety of certification and eco-labelling schemes. The Community's own eco-label award scheme covers some 20 industrial product groups. However, it does not apply to food products, like fish, drinks and medicines (EU, 2005).
The EU is currently working on standardizing EU organic seafood norms (Brussels 21.12.2005. COM (2005) 671 final). This standardizing will become effective in 2009 and Member states shall transmit statistical information necessary for the implementation and follow up of this regulation. This statistical programme will be defined within.the context of the Community Statistical Program.

According to a FAO study (2001) eco-labelling of fish and fishery products has the potential to create a market incentive to manage fisheries and aquaculture farms sustainably. Several benefits can accrue to the world community if this potential is realized:
- There will be environmental improvement in the aquatic ecosystems, reducing societal costs of the reduction in global biodiversity.
- Consumers will benefit as they receive more information concerning the products they purchase, are able to choose from more products of varying environmental qualities, and are able to make informed choices regarding the purchase of those seafood products. Consumers also benefit in the long run by continued availability of their favourite seafood products.
- Producers of eco-labelled seafood benefit from being able to extract that additional willingness to pay from consumers that they would not ordinarily be able to do in an undifferentiated market.
- The fisheries industry will benefit as the move from an unsustainable fishery to a sustainable fishery preserves production and jobs over the long run.

2.20.1 Material & methods

Definitions
The Global Eco-labelling Network‘s definition of eco-label is that: an "eco-label" is a label which identifies overall environmental preference of a product or service within a specific product/service category based on life cycle considerations, all activities geared towards stimulating this voluntary process of labelling and all produce being traded under such a label will be considered Eco-labeled.

EU definition: An eco-labelling scheme entitles a product to bear a distinctive logo, or statement, by way of which consumers are assured that the product has been produced according to a given set of environmental standards, such as the sustainability of the resource used as raw material, the environmental impact of the production method, or the recyclability of the product (EU, 2005)

Credibility problem
During the last few years the number of eco-labels has been increasing. Consumers, when faced with a growing number of eco-labels on the products they choose from, may become confused and decide that none of the labels is credible. There may also be confusion if there is not a common definition. “Environmentally friendly” or “sustainably harvested” have no clear meaning. Many of the environmental claims made by manufacturers are subject to interpretation; at worst, they are potentially deceptive or misleading. (FAO, 2001)

The debate should also be seen in the context of the international guidelines on eco-labelling recently adopted by the United Nations' Food and Agriculture Organisation (FAO, 2005) and discussions on these issues and their potential effects on free trade areas are progressing in other international fora such as the World Trade Organisation (WTO). The Commission drew up five EU minimum requirements for voluntary eco-labelling schemes (EU, 2005).

Minimum requirements for eco-labelling schemes for fishery products:

1. PRECISE, OBJECTIVE AND VERIFIABLE CRITERIA
The certification standard should rest on precise, objective and verifiable criteria and, where possible, be based on international standards.
Eco-labelling schemes should deliver what they promise and not promise what they cannot deliver. The award of the eco-label should be based on certification standards and criteria that guarantee that the product meets the claims made. Criteria must be objective and precise, in order to forestall allegations of subjectivity. Criteria must also be verifiable, i.e. they must reflect measurable elements, and be monitored by way of appropriate and recognized indicators. A criterion that “the fishery is conducted in a sustainable manner”, without any further objective parameters, would be obviously difficult to verify. On the other hand, requiring that "the fishery is subject to a management plan based on the precautionary approach" and indicating the specific features of the management plan that are required under the precautionary approach would be objective, precise and verifiable. Using "effort stays below FMSY" as a criterion is even more stringent and would allow for more precise measurement of the achievements of the scheme.
Furthermore, certification standard and criteria should be subject to appropriate and participatory consultation of interested parties. Finally, wherever relevant international standards and/or generally accepted standards for the conservation and management of living marine resources exist, they should be used as a reference point for eco-labelling criteria. One such reference-point is the FAO Code of Conduct for Responsible Fisheries.

2. INDEPENDENT ASSESSMENT AND CHAIN OF CUSTODY
Eco-labelling schemes should be based on independent assessment and ensure the accurate identification of the product throughout the chain, “from fish to dish”.

Appropriate procedures, including appeal and complaint procedures, should be in place. In order to protect consumers and the fishing industry, an eco-labelling scheme should be reliable and credible. To this end, the standard-setting body, the accreditation body and the certification bodies should be independent from one another. Without a proper separation of their respective responsibilities, the independence and integrity of eco-labelling schemes cannot be guaranteed. Accreditation and certification bodies and their respective procedures should also comply with the relevant international ISO standards[9]. In practice, eligibility for an eco-label has to be assessed against the relevant certification standard by independent certifying bodies. The certification process should be based on a clear assessment procedure and should cover both the fishery and the post-harvest chain so that eco-labelling can be seen to be fair to all producers and provide credible guarantees for the consumer. A chain of custody would then have to be constructed by a description of the technical means which ensure adequate traceability all the way through to the final consumer. Where levels of performance are set, either for a fisheries management system, a fish stock or a fishing vessel, they should be capable of being adequately monitored. After the initial assessment, and in order to uphold the credibility of the scheme for consumers and its economic benefits for fishermen, there should be a regular evaluation to verify that the product continues to meet the requirements and to ensure a regular validation of the criteria used.

3. OPEN ACCESS

Eco-labelling schemes should not discriminate in terms of access to the certification process. With regard to international trade, eco-labelling schemes should in no case lead to a distortion of trade or competition. Such schemes should not be unfairly discriminatory as to which fisheries, which vessels or which products are eligible for certification. Eco-labelling schemes should be open to all products marketed within the Community, whatever their provenance, in order to comply with the Community's WTO obligations under the Technical Barriers to Trade Agreement. They should not discriminate between domestic goods and imports, or between products from different trading partners. Developing countries contribute substantially to the Community's supplies of fish and fisheries products. The use of eco-labelling schemes could thus be an additional opportunity for them to get added value for their products. Special arrangements and technical and financial assistance would allow them to participate in such schemes. Fisheries Partnership Agreements could be appropriate vehicles to this end. Consideration must also be given to the potential difficulties that small and medium enterprises (SMEs) could encounter in acceding to eco-labelling schemes. Stock assessment and criteria monitoring are often highly demanding in terms of data quantity and data quality. This implies significant costs, which may go beyond the means of SMEs. The Commission would therefore encourage the use of alternative, less data demanding, methods for stock assessment where SMEs are concerned. The schemes should however provide for equal guarantee of sustainability for the fisheries concerned. Finally, it could also be the case that eco-labelling schemes already in

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[9] ISO 14020 series from the International Organisation for Standardisation (ISO) provide the standards for the design and implementation of different types of eco-labelling programmes - but do not lay down any certification standards for specific products or sectors. Anyhow, no cases of ISO 14020 certification has been identified for the fishery sector (EU Reference number FISH/2002/08).

operation encounter difficulties in complying with minimal requirements set. In such a case a reasonable delay should be foreseen for adaptation if ever needed.

4. CONTROL OF ECO-LABELLING SCHEMES
Eco-labelling schemes should be properly controlled, in order to ensure that they comply with the minimal requirements, that certification is satisfactory and that the information provided to consumers is accurate. Adequate controls will reinforce the credibility of schemes for consumers and offer additional guarantees to the fishermen that the schemes are applied in an independent and non-discriminatory manner. The monitoring and control of the Common Fisheries Policy will provide elements which may also be of interest for the supervision of the scheme. This will be of particular importance in situations where the participants in a certified fishery fail to comply with applicable conservation and management measures.

5. ACCURATE INFORMATION OF THE CONSUMER
The certification standard used to award an eco-label should be available to the consumer. Product information at the point of sale should reflect the assessment undertaken. It is essential that consumers know what an eco-labelling scheme stands for. The certification standard together with the criteria used should therefore be made available to consumers so that they can see for themselves what a given eco-labelling scheme represents. In addition, the information on the product at the point of sale should accurately reflect the certification standard. Without this, there would be a risk of misleading consumers about the real significance of eco-labels. (EU, 2005)

Data availability
The certification of a fishery with an eco-label is granted when a number of sustainability standards or criteria have been fulfilled. A central quandary in connection with the production of a single indicator is that several different eco-labelling schemes exist. Hence the most prominent and reliable schemes have been chosen to provide data for the overview in this chapter. However, the scale on which these schemes are applied differ considerably. The nature of the information does not allow for calculation of an indicator in any sensible way.

Problems
There is at present no systematic overview of initiatives with respect to eco-labelling. Information on the internet sites and from other sources is overlapping, diffuse and incomplete.

2.20.2 Results

The following is a sample of the most prominent schemes[10] of interest in the EU:

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[10] **Mark of Origin** is a simple labelling of fisheries products according to origin and species. It is thus not an actual certification, and hence it has not been included in this overview, but the information will enable consumers to purchase fish products from countries believed to pursue legal and sustainable fisheries. Although Article IX of GATT explicitly accommodates national provisions for a Mark of Origin, a mark does not necessarily imply sustainable production. Furthermore, there exists no comprehensive dataset for fish products marked with their country of origin.

“Marine Stewardship Council (MSC)” has established a broad set of principles and criteria for fisheries - e.g. healthy fish stocks to ensure that the fishery is sustainable, low impact on the marine environment including other non-target fish species, marine mammals and seabirds, and rules and procedures in place to maintain a sustainable fishery and to ensure that the impact on the marine environment is minimised. Fisheries meeting these standards will on a voluntary basis be eligible for a certification accredited by the MSC.

“Organic Seafood” labels introduced by fishing companies seeking to establish a marketing niche. The organic aquaculture labelling usually signifies that the food has been produced without artificial inputs - especially synthetic fertilisers and pesticides - and has been produced using environmentally sound management techniques. A few national and private bodies have so far developed standards on organic aquaculture production. There are many different certification processes for organic aquaculture with around 30 non governmental certifiers globally and 18 in Europe (EU 2005a).
With regard to the EU, The European Commission has committed itself to develop harmonized organic aquaculture regulations for the European market. The European Parliament and the Council of the EU have approved this commitment; still the process is right at an early phase. The promotion of international standards is needed in order to avoid confusion on the consumer side as confidence is particularly important for the acceptance of organic products. Standards for organic salmon farming have been developed for example by Naturland (Germany), Soil (UK), KRAV (Sweden), TÚN (Iceland), AIAB (Italy) and BioGro (New Zealand).(Franz, 2004)

"Dolphin Safe" labels have been adopted by a variety of producers in the US. The self-declarations comply with the Dolphin Protection Consumer Information Act (DPCIA) of 1991 that provides criteria for the manner in which tuna must be caught. The label is also used in Europe, where most of the tuna eaten is of the skipjack variety, rather than yellowfin. Skipjack tuna don’t swim with dolphins and so the label would seem rather superfluous (Porritt, 2005)

"Arrangement for the Voluntary Certification of Products of Sustainable Fishing" by the Nordic Council
In 2000, a technical working group of the Nordic Council of Ministers developed criteria for an environmental label based on an assessment of the sustainability of the fisheries. The report, as adopted in August 2001, identified a number of verifiable criteria that concentrate on the process of fisheries management by the public authorities. No fisheries have been certified to date. At the international level, the Nordic Council has initiated a debate on establishing international eco-labelling guidelines in the FAO.

*Friend of the Sea***,** Friend of the Sea Logo is an EU Trade Mark, registered in the EU for fish and fish products, molluscs and crustaceans and cannot be used without Friend of the Sea formal authorization. The Friend of the Sea Logo can be applied only on products originated exclusively from Friend of the Sea approved fisheries**.** Friend of the Sea products are fished: in areas where the resource is not overexploited nor depleted; with methods not considered harmful for the ecosystem; and respecting the FAO Code of Conduct for Responsible Fisheries. Companies engage formally, subscribing a declaration, provide evidence of complying with the above criteria and allow necessary spot-checks. (15 sustainable fisheries world-wide). The Friend of the Sea site provides "red listed" or "green listed" species..

*Waddengroep***.** In the Netherlands one vessel, the TS 31, fishing in the Wadden sea is eco-labelled by the Waddengroup. The eco-label is called 'Waddengoud' (Waddengold) and is used for sustainably caught and processed fish in the Waddensea. In the case of the TS31 this is grey mullet and sea bass. Also shrimps from Friedrichskoog in Germany have this certificate and the shrimps will be used in the "Kwekkeboom kroket". Waddengroep has the intention to expand their assortment with mussels and cockles (Visserijnieuws, 16-9- 2005)

Private arrangements

In parallel to the development of eco-labelling schemes, certain supermarket chains have committed themselves to restrict their supply of fish to sustainable fisheries. They have started to develop and join certification programs to this end. In addition to that, some others have even decided not to offer fish for sale at all. (EU, 2005).

Unilever Fish Sustainability Initiative

This Unilever program aims at guiding their internal selection of sources of whitefish supply. Fisheries have been classified from "sustainable" to "not sustainable" according to 5 criteria, each criteria being quoted by a green/orange/red light system. See: Unilever traffic light system (Porritt, 2005).

Carrefour - Logo "Pêche responsable"

Carrefour's own claim to be used on Icelandic cod as from September 2004 (announcement at Seafood International exhibition, May 2004). (EU, 2005). Carrefour Italy S.p.A. joins Friend of the Sea. Two aquaculture products, both from the Italian Company Acqua Azzurra, have undergone and passed preliminary analysis and will soon be on the shelves holding FOS Logo: European sea bass and Gilthead sea bream.

COOP Italy

sells products with the logo: "Friend of the Sea".

Sainsbury (UK) wants to stock only fish from "well managed sources" by 2010. To speed things up, Sainsbury's is looking at working with its suppliers to develop a custom-built framework to assess the relative sustainability of different stocks. This could operate alongside the MSC scheme, either as a consumer-facing "silver standard" below the MSC "gold standard", or would operate behind the scenes, so that Sainsbury's could ensure that the sustainability of its fish supply was improving independently of the protracted processes of the MSC ((Porritt, 2005).

ODUS (NL): development of sustainable shellfish fisheries in the Netherlands

Bio canned fish. In Germany and probably elsewhere "bio canned fish" is sold: Mackerel, sprat, herring. Probably all ingredients are organic except the fish. (http://www.nuernberger-bio-originale.de)

Other initiatives

Seafood Choices Alliance

The Alliance works with the seafood industry – from fishermen and fish farmers to distributors, wholesalers, retailers and restaurants – to make the seafood marketplace environmentally and economically sustainable. Founded in the United States in 2001, since 2005 established also in Europe, the Alliance has expanded to address the growing worldwide interest in environmentally responsible seafood and to highlight the need for a global solution to threats facing the ocean. The Alliance – in partnership with leading European conservation organizations WWF, North Sea Foundation, Marine Conservation Society and Greenpeace – will provide industry members from across the supply chain with access to consumer research, the latest in current market trends, scientific data on the status of species, sources of sustainable seafood, and other information professionals need to make informed decisions about the seafood they serve.

Fishonline is a website that gives a rating on fish from the North East Atlantic stocks based on its stock status, fisheries management and the environmental impacts of the fishing methods used. Fishonline has been developed by the Marine Conservation Society and designed by Juniperblue with the support of the Esmée Fairbairn Foundation and Marks and Spencer plc. Information on fish stocks in the North-East Atlantic has been obtained from the most recent scientific reports published by the International Council for the Exploration of the Sea (ICES 2003) **www.ices.dk**. Information about World Conservation Union (IUCN) assessments and Red List fish species is available at **www.iucn.org**. Fishonline also published the Good Fish Guide, first published in 2002. The Good Fish Guide provides comprehensive information on fishing methods and management; impacts of fishing on marine life and local communities; and information on biology, status, capture methods and fishing impacts for 65 species of fish commonly eaten in the UK. *"De Goede Visgids"* (NL) is a comparable initiative as the Good Fish Guide for the fish commonly eaten in the Netherlands. In the USA similar initiatives exist, like Audubon's seafood wallet card and the Ocean's Alive Seafood Selector. MSC is now working with the Seafood Choices Alliances and others to develop a common methodology for compiling fish lists, to help resolving confusion about the different lists and sources used.

Organic fish certificates:

'Agriculture Biologique' (AB) and EcoCert (France).
Naturland (Germany),
Soil (UK),
KRAV (Sweden),
TÚN (Iceland),
AIAB (Italy)
Andalusian Committee on Organic Agriculture , the C.A.A.E. (Spain)
BioGro (New Zealand)

2.20.3 Evaluation and interpretation

A central dilemma in connection with the production of a single indicator is that several different eco-labelling schemes exist. The most prominent and reliable schemes have been chosen to provide data for the overview in this chapter. The different eco-labels and supporting initiatives, however, are very different in character, ambition and scale of appliance. The nature of this information does not allow for calculation of an indicator.

There is a wide variety of eco-labelling schemes in existence. Eco-labelling nowadays can be considered an important marketing issue. For consumers it creates the possibility for more control over production methods and their impact on the environment. However, the large number of eco-labels also causes problems. It's difficult or at least time consuming for consumers to get all the information to make the right choices. The similar but slightly different claims of different labels may also cause a credibility problem and loss of interest by consumers.

2.20.4 Recommendations

Although it is valuable in itself to keep track of new initiatives in the field of environmentally friendly production and eco-labelling, the nature of this information does not yet allow for calculation of an indicator. As it currently stands it would be more interesting to have an annual report written by an independent expert that presents an annual overview of new developments in the field of eco-labelling.

2.21 Amounts of fish taken out of the market and/or traded on secondary (intervention) conditions.

Uncertainties in fishing result in fluctuating catches, fluctuating supply, and consequently fluctuating prices. Price intervention mechanisms have been put in place in order to mitigate the effects of these fluctuations. Council Regulation (EC) No 104/2000 on the Common Organisation of the Markets in Fishery and Aquaculture products motivates the use of the (price) intervention mechanisms and underscores the desirability to reduce excess supplies to the market and in particular to reduce complete withdrawals among other things in the light of the scarcity of certain species.

Market failure occurs when supply and demand do not match at prevailing prices. The intervention system mitigates the effects of fluctuating supply on the incomes of fishermen. On the other hand, without the intervention mechanism, there would be no market failure in this sense, but prices and incomes of fishermen would fluctuate more.

A secondary objective of the price intervention system is to restrict the volume of withdrawals by means of reduced price support when the withdrawn volume increases. Thus, it can be argued that large volumes of withdrawals indicate poor functioning of the intervention mechanism.

As argued in (EU, 2002) the level of withdrawals can be considered "an indicator of the extent to which the organisation of the markets has been able to capture the (inevitable) market failure". "The market may do this in a multitude of ways, e.g. by enhancing the use of the more intermediate mechanisms and by improved planning and implementation of fishing activities. Opting for the indicator on complete withdrawals only allows for a simple indicator and one that focuses on the least desired possibility".

2.21.1 Material & methods

Data on withdrawals are available at DG Fisheries as all EU Member States are compelled to provide this information to Brussels according to the data collection regulation.

For this study DG Fish provided data for 2002-2005 by species. Data per Member State or per region were not obtained and probably not readily available. Also, data from before 2002 are probably there but not readily available.

2.21.2 Results

Table Withdrawals 2002 - 2005

	PRODUCTION						WITHDRAWALS						% WITHDRAWALS/PRODUCTION					
	2002	2003	2003 6 months	2004	2004 6 months	2005 6 months	2002	2003	2003 6 months	2004	2004 6 months	2005 6 months	2002	2003	2003 6 months	2004	2004 6 months	2005 6 months
Herring	203,169	204,446	83,174	198,686	97,142	105,541	636	4,481	528	3,763	3,386	2,045	0.31%	2.19%	0.63%	1.89%	3.49%	1.94%
Sardines	160,105	150,474	53,313	153,581	59,339	59,645	5,379	3,713	1,351	2,970	775	3,659	3.36%	2.47%	2.53%	1.93%	1.31%	6.13%
Mackerel	114,084	94,759	63,568	98,426	50,300	69,819	539	1,128	302	768	376	261	0.47%	1.19%	0.48%	0.78%	0.75%	0.37%
Spanish mackerel	11,048	14,996	6,196	25,027	12,730	15,129	31	56	23	65	5	7	0.28%	0.37%	0.37%	0.26%	0.04%	0.04%
Anchovies	59,944	38,471	17,523	46,187	22,902	14,241	985	590	305	406	238	30	1.64%	1.53%	1.74%	0.88%	1.04%	0.21%
Albacore	13,395	15,580	718	15,999	965	1,173	3	155	0	39	0	0	0.02%	0.99%	0.00%	0.25%	0.00%	0.00%
PELAGIC FISH	561,745	518,726	224,492	537,906	243,378	265,548	7,573	10,122	2,509	8,009	4,780	6,001	1.35%	1.95%	1.12%	1.49%	1.96%	2.26%
Cod	107,831	81,981	42,909	79,610	49,920	37,729	26	27	18	20	18	9	0.02%	0.03%	0.04%	0.03%	0.04%	0.02%
Haddock	70,067	56,722	26,738	55,698	23,719	22,007	3,087	2,403	877	915	449	72	4.41%	4.24%	3.28%	1.64%	1.89%	0.33%
Saithe	57,540	53,341	28,659	46,622	24,390	23,735	743	1,849	725	1,219	643	650	1.29%	3.47%	2.53%	2.61%	2.64%	2.74%
Redfish	3,225	4,229	1,579	4,232	1,861	1,119	9	48	3	45	9	0	0.28%	1.14%	0.19%	1.07%	0.46%	0.04%
Whiting	31,703	26,261	15,560	22,265	12,409	12,603	703	487	334	190	115	24	2.22%	1.86%	2.15%	0.86%	0.92%	0.19%
Hake	40,924	39,763	18,714	48,152	21,811	32,101	563	440	207	503	251	199	1.38%	1.11%	1.11%	1.05%	1.15%	0.62%
Plaice	91,018	86,739	40,520	79,654	38,527	33,392	282	87	50	128	52	32	0.31%	0.10%	0.12%	0.16%	0.13%	0.09%
Ling	20,443	18,338	7,442	17,410	10,748	9,817	17	30	12	39	24	26	0.08%	0.16%	0.16%	0.23%	0.22%	0.26%
Spotted dogfish	11,057	9,603	3,280	11,396	4,997	5,927	573	608	273	449	176	136	5.18%	6.33%	8.32%	3.94%	3.53%	2.30%
Dogfish	5,628	4,178	3,387	3,730	1,329	1,143	101	59	21	40	9	3	1.79%	1.42%	0.62%	1.06%	0.69%	0.24%
Megrim	14,576	14,946	7,015	15,280	8,264	7,249	131	118	24	78	54	31	0.90%	0.79%	0.34%	0.51%	0.66%	0.43%
Monkfish (whole)	26,162	27,949	14,376	32,316	17,606	18,780	3	14	21	26	21	2	0.01%	0.05%	0.15%	0.08%	0.12%	0.01%

	PRODUCTION						WITHDRAWALS						% WITHDRAWALS/PRODUCTION					
(tails)	1,476	1,761	724	1,863	1,097	922	0	0	0	0	0	0	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%
Dab	11,659	12,405	5,660	16,058	6,566	6,595	371	776	586	181	86	105	3.18%	6.26%	10.35%	1.13%	1.32%	1.60%
Flounder	12,702	9,003	5,681	10,291	7,071	5,656	38	55	49	40	19	27	0.30%	0.61%	0.86%	0.39%	0.27%	0.47%
Sole	31,489	31,883	15,454	31,780	17,068	15,819	0	2	0	26	25	0	0.00%	0.01%	0.00%	0.08%	0.15%	0.00%
WHITE FISH	537,500	479,102	237,698	476,357	247,383	234,594	6,647	7,003	3,200	3,899	1,951	1,316	1.24%	1.46%	1.35%	0.82%	0.79%	0.56%
Shrimps (Crangon)	25,553	28,389	11,396	24,400	11,514	7,511	19	251	148	98	2	1	0.07%	0.88%	1.30%	0.40%	0.01%	0.02%
Northern prawns (Fresh)	5,421	6,516	4,346	4,995	2,688	2,157	0	0	0	0	0	0	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Northern prawns (Boiled)	2,847	1,145	910	1,484	676	539	11	53	23	56	49	12	0.39%	4.63%	2.53%	3.80%	7.25%	2.15%
Nephrops (whole)	28,169	26,527	12,611	26,696	13,672	15,441	1	0	0	16	16	0	0.00%	0.00%	0.00%	0.06%	0.12%	0.00%
(tails)	4,534	1,664	1,844	1,721	881	904	0	0	0	0	0	0	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
Edible crab	32,287	23,689	10,509	42,378	6,343	14,859	0	2	0	1	0	0	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%
CRUSTA CEANS	98,811	87,930	41,616	101,674	35,774	41,411	31	306	171	172	67	13	0.03%	0.35%	0.41%	0.17%	0.19%	0.03%
Cuttlefish	22,387	26,260	12,748	29,513	12,309	11,515	34	167	10	111	41	23	0.15%	0.64%	0.08%	0.38%	0.34%	0.20%
OTHER	22,387	26,260	12,748	29,513	12,309	11,515	34	167	10	111	41	23	0.15%	0.64%	0.08%	0.38%	0.34%	0.20%

	PRODUCTION						WITHDRAWALS						% WITHDRAWALS/PRODUCTION					
TOTAL	1,220,443	1,112,018	516,554	1,145,450	538,844	553,068	14,285	17,598	5,890	12,191	6,839	7,353	1.17%	1.58%	1.14%	1.06%	1.27%	1.33%

Source: DG Fish. The data comes out from the Data (FIDES - MIS 2000)

2.21.3 Evaluation and interpretation

Data for this indicator are available in Brussels as Member States are obliged to provide this information to DG fisheries. Although time series can be produced relatively easy, the interpretation of the indicator is not so straightforward. The main objective of the market intervention system is to stabilize fish prices and incomes of fishermen. From an environmental perspective, it is desirable to reach this objective with a minimum volume of withdrawals. The proportion of withdrawals can thus be seen as an indicator for environmental problems caused by the market intervention mechanism. Without further information about price fluctuations it can however not be used for evaluation of the market intervention mechanism in itself.

The proportion of total withdrawals as percentage of total production varies between 1.1 and 1.6% during 2002 – 2005. The time series is too short to distinguish a clear trend. The proportion of withdrawals differs by species, being higher for pelagic fish (1.1 to 2.3%) and whitefish (0.6 to 1.5%) and relatively low for crustaceans (0 to 0.4%).

2.21.4 Recommendation

When using this indicator for environmental impact of the market intervention system, it should be stressed that withdrawals serve a purpose of price and income stabilisation and that effectiveness of the system should be judged on basis of both the extent to which its primary objective is achieved and its environmental impact in the form of withdrawals. The proportion of withdrawals can be seen as an indicator for environmental problems caused by the market intervention mechanism. Without further information about price fluctuations it should not be used for evaluation of the market intervention mechanism.

2.22 Size of the European market for fish

The demand for fish and fish products has an impact on the fishing effort at sea and the pressure on stocks in EU waters. Aquaculture production and net-imports of fish can partly relief this pressure. Therefore five components of the size of the market are considered important: total fisheries production, total aquaculture production, imports, exports and resulting supply to the EU market which equals total consumption of fish.

2.22.1 Material & methods

The size of the EU market can be defined as total supply to the market: the sum of production (domestic landings + aquaculture production) and net imports. Total supply can be seen as a (partial) indicator for the pressure on fish stocks generated by market forces. This pressure can however be reduced by increasing share of aquaculture or by increasing share of net imports in total supply. Therefore the share of the sum of net imports and domestic aquaculture in total supply is proposed as a complementary indicator.

Data on production, imports, exports and supply to the European market are available from Eurostat (New Cronos) or FAO. Although Eurostat obtains these data from FAO, there are (for unknown reasons) small differences between the datasets. Below the FAO data have been presented.

2.22.2 Results

Table 2.22.1 Time series of production (sum of capture fisheries and aquaculture) and supply (sum of production and net-imports).

EU-25	1000 metric tonnes							
	1995	1996	1997	1998	1999	2000	2001	2002
Aquaculture	1158	1210	1236	1362	1413	1386	1373	1327
Capture fisheries	8117	7484	7578	7329	6896	6745	6877	6389
Production	9125	8534	8664	8573	8163	7968	8085	8085
Imports	15729	15648	16117	16370	16307	16726	17243	17243
Exports	9303	9451	9652	9881	10318	10148	10534	10534
Supply	15222	14498	15386	14828	14059	13980	14869	14869

Source: FAO database, http://www.fao.org/fi/statist/statist.asp
Comment: FAO data on production, imports and exports, presented in the database for the years 2001 and 2002 are exactly the same. Probably the data for 2002 are not available.

Table 2.22. 2 Complementary indicators for impact of market forces on the pressure on EU fish stocks: Share (%) of aquaculture and net imparts in EU supply.

	1995	1996	1997	1998	1999	2000	2001	2002
Aquaculture	7.6	8.3	8.0	9.2	10.0	9.9	9.2	8.9
Net imports	42.2	42.7	42.0	43.8	42.6	47.1	45.1	45.1
Total	49.8	51.1	50.1	52.9	52.6	57.0	54.4	54.0

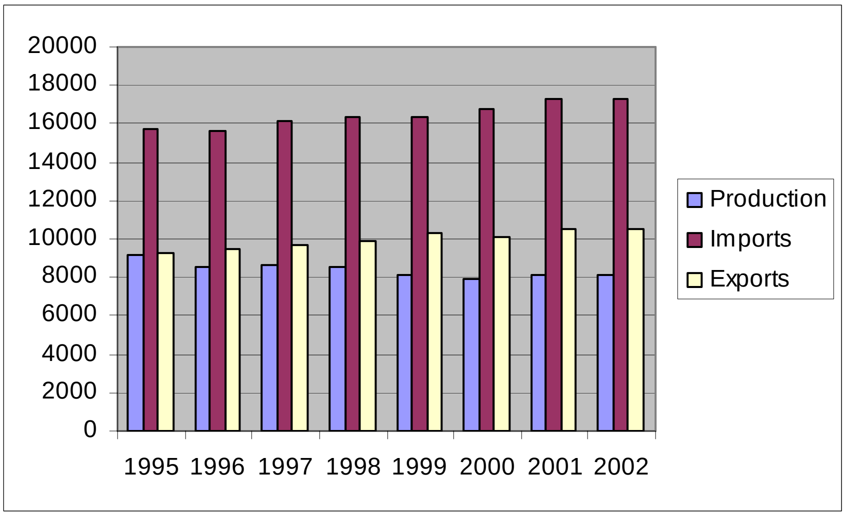

Figure 2.22.1. EU production, imports and exports of fish products

2.22.3 Evaluation and interpretation

Data for this indicator is readily available from both Eurostat and FAO. Interpretation of the indicator is not so straightforward. Increasing total demand for fish (consumption) may cause potential pressure on EU fish stocks. This pressure can

however be relieved by increasing share of net imports and aquaculture production in total supply. In order to evaluate changes in pressure on domestic fish stocks, data on both total supply and the share of net imports and aquaculture production in total supply is needed.
Between 1995 and 2002, domestic production of fish decreased and imports of fish increased (table 2.22.1). Exports also increased. The resulting supply to the EU market remained more or less stable. Table 2 shows that the share of aquaculture and net imports has increased during the period 1995 – 2002 from 50% to 54%. Consequently the share of EU capture fisheries in domestic supply decreased slightly.

2.22.4 Recommendation

The indicator size of the European market for fish describes the pressure on two types of European resources that fall under CFP: commercial fish stocks and aquaculture. Therefore this indicator could be complemented with two indicators that describe the production and hence the pressure on each of these two resources. In addition this indicator could be combined with the information on the status of the stocks (see section 2.1) and identify to what extent the European market puts demands on stocks that are outside safe biological limits (see section 2.31).

2.23 Changes in consumer preferences in relation to environmental issues

This indicator should measure changes in consumer preferences in relation to environmental issues such as consumption of depleted or threatened species or of undersized organisms.
Demand patterns are among other things reflections of attitudes, preferences and knowledge among consumers. The more consumers are aware of environmental issues, prefer products that safeguard the environment and have sufficient knowledge to react according to this, the higher will the pressure be on producers to supply such products to the market. Market surveys and consumer surveys can assist to shed light on the level of knowledge and preferences, while information campaigns and labelling can be used to enhance the level of knowledge. All of these aspects relate however to ex-ante perceptions with consumers and institutions about consumer behaviour. At the other end of the scale, one may say that the actual occurrences in the market are ex-post reflections of the extent to which the awareness, knowledge and information has actually generated a change in consumer demand, and the extent to which the supply side has responded to this. Consequently, in theory such an ex-post indicator is preferable but depends on the extent to which a definition can be established to distinguish the "eco-market" from the "traditional" market (EU, 2002).

2.23.1 Material & methods

It’s difficult to quantify the demand for eco-labelled products, as recent studies show certain limits in this regard. In a recent study in the US, the interrogated consumers indicated a preference for eco-labelled products but in contrast to that, an analysis of the shopping basket showed that the price was the first criterion of choice.
In other terms, the success of an eco-labelling scheme would depend, at least in part, on the additional costs which it carries with it. Moreover, consumer interest varies from country to country, depending on market peculiarities and public perception of

the concept of sustainability (EU, 2005).
Economical (price/quality) and cultural aspects like quality, tradition and eating habits are important features of consumer behaviour.

Data availability
There is hardly specific data available for the fish market on changes in consumer preferences in relation to environmental issues. Quantification of the demand for eco-labelled products is still very difficult. Due to this, time series are difficult to calculate and not (yet) available.

2.23.2 Results

Sustainable fish consumption
Results of a public opinion poll in the UK about eating fish that are threatened by over-fishing commissioned by Unilever (2005) indicates that 13% of people in the UK try to avoid types of fish that are threatened by over-fishing; 29 % would like to cut down on types of fish that are threatened by over-fishing, but they are not sure which ones are at risk; 14% admits sometimes to buy types of fish that may be threatened by over-fishing because taste, price and availability are more important to them ; and 36 % has never thought about the issue of over-fishing when buying fish.
(Source: Porritt, 2005. Populus survey data for Unilever. Populus interviewed a sample of 1,010 people in England, Scotland and Wales)
Some companies have attempted to wean consumers onto more sustainable products through active marketing. Several attempts have been made with fish products, with mixed results:
Introducing Hoki (MSC labelled fish) in Germany, Frosta assumed that consumers were willing to pay more for sustainable fish. This did not happen , Frosta lost 50% of their market share. In Germany people like to eat white fish and they buy it in a frozen form. In this case the consumers do not care whether the whitefish is pollock, or hoki. The content of the white fish package depends on the availability of a species on the market (Porritt, 2005).
Birds Eye in the UK introduced hoki steak products and hoki fish fingers as a sustainable alternative for cod. About 13 % of the cod steak buyers moved to hoki and 10% of cod fish fingers buyers. But most people returned to cod products. Nowadays in 2005 Birds Eye is not selling any hoki products to retailers in the UK. One of the problems was the competition between supermarkets. After the Birds Eye hoki initiative, supermarkets started to sell cod products for very low prices.

Ethical consumption
The problem of how to stimulate more ethical consumption is an old one that has yet to be solved. Consumer research typically shows that about a third of people in the UK say that they take ethical issues into consideration when choosing what to buy in the shops. When it comes to the crunch, the real drivers of choice are price and quality, and ethical considerations only get a look in with a paltry three to seven per cent of us, depending on whose research you believe.

Elsewhere, researchers have bundled together all the ethical products and services out there – from organic food to renewable energy, eco-tourism to green mortgages – and worked out how much people spend on them. Although this amount is creeping up slowly year by year, it is still under two per cent of the total amount we spend (The

Ethical Purchasing Index - see www.co-operativebank.co.uk)

2.23.3 Evaluation and interpretation

Changes in consumer preferences in relation to environmental issues can be of major influence on the development of environmentally friendly production methods. If environmental issues play a larger role in consumer preferences, eco-labelling becomes more interesting from a marketing perspective and the pressure on producers to adjust their production methods will increase. This means that it can be considered important to monitor consumer preferences with respect to environmental issues. However, consumer preferences are difficult to measure and therefore cannot be considered an indicator for environmental integration. It's rather a phenomenon that we would like to have an indicator for. In this case, for instance, share of eco-label products in total consumption, could be regarded as a valuable indicator for consumer preferences. The scarce and incomplete information about consumer preferences with respect to environmental issues presented here, suggests that at this point:

- Environmental issues do play a role in consumer choice
- The majority of consumers does not want to pay (much) extra for sustainable produced food

2.23.4 Recommendations

In order to monitor the phenomenon of consumer preferences for environmental issues it would be advisable to choose one or more indicators that can be measured better. In this case, the share of eco-label products in total fish consumption might be a better indicator for changes in consumer preferences.

2.24 Number of inspections per landing

This indicator was quantified to answer the question of whether the structure and organisation of the fishery inspection sector is supportive of environmental goals. As such, this indicator should be considered together with the indicators "number of infringements over number of inspections" (section 2.25) and "Level of imposition of punishment" (section 2.26).

2.24.1 Material and Methods

The two main data sources for quantifying the indicators were the Commission's annual serious infringements reports and its compliance scoreboard.

Serious infringements reports

In 1999 a Council Regulation was adopted (Regulation 1447/1999) establishing a list of types of behaviour which seriously infringe the rules of the CFP. The breaches included in the list are linked to the most important obligations imposed by the Community rules on stock conservation, monitoring and the marketing of fisheries products:

A1: Obstructing the work of fisheries inspectors;

A2: Falsifying, concealing, destroying or tampering with evidence;
B1: Obstructing the work of observers;
C1: Fishing without holding a fishing licence, a fishing permit or any other authorization required for fishing;
C2: Fishing under cover of a falsified document;
C3: Falsifying, deleting or concealing the identification marks of the fishing vessel;
D1: Using or keeping on board prohibited fishing gear;
D2: Using prohibited fishing methods;
D3: Not lashing or stowing prohibited fishing gear;
D4: Directed fishing for, or keeping on board of, a species subject to a fishing prohibition;
D5: Unauthorised fishing in a given zone and/or during a specific period;
D6: Failure to comply with the rules on minimum sizes;
D7: Failure to comply with the rules and procedures relating to transhipments;
E1: Falsifying or failing to record data in logbooks, etc;
E2: Tampering with the satellite-based vessel monitoring system;
E3: Deliberate failure to comply with the Community rules on remote transmission of movements of fishing vessels;
E4: Failure of the master of the fishing vessel of a third country to comply with the applicable control rules when operating in Community waters;
F1: Landing of fishery products not complying with the Community rules on control and enforcement;
F2: Storing, processing, placing on sale and transporting fishery products not meeting the marketing standards in force;
NA: Unspecified.

With the adoption of the Regulation establishing this list, Member States are obliged to report yearly to the Commission on action taken in relation to detected breaches. The procedure for this reporting is laid down in Regulation 2740/1999. The Commission has produced four reports to date summarising Member States performance:

Commission working paper number	Date Produced	Year Covered
COM(2001)650	12 November 2001	2000
COM(2002)687	5 December 2002	2001
COM(2003)782	15 December 2003	2002
COM(2005)207	30 May 2005	2003

Of the 20 types of serious infringements, all except two relate directly or indirectly to stock conservation (F2: Storing, processing, placing on sale and transporting fishery products not meeting the marketing standards in force; and NA: Unspecified). Of the remaining 18 classifications, they may all have implications for the environmental performance of the CFP, although none of them can be singled out as such.

Compliance Scoreboard
The European Commission launched a compliance scoreboard on 11 June 2003 (COM(2003)344). This was one of the first steps to implement the 2003-2005 Action Plan for Co-operation in Enforcement published in 2003 (COM(2003)130).

The scoreboard is a "name and shame" exercise, also intended to improve transparency and public scrutiny of Member States" compliance with Community rules. Four main areas are covered: catches taken by fleets, fleet capacity and fishing effort, funding to the fisheries sector, and national monitoring and inspection activities. In addition, it reports on the infringement procedures initiated by the Commission against Member States failing to comply with CFP rules. It is updated annually and can be found at http://europa.eu.int/comm/fisheries/scoreboard/index_en.htm

2.24.2 Results

This indicator was originally the "number of inspections per landing". However, as the number of fishing trips by Member State is not available, vessels numbers were used as a proxy. Furthermore, as data on the number of inspections per year by Member State is generally not available, the number of Commission inspections reported in the Commission compliance scoreboard, were considered. These are reported both by purpose and by Member State and are summarised in Table 2.24.1 and Table 2.24.2, with the number of inspections per vessels at the Community and Member State level respectively.

Table 2.24.1 Number and object of inspection visits by Commission inspectors 2002-2004

Object	2002	2003	2004
Checking the implementation of emergency measures to protect hake and cod	35	19	25
Checking the application of control measures under fisheries agreements	5	3	6
Monitoring landings of catches taken in the Baltic Sea, including those of third country vessels	16	0	0
Checking the application of fisheries control in the Baltic Sea	0	10	9
Monitoring landings of pelagic species	8	0	0
Checking of Member States monitoring of landings of pelagic species	0	4	7
Monitoring landings of catches taken in the Mediterranean. Checking compliance with technical measures.	19	0	0
Checking compliance with technical measures in the Mediterranean	0	2	0
Overall verification of the application of control by Member States	6	0	0
Verification of Member States" control of fishing for Highly Migratory Species	0	18	1
NAFO0 Scheme of inspection and surveillance. Inspections at sea.	17	17	14
Overall verification of the application of control by Member States	0	4	0
NEAFC0 Scheme of inspection and surveillance. Inspections at sea.	4	1	1
Checking the system of penalties imposed by the Member States	6	0	0
Monitoring of landings from the NAFO area	1	0	0
Verification of the control of landings from the NAFO area	0	7	2
Verification of Member States implementation of VMS	0	14	7
Verification of Member States" sanction systems	0	7	1
Screening of new Member States	0	6	0
Verification of the implementation of CFP rules in new Member states	0	0	1
Verification of the implementation of the Common Markets Standards	0	0	8

Object	2002	2003	2004
Verification of the landings by third country vessels	0	0	6
Verification of the implementation of the Sole recovery measures in area 7E	0	0	1
TOTAL	**117**	**112**	**89**
Number of EU Vessels	**90,342**	**88,075**	**88,075**
Inspections/Vessels x10^{04}	**130**	**127**	**101**

Table 2.24.2 Number of Commission inspection visits per vessel in each Member State, 2002-2004

	Number of Inspections			Vessels		Inspections/Vessels		
Member State	**2002**	**2003**	**2004**	**2002**	**2003**	**2002**	**2003**	**2004**
BE	3	4	2	129	126	0.023	0.032	0.016
DE	5	7	6	2240	2192	0.002	0.003	0.003
DK	9	8	6	3726	3552	0.002	0.002	0.002
ES	17	14	7	14817	14397	0.001	0.001	0.000
EL	4	4	1	19523	18979	0.000	0.000	0.000
FR	13	9	5	8082	8047	0.002	0.001	0.001
FI	2	2	1	3544	3420	0.001	0.001	0.000
IT	5	8	1	16069	15639	0.000	0.001	0.000
IE	8	4	3	1437	1490	0.006	0.003	0.002
NL	5	5	6	952	949	0.005	0.005	0.006
PT	3	10	4	10427	10313	0.000	0.001	0.000
SE	6	5	5	1840	1692	0.003	0.003	0.003
UK	10	8	9	7556	7279	0.001	0.001	0.001
EE	0	0	2	-	-	0	0	0
CY	0	0	2	-	-	0	0	0
LV	0	0	2	-	-	0	0	0
LT	0	0	2	-	-	0	0	0
MT	0	0	2	-	-	0	0	0
PL	0	0	2	-	-	0	0	0
SI	0	0	1	-	-	0	0	0
Outside the EU	27	24	20	-	-	0	0	0
TOTAL	**117**	**112**	**89**	**90,342**	**88,075**	**0.001**	**0.001**	0

2.24.3 Evaluation and interpretation

There are only three data points for four of the Commission inspection types[11]. Of these, only a trend exists for the NEAFC inspections, which are decreasing. The total number of Commission inspections and thus inspections per vessel, have declined between 2002 and 2004. There is no indication of which, if any, of the Commission inspections relate to enforcing environmental regulations.

The STECF suggested that the indicator should be broken down by major fishery. In practice it is not possible to assign values to the indicator in this way. Member State inspections are not recorded across the EU, and were they it would likely prove difficult, if not impossible, to break down inspections by fishery given the great variety in fisheries that characterise the EU. Added to this, it would be necessary to define which inspections relate to the environmental elements of the CFP. In conclusion, this indicator tells us little about how supportive the inspection systems are of environmental goals under the current reporting systems.

2.24.4 Recommendations

On the basis of the above limitations, the indicator provides little insight into whether the inspection sector supports environmental goals. Instead, it only provides an insight into Commission inspections generally. Indeed, it is not considered feasible to collect data on Member States enforcement of environmental regulations. It is therefore recommended that this indicator not be used for the purpose of illustrating the environmental performance of the inspection systems or the CFP more broadly.

If the Commission considers this indicator to be valuable, it could be improved by requiring Commission inspectors to more specifically define the purpose of their inspections and whether they relate to enforcement of environmental measures.

[11] Checking the implementation of emergency measures to protect hake and cod; Checking the application of control measures under fisheries agreements; NAFO- Scheme of inspection and surveillance. Inspections at sea; and NEAFC- Scheme of inspection and surveillance. Inspections at sea.

2.25 Number of infringements over number of inspections.

This indicator was quantified to answer the question of whether the structure and organisation of the fishery inspection sector is supportive of environmental goals. The approach we followed is closely related to that described in section 2.24.

2.25.1 Material & methods

See 2.24.1

2.25.2 Results

Because the number of inspections per year by Member State is not readily available, this indicator could only be calculated in terms of the number of infringements per Commission inspection (Table 2.25.1). It should be noted that the number of infringements are greater than inspections because the former is determined by Member State inspections and the data used here is Commission inspections. Two different datasets are therefore being compared.

Table 2.25.1 Number of infringements per Commission inspection visit in each Member State, 2002-2004

	Inspections			Infringements		Infringements/Inspections	
Member State	**2002**	**2003**	**2004**	**2002**	**2003**	**2002**	**2003**
BE	3	4	2	24	23	0.125	0.174
DE	5	7	6	118	128	0.042	0.055
DK	9	8	6	415	469	0.022	0.017
ES	17	14	7	1295	2861	0.013	0.005
EL	4	4	1	1018	756	0.004	0.005
FR	13	9	5	222	544	0.059	0.017
FI	2	2	1	2	10	1.000	0.200
IT	5	8	1	1072	2569	0.005	0.003
IE	8	4	3	20	82	0.400	0.049
NL	5	5	6	103	96	0.049	0.052
PT	3	10	4	1560	1238	0.002	0.008
SE	6	5	5	108	82	0.056	0.061
UK	10	8	9	?	?	-	-
EE	0	0	2	-	-	-	-
CY	0	0	2	-	-	-	-
LV	0	0	2	-	-	-	-

	Inspections			Infringements		Infringements/Inspections	
Member State	**2002**	**2003**	**2004**	**2002**	**2003**	**2002**	**2003**
LT	0	0	2	-	-	-	-
MT	0	0	2	-	-	-	-
PL	0	0	2	-	-	-	-
SI	0	0	1	-	-	-	-
Outside the EU	27	24	20	-	-	-	-
TOTAL	**117**	**112**	**89**	-	-	-	-

2.25.3 Evaluation and interpretation

The results suggest that the most effective level of Commission inspections is in Finland while the least effective is in Portugal, Italy and Greece. In all cases except Spain, France, Italy and Greece, the level of inspections per infringement appear to have increased between 2002 and 2003. These results are subject to the limitations described in the compliance scoreboard.

There is no indication of which, if any, of the Commission inspections relate to enforcing environmental regulations. The serious infringements also do not relate specifically to any environmental infringements. The results therefore tell us little about how supportive the inspection systems are of environmental goals under the current reporting systems.

As with the indicator above, it is not possible to assign values to the indicator by fishery or infringement type. The data is not currently collected, and collecting it is not considered feasible. The indicator therefore tells us little about how supportive the inspection systems are of environmental goals under the current reporting systems.

2.25.4 Recommendations

On the basis of the above limitations, the indicator provides little insight into whether the inspection sector supports environmental goals. Instead, it only provides an insight into Commission inspections generally. As it is not considered feasible to collect data on Member States enforcement generally, or of environmental infringements, it is recommended that this indicator not be used for the purpose of illustrating the environmental performance of the inspection systems or the CFP more broadly.

2.26 Level of imposition of punishment

This indicator was quantified to answer the question of whether the structure and organisation of the fishery inspection sector is supportive of environmental goals. The approach we followed is closely related to that described in section 2.24.

2.26.1 Material & methods

See section 2.24.1

2.26.2 Results

The serious infringements reports contain extensive data on the type and extent of punishments by Member State and by type of infringement. This includes data on:

- number of cases where penalties were imposed by type of infringement and by Member State;
- average fine by type of infringement and by Member State;
- number of seizures by type of infringement and by Member State; and
- amount paid by the fishery industry in each Member State as a consequence of serious infringements.

As there are three years of data, these are too lengthy to reproduce here. Instead, average fine by type of infringement and by Member State is reproduced in Table 2.26.1. The interested reader is directed back to the annual reports from the Commission for further details.

Table 2.26.1 Average fine by type of infringement and by Member State (Euros)

Code		BEL	DNK	DEU	GRC	ESP	FRA	IRL	ITA	LUX	NLD	AUT	PRT	FIN	SWE	GBR	TOTAL
A1	2003		839			5,289	150		684							154	4,492
	2002		805			5,079		12,800	206							3,384	4,924
	2001	2,479	906	500		1,587	648	3,794	515							343	1,563
A2	2003					3,383											3,383
	2002																
	2001							2,540									2,540
B1	2003					180											180
	2002		671						68								370
	2001					270											270
C1	2003		335	3,472	385	2,087	2,885		575				689		475	4,236	1,514
	2002		568	3,962	384	1,463	2,000	21,400	2,052				435				1,314
	2001			866	641	849	30,000	1,905	795				6,277		367	396	1,288
C2	2003				300	818											805
	2002				300	545			185								474
	2001				300												300
C3	2003				341	3,934	350		1,434				204				2,398
	2002			83	300	1,282			68				139				924
	2001				353	241		571	100				458				180
D1	2003	7,500	2,884	1,520		870	736		7,649		9,000		451		674	3,321	3,871
	2002		447	1,247	933	2,660	7,563	20,000	1,066		5,590		580			3,145	1,518
	2001	7,436		394	596	433	304	15,250	1,538				10,882			5,609	3,205
D2	2003				692	5,107	801		989		1,100		219			385	2,016
	2002		1,342		632	3,025			1,026		310		1,157			1,999	1,052
	2001				1,032	2,817			999				905			792	1,596
D3	2003					634	600		2,064								790
	2002				1,200	105,628			1,395								31,148

Code		BEL	DNK	DEU	GRC	ESP	FRA	IRL	ITA	LUX	NLD	AUT	PRT	FIN	SWE	GBR	TOTAL
	2001					3,005			581				424				**756**
D4	**2003**		386	20		8,379	2,224		1,033						172	5,007	**4,698**
	2002		1,565	200	300	1,334	1,875	23,125	1,033				253			2,328	**2,719**
	2001		839	150		1,095	7,139	11,567	1,148				312			2,870	**1,618**
D5	**2003**	375	671		977	1,781	1,808		9,889				568	526	1,352	19,255	**4,371**
	2002		3,354	1,423	1,111	2,014	2,000		2,186				394		100	2,518	**1,796**
	2001	869	1,040	6,141	869	689	1,250	12,700	1,515		1,174		1,224	84		6,334	**1,137**
D6	**2003**	917	686	355	816	3,425	638		1,033		1,042		813		333	5,589	**2,494**
	2002		793	1,290	744	1,956	792		1,018		738		690			3,238	**1,201**
	2001		411	56	594	1,178	743		815		455		552			752	**978**
D7	**2003**					1,500	1,000		1,032								**1,258**
	2002																
	2001					902											**902**
E1	**2003**	1,214	364	98		4,558	273		73,336		456		400	150	418	132,056	**17,913**
	2002	1,083	393	102		2,275	206	8,455	61		1,511		809	420	741	9,148	**2,813**
	2001	3,470	202	155		538	745	7,537	651		82		499	191	260	5,434	**1,285**
E2	**2003**					5,091								60		3,139	**4,917**
	2002																
	2001	1,239				1,116		127								792	**979**
E3	**2003**						750		55						826		**449**
	2002	1,500				1,212										31,980	**3,043**
	2001					730	1,000	8,932	57								**1,903**
E4	**2003**														167		**167**
	2002																
	2001					1,202											**1,202**
F1	**2003**					10,415	1,513		1,033		1,697		622		1,278	2,696	**9,520**
	2002		1,610			2,245		4,600			343		757				**2,187**
	2001		1,342			795	114	95	2,066							5,542	**873**
F2	**2003**				831	1,917	448		6,503		430					385	**3,602**
	2002		787		892		288		1,119				1,232				**1,075**
	2001		268		587	873			3,665				1,097				**1,239**
NA	**2003**								1,397				135				**1,361**
	2002												667				**667**
	2001					205			386								**362**
Average for Member State	**2003**	1,500	455	379	700	3,202	1,156		8,304		1,075		588	282	742	77,922	**4,664**
	2002	1,143	622	820	678	2,126	2,367	11,978	1,691		1,727		491	420	536	8,795	**1,757**
	2001	2,356	369	522	811	928	2,483	7,470	1,350		653		4,309	137	324	4,476	**1,338**

In an attempt to provide further insight to the extensive results, four types of infringements that may closely represents environmental infringements were focused on:

D1: Using or keeping on board prohibited fishing gear;
D2: Using prohibited fishing methods;
D3: Not lashing or stowing prohibited fishing gear; and
D5: Unauthorised fishing in a given zone and/or during a specific period.

The average fine for each of these infringements over time is illustrated in Figure 2.26.1.

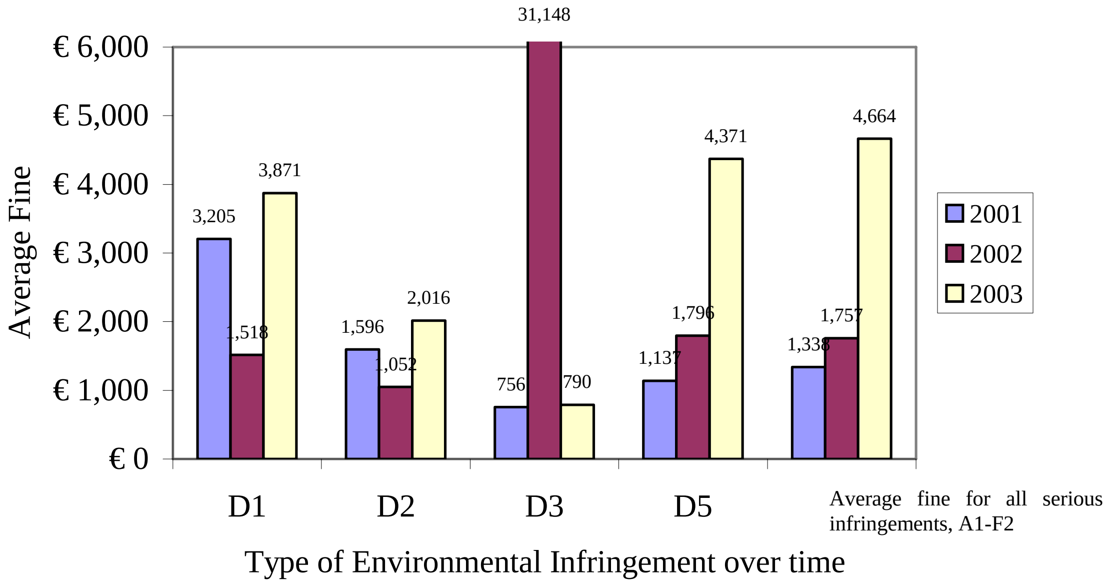

Figure 2.26.1: Average fine by each type of infringement

In attempt to develop a simpler indicator that encapsulates much of the above, a ratio was calculated of the average fine for the above environmental infringements over the average fine for all infringements (Figure 12.26.2). The closer this figure comes to one, the closer that such infringements are fined on an equal basis. As it falls below one, this suggests that fines are below average, and conversely as it climbs above one then fines are above average. As a proportion of total fines, the level of fines for environmental infringements seems to have decreased, compared to other fines. In this case the significantly high €30,000 fine was removed because it distorted the results.

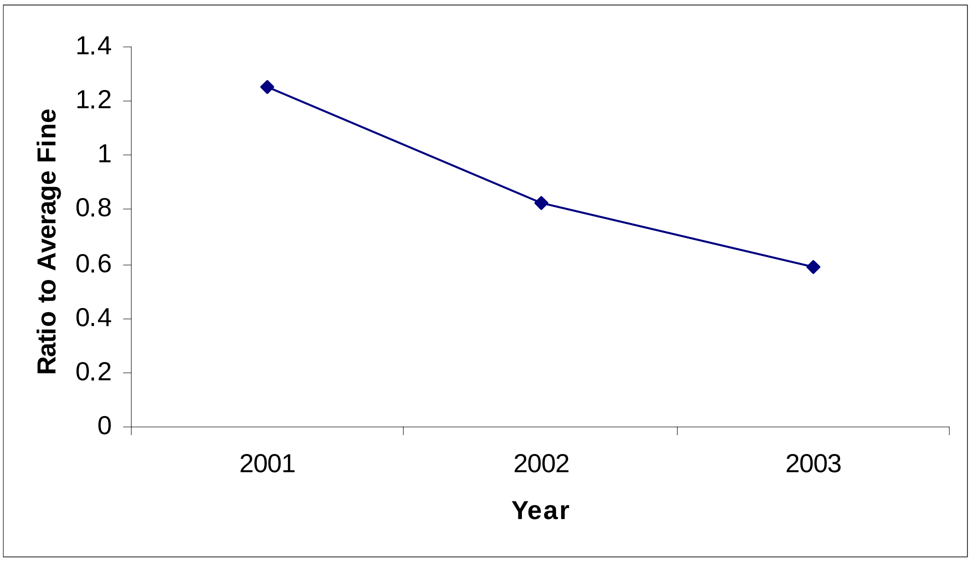

Figure 1 Fines for environmental infringements in relation to average fines

Punishment and inspections procedures of Member States

For further insight into the Member State enforcement procedures, the reader is directed to the European Commission's assessment reports of the Member States implementation of the CFP control systems (COM(2004)849 and COM(2001)526), as required under the Control Regulation (Regulation 2847/93). In particular, the Annex to the 2002 contains a detailed description and assessment of the fisheries control systems in each Member State (SEC(2004)1718).

2.26.3 Evaluation and interpretation

The results suggest that there is no particular trend in the level of individual fines for each type of infringement from 2001 to 2003, although overall fine levels appear to be increasing. However, compared to the average levels of fines, fines for environmental infringements appear to be below average and falling. This suggests the fishery inspection sector may not be as supportive towards environmental issues as compared to other infringements such as falsifying record data (E1) or landing incompliant fishery products (F2).

However, because only a very small sample size (3 years) was used, the results are not considered to be sufficiently conclusive. Expanding the analysis to incorporate a longer time span would provide better results for assessing any trends. The sensitivity of the short time series is illustrated by the outlying data points. The €31,148 average D3 fine in 2002 resulted from two very high fines (€105,628) issued by Spain, which somewhat distorted the data. If we remove the Spanish fines from the calculations, the average fine reduces to €1,356. In addition, it is also important to note that the analysis is based on the average fine for the EU, which masks any differences within or between Member States.

While the above points are limitations in the usefulness of the indicator, they can arguably be overcome over time as a longer time series of data is built up. Comparisons between Member States could also be made. The data is also collected as a matter of course under the serious infringements Regulation, making the use of the data relatively cost effective. However, there are a number of more fundamental limitations with the indicator and the data.

It is assumed that the variation in fines by infringement type over time is an indicator of the level of support of fishing inspection towards environmental goals, with higher fines for environment related infringements suggesting higher support. While this may be so, none of the infringement types are explicitly environmental in nature, although they may all in some way include environmental infringements.

A further limitation with the indicator is that it is narrow, concerning only fine levels. Other penalty types may include gear confiscation, civil/criminal sentencing or warnings. Static or decreasing fine levels may not necessarily therefore mean that support of the enforcement sector is poor. Other penalty types may simply be employed instead. The levels of fines should also be considered in relation to national fishermen's incomes or costs, as these will vary between Member State and fishing operation, meaning that equal fines between Member States does not necessarily mean that the deterrent is the same.

2.26.4 Recommendations

Despite the various limitations of the indicator, it is recommended that the Commission use this indicator since it provides a relatively cheap and quick, if only general, oversight of whether Member States enforcement systems are generally supportive of environmental goals. However, for more meaningful results to be drawn it is necessary for data collection and the analysis be carried conducted over a long time period.

The indicator could be made more useful by including an environmental infringement in the serious infringements Regulation list. Indeed, doing this would provide further insight into the number of such infringements (indicator 28, section 2.32.4), and could include fishing in protected areas. The Commission should consider such an expansion of the serious infringements Regulation list.

2.27 Attitudes and awareness of stakeholders towards CFP environmental goals

This indicator was selected, together with indicator 32, to answer the question of whether stewardship of stakeholders is increasing.

2.27.1 Material & methods

Four different approaches were tested to quantify the attitudes and awareness of different types of stakeholder towards CFP environmental goals:

Methodology	Stakeholder
publications review	Scientists, practitioners and academics
popular press review	General public
quantification of research done in collaboration with the fishing industry	Fishing industry
stakeholder questionnaire	Informed public

In the first three cases, a five year time series was developed for the period 2000-2004. As this was not possible in the case of the stakeholder questionnaire, the main aim was to develop a robust methodology and generate a baseline study.

Publications review

The number of articles on environmental issues in a selection of academic and professional publications were used as a proxy for awareness of stakeholders towards CFP environmental goals. *Marine Policy*[12] and the *ICES Journal of Marine Science*[13] were selected in order to cover a policy and science related journal respectively. They were also selected because of their high coverage of articles on or relating to the EU, unlike some other journals e.g. *Fisheries Research*[14], *Ocean & Coastal Management*[15]. *World Fish Report*[16] and *Fishing News*[17] were selected on the basis that they cover CFP developments, and are not excessively international in scope, as was considered the case with *Fishing News International*, for example.

A random sample of the publications in each year was taken to generate a time series of results (Table). All the issues in each year were numbered where not already the case e.g.

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[12] http://www.elsevier.com/wps/find/journaldescription.cws_home/30453/description#description

[13] http://www.elsevier.com/wps/find/journaldescription.cws_home/622885/description#description

[14] http://www.sciencedirect.com/science?_ob=JournalURL&_cdi=5035&_auth=y&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=e9ac72d4b959f86d62495384351fb905

[15] http://www.elsevier.com/wps/find/journaldescription.cws_home/405889/description#description

[16] http://www.agra-net.com/NASApp/cs/ContentServer?pagename=agra/puboptions&PageName=menu&pubId=ag014

[17] www.fishingnews.co.uk/

Fishing News, and the Random Number Generation function in Microsoft Excel used to randomly generate the sample on the basis of a uniform distribution.

Table 2.27.1 Sample size of publications scanned for environmental articles

Journals	No of issues per year	% of issues sampled per year	Professional press	No of issues per year	% of issues sampled per year
Marine Policy	6	33	Fishing News	50	16
ICES Journal	7	29	World Fish Report	24	33

For the journals, all of the articles were scanned, including the editorials. For the World Fish report however, only the "Brussels in Brief" section was reviewed, as the rest largely covered international affairs. Similarly, only the first three pages of the Fishing News were surveyed. This was to make the task manageable given the high number of articles in each edition and also to avoid the pages devoted to advertisements and market reports.

Articles were classified distinguishing different levels of environmental impact and how they are related to fishing. These classifications were the same as for indicator 28. In the course of categorising the articles, it became apparent that it was difficult to place some articles under these headings. A fourth category was therefore established for those articles relating to environmental issues more loosely. This gave the following four categories:

- **Primary environmental impacts of fishing** addressing commercial fish stock depletion and how to prevent and reduce these impacts, including ex ante and ex post evaluation of relevant policy measures
- **Secondary environmental impacts of fishing** addressing issues not directly related to the commercial fish stocks, e.g. bycatch, discards, benthic disturbance, ecosystem impacts) and how to prevent and reduce these impacts, including development of fishing methods and gear, ex ante and ex post evaluation of relevant policy measures
- **Other environmental impacts** not directly related to fishing, e.g. litter, energy use, pollution and development of prevention and mitigation measures to alleviate anthropogenic impacts and relevant policy measures.
- **Wider environmental issues,** e.g. regarding political discussions, such as TAC negotiations

In the course of categorising the articles, it became apparent that it was difficult to place some articles under these headings. A fourth category was therefore established for those articles relating to environmental issues more loosely e.g. regarding political discussions, such as TAC negotiations.

A keyword search was considered inappropriate on the basis that it would lead to both false positives (articles which are not in fact about environmental issues but contain a specific keyword) and to false negatives (the omission of relevant articles). Articles were therefore categorised on the basis of reading their titles, and where necessary, the abstracts or entire articles. The yearly variation was calculated in absolute (total number of environmental articles) and relative (percentage of articles which were environmental) terms, both by publication and in total.

Popular press review

The number of articles relating to environmental issues in European fisheries was estimated in three daily national newspapers from the UK as an indicator of broader public attitudes towards the CFP. An attempt was made to select newspapers that represented the broad political spectrum and newspaper type. This was not fully possible however due to data availability limitations, although two broad sheets were surveyed (The Times[18] and the Daily Telegraph[19], both left wing) together with one tabloid (The Sun[20]). The average daily circulation figures for the newspapers for February 2006 are as follows: The Times- 669,691; Daily Telegraph- 901,123 (highest broadsheet circulation in the UK); and The Sun- 3,145,433 (highest newspaper circulation in the UK)[21].

Article counts based on keyword searches were conducted using an online newspaper archive service, available from www.dialognewsroom.com. The searches were conducted from 2001 – 2005 since no data were available before 2001. A number of keywords were identified in relation to environmental issues in European fisheries:

- Common Fisheries Policy;
- Overfishing;
- Total Allowable Catch;
- Marine Protected Area;
- Fishing Industry;
- Fish Stock;
- Fishing Quota;
- Cod Stock; and
- By-catch.

In the course of the search, it became apparent that the most appropriate keywords were Common Fisheries Policy; Fishing Quota; and Cod stock. These tended to be specific, picking up articles on fisheries issues in Europe and generating fewer false positive results. The other keywords often failed in these respects. The analysis therefore focused on the results from these three keywords.

Industry/scientist collaborative research

Quantifying the amount of research conducted by scientists in collaboration with fishermen was approached by contacting research organisations directly based on the research projects started between 2000 and 2004, as identified in the course of indicator [28], and asking whether they these projects had entailed any collaborative work with industry since 2000.

It was only practical to do this in the case of the UK because the information on the projects in the other Member States was not sufficiently disaggregated to allow the research organisations to be identified. In the course of determining whether there had been industry collaboration, it became evident that this term needed defining. Some projects entailed

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[18] Times- www.timesonline.co.uk

[19] Daily Telegraph -www.telegraph.co.uk

[20] The Sun- www.thesun.co.uk

[21] February 2006 average UK newspaper circulation figures obtained from the Audit Bureau of Circulation (ABC), available from: http://www.timesonline.co.uk/section/0,,1782,00.html

working with industry on a small level through, for example, hiring vessels or using log book data. Others were much more extensive in terms of working with industry to develop and interpret models. As the purpose of the exercise was to develop and quantify an indicator of stakeholder attitude and awareness it was considered necessary to distinguish between the two levels of engagement. Three levels of coding were therefore used:

0 No industry engagement
1 A small level of industry engagement e.g. tagging fish
2 Active industry cooperation

Contacting industry organisations and posing the same question was considered as an alternative or complementary approach. However, in discussing this with members of the industry it was evident that, again, defining levels and units of engagement was difficult e.g. an ICES meeting attended would probably be considered as active engagement, but defining and/or quantifying the number of units would be difficult e.g. by number of hours, meetings or projects.

Stakeholder Questionnaire

A questionnaire was designed, piloted and implemented with the aim of developing a methodology to determine the attitude and awareness of stakeholders towards CFP environmental goals (see Annex1 and Annex 2). The questionnaire was developed with input from a number of stakeholders and technical specialists working with IEEP on the INDECO project as member of the Advisory User Group[22].

The questionnaire was administered via a web based survey tool, and the results were imported directly to Microsoft Excel for subsequent data analysis.

The questionnaire was first piloted by applying it to several people, on the basis of which refinements were made. It was then distributed to ACFA (Advisory Committee for Fisheries and Aquaculture) members[23] and members of the European Parliament Fisheries[24] and Environment[25] Committees. The primary stakeholders to whom the questionnaires were sent were therefore:

1. environment or development NGO/interest group;
2. consumer NGO/interest group;
3. national and local fishermen"s organisations;
4. individual fishermen;
5. national and local aquaculture organisations;
6. individual fish farmers;
7. processors/traders; and
8. MEPs" advisors (as a proxy for MEPs).

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[22] For further details see http://www.ieep.org.uk/projectMiniSites/indeco/index.php

[23] see http://europa.eu.int/comm/fisheries/dialogue/acfa_en.htm#members

[24] http://www.europarl.eu.int/committees/pech_home_en.htm

[25] http://www.europarl.eu.int/comparl/envi/default_en.htm

2.27.2 Results

Publications Review

All of the four publications were sampled as planned. It was not possible however to obtain the 2000 editions of World Fish Report or 2001 of Fishing News. The number of environmental articles in the each publication per year is presented in Table 2.27.1. The fact that the data is incomplete makes it difficult to compare the number of articles between years. Table 2.27.2 however provides further insight by presenting the proportion of articles that relate to the environment. The number and proportion of such articles in the ICES Journal appears to be decreasing over time, while the World Fish report figures remain roughly constant. Marine Policy fluctuates too much to draw any conclusions. The number of environmental articles is broken down by category in Table 2.27.3, which reveals that where articles report on the environmental effects of fishing, they are predominantly on the direct impacts with 25 per cent relating to indirect or wider impacts. It is not possible however to deduce whether the number or proportion is increasing because journals are often produced on a thematic basis, meaning that environmental articles appear in groups rather than being distributed evenly between editions.

Table 2.27.1 Number of environmental articles by journal, 2000-2004

	Year					
	2000	**2001**	**2002**	**2003**	**2004**	**Grand Total**
Fishing News	40		40	23	17	120
ICES Journal	36	18	4	3	1	62
Marine Policy	3	0	4	5	3	15
World Fish Report		17	18	15	19	69
Grand Total	**79**	**35**	**66**	**46**	**40**	**266**

Table 2.27.2 Percentage of articles relating to the environment by journal, 2000-2004

	Year					
	2000	**2001**	**2002**	**2003**	**2004**	**Grand Total**
Fishing News	44	-	49	26	24	36
ICES Journal	50	38	13	7	1	22
Marine Policy	17	0	25	33	18	18
World Fish Report		52	49	42	52	49
Total Percentage	**41**	**41**	**43**	**31**	**32**	**37**

Table 2.27.3 Number of environmental articles by category[1] and journal, 2000-2004

		Environmental category				
	Year	**1**	**2**	**3**	**4**	**Total**
Fishing News	2000	28	0	0	12	40
	2002	32	1	0	8	40
	2003	22	0	0	1	23
	2004	13	4	0	1	17
Fishing News Total		95	5	0	22	120
ICES Journal	2000	7	29	0	0	36
	2001	1	1	16	0	18
	2002	2	2	0	0	4

	2003	1	2	0	0	3
	2004	0	1	0	0	1
ICES Journal Total		11	35	16	0	62
Marine Policy	2000	2	1	0	0	3
	2001	0	0	0	0	0
	2002	4	0	0	0	4
	2003	3	0	0	2	5
	2004	2	1	0	0	3
Marine Policy Total		11	2	0	2	15
World Fish Report	2001	13	1	1	3	17
	2002	14	0	0	4	18
	2003	11	2	1	2	15
	2004	13	3	0	4	19
World Fish Report Total		51	6	2	13	69
Grand Total		**168**	**48**	**18**	**37**	**266**
% of total		63.16%	18.05%	6.77%	13.91%	

[1] Where 1: Primary environmental impacts of fishing; 2: Secondary environmental impacts of fishing; 3:Other environmental impacts not related to fishing; 4:Wider environmental issues.

Popular press review

The total number of articles per year in the three newspapers that featured at least one of the three keywords varied between 33 and 100 (Figure 2.27.1). Over the five year time series however, there was no trend. Rather, there were two noticeable peaks in 2002 and 2004.

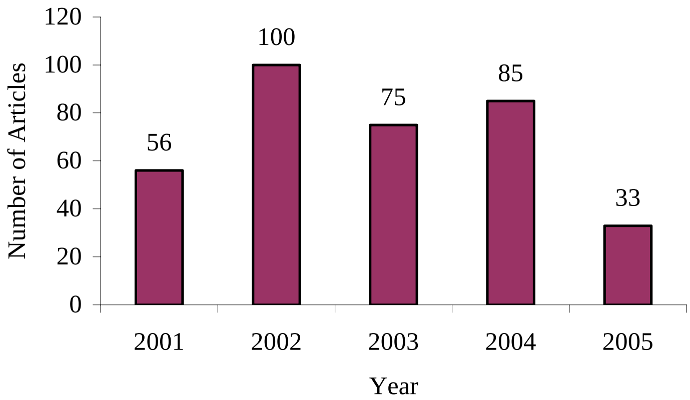

Figure 2.27.1 Total number of articles by year

The CFP[26] produced the highest number of hits followed by cod stock and fishing quota (Table2.27.4 and Figure2.27.2). Each keyword demonstrated a different trend, with CFP recording the highest number of articles in 2002 and 2004 compared to 2003 for fishing quota and 2002 for cod stock. The fact that the CFP keyword generated the highest hits is demonstrated in Figure whereby the CFP trend is similar to that of the over all trend (Figure 2.27.2). It is interesting to note that cod stock follows a very different pattern, with an apparent decline since a peak in 2002.

[26] The full term “Common Fisheries Policy” was used as the keyword in the newspaper search. However, it is abbreviated to CFP in the analysis for convenience.

It should be noted that the total figures do not correspond with those of Table2.27.4 because some articles contained more than one keyword. Double counting was avoided in Figure 2.27.1 Total number of articles by yearby employing combined keyword searches i.e. Common Fisheries Policy and Cod Stock and Fishing Quota.

Table 2.27.4: Number of articles by keyword and year for all newspapers

Newspaper:	Year	Keyword			Total
		CFP	Fishing Quota	Cod Stock	
ALL	2001	27	4	26	57
	2002	63	11	38	112
	2003	35	29	29	93
	2004	62	4	23	89
	2005	23	4	10	37
Total		210	52	126	388

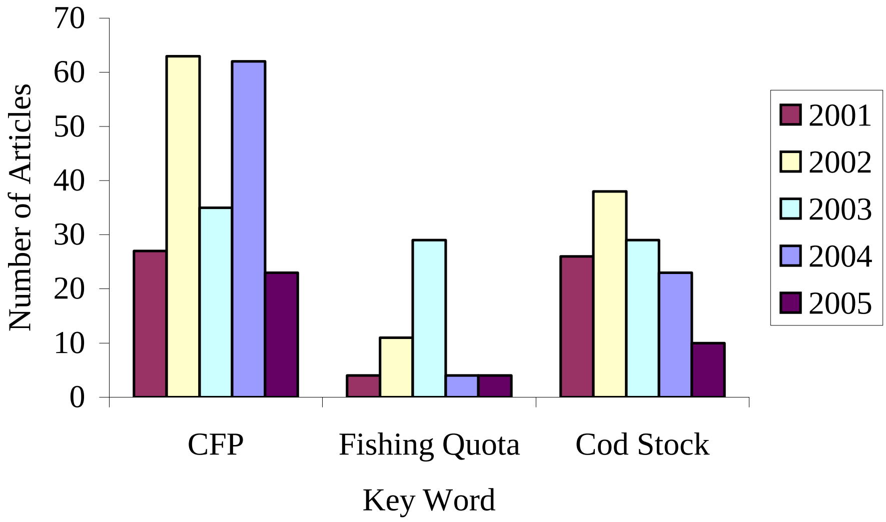

Figure2.27.2: Number of articles by keyword from 2001-2005

The number of articles varied by newspaper as well as by keyword. The Times reported the highest number of articles while The Sun reported the least, with around a quarter of the number in The Times (

Table2.27.5 and Figure2.27.3). Despite the differences in total numbers of articles, all three papers demonstrated the same trends in the number of articles containing the CFP (

Figure2.27.4). This is not the case however for the other two keywords, with The Times again containing more articles containing these keywords than the other newspapers. This would suggest that The Times includes both more articles in general, with these articles containing more detail and elaboration on the issues than The Telegraph and The Sun.

Table2.27.5: Number of articles by newspaper, year and keyword

Newspaper:	Year	Keyword			Total
		CFP	Fishing Quota	Cod Stock	
Times	2001	14	3	10	27
	2002	32	7	18	57
	2003	26	22	20	68
	2004	31	1	15	47
	2005	11	3	4	18
Times Total		114	36	67	217
Sun	2001	3	0	7	10
	2002	6	4	11	21
	2003	1	3	6	10
	2004	10	3	3	16
	2005	2	0	1	3
Sun Total		22	10	28	60
Telegraph	2001	10	1	9	20
	2002	25	0	9	34
	2003	8	4	3	15
	2004	21	0	5	26
	2005	10	1	5	16
Telegraph Total		74	6	31	111

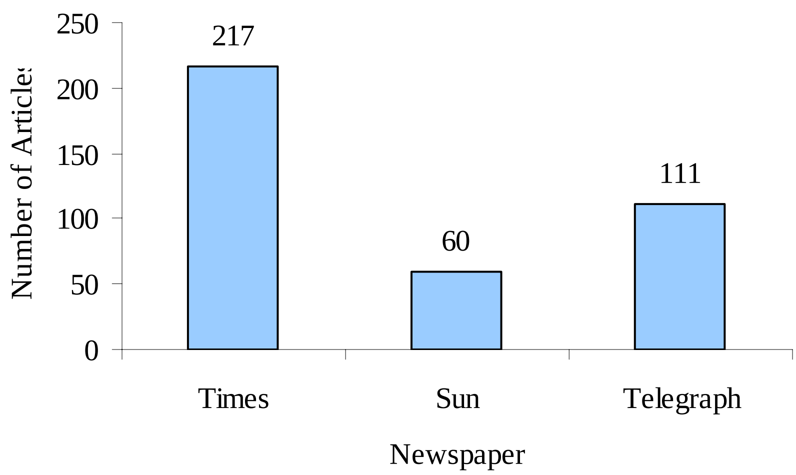

Figure 2.27.3: Total number of articles by newspaper type

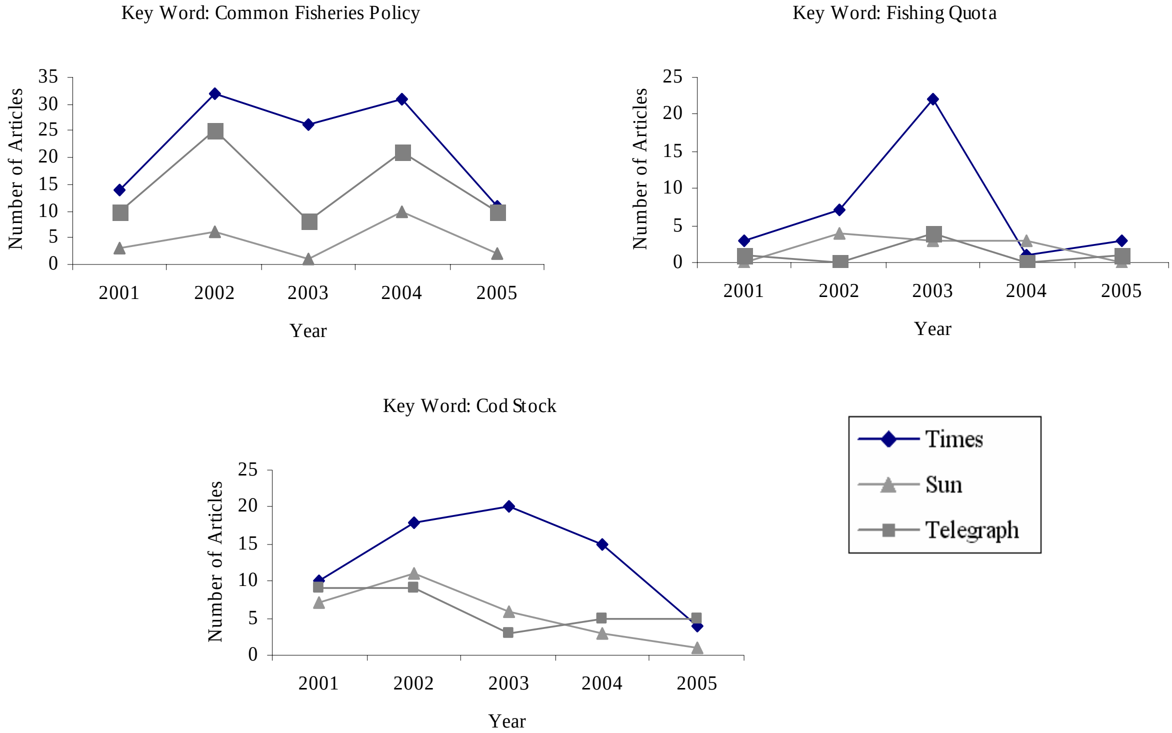

Figure2.27.4: Number of articles by each newspaper for each keyword

Industry/scientist collaborative research

Of the 41 total projects funded by Defra in England and Wales in the period 2000-2004, about 70% (28) entailed no industry participation (Table 2.27.6). Only two projects (<5%) involved active industry participation. One was the Invest in Fish[27] initiative, a stakeholder based project identifying and developing stock management options, and the other a project to develop more ecofriendly fishing methods. There was no apparent trend in the number of projects involving the industry, although 10 of the 13 projects that involved industry in some way started on or after 2002. In terms of funding, the two projects that entailed active industry participation accounted for just 3% (£423,053) of total funding in the period (Table 2.27.7).

Table 2.27.6 Number of projects by degree of participation[2], 2000-2004

[27] http://www.investinfish.org/

Degree of collaboration	Year					Grand Total
	2000	2001	2002	2003	2004	
0	8	6	4	6	4	28
1	3		4	3	1	11
2			1	1		2
Grand Total	**11**	**6**	**9**	**10**	**5**	**41**

2 Where 1: No industry engagement; 2: A small level of industry engagement; 3: Active industry cooperation

Table 2.27.7 Funding of projects by degree of participation[3], 2000-2004

Degree of collaboration	Year					Grand Total
	2000	2001	2002	2003	2004	
0	£2,978,697	£579,866	£1,611,946	£3,964,606	£1,615,437	£10,750,552
1	£823,023		£2,027,607	£1,505,158	£24,025	£4,379,813
2			£379,913	£43,140		£423,053
Grand Total	**£3,801,720**	**£579,866**	**£4,019,466**	**£5,512,904**	**£1,639,462**	**£15,553,418**

3 Where 1: No industry engagement; 2: A small level of industry engagement; 3: Active industry cooperation

Stakeholder Questionnaire

The questionnaire was sent to approximately 200 individuals, composed of approximately 40 individuals from the Advisory Committee on Fisheries and Aquaculture (ACFA) and the remaining from the Fisheries and Environment MEPs. Twenty one fully completed responses were received (10% response rate) with 18 from ACFA (45%)[28] and three from the MEPs (2%). Of the 21 response, 17 individuals (80%) were directly involved with national or European fisheries policies.

Respondents were asked to consider a series of questions concerning the environmental objectives of the CFP. The first question relates to how adequate the CFP objectives are, while the second question relates to how adequate the implementation strategies are in meeting the objectives.

The environmental objectives of the CFP are:

i. protect and conserve living aquatic resources

ii. minimise the impact of fishing activities on marine eco-systems

iii. the application of the precautionary principle

iv. progressive implementation of an eco-system-based approach to fisheries management.

The responses to the two questions relating to specific CFP objectives are summarised in Table2.27.8 and Table2.27.9.

Table 2.27.8: Level of response towards adequacy of each CFP objective

Response	CFP Environmental Objectives	Total

[28] The questionnaire was sent to 40 ACFA members but it is not known whether the questionnaire was forwarded to other members, in which case the response rate would actually be lower.

	i	ii	iii	iv		
High	10	7	6	8	31	37%
Good	4	6	6	5	21	25%
Low	5	6	8	2	21	25%
Not at all	0	0	0	4	4	5%
Don"t Know	2	2	1	2	7	8%

Table 2.27.9: Level of response towards adequacy of the strategies in meeting the CFP objectives

Response	Strategies in meeting CFP Objectives				Total	
	i	ii	iii	iv		
High	4	4	5	4	17	20%
Good	2	6	1	2	11	13%
Low	12	8	11	11	42	50%
Not at all	0	0	1	1	2	2%
Don"t Know	3	3	3	3	12	14%

While there are some differences between each of the objectives, the number of responses was considered too low to draw detailed conclusions at this level. The results were therefore aggregated across all of the objectives (Table2.27.9, Figure2.27.5).

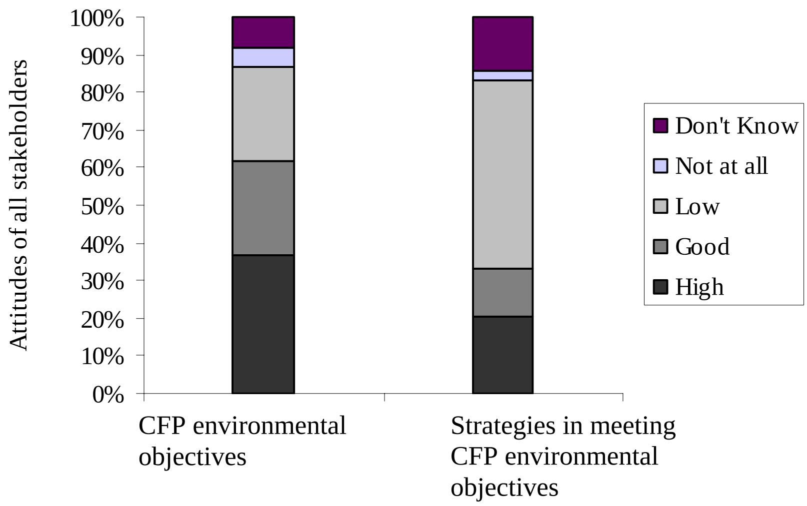

Figure 2.27.5: Combined attitudes of all stakeholders towards CFP environmental objectives and its strategies.

The results suggest that the majority of respondents considered all four of the CFP environmental objectives to be adequate, i.e. answered good or high. In contrast, the strategies to meet the objectives were indicated to be comparatively low. 62% of respondents thought the CFP objectives were "high" or "good" compared to just 33% who thought the strategies in meeting the objectives were "high" or "good".

The low number of responses means that it is not appropriate to break down the results in detail by all stakeholder groups, CFP objectives or factors such as age, gender, degree of policy participation or education. However, to demonstrate how more detailed comparisons can be made based on the survey methodology, differences in attitudes towards the CFP objectives and strategies between NGOs and industry were considered (

Figure2.27.6 and

Figure2.27.7). Industries consisted of the responses from fishing organisations, aquaculture organisations and processor/trader organisations. NGOs consisted of environment and development NGOs.

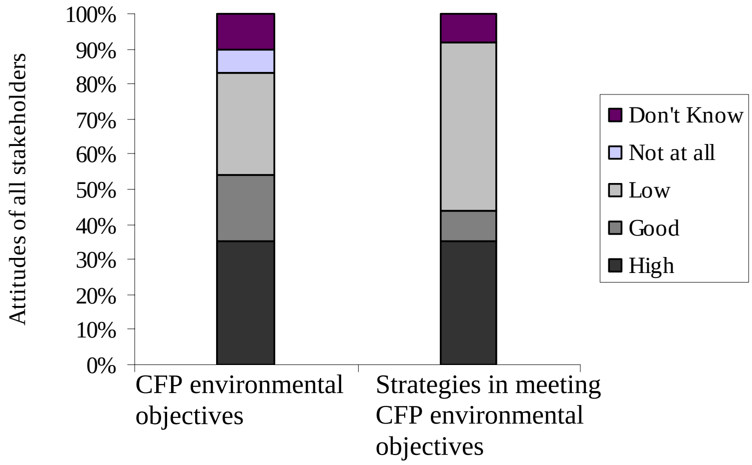

Figure2.27.6: Attitudes of industry organisations towards CFP environmental objectives and its strategies.

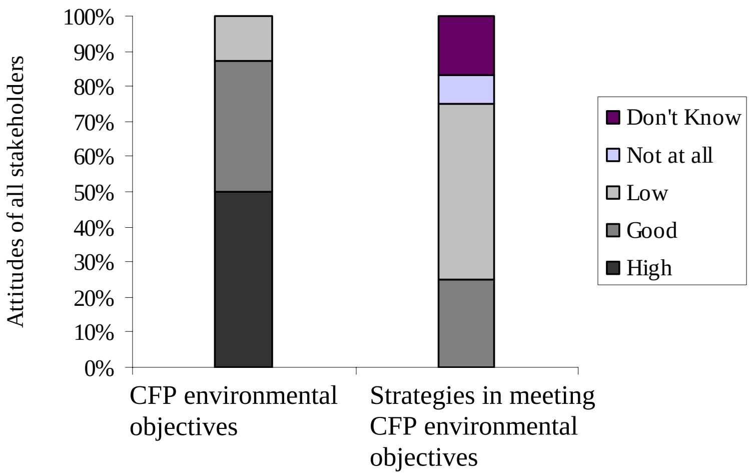

Figure 2.27.7: Attitudes of non-governmental organisations (NGOs) towards CFP environmental objectives and its strategies.

The main difference in attitudes between the two groups is that NGOs appeared to be most satisfied with the objectives (88% "high" or "good") but dissatisfied with the implementation strategies (58% "low" or "not at all") (

Figure2.27.7). In contrast, the industries appeared to be less satisfied with both the objectives and implementation strategies, but without such a difference between the objectives and implementation (54% "high/good" for objectives compared to 44% "high/good" for strategies) (

Figure2.27.6). These numerical results are supported by some of the comments that respondents made in the questionnaire.

2.27.3 Evaluation and interpretation

Press

If it could be accurately measured, the number of environmental articles may be a good indicator of the level of awareness and attitudes of stakeholders towards the environmental objectives of the CFP. However, a number of factors make it difficult to quantify this indicator in practice.

Despite defining the types of environmental article from the outset, it is difficult to accurately (and therefore consistently) classify articles. The challenges vary by the type of article and publication, but one common point is that many articles concern the issue of stock depletion or stock assessment, but are not necessarily written from an environmental viewpoint. They may be economic, political or social in their approach, for example. Whether they should be classified as environmental is therefore debatable.

In response to this difficultly, Category 4 was created for articles vaguely concerning environmental issues. However, the problem remains that classification becomes subjective, inconsistent and therefore unreliable and not possible to replicate. This is less of an issue for category 2 and 3 articles (indirect and wider impacts), as they tend to be more focused and technical in nature.

Furthermore, the methodology did not allow for the classification of articles according to whether they were negative or positive in their portrayal of the environmental issues. This is a major shortcoming. Articles in *Marine Policy* and the *ICES Journal* generally focus on improving policy and science, and on debating the issues related to meeting these objectives. *Fishing News* articles however tend to be more sceptical, portraying the EU and fishing policy negatively, and questioning science and stock depletion.

While *World Fish Report* was CFP focused, the journals often contained articles that were either global, non-EU or simply not geographically focused at all. No distinction was made in the methodology.

In conclusion, the methodology is best suited to the academic journals and *World Fish Report*, and in practice is not possible to apply to the Fishing News. The problem of classification and therefore lack of replicability remains throughout however.

In all cases, data sets beyond what were generated for this study are not available, but require literature searches to be conducted. This is essentially a desk based exercise, so does not entail significant costs.

Popular press review

Rather than any particular increasing or decreasing trend in the number of articles over time, there was a peak in 2002, followed by 2004 (Figure 2.27.2). This could be attributed to political events at the time, namely the coverage of the CFP reform and the UN WSSD Johannesburg Summit in 2002. Similarly, the increase in fisheries articles in 2004, particularly on the CFP, could be related to increased political discussions on the CFP ahead of the 2005 UK general election. The UK Royal Commission on Environmental Pollution also published a major report on the environmental effects of marine fisheries in December 2004[29], which attracted a lot of media attention.

The Times newspaper appears to be the most informative towards fisheries issues while The Sun appears to be the least informative. This is illustrated by both the number of articles in total and the number of articles containing keywords beyond the CFP. This result reflects the fact that The Sun is a tabloid newspaper. It also suggests that the CFP keyword is the most consistent indicator of the total number of fisheries related articles in all newspapers.

The CFP keyword is also the most reliable in that it was the most specific and so generated fewer "false positive" results than fishing quota or cod stock i.e. articles which are not related to European fisheries management issues such as reports on fisheries issues outside the EU, climate change, fish restaurants and books. In many cases it was difficult to adjust the data for false positives, as their classification was often subjective.

The newspaper review provides an indication on the quantity of fisheries related articles being written in newspapers in the UK, bearing in mind that only three newspapers were surveyed. Assuming that public awareness is related to the number of newspaper articles, the methodology provides an indicator of the level of awareness of the general public on fisheries management issues. However, it is not realistic to suggest that it is an indicator of public awareness towards CFP goals, as even when articles are on the CFP, the goals or objectives of the CFP are rarely discussed.

It is difficult to read much more detail into the results of the newspaper review because they do not differentiate between the subject or tone of the articles ie whether they are positive or negative, or on the CFP or the environment. The results do not therefore provide any insight into how well the CFP is performing. Indeed, observation made in the course of the searches suggest that most of the articles are "bad news" stories, reporting on the poor state of fish stocks and the fishing industry's negative responses to quota decisions. In this sense, more articles are therefore an indication that the CFP is performing more poorly. TAC cuts to recover fish stocks, which can be argued as positive initiatives by some interests or nationalities, may be regarded negatively by others. The positive or negative nature of an article is therefore not a reliable indicator of whether a policy is good or bad. We can not therefore conclude anything beyond the point that the methodology provides an indicator of the level of awareness of the general public on fisheries management issues.

Another limitation is that the number of articles is arguably a rather crude indicator of press coverage. The length or prominence of articles is not accounted for. Front page articles with large headlines and graphic pictures thus receive equal weighting to very small articles on

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[29] Turning the Tide - Addressing the impact of Fisheries on the Marine Environment http://www.rcep.org.uk/fisheries.htm

inside pages with no illustrations. Accounting for these differences was beyond the scope of this study, but could be catered for in any future studies by developing an appropriate weighting system for these factors and/or measuring column space and the proportion of page taken up.

The newspaper review was performed using the dialog newsroom website. This made it relatively cost effective. It is also a reasonably quick and simple process with very good data availability covering a large proportion of newspapers across the EU. Methodologically, this makes it a straight forward indicator to replicate throughout the EU Member States. In doing this, it would be necessary to identify reliable key words, as done for the UK. This is likely to be the appropriate translation of the CFP.

Industry/scientist collaborative research

The number and value of projects funded by Defra in England and Wales that involve active industry participation are only 5% and 3% respectively. Even if it is argued that science is the realm of scientists, requiring rigour and scientific methodology, these still seem very low figures. While it would seem that industry is actively involved in very few projects, it should be recalled that these are only Defra funded research projects. Research is undertaken with industry in areas such as gear technology and processing by other organisations e.g. Seafish[30], but this is not captured in these data.

A measure of the level of industry collaboration is considered to be a good indicator of the level of stakeholder (industry in this case) stewardship. The problem that was faced in quantifying this indicator was that the data are rarely available. Only in the UK was a comprehensive record of central government funded projects available, from which it was possible to quantify the level of industry participation. Even if the data were available in other Member States, the issue of different funding systems and scope, as reported for indicator 25 (Total quantity of funds allocated to relevant research and distribution of research funds), remains which would make comparisons between Member States impossible. Comparison between years would also be made problematic by reforms of the national funding systems.

Stakeholder Questionnaire

The results implied that the attitudes towards the CFP objectives and strategies are consistent between all stakeholder groups in the sense that they all indicate that the implementation strategies are considered less adequate than the objectives. The contrast in attitudes between the objectives and strategies appears to be greatest with the NGOs and least with the industries, although the number of responses from MEPs was too low to report on or to draw any conclusions. Indeed, because of the low number of responses (small sample) it is generally not possible to draw firm conclusions, and what has been reported should be interpreted with caution. Nonetheless, the results suggest therefore that the objectives of the "new" CFP, resulting from the 2002 reform process, are largely considered satisfactory. Instead, the perceived problems with EU fisheries management lie in the interpretation and implementation of the objectives and policy framework.

A web-based questionnaire was selected as the choice of survey method since it is relatively cheap, quick and simple to implement on a large scale. The interactive design makes it more user friendly by guiding individuals through the questionnaire in a step-by-step process. It is

[30] http://www.seafish.org/

also easier to monitor and analyse the responses than other survey methods since the web software tracks and compiles the data automatically. However, a web questionnaire can only be completed using computers and is therefore potentially limited and biased in its coverage, and also requires a familiarity with the media. As it is implemented through mass emailing, it is sometimes considered informal, disliked and often ignored especially if it is unsolicited. There is also no control over who responds to the questions and there is no way to validate the answers provided.

As with all questionnaires, in particular those involving measurement of attitudes, there are a number of limitations associated with this approach. The nature of the questions in the questionnaire are based upon individual perceptions of what constitutes “high” or “low” resulting in possible inconsistencies between different individuals, further exacerbated by different interpretations of the questions themselves.

The “additional comments” component provides a useful platform to verify the quantitative results as well as providing some further insights into the stakeholders’ opinions on the CFP. However, judging from the similarity of comments received with this questionnaire it is perhaps sufficient to have just one general comments section at the end of the questionnaire rather than for each question.

Some comments were made on the confusing similarity between the two questions on objectives and strategies. Indeed, 12 respondents (35%) only answered the first question but not the second, perhaps in part due to the confusion caused from the two questions. It is would therefore be useful to clearly distinguish the two questions and its objectives in the beginning.

Omitting the MEPs, the ACFA response rate was considered good (up to 45%). It is difficult to determine why the response rates differ so substantially and therefore difficult to assess the effectiveness of the survey methodology. Web survey responses can vary considerably and depends largely on how the surveys are implemented, questionnaire design, frequency of any follow up, the audience and number of responses received and purpose of the survey, among other factors. As a response rate between 5-30% is generally expected for web surveys, the effectiveness of the survey was considered reasonable.

In summary, the survey is considered a relatively effective means of gauging the attitudes of stakeholders towards CFP objectives and CFP implementation. This can only be concluded for stakeholders that have some level of understanding of the CFP, as these were the only people to whom this survey was sent. Taking such an approach with the more general public may warrant a slightly different approach, both in questionnaire design and implementation.

2.27.4 Recommendations

Publications review

The over riding problem of classification of articles, and therefore lack of replicability, undermines the methodology to the extent that it is recommended that it not be used as an indicator of stakeholder attitudes. If it is retained as a methodology, then it should be noted that it is best suited to the academic journals and *World Fish Report*, with industry papers such as the Fishing News being least suited.

Popular press review

The indicator tells us little beyond the level of awareness of the general public on fisheries management issues. It therefore generates little, if any, information of use to fisheries managers. It is therefore recommended that the indicator not be used. However, if the level of public exposure to CFP related issues is a matter of interest, in relation to CFP outreach work for example, then this methodology is considered a good starting point.

Industry/scientist collaborative research

Because of the unavailability of data, and variability between Member States, it is recommended that this indicator is not used in the future.

Stakeholder Questionnaire

With further refinement, as those suggested in the evaluation, the questionnaire could be considered a simple and effective methodology in capturing the attitudes of informed stakeholders towards the CFP objectives. It is therefore recommended that the Commission uses this methodology if it wishes to quantify this indicator for such stakeholders.

2.28 Total quantity of funds allocated to relevant research and distribution of research funds

2.28.1 Material & methods

The total quantity of funds spent, and the proportion of the total spend, on fisheries research in relevant areas were quantified at the EU and Member State level. It was decided to focus on funding rather than on the budgets of mandated research organisations, as suggested by the Commission (SEC(2004)892), to determine the allocation of research funds. This was because there are many research institutes or organisations and single projects are often undertaken by more than one research institution. This would make it difficult to accurately determine research funds and would also risk double counting.

The approach focused on the most important funding sources at the EU and Member State levels. At the EU level this is DG Research, DG Fish and DG Environment. At a Member State level, the fisheries ministries/departments of the national governments are typically, if not always, the most important funders. With the resources available it was not possible to survey all 25 Member States, so instead some of the key Member States with an interest in fishing were sampled: the UK, Spain, Poland, and the Netherlands. This was to test the methodology as much as to provide an insight into the indicator value. In each case, the relevant authorities were contacted and information on their funding allocation in the period 2000-2004 requested. This was then analysed and categorised in terms of how it related to the criteria outlined above.

Initially, a three level system of classifying projects was devised:

- **Primary environmental impacts** of fishing (commercial fish stock depletion) and how to prevent and reduce these impacts, including ex ante and ex post evaluation of relevant policy measures;
- **Secondary environmental impacts** of fishing (e.g. by-catch, discards, benthic disturbance, ecosystem impacts) and how to prevent and reduce these impacts, including development of fishing methods and gear, ex ante and ex post evaluation of relevant policy measures;
- **Other environmental impacts** not related to fishing e.g. litter, energy use, pollution and development of prevention and mitigation measures to alleviate anthropogenic impacts and relevant policy measures.

In the course of applying this however it became apparent that it was not sensitive enough to both the range of project types and to the needs of the European Commission in their own monitoring and classification systems. While it was applied in all the Member States, it was revised in classifying the Commission funded projects. Projects were classified according to how they related to the following six themes:

1. target species impacts
2. non-target species (commercial species and non-commercial species) impacts
3. habitat impacts
4. food web effects
5. ecosystem functioning;
6. wider environmental impacts e.g. litter, energy use, pollution

2.28.2 Results

EU Funding Sources

- *LIFE programme – DG Environment*

The main source of funding managed by DG Environment is under the LIFE programme[31]. There are a number of LIFE projects that are at least indirectly related to fisheries. These include nature conservation projects (LIFE Nature), which are restoring rivers or improving water quality. Historically, LIFE projects have also related to coastal zone management. The EU has allocated approximately €300 million for LIFE-Nature for the period 2000-2004. The rate of Community cofinancing may be up to 50% of the costs. By way of exception, for projects concerning priority natural habitats or priority species defined in the habitats Directive the Commission can finance up to 75% of the eligible costs. DG environment was not able to indicate what percentage of LIFE Nature projects is related to fisheries.

- *Biological studies 1997 – 2000 – DG Fish*

DG Fish has analysed the distribution of total funding for fisheries biological studies in the period 1997-2000. Eight per cent of the biological studies between 1997 and 2000 were in the field of environmental integration (Table 2.28.1 and Table 2.28.2). Unfortunately the report does not contain enough information to determine the funding allocation according to the three areas of environmental research areas detailed above. There is also no such analysis available for funding since 2000 and this was beyond the scope of this study.

Table 2.28.1 Yearly breakdown of projects and EU financial support, 1997-2000

Year CFS (€)*	No of projects	Total cost (€)	CFS (€)*
1997	66	36 408 817	19 501 624
1998	49	47 468 885	26 068 247
1999	44	36 781 619	20 893 548
2000	23	15 976 504	9 094 242
Total	**182**	**136 635 825**	**75 557 661**

* CFS= Community Financial Support
Source: Classification and analysis of the scientific domains covered by the biological studies 1997-2000 in support to the CFP (report M. Epps)

Table 2.28.2 Number of projects and EU financial support by scientific domain, 1997-2000.

Scientific domain	Number of projects	Total budget	Community Financial support	% of total budget
1. Research Surveys	39	43 532 251	22 699 887	30
2. Sampling of Commercial Fisheries	53	41 909 409	23 055 418	32
3. Technical Measures	21	10 540 824	6 074 887	8
4. Miscellaneous Data Collection	7	4 823 805	2 639 445	3
5. Fleet Studies	10	3 920 198	2 392 501	3
6. Fish stock population	21	12 564 870	6 898 255	9

[31] http://europa.eu.int/comm/environment/life/home.htm

Studies				
7. Environmental Integration	17	8 434 073	6 019 218	8
8. Monitoring and Control	1	564 694	282 347	0
9. Socio-economic dimensions	7	2 924 383	1 647 960	2
10. Dissemination of Information	6	7 421 318	3 847 743	5
Total	**182**	**136 635 825**	**75 557 661**	**100**

Source: Classification and analysis of the scientific domains covered by the biological studies 1997-2000 in support to the CFP (European Commission, 2004)

- *Fifth framework programme – DG research, DG Fish*

Research activities relating to fisheries in the 5th Framework Programme (FP5) concern three key actions (KA) of the thematic programme Quality of Life (QoL):
KA 1 (Food, nutrition and health);
KA 2 (Control of infectious diseases); and
KA 5 (Sustainable agriculture, fisheries and forestry).

Those of most relevance (88 % of projects) were funded under the specific Key Action 5 “Sustainable agriculture, fisheries and forestry, and integrated development of rural areas, including mountain areas”. According to this analysis the percentage of research funds within KA 5 allocated to research of impact of fisheries on the environment (E3, E4) was 20%. (as bold in Table 2.28.3).

Table 2.28.3 Distribution of fisheries research funds within fp5, KA 5, 1998 – 2002

FP 5, Key Action 5	**Commission contribution (Mio €)**	**Percentage of total**
AREA: 5.1.2 Sustainable fisheries and aquaculture	30.8	26%
E.1 Impact of environment changes on the dynamics of commercial harvested living resources	7.9	7%
E.2 Impact of environment changes on aquaculture	2.5	2%
E.3 Impact of fisheries on the marine ecosystems	**11.2**	**10%**
E.4 Impact of aquaculture on the environment	**9.2**	**8%**
E.5 Protection of biodiversity	**2.8**	**2%**
SUB-AREA: 5.1.2.2 Scientific basis of fisheries management	32.5	28%
SUB-AREA: 5.1.2.3 Improvement of aquatic production	35.8	31%
AREA: 5.4.3 Monitoring and enforcement of the CFP	5.3	5%
AREA: 5.4.4 Social and economic basis of the CFP	9.5	8%
Total	**116.7**	**100%**

Source: "Analysis of specific scientific domains covering key action 5 of qol (5fp) in the fields of fisheries and aquaculture (1998 – 2002)"

Energy, Environment and Sustainable Development (EESD) is one of the four thematic programmes of the Fifth RTD Framework Programme (1998-2002)[32]. Recalling the six themes, the projects were classified accordingly (Table 2.28.4):

1. target species impacts
2. non-target species (commercial species and non-commercial species) impacts
3. habitat impacts
4. food web effects
5. ecosystem functioning;
6. wider environmental impacts e.g. litter, energy use, pollution

Table 2.28.4 EESD environmental projects under 5FP

Category	**Funding, €**	**%**
1	€ 524,100	7.8
4	€ 381,000	5.7
1 & 2	€ 27,830	0.4
1 & 6	€ 904,000	13.5
3 & 5	€ 1,829,290	27.4
4, 5 & 6	€ 114,272	1.7
5 & 6	€ 2,906,930	43.5
Total	**€ 6,687,422**	

32 http://cordis.europa.eu/eesd/home.html

It is difficult to draw conclusions on the relative focus of funding by area because projects often address more than issue. This demonstrates the difficulty of developing a classification system. Nonetheless, it is evident that non-target species impacts (category 2) receives proportionately less funding than the other areas, at only 0.4%.

- *Sixth framework programme – DG research, DG Fish*

The research projects funded under the sixth framework programme under the following areas were categorised according to the six criteria:

- Food (Priority 1.5);
- Environment (Priority 1.6.3);
- Cooperative and Collective Research (SMEs);
- International Cooperation (INCO);
- Infrastructures; and
- ERA-NET (Coordination Actions)

Most funding was allocated to research into the wider environmental impacts of fishing (category 6, 60%) (Table 2.28.5). As with FP5, there was little research into non-target species impacts (category 2), as was also the case with habitat impacts (category 3) and ecosystem functioning (category 5). In addition to these figures, €1,680,143 was also allocated to projects falling under category three under SSP AREA 1.4 (Disease).

Table 2.28.5 Environmental categories of FP6 projects

Category	Total	%
0	€ 31,906,420	19
1	€ 21,111,775	13
3	€ 2,155,414	1
5	€ 7,122,983	4
6	€ 98,773,037	60
1 to 4	€ 3,000,000	2
Total	**€ 164,069,629**	

SSP - AREA 1.3 (Fisheries - Aquaculture) was further analysed as this relates more specifically to the CFP (Table 2.28.6). Of the €20 million spent under this heading, almost half of it was on habitat impacts (category 3) with the least on ecosystem functioning and wider environmental impacts (categories 5 and 6).

Table 2.28.6 Project type under SSP - AREA 1.3 (Fisheries - Aquaculture)

Category	Total	%
1 to 4	€ 500,000	2.5
1&2	€ 4,273,854	21.6
3	€ 9,585,909	48.4
4	€ 2,965,914	15.0
5	€ 1,000,000	5.0
6	€ 1,499,970	7.6
Total	**€ 19,825,647**	

Member State Funding

Member States have a role in co-financing fp5 and fp6 projects as well as in funding their own national research.

- *The Netherlands*

The Netherlands" ministry for Agriculture was unable to provide data on the allocation of fisheries research funding. According to a statement, the proportion of research funds allocated to environmental issues, including co-financing of EU funded projects, has been increasing gradually from 40% in 2000 to 70% in 2005, while the total budget for fisheries research remained constant at €11 million. However, because there were no data or project descriptions available it was not possible to validate this.

- *England and Wales*

The Department for Food, Environment and Rural Affairs (Defra) was able to provide a comprehensive record of projects funded in England and Wales and their details for the last fifteen years. From this, a time series of the number of projects (2.28.5) and funding (2.28.6) by project type (2.28.4) per year started was generated.

Table 2.28.4 Project type classification

Number	**Category**
0	Not related to environment
1	primary environmental impacts of fishing
2	secondary environmental impacts of fishing
3	other environmental impacts not related to fihshing
4	Environmental, but not possible to categorise

Table 2.28.5 Number of environmental projects per year in England and Wales, 2000-2004

	Type of Project					
Year	**0**	**1**	**2**	**4**	**1+2**	**Total**
2000	6		3	1		10
2001	4	1	1			6
2002	3	2	3		2	10
2003	4	2	1	2		9
2004	4			1		5
Total	21	5	8	4	2	40

Table 2.28.6 Funding of project type per year in England and Wales, 2000-2004

	Project Type										
Year	**0**		**1**		**2**		**4**		**1+2**		**Grand Total**
	Amount	**%**	**Amount**	**%**	**Amount**	**%**	**Amount**	**%**	**Amount**	**%**	
2000	£ 2,998,696	81		0	£ 584,415	16	£ 114,609	3		0	£ 3,697,720
2001	£ 361,020	62	£ 120,347	21	£ 98,499	17		0		0	£ 579,866
2002	£ 1,581,926	27	£2,441,476	42	£ 519,133	9		0	£1,307,656	22	£ 5,850,191
2003	£ 252,054	7	£1,054,050	29	£ 957,289	26	£1,418,786	39		0	£ 3,682,179
2004	£ 784,449	48		0		0	£ 855,013	52		0	£ 1,639,462
Grand Total	£ 5,978,145	39	£3,615,873	23	£2,159,336	14	£2,388,408	15	£1,307,656	8	£15,449,418

Of the forty projects funded in the period 2000-2004, a little under half of them related to the environment. Those not related to the environment appear to be relatively smaller however as they accounted for only a third of total funds in this period. Of these, most were related to the direct or indirect impacts of fishing, with none relating to the wider environmental aspects. A quarter of the projects were classified as relating to the indirect environmental impacts of fishing.

There is no clear trend as to whether the proportion of funds spent on environmental projects is increasing or decreasing. This may be in part because the start date is used to place each project in a year, and both national and EU funded projects are included, which may run to different administrative cycles.

- *Poland*

Poland was able to provide a break down of project title and funding from 2000-2005. These were again analysed in terms the number of projects (2.28.7) and funding (2.28.8) by project type per year started

Table 2.28.7 Number of environmental projects per year in Poland, 2000-2005

	Type of Project				
Year Started	**0**	**1**	**2**	**4**	**Grand Total**
2000	10	1		6	17
2001			1		1
2002		1			1
2003	3		1	1	5
2004	3	1			4
2005	5	2	4		11
Grand Total	21	5	6	7	39

Table 2.28.8 Funding of project type per year in Poland, 2000-2005 (euros)

	Project Type								
Year	**0**		**1**		**2**		**4**		**Grand Total**
	Amount	**%**	**Amount**	**%**	**Amount**	**%**	**Amount**	**%**	
2000	3,285,380	71	346,465	8		-	969,988	21	4,601,833
2001		-		-	298,335	100		-	298,335
2002		-	23,734	100		-		-	23,734
2003	78,509	18		-	182,952	43	167,414	39	428,875
2004	120,505	90	13,064	10		-		-	133,569
2005	230,620	21	797,596	74	48,131	4		-	1,076,347
Grand Total	**3,715,014**	**57**	**1,180,860**	**18**	**529,417**	**8**	**1,137,401**	**17**	**6,562,693**

Of the 39 projects initiated in the period 2000-2005, over half (21) were not related to the environment. This was reflected in the funding, with 57 per cent of funds allocated to these projects. Most environmental projects related to the primary environmental impacts of fishing, with only 8 per cent of funds being spent on the secondary impacts. There was no trend in the proportion or amount of funds spent on environmental projects.

- *Spain*

Spain, through the Instituto Oceanográfico Español (IEO), was able to provide a breakdown of project titles and funding from 2000 to 2005. However, the data supplied was only for projects pre-selected according to the defined criteria by, therefore it was not possible to estimate what percentage of total fisheries research concerns environmental issues.

However, within these constraints the projects were classed into separate categories following the same methodology as for other countries.

Table 2.28.9 Number of environmental projects per year in Spain, 2000-2005

Type of Project					
Year Started	**0**	**1**	**2**	**3**	**1+2**
2000	2	1	1		4
2001	0		1		1
2002	0	4	1		5
2003	2		3	2	7
2004	0	0	0	0	0
2005	0	1	1		2
Grand Total	4	6	7	2	19

	Project type									
Year Started	**0**		**1**		**2**		**1+2**		**Total Env.**	**Grand Total**
	Amount	**%**	**Amount**	**%**	**Amount**	**%**	**Amount**	**%**	**%**	
2000	€ 87,487	n/a	€ 34,708	n/a	€ 6,674	n/a	€ 0	n/a	n/a	n/a
2001	€ 0	0	€ 0	0	€ 376,258	9	€ 0	0	9	€ 3,967,872
2002	€ 0	0	€ 173,302	5	€ 141,101	4	€ 0	0	9	€ 3,645,639
2003	€ 234,502	5	€ 0	0	€ 153,074	3	€ 151,762	3	11	€ 5,091,507
2004	€ 0	0	€ 0	0	€ 0	0	€ 0	0	0	€ 6,149,882
2005	€ 0	n/a	€ 110,280	n/a	€ 310,444	n/a	€ 0	n/a	n/a	n/a
Grand Total	€ 321,989	2	€ 318,290	2	€ 987,551	5	€ 151,762	1	9	€ 18,854,900

Of the nineteen projects classed as environmental by Spain four were not considered to fulfil the criteria. Of those remaining, six projects (32 per cent) addressed the direct environmental impacts of fishing, seven (37 per cent) on the indirect impacts, and two (11 per cent) on the wider environmental impacts. Also, two projects covered both direct and indirect impacts.

In terms of funding, the percentage of total fisheries research funding allocated to environmental projects was between 9 and 11 per cent in the years 2001, 2002 and 2003. In 2004, there were no identified environmental fisheries projects, therefore the percentage is zero. Added to this, the fact that no total expenditure data was available for either 2000 or 2005, we cannot with any certainty determine whether the proportion of funding being allocated to environmental issues is increasing of decreasing.

2.28.3 Evaluation and interpretation

It is difficult to draw conclusions about changes over time in the distribution of research funds. At the EU level no (annual) time series could be provided. The distribution of funds for biological studies concerns the total budget for 1997-2000 (four years). The fifth framework programme is a multi-annual programme and the distribution of funds presented in Table concerns the whole budget 1998-2002. Although the projects included in these two studies are not fully comparable we can draw the preliminary conclusion that the proportion of fisheries research funds allocated to environmental issues has increased from 8% in 1997-2000 to 20% in 1998-2002. Note however that these periods are overlapping and the data for the first period concern only biological studies. The data for fp5 are incomplete because only key action 5 (88% of fisheries research within fp5) has been taken into account. This is also the case for FP6 funding, as INCO, EESD or FELLOWSHIP projects were too complex to classify. Even with those projects that were considered, it was very difficult to accurately, or consistently, categorise them. Some related very peripherally to the environment, making it subjective whether to include them, while it was not always clear which categories they should fall under.

In The Netherlands the total funds for fisheries research remained constant during the period 2000-2005 while the proportion of funds allocated to environmental issues reportedly increased from 40% to 70% over this period. In Poland and the UK it is difficult to determine how the amount and proportion of funding being spent on environmental related research is changing because of the length of funding cycles and uncertainty over project classification. The proportion of environment related projects in the UK appears to be on the increase since 2000, although the highly variability in the figures brings the reliability of such a conclusion into question.

On the face of it, the proportion of research funds allocated to environmental issues is a good and simple indicator of the level of scientific understanding of the interactions between fisheries and the environment. However, upon attempting to assign values to the indicator it becomes apparent that its reliability is mixed.

In principle the data on research funding at an EU level is available from the Commission. However, it is not always in a form that can be analysed in terms of identifying which projects related to fisheries and the environment. This is particularly the case with DG Environment funding. DG Fish and DG Research funds are sometimes in a form that permits analysis.

While some of the Member States data is presented in a form that allows relatively straightforward classification of projects, two key points undermine the indicator. Firstly, it is necessary to define the scope of the funding systems that are analysed. For example, whether or not to include research on marketing, gear technology and food safety. The way in which the different areas are funded varies significantly between Member State, therefore the work here focused on research funded by national fisheries ministries/departments. This difference in funding systems makes comparison between Member States impossible. Comparison between years is also made problematic by reforms of the national funding systems.

Secondly, classifying the projects as environmental or not, and the type of environmental project, can be difficult from the project titles and descriptions alone. To do this reliably, which is necessary for the indicator to be valid, requires more information than is often available, or else classification as a matter of course by the Member States.

Because of these limitations, the values reported in the results should not be interpreted as definitive. Calculations above have been made on the basis of rough and incomplete data in parts (e.g. the Netherlands) and on debatable project classification. If this indicator is to be calculated on an annual basis, some improvements in data availability will be necessary (see section 2.28.4). Until then it is not possible to compare the performance between Member States.

2.28.4 Recommendations

Given the major problems of inconsistency in reporting between Member States and definition of research programmes, it is not recommended that the allocation of national research funds be considered as an indicator. This is easier at the EU level where the programmes are more discreet and centrally managed. At this stage the allocation of money is not clear enough to provide a reliable indicator. If the Commission considers this important enough to pursue, then internal monitoring and reporting requirements should be developed that including how different projects relate to the environment.

2.29 Scientific advice in decision making

2.29.1 Material & methods

To generate an indicator of the integration of scientific advice into decision making, the Total Allowable Catch (TAC) decision making system was examined to generate a quantitative evaluation of the degree to which International Council for the Exploration of the Sea (ICES) advice on catch levels is reflected in decision making. In reviewing the literature, this has been done by Hammer and Zimmermann (unpublished). Their relevant findings and conclusions are therefore summarised here.

2.29.2 Results

TAC decision making system

Hammer and Zimmermann 2003 examined the TAC decision making system and calculated the average annual deviation of TAC levels agreed by the Council with those advised by ICES for the period 1987 to 2003. They demonstrated that there is a significant level of deviation, ranging from –90% to +600% with an average deviation of +32% (see Figure2.29.1).

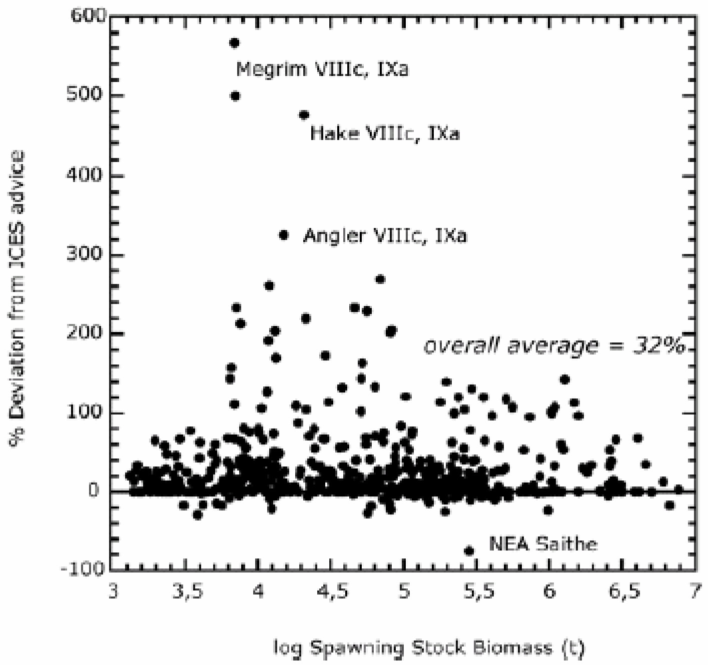

Figure 2.29.1: Relative deviation of official total allowable catches (TACs) from those scientifically proposed (four extreme values between 1000 and 2200 % have been omitted) vs stock size. Average annual deviation of endorsed TAC from scientifically proposed by ICES (period 1987-2003) (from Hammer and Zimmermann 2003[33]).

[33] Hammer, C and Zimmermann, C 2003, *Influence of the implementation of the ICES advice on the state of fish stocks since the introduction of the precautionary approach*, Inf. Fischwirtsch. Fischereiforsch. 50(3), 2003

The trend in annual deviation in recent years was also evaluated, demonstrating a substantial increase in the average deviation between the 1980s and late 1990s, rising from around 20% to 30-50% in the 1990s (see Figure2.29.2).

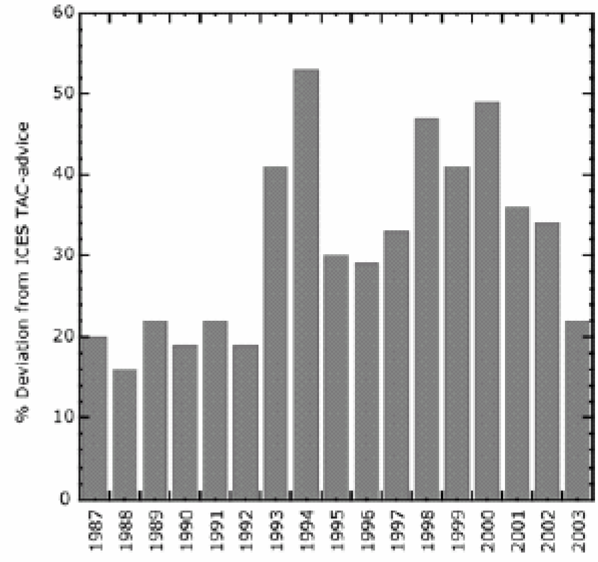

Figure 2.29.2: Deviations of officially adopted TAC"s from ICES recommended TAC"s for the ICES convention area (1986-2003).

In recent years between 2001-2003, there seemed to be an observed decline in deviation from ICES TAC recommendation suggesting an improvement in the system. However, this decline of deviation in 2001-2003 was primarily due to the sharp increase in stocks for which ICES gave a zero-TAC-advice (see Figure2.29.3), which were omitted from the analysis. The decline and apparent improvement of the situation is thus falsely observed.

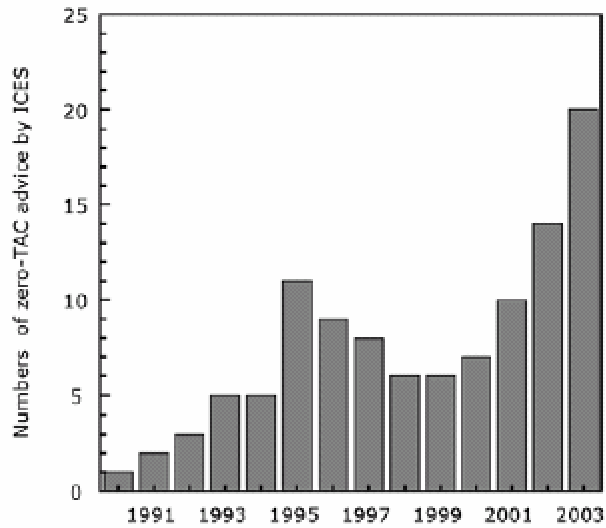

Figure 2.29.3: Number of stocks for which ICES gave a zero-TAC-advice

2.29.3 Evaluation and interpretation

TAC decision making system

Significantly high deviations between TAC advice and decisions were demonstrated by Hammer and Zimmerman. However, the analysis was conducted under a number of defined conditions and it is therefore important to consider these in evaluating the results from the analysis.

1. The analysis was conducted only for fish stocks where comparison could be made with sufficient reliability, which excluded those without an SSB estimate i.e. salmon, sea trout, brill, dab, turbot, eel, sandeel, capelin, redfish, Nephrops, Pandalus, Norway pout, Greenland halibut, Icelandic cod and seals. Very small stocks with an SSB <1000t were also excluded from the analysis.
2. Extreme deviations of ±1000% were excluded from their analysis because of the discrepancy between the rebuilding concepts between TAC advice and managers. This would have likely to have resulted in a further underestimate of the average deviation.
3. Stocks where a zero TAC was recommended were also excluded since relative deviations from zero cannot be computed, thus resulting in further bias in the deviation.

The results can thus be considered an underestimate of the full extent of deviations, although not all stocks were represented.

Despite the limitations in the analysis methodology, the indicator is considered a useful measure of the extent to which scientific advice is incorporated into decision making. Historical data is available, as demonstrated by the analysis, and this can be updated each year. This makes the exercise both low in cost and easy to perform. Measurement is qualitative and consistent, being replicable and reliable.

Key environmental policies

As the TAC system only covers stock harvesting levels, rather than environmental integration more broadly, it was planned to similarly examine key environmental policies. This would have entailed comparing finally agreed Regulations with the scientific advice issued by ICES. A key difference however would have been that this would be more qualitative than quantitative. The comparison was to be in terms of content and timeliness, comparing when ICES advice was first issued to the date of Commission proposal and final Council decision. Two recent environmental policies were considered:

- cetacean bycatch Regulation; and
- shark finning Regulation.

In practice, such an approach was not practical. Data or qualitative scientific advice was either unavailable or very difficult to obtain. Once obtained, comparison was inevitably objective and the approach varied significantly between Regulations. The main problem with this was that it means it is not possible to compare the degree of incorporation of scientific advice into decision making between Regulations.

2.29.4 Recommendations

Given the limitations with the qualitative analysis of the environmental policies, it is not recommended that it be used as a methodology or indicator.

It is recommended that the Commission use the indicator of the degree to which ICES advice on catch levels is reflected in decision making, as developed by Hammer and Zimmerman. The indicator is the Deviations of officially adopted TAC's from ICES recommended TAC's (see Figure2.29.2). The number of stocks for which ICES gave a zero-TAC-advice (Figure2.29.3) is necessary for interpretation.

If the indicator is adopted, then criteria should be developed for selecting which fisheries should be included. Ideally the indicator should be consistent with indicator 1. In developing this criteria, all fish stocks for which the Council adopts TACs, including those without an SSB estimate should be considered. Stocks covered by the North East Atlantic Fisheries Commission (NEAFC) should also be considered as this is a Regional Fisheries Management Organisations (RFMOs) in which the EU plays a significant role in setting TACs. Similarly, the International Commission for the Conservation of Atlantic Tuna (ICCAT) agreed TACs for tuna in the Mediterranean should be considered. Where scientific advice is available, the TAC or fishing effort levels set under third country access agreements should be considered.

2.30 Policy makers performance

2.30.1 Material & methods

The performance of policy makers was evaluated on the basis of progress against officially stated commitments in:

- the Community Action Plan to integrate environmental requirements into the CFP (COM(2002)186); and
- the Plan of Implementation adopted at the 2002 World Summit on Sustainable Development (WSSD).

The first of the two is a Community Action Plan, while the later is an international plan signed up to by the EU and its Member States. In responding to the Community Action Plan , the Council of 27 and 28 January 2003 made specific reference to the 2002 WSSD plan of implementation:

"3. RECALLING other recent developments in the field of fisheries and the environment, including the Declaration made at the Reykjavik Conference on Responsible Fisheries in the Marine Ecosystem (October 2001), the Bergen Declaration of the Fifth International Conference on the Protection of the North Sea (March 2002), and, especially, the Plan of Implementation adopted at the World Summit on Sustainable Development (Johannesburg, 2002), and in particular the commitments acquired in its paragraph 30 on the maintenance of stocks including the restoration of depleted stocks, fisheries subsidies and sustainable aquaculture."

Against each target in the Community Action Plan and the WSSD Plan, progress was evaluated on the following basis:

Criteria	Unit of measurement
Extent of Progress	Ranked in terms of fully/partly/not done
Details of Progress	The implementing legislation is summarised and referenced
Date done	When the legislation was adopted
Punctuality	+/- months
Comments	Any further points of interpretation are noted

2.30.2 Results

Community Action Plan to integrate environmental protection requirements into the CFP

Management measures	Targets and associated timetables	Observations	Extent of Progress (fully/partly/not done)	Details of Progress	Date done	Punctuality (+/- months)	Comments
Reduction of overall fishing pressure	1. New legislation comprising 1) the general framework for the management of fishing capacity, and	Specific reduction targets and mechanisms shall be set up, for fleet segments or by fishery, in implementing legislation. Reduction of fishing pressure is in any case required to ensure sustainability of commercial stocks but at the same time is essential for environmental integration.	Partly	New basic Regulation (2371/2002, Chapter III) contains new fleet exit entry rules. Implemented through Commission Regulations 1438/2003 and 26/2004	20 December 2002 and 12 August 2003	0	While new legislation was adopted, there are several questions over the details: There are questions over how Member State fleet reference levels were set e.g. for French and Dutch fleet (see e.g. Earle 2003). Monitoring of new Member State fleet sizes is more difficult and conditions on the use of public aid for fleet management in these Member States is relaxed by Regulation 1242/2004. Significant derogations from the system for Outer Regions established under Regulation 639/2004.

Management measures	**Targets and associated timetables**	**Observations**	**Extent of Progress (fully/partly/not done)**	**Details of Progress**	**Date done**	**Punctuality (+/- months)**	**Comments**
	2. New legislation comprising: 2) specific legislation to reduce fishing effort on fisheries subject to emergency measures, recovery plans or multi-annual management programmes, to be adopted **before end of 2002**.		Partly	New basic Regulation (2371/2002, Article 5) requires recovery plans to include limitations on fishing effort unless this is not necessary to achieve the objective of the plan. No such requirements for management plans or emergency measures	20 December 2002	0	Three recovery plans in place: cod recovery plan (Regulation 423/2004, adopted December 2003); northern hake recovery plan (Regulation 811/2004, adopted April 2004); and Southern hake and Norway lobster recovery plan (Regulation 2166/2005, agreed October 2005). No effort limitation in hake plan, although proposed, and weakened from proposal in cod plan.

Management measures	Targets and associated timetables	Observations	Extent of Progress (fully/partly/not done)	Details of Progress	Date done	Punctuality (+/- months)	Comments
Improve fishing methods to reduce discards, incidental bycatch and impact on the sea bed	3. New set of technical measures specifically addressing discard reduction **before 31 December 2003**.	This may include the setting of discard bans.	Not done	Commission action plan to reduce discards of fish (COM(2002)656) tabled on 26 November 2002. Contains a number of potential technical measures. No specific package since forthcoming.	-	>-29	
	4. New set of technical conservation measures designed to reduce by-catch of cetaceans to levels guaranteeing favourable conservation status of cetacean populations, **before 31 December 2002**	Both by-catch and population sizes to be estimated on the basis of scientific advice.	Partly	Council agreement (Regulation 812/2004) adopted to curb the accidental capture of cetaceans such as dolphins and harbour porpoises	April 2004	-16	

Management measures	Targets and associated timetables	Observations	Extent of Progress (fully/partly/not done)	Details of Progress	Date done	Punctuality (+/- months)	Comments
	5. Designation of protected areas where bottom trawls and similar towed gear operating on the bottom are prohibited **before 31 December 2004**.	Some of these measures may be taken in the context of Natura 2000 sites.	Partly	Bottom trawling banned in the area known as the Darwin mounds 180 kilometres north west of Scotland to protect deep-sea corals in the area (Commission Regulations 1475/2003 & 263/2004; Council Regulation 602/2004). Bottom trawling banned to protect deep-sea corals around the Azores, Madeira and Canary Islands (Regulation 1811/2004; 27/2005; 1568/2005)	20 August 2003 temporarily 22 – 23 March 2004 permanently 11 October 2004	+2	Only two areas closed from trawling. Azores, Madeira and Canary Islands only necessary because of opening of western waters by Regulation (1954/2003) in 2004.

Management measures	Targets and associated timetables	Observations	Extent of Progress (fully/partly/not done)	Details of Progress	Date done	Punctuality (+/- months)	Comments
	6. Implement Community Action Plans to manage sharks and protect seabirds in the context of FAO IPOAs. Propose legislation **before end of 2003**.		Not done	No Community shark or seabird plans are in place. The EC has signed up to the IPOA-Sharks and IPOA-seabirds on behalf of Member States but has not developed Community plans of action. Member States were consulted on draft Plans in 2000 and circulated "preliminary drafts" to COFI in 2001 that was largely a review of shark fishery knowledge. These plans failed to meet most of the requirements of IPOAs and have since been withdrawn, meaning that formal plans remain to be conceived. Council Regulation	-	>-29	Subsequent target set in the Malahide Message, Target 7.4: Community Plans of Action on sharks and seabirds adopted by 2006 with progressive implementation thereafter. Not met. While there is presumption against finning under Regulation 1185/2003, vessels that can demonstrate a capacity to use all parts of sharks and justify the need for separate processing on board are eligible for a special fishing permit that allows finning.

Management measures	Targets and associated timetables	Observations	Extent of Progress (fully/partly/not done)	Details of Progress	Date done	Punctuality (+/- months)	Comments
Eliminate public aid for modernisation	7. Amendment to Regulation 2792/1999 to be adopted **before end of 2002**.		Partly	Phase out of modernisation subsidies agreed as part of the 2002 CFP reform package (Council Regulation 2369/2002).	December 2002	0	The amendments to the structural aid rules eliminate some of the most problematic subsidies to the sector, relating to the construction of new vessels and export of capacity (including under joint ventures). However, the subsidies were still available until the end of 2004, potentially enabling Member States to use up all the aid allocated under these headings for the period 2000-2006. Modernisation projects continue to be eligible for aid, but are restricted to projects involving equipment, vessel monitoring systems and safety measures. Aid should not increase tonnage, apart from

Management measures	Targets and associated timetables	Observations	Extent of Progress (fully/partly/not done)	Details of Progress	Date done	Punctuality (+/- months)	Comments
Defend objectives and principles in international fora	8. Present proposals specifically designed to protect non-commercial species and habitats in each Regional Fisheries Organisations where EC is a member.	As a first step, the EC initiatives to protect sharks should be promoted within ICCAT	Partly	First step met, in that the EC supported the adoption of finning prohibitions in ICCAT, IATTC, IOTC and NAFO (COM(700)2005) Prohibitions to trawl beyond 1000m depth in Mediterranean Prohibition to trawl in three areas of the Mediterranean	ICCAT recommendation adopted 2004 GFCM 2004 GFCM 2005	n/a	The Commission proposed these finning prohibitions, which reflect the details of the EU shark finning Regulation (1185/2003) ie 5% fin/body weight ratio. The EU Regulation however approach has been the subject of criticism on the basis that it is difficult to monitor when fins are landed separately from carcasses; the Commission is not required to report in the future on the Regulation; and that there are concerns over the 5% figure[34].
Implement the Biodiversity Action Plan for	9. Achieve full implementation of all the actions	Progress will be concomitant with development of	Partly	Detailed assessment beyond the		n/a	Commission evaluation undertaken in

[34] Shark Trust and Co-Habitat. (2005) *Shark Finning and the European Commission. Where are we now?*

Management measures	Targets and associated timetables	Observations	Extent of Progress (fully/partly/not done)	Details of Progress	Date done	Punctuality (+/- months)	Comments
Fisheries (BAPF).	specified in the BAPF **by 31 December 2006**.	scientific knowledge		scope of this study			advance of Malahide (March 2004)[35]
Measures adding value to environmental integration (Articles 13 to 15 and 17 of Regulation (EC) No 2792/1999)	10. The Commission will consult, for the first time **before the end of 2003**, the European-level organisations defined in Article 8 of Regulation (EC) No 1260/1999 and other relevant stakeholders, such as the Regional Advisory Councils on possible measures	Examples: litter projects, re-stocking, contribution to environmental monitoring.	Fully	Commission consulted with stakeholders on Communication on positive environmental incentives at time of writing.	June 2004	- 6	
Principles and guidelines for integration in the sector of aquaculture	11. Legal framework adopted **before the end of 2003**. Implementing legislation finalised **before end of 2005**.		Not done	"Strategy for the sustainable development of European Aquaculture" (COM(2002)511) tabled in September 2002.		>-5	Despite references to the EU Sustainable Development Strategy, the aquaculture strategy is aimed at *sustained growth* rather than *sustainable development*, as

[35] Status of Implementation of the Biodiversity Strategy and Action Plans DRAFT Implementation Assessment of BAP Fisheries. Commission Working paper. http://europa.eu.int/comm/environment/nature/biodiversity/develop_biodiversity_policy/malahide_conference/pdf/malahide_wgp_audit_3.pdf

Management measures	Targets and associated timetables	Observations	Extent of Progress (fully/partly/not done)	Details of Progress	Date done	Punctuality (+/- months)	Comments
				No legal framework or implementing legislation in place.			underlined by the twin aims of increasing employment and increasing growth year on year. Environmental commitments made under (COM(2002)511), include: • Mitigate the impact of wastes • Manage the demand for wild fish for on-growing • Develop instruments to tackle the impact of escapees, alien species and GMOs • Integrated pollution prevention and control • Specific criteria and guidelines for aquaculture Environmental Impact Assessments • Recognise and strengthen the positive impact of extensive culture and re-

Management measures	Targets and associated timetables	Observations	Extent of Progress (fully/partly/not done)	Details of Progress	Date done	Punctuality (+/- months)	Comments
Strategy for distant water fisheries	12. Adoption **before end of 2003**.		Fully	Commission Communication tabled "on an Integrated Framework for Fisheries Partnership Agreements with Third Countries" (COM(2002)637)	**23 December 2002**	+12	

Management measures	Targets and associated timetables	Observations	Extent of Progress (fully/partly/not done)	Details of Progress	Date done	Punctuality (+/- months)	Comments
Further fulfilment of Habitats and Birds Directives	13. Natura 2000 sites at sea and associated management measures to be completed **before end of 2004**.		Not done	Difficult to monitor progress because lack of implementation only evident when at advance legal stages e.g. the ECJ found against the UK its non-application of the whole of the habitats Directive outside the UK"s territorial waters in October 2005 (Case C-6/04). Data on site designation contains so many limitations that drawing meaningful conclusions on extent of area designation becomes impossible[36]. Nonetheless, designation of marine sites is evidently slow.	-	>-17	Poor progress recognised in the shifting of the deadline. Subsequent target set in the Malahide Message 1.1: "take the necessary steps to complete the Natura 2000 network on land by 2005, the marine sites by 2008." Another subsequent target set in the draft Commission Communication "Halting the Loss of Biodiversity by 2010 - and Beyond" submitted to the Biodiversity Expert Group (15 November 2005): "Accelerate efforts to finalise the Natura 2000 network including: adoption of the lists (for terrestrial, freshwater and coastal sites by 2006, for marine sites by 2008); designation of all sites and adoption of effective management measures (for terrestrial, freshwater and coastal sites by

Management measures	Targets and associated timetables	Observations	Extent of Progress (fully/partly/not done)	Details of Progress	Date done	Punctuality (+/- months)	Comments
	14. Monitoring of populations of marine species of Annex IV of Directive 92/43/EEC. Aim at full monitoring and complete report to Commission for the first time **before end of 2003**, without prejudice to the existing legal obligations.	This is an obligation for Member States in accordance with Article 12(4) of Directive 92/43	Not done	Difficult to monitor progress because lack of implementation only evident when at advance legal stages. However, a number of Member States are known to be failing to meet their legal obligations.	n/a	>-29	Inadequate implementation reflected by Commission initiation of legal action relating to protection of cetaceans (whales and dolphins) under the habitats Directive (92/43) in December 2005. The action is against Belgium, France, Greece, Italy, the Netherlands, Portugal, Spain, and the UK[37].

Management measures	Targets and associated timetables	Observations	Extent of Progress (fully/partly/not done)	Details of Progress	Date done	Punctuality (+/- months)	Comments
Better understanding of marine ecosystems	15. Specific target to ensure, by 2004, Community participation in all scientific fora dealing with the structure and functioning of marine ecosystems. The Commission shall specify this item among the fields of work eligible for Community funding.		Fully	Commission participates regularly in scientific and technical committees of OSPAR, HELCOM and other MEAs. Commission scientists also participate in ICES meetings and international conferences. Funds have been made available to facilitate participation of Community scientists in all these fora, especially ICES. Ecosystem approach related research actively funded under 6^{th} framework	Ongoing	n/a	

Management measures	Targets and associated timetables	Observations	Extent of Progress (fully/partly/not done)	Details of Progress	Date done	Punctuality (+/- months)	Comments
Development of operational procedures to apply principles of precaution, prevention, rectification at source and polluter pays to fisheries.	16. Permanent task, in collaboration with scientific fora and Regional Fisheries Organisations. As intermediate target, the Commission will present a progress report **by the end of 2004**		Partly	No progress report presented. Implementation open to debate/assessment, but apparently variable e.g. Access fees to third country waters increased.	-	>-17	

Management measures	Targets and associated timetables	Observations	Extent of Progress (fully/partly/not done)	Details of Progress	Date done	Punctuality (+/- months)	Comments
Pilot projects on the collection of basic information on the effects of fishing and aquaculture on the environment	17. Based on these studies, the Commission shall review, **before 31 December 2003**, whether it is appropriate to extend the obligations set up by Council Regulation (EC) No 1543/2000, in order to cover the relationship between fisheries and aquaculture with the environment	Target and deadlines already existing Article 10 of Regulation (EC) No 1543/2000	Fully	A study was commissioned to determine the appropriateness and feasibility of extending the current obligations of Regulation 1543/2000 to include interactions between fisheries and the environment[38].	July 2003	+5	Commission has not tabled any proposals since this report. The need and demands of an ecosystem approach to management and associated data collection is flagged as a "priority" in the Commission report on the CFP Community framework of data collection and management (COM(2004)225).. This includes the environmental effects of fishing, and impacts on non-target species and habitats. Additional funding to meet identified shortcomings (including environmental data) not yet forthcoming.

Management measures	Targets and associated timetables	Observations	Extent of Progress (fully/partly/not done)	Details of Progress	Date done	Punctuality (+/- months)	Comments
Use of trade measures to promote environmental integration	18. Implementation as measures are adopted at international fora.	Effectiveness of trade measures requires international decisions.	Partly			n/a	On **29 April** the EU decided to ban the import of tuna and swordfish products from Bolivia, Cambodia, Equatorial Guinea, Georgia and Sierra Leone Equatorial Guinea and Sierra Leone Sierra Leone under its commitments as a member of the International Commission for the Conservation of Atlantic Tunas (ICCAT) (Regulations 826-8/2004). Similar measures been in place since at least 2001.

Management measures	Targets and associated timetables	Observations	Extent of Progress (fully/partly/not done)	Details of Progress	Date done	Punctuality (+/- months)	Comments
Debate on eco-labels	19. Following presentation of a Communication by the Commission, Council shall issue conclusions **before end of 2003.**		Partly	Debate initiated with ecolabelling Commission Communication “Launching a debate on a Community approach towards eco-labelling schemes for fisheries products” (COM(2005)275) on 29 June 2005. No Council conclusions at the time of writing.	-	>-29	Communication scope limited to capture fisheries, not covering aquaculture. Tabled 18 months later than Council conclusions were due.
Indicators of environmental integration	20. Pilot system in place **during 2003**. First report by the Commission **before the end of 2005**. Comprehensive indicator scheme **before the end of 2006**.		Partly	No comprehensive scheme in place. This report meets the commitment of a first report due before the end of 2005.	-	>-5	

Progress against the 20 targets is mixed (Table 2.30.1). More targets were considered not to have been met (25%) than those that were fully met (20%). Just over half of the targets were considered partly met (55%). The punctuality, in months, with which the targets were met is summarised in Figure . Removing the four targets for which the punctuality assessment was not applicable, the average punctuality was 10.2 months late at the time of writing (May 2006). This is likely to increase over time as most of the targets not met are not expected to be met in the near future.

Table 2.30.1 Progress against EU CFP Environmental Integration Action Plan Targets

Extent of Progress	Total	%
Fully	4	20
Not done	5	25
Partly	11	55
Total	20	

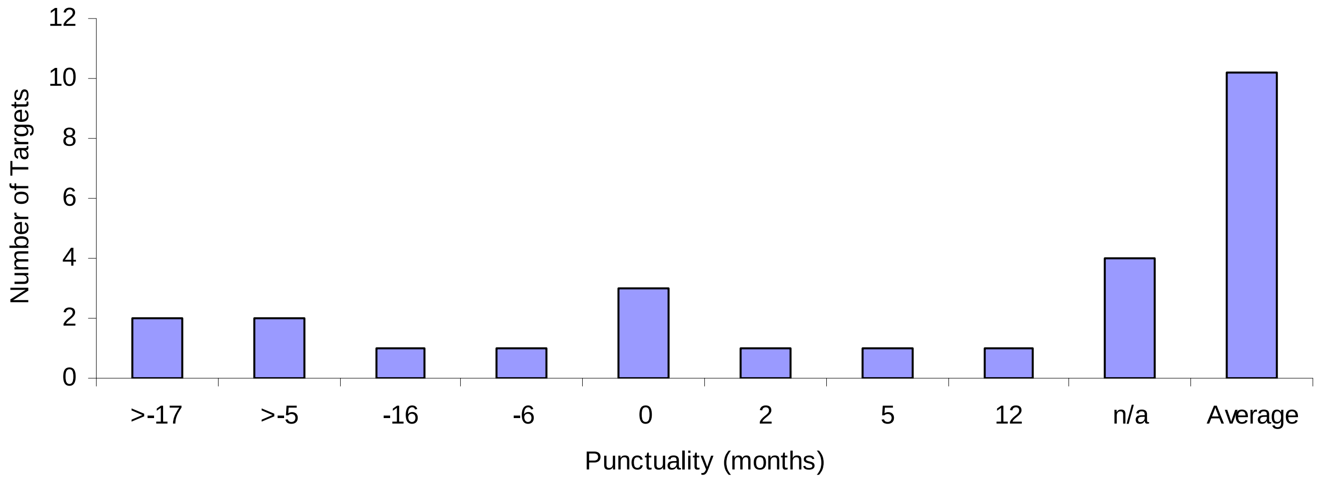

Figure 2.30.1 Punctuality against EU CFP Environmental Integration Action Plan Targets

The WSSD Plan of Implementation

Action	Extent of Progress (fully/partly/not done)	Details of Progress	Date done	Punctuality (+/- months)	Comments
(a) Maintain or restore stocks to levels that can produce the maximum sustainable yield with the aim of achieving these goals for depleted stocks on an urgent basis and where possible not later than 2015;	See indicator [1]			n/a	

Action	Extent of Progress (fully/partly/not done)	Details of Progress	Date done	Punctuality (+/- months)	Comments
(b) Ratify or accede to and effectively implement the relevant United Nations and, where appropriate, associated regional fisheries agreements or arrangements, noting in particular the Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks and the 1993 Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas;	Partly	UN Fish Stocks agreement ratified by the EC and Member States Compliance Agreement ratified by EC	December 2003 August 1996	n/a	Cyprus and Malta are the only two of the ten new Member States to have ratified the UN Stocks Agreement. In June 2005 the eight Member States concerned received a letter from Commissioner Borg reminding them to complete internal ratification formalities as soon as possible. Lithuania estimates completion during the first quarter of 2006, Poland, slovenia and Slovakia (and Bulgaria) indicate that they will do their utmost to complete formalities by May 2006. Hungary, Estonia and Czech Republic have indicated procedures are underway but they are unable to provide an estimate for completion. Only Latvia has so far failed to provide feedback, and a reminder was to be sent by the Council secretariat. Finally, candidate State Romania also indicated that procedures had been launch with a view to ensure its accession by the time it joins the EU. Given the state of stocks fished by community vessels, implementation of UN Stocks Agreement is arguably lacking. The FAO Compliance Agreement provisions are mainly incorporated into secondary Community Legislation, particularly Chapter V of the CFP basic Regulation,

Action	Extent of Progress (fully/partly/not done)	Details of Progress	Date done	Punctuality (+/- months)	Comments
(c) Implement the 1995 Code of Conduct for Responsible Fisheries, taking note of the special requirements of developing countries as noted in its article 5, and the relevant Food and Agriculture Organization of the United Nations (FAO) international plans of action and technical guidelines;	Partly	-	-	n/a	Progress assessment based on European Commission"s response to FAO 2004 questionnaire on Code of Conduct Implementation. Full evaluation beyond the scope of this report[39].

Action	Extent of Progress (fully/partly/not done)	Details of Progress	Date done	Punctuality (+/- months)	Comments
(d) Urgently develop and implement national and, where appropriate, regional plans of action, to put into effect the FAO international plans of action, in particular the international plan of action for the management of fishing capacity by 2005 and the international plan of action to prevent, deter and eliminate illegal, unreported and unregulated fishing by 2004. Establish effective monitoring, reporting and enforcement, and control of fishing vessels, including by flag States, to further the international plan of action to prevent, deter and eliminate illegal, unreported and unregulated fishing;	Partly	Community Action Plans to manage fishing capacity, manage sharks and protect seabirds not developed (see above). Community IUU Action Plan adopted	n/a May 2002	n/a	Given continuing level of IUU fishing by EU vessels (e.g.Greenpeace, 2006; EJF, 2005[40]), implementation of IUU plan questionable.

Action	Extent of Progress (fully/partly/not done)	Details of Progress	Date done	Punctuality (+/- months)	Comments
(e) Encourage relevant regional fisheries management organizations and arrangements to give due consideration to the rights, duties and interests of coastal States and the special requirements of developing States when addressing the issue of the allocation of share of fishery resources for straddling stocks and highly migratory fish stocks, mindful of the provisions of the United Nations Convention on the Law of the Sea and the Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, on the high seas and within exclusive economic zones;	Partly	Commission Communication adopted "on an Integrated Framework for Fisheries Partnership Agreements with Third Countries" (COM(2002)637) Council Conclusions on Partnership Agreements July 2004, recalling inter alia, that the Community must: "facilitate the integration of developing coastal States into the global economy, (…) by promoting fair conditions of employment, (…) by encouraging the creation of an environment that is favourable to private investment and to the development of a dynamic, viable and competitive private sector, notably by a framework supporting European investments and the transfer of technology and vessels"	23 December 2002 July 2004	n/a	While Policy Guidelines are in place together with political commitments, the question becomes how well these are implemented. Some FPAs now in place. Financial compensation remains linked to access levels. Full evaluation against this target requires assessment of agreements and EU positions within relevant RFMO quota negotiations (e.g. IOTC), which is beyond the scope of this work.

Action	Extent of Progress (fully/partly/not done)	Details of Progress	Date done	Punctuality (+/- months)	Comments
(f) Eliminate subsidies that contribute to illegal, unreported and unregulated fishing and to over-capacity, while completing the efforts undertaken at WTO to clarify and improve its disciplines on fisheries subsidies, taking into account the importance of this sector to developing countries;	Partly	See IUU Community Action plan above. Evidence that Italy provides subsidies to vessels operating illegal drift nets)[41]	-	n/a	
(g) Strengthen donor coordination and partnerships between international financial institutions, bilateral agencies and other relevant stakeholders to enable developing countries, in particular the least developed countries and small island developing States and countries with economies in transition, to develop their national, regional and subregional capacities for infrastructure and integrated management and the sustainable use of fisheries;	?	?	-	n/a	Beyond scope of this report

Action	Extent of Progress (fully/partly/not done)	Details of Progress	Date done	Punctuality (+/- months)	Comments
(h) Support the sustainable development of aquaculture, including small-scale aquaculture, given its growing importance for food security and economic development.	Partly	See Strategy for the sustainable development of European Aquaculture above	-	n/a	-

2.30.3 Evaluation and interpretation

The EU has failed to meet a quarter of its own set targets, while the remaining three quarters have been met or are being worked towards. Progress is notably poorest in:

- addressing discards through technical measures;
- implementing Community Action Plans to manage sharks and protect seabirds;
- development of Principles and guidelines and a legal framework for environmental integration in the sector of aquaculture; and
- further fulfilment of the Habitats and Birds Directives.

Most progress was made in meeting the targets relating to:

- consulting stakeholders on environmental initiatives;
- adopting a strategy for distant water fisheries;
- participating in international fora to improve understanding of marine ecosystems; and
- reviewing whether the data collection Regulation should cover the relationship between fisheries and aquaculture with the environment

None of the eight WSSD commitments have been fully met by the EU, although it is worth noting that it is too early to judge against the first commitment because the deadline has not yet passed. Neither is it possible to determine the average punctuality of reaching each target. This is not to say that no progress has been made, but rather that they have only been partly met.

In assessing this indicator as a means of evaluating the performance of policy makers, most of the data are available, although not always readily. While the exercise of assessing progress against the targets, and hence quantifying the indicator, is largely desk based it requires prior knowledge and expertise of the issues and policy processes. As a desk exercise however, it is relatively inexpensive.

Most of the targets are straight forward to assess. However, measurement is to some extent qualitative and subjective. This makes comparison between years difficult. This is addressed by the assessment of the extent of progress and punctuality, which enables qualitative analysis. Room is then left for justifying these assessments and making additional comments.

Perhaps the main question of this indicator is the targets against which the EU is being assessed. As noted, the WSSD targets pose the problem that they are not very specific. Common to both groups of targets is the issue of whether the targets themselves are demanding enough to determine whether policy makers are performing sufficiently. This is both a technical and, perhaps more so, a political issue.

The EU Action plan was devised by the European Commission. Given that the Commission proposes all EU policy, and that many of the targets relate specifically to the Commission, it is to a large extent setting standards against which it will be tested. It could be argued that a preferable approach may be for the targets to be set more independently. How this could work in practice is difficult to envisage however, given that the targets are part of an official Community Action Plan, developed by the Commission and endorsed by the Council and Parliament. A counter to this issue is that stakeholders contributed through the Advisory Committee for Fisheries and Aquaculture (ACFA) and the international WSSD targets were also used to evaluated EU progress.

While it is useful to routinely revaluate progress against each of the targets, and so build up a time series of progress, it can at some point be expected that the targets will be revised to accommodate new issues. Indeed, there is a need to revisit the targets in order to keep the analysis and conclusions meaningful. This inadvertently means that comparing progress between existing and future targets will become more difficult.

A final point common to all of the targets is that they are not in any way weighted. The state of progress for each was treated equally. This is despite the fact the some of the targets are arguably more important than others. The development of a robust framework for the management of fishing capacity for example is arguably more important than developing the ecosystem based approach when fishing capacity is a key driver of overfishing and the ecosystem based approach is less tangible and the benefits less obvious or immediate.

2.30.4 Recommendations

The evaluation of progress in implementing the Community Action Plan and meeting the WSSD targets is a useful "auditing" exercise. It highlights the different levels of progress in the different areas. However, this exercise does not qualify as a good indicator, therefore it is not recommended that it be used as such. However, the Commission should consider commissioning the exercise on a routine basis by an independent evaluator to gauge progress. To maximise the meaningfulness of such an exercise, progress towards the existing Community Action Plan should be determined, but more importantly, the Action Plan should be revisited by the Commission to establish new targets. Progress towards the WSSD targets is also important, but to be of any value requires more resources to ensure meaningful evaluations.

2.31 Proportion of landings covered by catch plans

The indicator "Proportion of landings covered by catch plans" did not occur on the original list of potential indicators that passed through STECF. In the revised CFP there is no mentioning of "catch plans" but there is the mentioning of "recovery plans" and "management plans".

One important challenge for the new CFP is establishing a fixed and stable system with the relevant variables and parameters to make the science-based management operable. Recovery and management plans will set long-term standards, targets and other parameters in a legally binding format. These will guide, and to a large extent tie, the Commission's future work in preparing the proposals for annual quotas, based on the inputs given in the scientific advice – and consequently also the Council's decisions. With sound recovery and management plans and good scientific advice, it is to be hoped that with these measures the practice of – political "horse trading" over TACs and quotas in the Council will come to an end.

According to the CFP, the difference between recovery and management plans is that recovery plans should be developed for already overfished stocks and management plans for other stocks.
At its meeting in December 2003, the Council adopted the Commission recovery plan for the following stocks:

- Kattegat cod,
- Skagerrak, North Sea cod
- Eastern Channel cod,
- Cod west of Scotland,
- Cod in the Irish Sea,
- Northern hake

and more recovery plans are planned for the following stocks:

- Baltic cod
- Hake in VIIIc and IXa
- Nephrops in VIIIc and IXa
- Bay of Biscay sole
- Western Channel sole
- North Sea plaice
- North Sea haddock,
- North Sea whiting
- North Sea saithe
- Celtic Sea cod
- Celtic Sea plaice
- Celtic Sea whiting

According to the scientific advice, these stocks are in danger of collapse. Control of fishing effort, effectively limiting the days that vessels spend at sea, is a central pillar in this recovery plan, in combination with reinforced inspection and control measures.
At present it is unclear what the status is of the management plans that are supposed to be developed for all other stocks.

Considering that only recovery plans apply to overfished stocks (or to be consistent with indicator 1: stocks outside safe biological limits), while management plans cover all the remaining stocks, the indicators should be: "Proportion of landings covered by recovery plans".

2.31.1 Material and methods

Landings data are being collected as part of the EU data collection regulation. However, at present these data for all member states are not readily available to the scientific community. If these were available it would be possible to weight each stock with the amount of landings in a particular region and calculate the proportion of landings of stocks covered by recovery plans.

2.31.2 Discussion

As an indicator for Market measures the indicator does show to what extent the market drives the exploitation of stocks outside safe biological limits. However, the value of this indicator is largely driven by which stocks are considered outside safe biological limits and therefore becomes more of an indicator of the ecological status of the commercial stocks and thus a conservation measures indicator. The indicator "Percentage of the total catches taken from stocks considered to be outside 'safe biological limits'" is already quantified (see http://epp.eurostat.cec.eu.int) for all EU Member States and stocks for which ICES provides management advice to the Community. The data cover the fishing areas of the Northeast Atlantic which are managed autonomously or jointly by the EU. Here, however, the indicator is considered a structural indicator.

For a conservation or structural measure indicator it has considerable problems as it is difficult to interpret the signal the indicator provides. A decrease of the indicator can be the result of a reduction of the landings of the stocks part of recovery plans through management measures that reduced fishing pressure (i.e. a sign of effective management that in time should result in the recovery of the stock) but also by a higher proportion of discarding (e.g. due to a higher proportion of small fish in the stock) or a further decrease in abundance of the stocks, which are both the sign of a further deterioration of the ecological status of the stocks. As a conservation measure indicator the "proportion of stocks within safe biological limits" is not only a more straightforward indicator but also less prone to conveying an ambiguous signal and hence should be preferred.

As an indicator for market measures the above considerations may not apply but one concern remains, i.e. this indicator is sensitive to bias through misreporting. Because of their recovery plan status and hence relatively low amounts of landings, misreporting of landings (e.g. reporting it as Baltic Sea cod or Celtic Sea cod instead of Kattegat/Skagerrak/North Sea cod) will result in an underestimation of the value of the indicator.

2.31.3 Recommendation

This indicator may have potential as a market measure indicator providing high quality international landings data become available and the following concerns are addressed:

- The decision that a particular stock should fall under a recovery plan should be based on clear and unambiguous criteria (e.g. comparable to the definition of "within safe biological limits", see section 2.1)
- The time-series of the indicator should not be affected by changes in the suite of stocks that fall under recovery plans

In practice the indicator "Percentage of the total catches taken from stocks considered to be outside 'safe biological limits'" could be used. However, the problems with the interpretation of trends remain.

2.32 Number of infringements

This indicator was selected, together with indicator 27, to answer the question of whether stewardship of stakeholders is increasing.

2.32.1 Material & methods

For the secondary indicator, and as with indicator [25], the Commission"s annual serious infringements reports were the main data source. It should be noted that this indicator was added by the Commission after the STECF process of reviewing the indicators. The indicator originally read "number of violations", but this was changed to "number of infringements" for consistency purposes with indicator [25] (number of infringements over the number of inspections).

2.32.2 Results

The Commission's annual serious infringements reports contain extensive data on the number of infringements in relation to the serious infringements defined in Regulation 1447/1999. Data for the years 2000-2003 are presented by Member State for each type of serious infringement in Table 2.32.1 and Table 2.32.2. Information is only available for the 15 old Member States.

The proposed indicator is further developed in Table 2.32.3 where the number of infringements over the number of vessels is presented, to provide an insight into which Member States fishing industry is committing the most offences per vessels. This suggests that Belgium is the worst offender of the Member States, with offences in Spain and Italy also being above average.

Table 2.32.1 Number of cases discovered by type of infringement and by Member State 2000-2003

		A1	A2	B1	C1	C2	C3	D1	D2	D3	D4	D5	D6	D7	E1	E2	E3	E4	F1	F2	DA	Total
BEL	2003	0	0	0	0	0	4	15	0	0	0	3	4	0	32	0	0	0	0	1	0	**59**
	2002	0			1		8	7				9			21	33					0	**79**
	2001	7					4	12				21			11	1					0	**56**
	2000	2					9	8				7			23						19	**68**
DDK	2003	68	1	1	8	0	0	37	12	0	54	13	54	0	220	0	0	0	1	16	0	**485**
	2002	2	3 3	1 1	12	1		95	4		33	13	69		183	22	2		7	15		**458**
	2001	2			3	2		93			4	19	42		202				11	3		**381**
	2000	2			13			59			5	9	21		68				12	3		**192**
DEU	2003	0	0	0	10	0	0	6	0	0	1	0	8	0	103	0	0	0	0	0	0	**128**
	2002				21		2	8			6	2	16		56	0	7			0		**118**
	2001	1			15			6			2	6	7		83	0	0			0		**120**
	2000				22			6			2	2	12		53	1	3			1		**102**
GRC	2003	0	0	0	114	2	7	0	443	0	0	105	86	0	0	0	0	0	0	9	0	**766**
	2002				138	3	6	3	648	1	1	154	52		0					15		**1021**
	2001				23	1	5	16	72		0	178	59		0					10		**364**
	2000				40		10	51	108		1	150	19		1					5		**385**

		A1	A2	B1	C1	C2	C3	D1	D2	D3	D4	D5	D6	D7	E1	E2	E3	E4	F1	F2	DA	Total
ESP	2003	59	4	1	677	37	45	61	197	9	20	674	259	2	293	69	0	0	202	549	0	**3158**
	2002	36		0	445	32	28	16	122	2	3	375	61	0	344	94	0	0	227	0	0	**1785**
	2001	133	3	3	1 226	3	9	54	88	1	178	684	347	4	164	11	40	1	155	607	6	**2491**
	2000	150		3	1196		29	62	106	4	150	798	312	1	172	6	55	22	76	81	88	**3311**
FRA	2003	27	0	0	42	0	11	132	5	11	32	99	101	1	93	0	12	0	7	23	0	**596**
	2002	15			7	0	1	18	3	4	26	21	88		37	1	38		6	23		**288**
	2001	14			16	0	0	27	3	7	17	36	73		104		24		16	35		**372**
	2000	29			18	2	2	31	1	5	20	36	67		64		58		2	7		**342**
IRL	2003	6	1	0	10	0	1	3	0	0	26	8	1	0	41	0	3	0	0	0	3	**103**
	2002	1			3		1	1			2	3			13				2			**26**
	2001	4	1111		4		1	4			13	4			23	1	4		4			**1173**
	2000				7		1	1	8		6	1			19							**43**
ITA	2003	11	0	0	230	1	12	205	130	2	17	771	135	1	63	0	28	0	3	571	389	**2569**
	2002	1		1	156	6	3	143	31	5	24	479	84		1		4		0	136	0	**1074**
	2001	1			209	0	34	213	80	11	39	669	86		17		13		2	228	26	**1628**
	2000			1	155	1	8	195	78	1	47	450	57		40		1		3	33	35	**1105**
LUX	2003																					**0**
	2002																					**0**
	2001																					**0**
	2000																					**0**
DLD	2003	1	0	0	0	0	6	21	2	1	0	1	27	0	38	0	0	0	17	10	0	**124**
	2002					0		15	10			4	31	2	49				11	0		**122**
	2001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
AUT	2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	2002																		0	0		**0**
	2001																			1		**1**
	2000																			1		**1**
PRT	2003	0	0	0	520	0	56	187	137	2	2	368	17	0	6	0	0	0	8	0	13	**1316**
	2002		0		420		21	217	66	0	3	357	135		35	1			120	199	5	**1579**
	2001		5	1	241		19	190	134	2	14	410	27		15				6	52	2	**1118**
	2000		1		442		41	155	75	8	8	494	32		33					31		**1320**
FID	2003	0	0	0	1	0	0	1	0	0	0	4	0	0	3	1	0	0	0	0	0	**10**
	2002														2				0			**2**
	2001							1				6			5							**12**
	2000																					**0**
SWE	2003	0	0	0	15	0	0	3	0	0	10	34	3	0	17	0	8	4	3	0	0	**97**
	2002	5			55			0	1		8	13	0		27		6	6	3	1		**125**
	2001				10				3		1	6	4		7		6	6	1			**44**
	2000				25			2			3	22	5		8		4	19	7			**95**
GBR	2003	1	0	0	2	0	0	8	9	0	3	2	7	0	52	4	0	0	2	1	0	**91**
	2002	4			0			6	2		9	2	4		89	6	3					**125**
	2001	6			6			12	2		6	6	8		46	2	0		2			**96**
	2000	2			4			24	2		15	6	15		76	5	6					**155**

Table 2.32.2 Number of cases discovered by nationality of the party which committed the infringement and by Member State

	National				Unspecified				Third country				EU				Total			
	2003	**2002**	**2001**	**2000**	**2003**	**2002**	**2001**	**2000**	**2003**	**2002**	**2001**	**2000**	**2003**	**2002**	**2001**	**2000**	**2003**	**2002**	**2001**	**2000**
BEL	23	24	32	49	36	19	4	8				0		6	20	11	59	49	56	68
DNK	469	415	355	153				0	3	1	11	4	13	26	15	6	485	442	381	163
DEU	128	118	109	86				0			0	3	0		11	9	128	118	120	98
GRC	756	1018	361	383				0	0		1	1	10	3	2	0	766	1021	364	384
ESP	2861	1295	3 662	0	84	271	111	0	18	34	19	0	195	185	255	0	3158	1785	3 717	0
FRA	544	222	294	0	5		0	0	0		0	0	47	59	78	0	596	288	372	0
IRL	82	20	48	24				0	0		0	1	21	6	15	18	103	26	63	43
ITA	2569	1072	1 594	0		2	33	0	0	0	1	0		0	0	0	2569	1074	1 628	0
LUX	0	0	0	0	0		0	0	0		0	0			0	0			0	0
NLD	96	103	128	0	0		0	0	0		0	0	28	21	39	0	124	122	167	0
AUT	0			0	0		1	1	0			0	0			0	0	0	1	1
PRT	1238	1560	1 078	1140	6	0	13	1		2		0	72	17	27	150	1316	1579	1 118	1291
FIN	10	2	12	1	0			0		0	0	0	0			0	10	2	12	1
SWE	82	108	33	66	2	1		0	11	10	8	21	2	6	3	1	97	125	44	88
GBR	0	0	71	30	91	125		0	0	0	0	3	0	0	25	14	91	125	96	47
	8858	5955	7 777	1932	224	425	62	10	32	47	40	33	388	329	260	209	**9502**	**6756**	**8 139**	**2184**

Table 2.32.3 Number of infringements detected per vessel by Member State, 2001-2003

	Number of vessels			Serious infringements			Infringements/vessel numbers		
Member State	**2003**	**2002**	**2001**	**2003**	**2002**	**2001**	**2003**	**2002**	**2001**
Belgium	126	129	130	59	49	56	0.5	0.4	0.4
Denmark	3552	3726	4046	485	442	381	0.1	0.1	0.1
Germany	2192	2240	2191	128	118	120	0.1	0.1	0.1
Greece	18979	19523	20138	766	1021	364	0.0	0.1	0.0
Spain	14397	14817	15386	3158	1785	3717	0.2	0.1	0.2
France	8047	8082	7932	596	288	372	0.1	0.0	0.0
Ireland	1490	1437	1061	103	26	63	0.1	0.0	0.1
Italy	15639	16069	16491	2569	1074	1628	0.2	0.1	0.1
Netherlands	949	952	599	124	122	167	0.1	0.1	0.3
Portugal	10313	10427	10514	1316	1579	1118	0.1	0.2	0.1
Finland	3420	3544	3610	10	2	12	0.0	0.0	0.0
Sweden	1692	1840	1845	97	125	44	0.1	0.1	0.0
United Kingdom	7279	7556	7519	91	125	96	0.0	0.0	0.0
TOTAL	**88075**	**90342**	**91462**	**9502**	**6756**	**8138**	**0.1**	**0.1**	**0.1**

As with indicator 23 (section 2.26.4), four types of infringements that may closely represent environmental infringements were focused on in an attempt to provide further insight to the extensive results:

D1: Using or keeping on board prohibited fishing gear;
D2: Using prohibited fishing methods;
D3: Not lashing or stowing prohibited fishing gear; and
D5: Unauthorised fishing in a given zone and/or during a specific period

Of these four infringements, “Unauthorised fishing” was by far the most frequent offence, with very few cases of “Not lashing or stowing prohibited fishing gear” (Figure 2.32.1). There appears to be no trend in the level of infringements, although the number of cases of “Using prohibited fishing methods” more than doubled over the four year period.

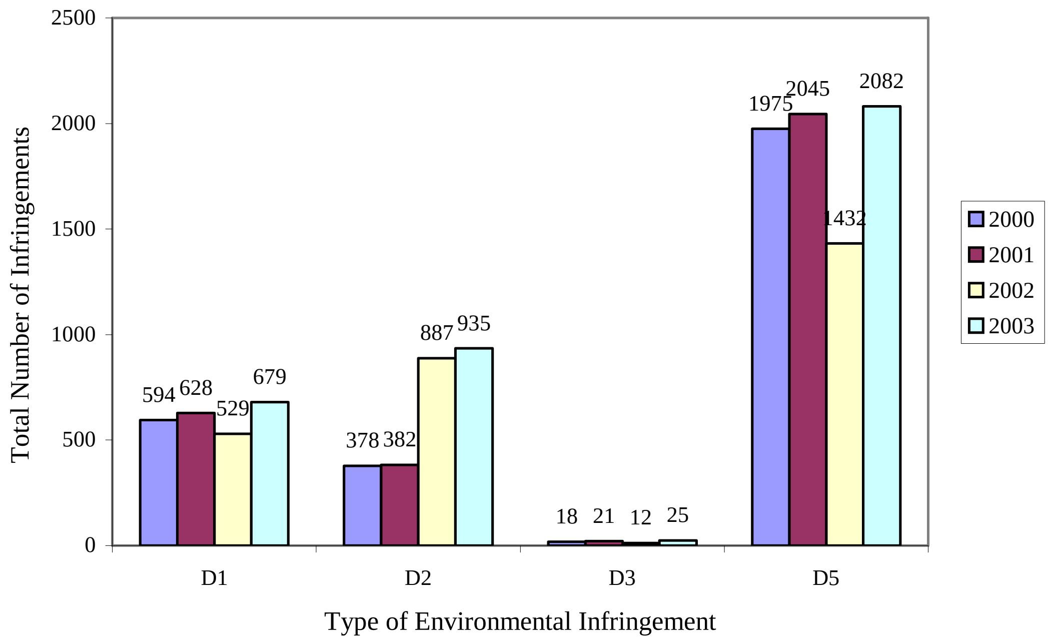

Figure 2.32.1 Total number of infringements by type of environmental infringement

As with the levels of fines indicator, in attempt to develop a simpler indicator that encapsulates much of the preceding analysis, a ratio was calculated of the average number of environmental infringements over the average number of all infringements (Figure 2.32.2). The closer this figure comes to one, the closer that such infringements are committed on an equal basis. As it falls below one, this suggests that the number of environmental infringements are below average, and conversely as it climbs above one then they are above average. As a proportion of infringements, the number of environmental infringements appears to have remained fairly constant at a level twice as high as other infringements.

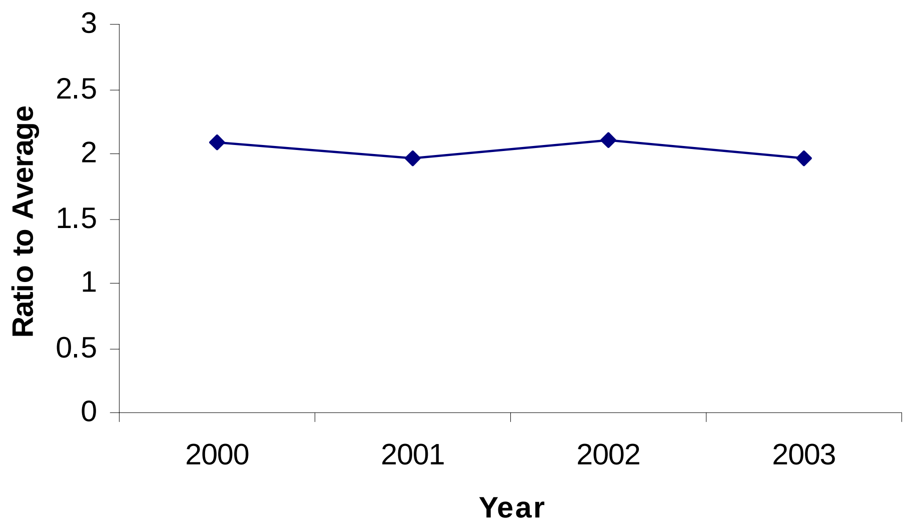

Figure 2.32.2 Fines for environmental infringements in relation to average fines

2.32.3 Evaluation and interpretation

Indicator 32 was added by the Commission to the indicator list developed by STECF. Assuming that inspection is efficient, this would indeed be a good indicator of industry attitudes towards the CFP and the degree of resource stewardship. However, this assumption does not hold true. This point is made by the Commission in the 2005 annual serious infringements report (COM(2005)207), together with a number of other data limitations:

- some reported infringements may include recreational fishing and other fishing activities not covered by the CFP;
- the accuracy of data collected varies greatly between and within Member State; and
- Member States may not always use the correct infringement codes or report accurately.

While the data used from the annual serious infringements reports is the best available, it does not identify infringements that may relate specifically to the breaking of environmental regulations. Furthermore, the calculation of infringements per vessel (Table 2.32.2) is not an accurate reflection of Member State performance as some infringements to not relate to fishing activities.

Despite the data limitations, the indicator is easy to understand and a reflection of industry stewardship. The limitations are also likely to remain reasonably consistent, at least in the short term, so that the performance of individual Member States can be monitored over time.

Bearing in mind the data limitations, Belgium appears to be the worst offender of the Member States, with offences in Spain and Italy also being above average. The number of infringements has increased significantly since 2000 (Table 2.32.1 and Table 2.32.2), suggesting that stewardship is decreasing. However recalling that the assumption that inspection is efficient is unlikely to be true, this trend should be interpreted with caution. Indeed, as enforcement systems receive increasing attention from Member States and the Commission, improving efficiency is likely to be a major factor in this increase in detected infringements.

2.32.4 Recommendations

The recommendations for this indicator are similar to those for indicator 23 on level of imposition of punishment (section 2.26.4). Despite the various limitations of the indicator, it is recommended that the Commission use this indicator since it provides a relatively cheap and quick oversight of the level of industry stewardship. However, for more meaningful results to be drawn it is necessary for data collection and the analysis be conducted over a long time period.

The indicator could be made more useful by including an environmental infringement in the serious infringements Regulation list, such as “fishing in protected areas”. The Commission should consider such an expansion of the serious infringements Regulation list.

3 Synthesis and conclusions

3.1 Final evaluation

For the final evaluation of the indicators we chose to evaluate them against a set of screening criteria. Rice & Rochet (2005) published a framework for selecting a suite of indicators for fisheries management. In this framework they use nine screening criteria:

1. Concreteness,
2. Theoretical basis,
3. Public awareness,
4. **Cost,**
5. **Measurement,**
6. **Historical data,**
7. Sensitivity,
8. Responsiveness and
9. Specificity.

As the main objective of INDENT was to “attribute numerical values” to each of the indicators and “determine gaps in data or information” we focused on the criterion of “Historical data” while considering also “Cost” and “Measurement” (as in bold above). Therefore only for “Historical data” we tested the indicators against all sub-criteria. For “Cost” there was only one criterion and for “Measurement” we provided qualitative scorings on the two main aspects of measurement, i.e. bias and variance. The sub-criteria for “Historical data” are:

- Necessary data are available for: periods of several decades (H) to only relatively recent period (M), to opportunistic or none available (L)
- Necessary data are: from the full area of interest (H), to restricted but consistent sampling sites (Moderate), to opportunistic and inconsistent sources, or none (L)
- Necessary data have high contrast, including periods of harm and recovery (H), to high contrast but without known periods of harm and recovery (M), to uninformative about the range of variation expected (Low)
- The quality of the data and archiving is known and good (H), to data scattered with reliability but not systematically certified, and archives not maintained (L)
- Data sets are freely available to research community (H), to private or commercial holdings (L)

For “Cost” we modified the scoring of Rice & Rochet (2005) so that high costs, scored “H” and low costs “L” and allowed “M” as in between. This was so that the scoring results were more logical to the reader:

- Uses measurement tools that are widely available and inexpensive to use (L), to needs new, costly, dedicated, and complex instrumentation (H)

In our analysis we made the distinction between fixed and marginal costs as in most cases the indicators can be calculated at only little additional expense (marginal costs) from e.g. monitoring data or assessment results that are collected at considerably higher expenses (fixed costs) in support of existing services. However, as most of the indicators presented in this report are based on data from existing data collection programs only the marginal costs apply and were therefore scored.

Rice & Rochet (2005) suggested the following sub-criteria for "Measurement":

- Can variance and bias of IND be estimated? Yes (H); No (L)
- If variance can be estimated, is variance low (H) to high (L)
- If bias can be estimated, is bias low (H) to high (L)?
- If IND is biased, is direction usually towards overestimating risk (H), or towards underestimating risk (L)
- If both can be estimated, have variance and bias been consistent over time (H), or have they varied substantially (L)
- Probability that IND value exceeds reference point can be estimated with accuracy and precision (H), to coarsely or not at all (L)
- IND measured using tools with known accuracy and precision (H), to unknown or poor/inconsistent (L)
- Value obtained for indicator unaffected by sampling gear (H), to sampling methods can be calibrated (M), to calibration difficult or not done (L)
- Seasonal variation unlikely or highly systematic (H) to irregular (L)
- Geographic variation irrelevant or stable and well quantified (H), through random (M) to systematic on scales inconsistent with feasible sampling (L)
- Taxonomic representivity: IND reflects status of all taxa sampled/modelled (High), through ecologically predictable subset of species (M), to only specific species with no identifiable pattern of representivity (L)

For a proper evaluation against the "Measurement" sub-criteria much more information is required and statistical tests (e.g. power analyses) need to be applied. This was beyond the Terms of Reference and resources available to the project therefore we concentrated on providing a qualitative scoring on the two main aspects of measurement, i.e. bias and variance for those indicators for which a time-series was available.

As the indicators are supposed to be used in a regional context we distinguished between data sources that only allow the indicator to be quantified at the EU level or also at the regional level (see section 1.4). For those indicators that we had the information to do the evaluation by region, we indicated the region for which the evaluation applied. The North-East Atlantic may be based on studies in the North Sea, Irish Sea or Celtic Sea or based on data of the Netherlands or UK fleet. The Mediterranean includes studies in sub-areas like Balearic waters, Sardinian waters or the Cyclades. If the analysis was based on

EU statistics without regional specification, EU was indicated. This does not necessarily imply that regional specification was not possible with those data.

For most of the historical data sub-criteria, the scoring was relatively straightforward and with enough guidance in the Rice & Rochet (2005) paper. For the "contrast" sub-criterion this was less straightforward and to a considerable extent directly related to the length of the time-series in the region. For example, for any of the conservation measure indicators any period that includes the harm and recovery of an ecosystem component important enough to be relevant for one of these indicators will also affect the other indicators. Moreover, any time series covering a period of several decades will show considerable contrast in any of the EU regions as this was probably the period with the highest increase in exploitation rates. A period of about a decade will show considerable contrast in terms of the effects of climate change but this may not be representative for the (near) future. As such our scoring of "contrast" was usually equal to, or just below that of "period" and as such this sub-criterion does not provide any additional information and at least for the indicators and regions that we evaluated was considered redundant.

Below are more detailed explanations of the approach and the scorings. First we address each of the policy areas (i.e. conservation, structural, market, horizontal) in general followed by a more detailed discussion of each of the individual indicators within those areas. Finally we describe the process that has lead to the characterization of the indicators into the following four classes:

1. Informative indicators which can be made operational with little or no additional effort
2. Informative indicators which require further development before they can be made operational
3. Potentially informative indicators which require further development prior to re-evaluation
4. Indicators which are not informative or redundant

It is important to realize that the scoring of indicators was only against those criteria that were considered within the remit of INDENT. This does not imply that the "best" indicators from this selection process will also perform well against the other criteria. This could be done in another exercise.

Table 3.1. Evaluation of the indicators against the Rice & Rochet (2005) screening criteria; For region the following codes were used: North East Atlantic (NEA), Mediterranean (MED) or European Community (EU). For indicator 13: a=capacity, b=effort, c=frequency based on EU logbooks and d=frequency based on VMS. For indicator 27: a=publications, b=press, c=collaboration with fishing industry and d=stakeholder questionnaire.

Indicator	Region	Period	Area	Quality	Available	Cost	Measurement
1	NEA	H	H	H	H	L	H
1	MED	L	M	M	H	L	M/L
2	NEA	H	H	H	H	L	H/M
3	NEA	H	H	H	H	L	H/M
3	MED*	M	M	M	H	L	L
4	NEA	H	H	H	H	L	H/M
4	MED*	M	M	M	H	L	L
5	NEA	H	H	H	H	L	H/M
5	MED*	M	M	M	H	L	L
6	NEA	H	H	H	H	L	H/M
6	MED*	M	M	M	H	L	L
7	NEA	M/L	M/L	M	H	M	L
7	MED	L	M	M	H	L	
8	NEA	L	L	L	L	H	L
8	MED	L	L	L	L	H	
9	EU	H	H	H	H	L	
10	EU	H	H	H	H	L	
11	EU	H	H	H	H	L	
12	EU		L	L	L	H	
13a	NEA	H	H	M/L	H	L	L
13b	NEA	M	H	H	L	L	L
13c	NEA	M	H	H	L	L	M
13d	NEA	M/L	H	L	L	H	L
14	EU						
15	NEA	M	M/L	L/M	H	L	M
16							
17	NEA	M	M	M	H	L	H
18	NEA	M	M/L	M	L	H	L
19							L
20							
21	EU	H	H	H	H	L	
22	EU	H	H	H	H	L	
23							
24	EU	L	H	H	H	L	L
25	EU	L	M	L	H	L	L
26	EU	L	M	M	H	L	M
27a	EU	M	H	L	H	M	L
27b	NEA	M	L	H	H	L	L
27c	NEA	M	L	L	L	M	L
27d	EU					L	L
28	EU	M	H	H	H	L	
29	EU	H	H	H	H	L	H
30						M/L	M
31							
32	EU	L	M	M	H	L	M

* for indicators 3-6 in the Mediterranean the scorings will probably change when based on the MEDITS survey

Conservation measures
Overall we thought that for most of these types of indicators the availability of historical data was adequate and could be quantified at relatively low marginal costs but with some concerns on bias and variability of the data. The scoring showed considerable differences between regions. Scorings for the North-East Atlantic region are markedly higher than for the Mediterranean.

For most of the conservation measure indicators we evaluated the indicators separately for the North-East Atlantic (in practice mostly based on North Sea, Irish Sea or Celtic Sea) and the Mediterranean. Although we did not address the Baltic Sea Region the scorings for most indicators will probably be comparable to those of the North-East Atlantic. For indicators 2-6 in the Mediterranean we only had access to the historical data for Greek national waters and therefore based our scorings on those. However, when the MEDITS survey data become available, at least the scoring for the Area and probably Period will increase. How this affects the scoring against other (sub-) criteria like Contrast, Quality and Measurement is uncertain.

Pertaining to the difference between regions in the scoring of "measurement", it should be noted that the Mediterranean region may be intrinsically more variable for at least the fish community indicators as the fish community in this region consists of smaller bodied species with more variable life-spans.

Indicators for which quantification is based on the same data-sources will show identical scorings. For example, indicators 2-6, are all based on Research Vessel (RV) surveys. These always provide survey-gear dependent values for the indicators and as such may cause bias. Lack of consistency over time in terms of e.g. the gear used, international partners involved, area covered etc. may increase the variation in the time-series, whereas an increase of sampling effort will reduce this. The latter, however, has consequences for the fixed costs.

Within the conservation measures the indicator trophic structure was thought to be redundant as it basically reflects changes in size structure or species composition that are also reflected in respectively indicators 3 and 5 (see table 2.1).

The individual Conservation measures indicators were evaluated as follows:

1 Proportion of commercial stocks that are within safe biological limits:
This indicator describes the status of commercial fish stocks. Data are available on a regional basis, can be made operational immediately in all regions except for the Mediterranean. Main measurement issue is probably bias in the final 2-3 years when the proportion within safe biological limits is overestimated.

2 Relative abundance of a set of populations that are not regularly assessed but which are decreasing in number.

This indicator describes the status of non-target species. Data are based on monitoring programs (e.g. trawl surveys) and can be made operational in all regions with such programs. Main measurement issues are variation caused by lack of consistency in sampling practices. The indicator is particularly sensitive to changes in distribution of the species if the monitoring program does not cover the whole area. Note that the values are specific for the monitoring program and the suite of species selected to calculate the indicator.

3 Average size (length and weight) in the community

This indicator describes the size structure of the fish community. Data are based on monitoring programs (e.g. trawl surveys) and can be made operational in all regions with such programs. Main measurement issues are variation caused by lack of consistency in sampling practices. Variation may be reduced by excluding the smaller species. Note that the values are specific for the monitoring program and the size-range included.

4 Mean trophic level

This indicator is supposed to provide information on the fish community but is considered redundant as it basically reflects changes in size structure or species composition that are described by other indicators

5 Mean maximum length

This indicator describes the species composition of the fish community. Data are based on monitoring programs (e.g. trawl surveys) and can be made operational in all regions with such programs. Main measurement issues are variation caused by lack of consistency in sampling practices and bias caused by changes in distribution of the species if the monitoring program does not cover whole area. Note that the values are specific for the monitoring program and the suite of species selected to calculate the indicator.

6 Biodiversity indicators

This indicator describes the species composition of the fish community. Data are based on monitoring programs (e.g. trawl surveys) and can be made operational in all regions with such programs. Main measurement issues are variation caused by lack of consistency in sampling practices. A problem with this indicator is that it is not understood how fishing affects it, which makes it difficult to interpret trends. The indicator is particularly sensitive to changes in sampling effort. Note that the values are specific for the monitoring program.

7 Trends in abundance of sensitive benthos species.

This indicator describes the species composition of the benthic community. Currently there are only few potentially useful monitoring programs (e.g. trawl surveys or grab samples) and the methodology to calculate the indicator is not fully developed.

8 Area coverage of highly sensitive habitats.
Although this is considered a potentially informative indicator that describes the status of sensitive habitats, it is probably not feasible even in the longer term to initiate a regular monitoring program. Therefore we suggest this indicator should be dropped.

9 Total aquaculture production and total area occupied by aquaculture installations
This indicator describes the pressure of aquaculture on the environment. Data on aquaculture production are readily available and can be attributed to regions. The indicator can be made operational with relatively little additional development. Variation in this indicator may be due to changes in the countries included and bias may come from the suite of species used to calculate the indicator.

10 Effluent water quality
In order for this indicator to be informative more information is needed than is currently available. Therefore the suggestion is to re-evaluate the usefulness of this indicator when more information becomes available.

11 Eco-efficiency of aquaculture
This indicator is strongly linked with the previous indicator (10) and therefore the same evaluation applies.

12 Potential impact of aquaculture, and particularly on the impact of reared fish (such as salmon) escaping from fish farms, on the genetic structure of wild (fish) populations.
Although this is considered a potentially informative indicator that describes the pressure on wild fish stocks, the lack of information available necessitates re-evaluation when more data become available.

Structural measures
For these types of indicators we found that even though data are being collected more or less routinely, access to these data is often a problem. However, for most indicators there is methodology available that allows quantification when access to those data is achieved. For these indicators there are also issues of bias and variance that need to be resolved.

When using VMS data to quantify this indicator, bias will result in a lower scoring of “measurement” in the Mediterranean region because a markedly larger proportion of the fleet consists of vessels under 15 m in length, for which VMS is not mandatory.

Another issue that prevents quantification of indicators is that of definition. Even if the data exist that potentially could be used to quantify the indicator, it is unclear how to attribute these data to environmental friendly fishing practices or gears since no definitions exist for these categories, either in the scientific community or within EU policy. Moreover, even if a classification scheme for “environmental friendliness” of fishing practices or gears would exist, the characterization of fishing practices or gears (i.e. métiers) that are currently used in the fleet capacity or effort databases are not adequate.

When developing indicator 13 “Effective fishing capacity (adjusted fishing effort) and its spatial and temporal distribution” we established increasingly informative “Pressure” indicators that may affect the “State” indicators developed as part of the conservation measures and conclude that the ultimate measure of fishing pressure is the mortality or damage induced on an ecosystem component. This ecosystem component may be the commercial species, either discarded (indicator 18) or landed, the non-target and/or protected species (indicator 18) or the sensitive areas/habitats (indicator 15). Although the methodology to estimate this exists and is presented in the section of this indicator (2.13) and to some extent in the section 2.15, the data necessary are at present not available and would require considerable expenses to obtain as part of regular monitoring programs. A way forward that can be achieved with low marginal costs because it draws on existing data collection programs is to use a simulation model that provides output that addresses issues for which indicators 13, 15, 16 and 18 were suggested. For indicator 13 it would provide the ultimate measure of fishing pressure whereas fishing capacity or fishing effort are at best only proxies of the fishing impact. For indicator 15 it would be a measure of damage to the sensitive areas or habitats. For indicator 16 it would provide and objective measure of impact instead of an arbitrary characterization on whether or not the gear is “environmental friendly” (e.g. proportion mortality of ecosystem component(s) X caused by the gear). A necessity for developing these indicators either data based on a regular monitoring program or simulation modeling is a comprehensive characterization of the métiers present in a region and a consistent recording of their activity in each region. In general bias in the pressure indicators decreases with information content and spatial resolution.

The individual Structural measures indicators were evaluated as follows:

13 Effective fishing capacity (adjusted fishing effort) and its spatial and temporal distribution:

This is an informative indicator that describes the pressure of fishing on the ecosystem and its components. Data are collected nationally according to EU regulations but are not readily available for all international fleets. This applies for both effort based on logbooks and to a much larger extent based on VMS. The main measurement issue for the logbook data is probably bias due to misreporting, for VMS-based data bias through lack of representivity of the sample of the fleet for which VMS data are collected.

14 Structural support and proportion allocated to promote environmental friendly fishing practices.

Although potentially informative, usefulness of this indicator is hampered by the fact that “environmental friendly fishing practices“ are currently undefined and the areas of uptake of FIFG structural support is not sufficiently detailed at the Member State level. If these shortcomings can be resolved the indicator should be re-evaluated.

15 Mapping of effort distribution over the sensitive areas

This is the only potentially informative indicator of fishing impact on habitat. The main problem with this indicator is the lack of habitat maps as the spatial distribution of the fisheries is known from the VMS data. If these data become available and the VMS registrations can be translated into an area fished the indicator can be made operational.

16 Use of environmentally friendly gears

There is no scientific or EU legal/policy definition of environmentally friendly gears. Furthermore, the impact of gear depends on how it is employed e.g. duration, area, season. If this information is available it should be used to further develop indicator 13 to its highest level of information content which could make this indicator redundant.

17 Oil consumption as a proxy for CO2 production.

Several potentially useful indicators were identified and quantified for one specific fishery but these can only be made operational on a regional or EU-scale if data on oil consumption by the fishery become available. The choice of indicator also depends on the operational objectives for which the suggested indicators are expected to monitor progress. This indicator should therefore be re-evaluated after the data become available and operational objectives have been set.

18 Unwanted by-catches of protected species and discards

This indicator assesses the impact of fishing on non-target species. The indicator can not be made operational because of issues pertaining to the availability of data. Currently international data are not available, and for those data available the level of sampling of different fisheries is low thereby reducing the representivity. Even at relatively high levels of sampling it may still prove difficult to obtain sufficient data for protected or threatened and declining species as these are, by definition, rare and infrequently captured by any gear.

Market measures

Some of the indicators for market measures were difficult to quantify because data are not (yet) collected in a manner that allows quantification of an indicator. Moreover, it was felt that for most of the market measure indicators it was unclear towards which operational objectives the suggested indicators were expected to monitor progress. This needs to be resolved before the market measure indicators can be evaluated.

Some of the investigated market indicators give insight in the private initiatives that support the ecosystem approach of the CFP. Private initiatives, like certification, may become important in supporting the CFP. Because certification, like eco-labelling (Indicator 19), is a rather new phenomenon in fisheries, quantification of the indicator in a systematic manner is still difficult. This can be resolved if all existing and forthcoming eco-labelling initiatives are matched with the EU minimum requirements for eco-labelling (EU 2005).

The individual Market measures indicators were evaluated as follows:

19 Share of fish produced (or consumed) that are eco-labelled.
This indicator should be considered as two separate indicators. While eco-labelled EU fish *production* may give insight into the performance of the CFP, eco-labelled fish *consumption* only reflects consumer preferences.

20 Initiatives to support eco-labelling and use of eco-labels and similar awards
This is not a useful indicator because of difficulties in interpreting the results. A growing number of eco-labels may lead to consumer confusion, rather than illustrate a growing application of eco-labels in the EU

21 Amounts of fish taken out of the market and/or traded on secondary (intervention) conditions.
For this indicator it is unclear what environmental performance objectives could be met by these market interventions. Data for this indicator are available in Brussels as Member States are obliged to provide this information to DG fisheries. Time series can be produced relatively easy. The main objective of the market intervention system, however, is to stabilize fish prices and incomes of fishermen and is therefore not a useful indicator for the environmental performance.

22 Size of the European market for fish
Although for this indicator the data are available that allow the creation of time-series, it is unclear what environmental performance objectives could be met. As an indicator for change in stock pressure, an indicator of landings might be more appropriate.

23 Changes in consumer preferences in relation to environmental issues
This indicator may provide insight in the individual initiatives that support the ecosystem approach of the CFP but there are no data available. It would be advisable to collect data on an annual or bi-annual basis EU wide to build up time series if it is considered desirable to quantify this indicator.

31 Proportion of landings covered by catch plans
As there is no mentioning of catch plans in CFP the indicator was interpreted, and as such reworded, as “Proportion of landings covered by recovery plans”. This indicator may have potential as a market measure indicator providing high quality international landings data become available and strict criteria are used to determine which stocks fall under recovery plans. Large variation over time in the number of stocks that fall under recovery plans may however make the indicator unsuitable to assess to what extent the market drives the exploitation of stocks outside safe biological limits

Horizontal measures
In several cases the indicators for horizontal measures were difficult to quantify because often data are not collected in a suitable manner . Moreover, it was felt that for several of the horizontal measure indicators it was unclear towards which operational objectives the suggested indicators were expected to monitor progress. The indicators that were quantified were structured around three ‘policy questions’:

1. Are the structure and organisation of the fishery inspection sector supportive of environmental goals?
2. Is stewardship of stakeholders increasing
3. Is scientific understanding of complex environmental issues improving in research as well as in the integration of the scientific advice into the decision making process?

None of the indicators were considered satisfactory in answering the first question because of the lack of suitable data. The value of these indicators is therefore strongly questioned. The second question is notoriously difficult to quantify. However, a template for a stakeholder questionnaire was developed, and the Commission may wish to consider building on it. Finally, the third question was considered most valuable, in particular the second element. Data on the degree to which annual TAC decisions reflect ICES TAC advice is readily available, reliable and easily analysed. For all three questions, it is not immediately clear how they relate to the stated policy objectives of the CFP.

The individual Horizontal measures indicators were evaluated as follows:

24 Number of inspections per landing
This indicator provides little insight into whether the inspection sector supports environmental goals. Instead, it only provides an insight into Commission inspections generally because data on Member State inspections are not available. Indeed, it is not considered feasible to collect data on Member States enforcement of environmental regulations. It is therefore recommended that this indicator not be used for the purpose of illustrating the environmental performance of the inspection systems or the CFP more broadly. If the Commission considers this indicator to be valuable, it could be improved by requiring Commission inspectors to more specifically define the purpose of their inspections and whether they relate to enforcement of environmental measures.

25 Number of infringements over number of inspections.
As with indicator 24, the usefulness of this indicator is limited because data on Member State inspections are not available. Coupled with other limitations, the indicator provides little insight into whether the inspection sector supports environmental goals. Instead, it only provides an insight into Commission inspections generally. As it is not considered feasible to collect data on Member States enforcement generally, or of environmental infringements, it is recommended that this indicator should not be used for the purpose of

illustrating the environmental performance of the inspection systems or the CFP more broadly.

26 Level of imposition of punishment

This indicator provides a very general oversight of whether Member States enforcement systems are supportive of environmental goals. However, because it is relatively cheap and quick to quantify, already being routinely undertaken, it is recommended that the Commission retain it as an indicator of environmental performance. For more meaningful results to be drawn it is necessary for data collection and the analysis be conducted over a long time period. The indicator could be made more useful by including an environmental infringement in the serious infringements Regulation list. Indeed, doing this would provide further insight into the number of such infringements (see indicator 28), and could include fishing in protected areas. The Commission should consider such an expansion of the serious infringements Regulation list.

27 Attitudes and awareness of stakeholders towards CFP environmental goals

Four methodologies were tested in order to assess the attitudes and awareness of different stakeholder groups towards CFP environmental goals. The authors were unaware of any reliable and replicable information being available on this before this exercise was undertaken. The most reliable method was considered to be the administration of a questionnaire, although even this is subject to limitations and would require refinement depending on the target group to which it is administered.

28 Total quantity of funds allocated to relevant research and distribution of research funds

EU and Member State level research funds were analyzed to try and determine how the amount of money spend on environment related research has varied over time. At the Member State level this was not generally possible because of data availability and quality issues, making comparison within and between Member States over time impossible. This was also an issue at the EU level, although less so. There is scope for improving the situation at the EU level so that project types can be classified according to how they relate to the environment. If the Commission considers this a valuable indicator then a system of categorization and monitoring would need agreeing, perhaps based on what was used in this study.

29 Scientific advice in decision making

It is not possible to develop and quantify an indicator of the level of use of scientific advice into fisheries policies generally. However, it is possible to do this for the annual TACs that the Council agrees. The degree to which ICES advice on catch levels is reflected in decision making has already been developed and could be used in its current form, both cheaply and effectively. It is recommended that this indicator be adopted and used. It should also be scrutinised with a view to refining it, such as developing criteria for selecting which fisheries should be included. The indicator should also be consistent with indicator 1.

30 Policy makers performance

Evaluating the EUs' performance against the Community Action Plan and the WSSD targets is a useful 'auditing' exercise. It is therefore recommended that the Commission considers commissioning this on a regular basis. However, this exercise does not qualify as a good indicator. Therefore it is not recommended that it be included in the final suite of indicators.

32 Number of violations (assuming that inspection is efficient)

The recommendations for this indicator are similar to those for indicator 26 on level of imposition of punishment. Despite the various limitations of the indicator, it is recommended that the Commission use this indicator since it provides a relatively cheap and quick oversight of the level of industry stewardship. However, for more meaningful results to be drawn it is necessary for data collection and the analysis to be conducted over a longer time period. It should also be borne in mind that the assumption of efficient inspection does not hold true, therefore the result should be treated with caution. To improve the usefulness of the indicator an environmental infringement could be included in the serious infringements Regulation list, such as 'fishing in protected areas'.

Selection of indicators across policy areas

This section considers all indicators across the policy areas in order to determine indicators that are redundant because an indicator in another policy area may be more suited to monitor the progress towards that specific operational objective. Some examples are below:

- The conservation measure indicator "area coverage of highly sensitive habitats" (Indicator 8) was considered a potentially informative State indicator but not as part of a regular monitoring program since this will be much too costly and not applicable even in the medium term. Alternatively, it is possible to use the market measure indicator "Mapping of effort distribution over sensitive areas" (Indicator 15) which essentially is a measure of the Pressure exerted by the fishery on the sensitive areas/habitats.
- For the market measure indicator "Proportion of landings covered by catch plans" (Indicator 31) we suggested an alternative indicator "Proportion of landings of stocks outside safe biological limits" and this indicator does not provide much additional information to the indicator "Proportion of commercial stocks within safe biological limits" (Indicator 1): if more stocks are within safe biological limits the proportion of the landings of stock outside safe biological limits will decrease. The concern that "Proportion of landings covered by catch plans" conveys different information from the indicator "Proportion of landings of stocks outside safe biological limits" can be addressed by incorporating the indicator "Scientific advice in decision making" (Indicator 29) which displays the discrepancy between scientific advice and official policy. Depending on the status of a stock the advice will be a change in TAC or, if the stock is outside safe biological limits, a management or recovery plan. If scientific advice is fully implemented, indicator 29 will reflect this and the link between the status of the

stocks and the adoption of management or recovery plans is established. Thus the suggestion is that when indicators 1 and 29 are operational, indicator 31 becomes redundant.

- For several of the indicators (9 Total aquaculture production, 22 Size of the EU market for fish, 31 Proportion of landings) the same type of information is required i.e. that of the production or landings per fish species. Therefore this type of information should be available per Member State, per region and per year.

3.2 Selection of indicators

Based on the above considerations and according to the decision scheme in figure 3.1 we allocated the indicators into four categories depending on how informative they are to monitor the process of environmental integration of CFP and how easily they can be made operational (Table 3.2).

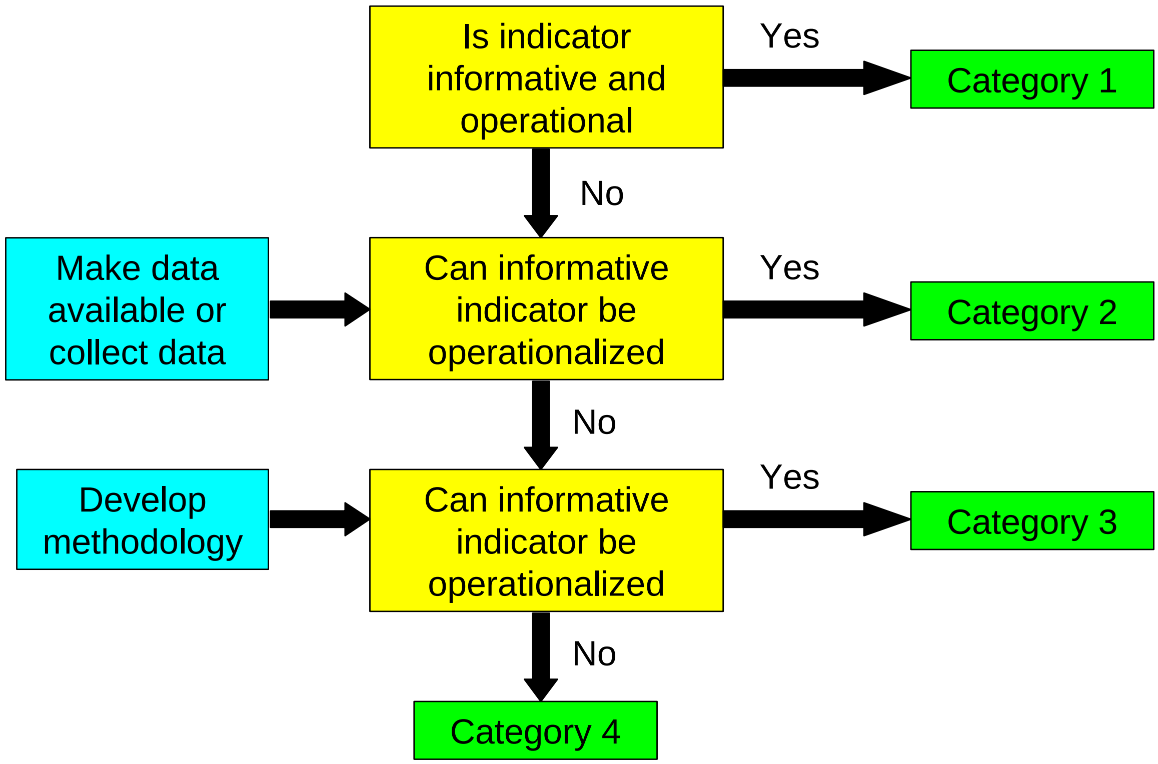

Figure 3.1. Decision scheme that has lead to the four categories of indicators. Explanation boxes: Yellow=decision criteria, blue=action needed, green=categories

Table 3.2. Evaluation categories of indicators. The decision scheme leading to these categories is explained in figure 3.1. For each indicator the policy area is indicated (C=Conservation measures, S=Structural measures, M=Market measures and H=Horizontal measures)

Category 1: Informative indicators which can be made operational with little or no additional effort		
C	**1**	Proportion of commercial stocks that are within safe biological limits
C	**2**	Relative abundance of a set of populations that are not regularly assessed but which are decreasing in number.
C	**3**	Average size (length and weight) in the community
C	**5**	Mean maximum length
C	**6**	Biodiversity indicators
C	**9**	Total aquaculture production and total area occupied by aquaculture installations
H	**29**	Scientific advice in decision making

Category 2: Informative indicators which require further development before they can be made operational		
C	**7**	Trends in abundance of sensitive benthos species.
S	**13**	Effective fishing capacity (adjusted fishing effort) and its spatial and temporal distribution
S	**15**	Mapping of effort distribution over the sensitive areas
S	**17**	Oil consumption as a proxy for CO2 production.
S	**18**	Unwanted by-catches of protected species and discards
H	**26**	Level of imposition of punishment
H	**27**	Attitudes and awareness of stakeholders towards CFP environmental goals
H	**28**	Total quantity of funds allocated to relevant research and distribution of research funds
H	**32**	Number of violations (assuming that inspection is efficient)

Category 3: Potentially informative indicators which require further development prior to re-evaluation		
C	**10**	Effluent water quality
C	**11**	Eco-efficiency of aquaculture
C	**12**	Potential impact of aquaculture, and particularly on the impact of reared fish (such as salmon) escaping from fish farms, on the genetic structure of wild (fish) populations.
S	**14**	Structural support and proportion allocated to promote environmental friendly fishing practices.
S	**16**	Use of environmentally friendly gears
M	**19**	Share of fish produced (or consumed) that are eco-labelled.
M	**22**	Size of the European market for fish
M	**23**	Changes in consumer preferences in relation to environmental issues
M	**31**	Proportion of landings covered by recovery plans

Category 4: Indicators which are not informative or redundant		
C	**4**	Mean trophic level
C	**8**	Area coverage of highly sensitive habitats.
M	**20**	Initiatives to support eco-labelling and use of eco-labels and similar awards
M	**21**	Amounts of fish taken out of the market and/or traded on secondary (intervention) conditions.
H	**24**	Number of inspections per landing
H	**25**	Number of infringements over number of inspections.
H	**30**	Policy makers performance

3.3 Interpretation of indicators

The progress of environmental integration can be monitored by interpreting the trends of the indicators. For this we chose to look at the category 1 and 2 indicators only.

All conservation indicators show the same pattern, that of an ecosystem that is not in a healthy state and further changing in a direction consistent with the expected effects of fishing. The indicator that describes the status of the commercial stocks (figure 2.1.2) shows that in most EU waters, most of the stocks are outside safe biological limits and have been for at least the past decade. The indicator that describes the status of the non-assessed species (figure 2.2.2) shows that, on average, all the non-assessed species in the North Sea could be considered threatened (as defined according to the IUCN criteria) from the late 1990s onwards. The size structure and the species composition of the fish community described by respectively the mean weight and mean maximum length of fish has deteriorated. Both mean weight and mean maximum length were shown to decrease in all EU waters over the entire time period for which the indicators were quantified. In the North Sea and Celtic Sea this was over the last two decades, in the Mediterranean this was over the last decade.

For the structural indicators on fishing applies that it is extremely difficult to obtain reliable international data of fishing pressure. The structural indicators of one specific métier of one Member State for which data were available (i.e. beam trawling by the Dutch fleet in the North Sea) show that even though fleet capacity and fishing effort seem to have decreased (figure 2.13.2), this has not resulted in a decrease of the impact on commercial species expressed as the fishing-induced mortality (figure 2.13.10). For another structural indicator (that was initially put forward as a conservation indicator), Total aquaculture production, data are readily available and they show that this has increased in European waters.

Most horizontal indicators were not sufficiently developed to make any inferences. The best and most informative horizontal indicator shows that the incorporation of scientific advice in decision making is poor and has not improved in the last decade (figure 2.29.2).

Altogether the above paints a grim picture that to a more or lesser extent applies to all European waters: the ecosystem is severely affected by fishing and shows no sign of improvement. One significant problem in the management of the fishery is the lack of reliable international data of fishing impact. To some extent the current situation of the ecosystem and the fishery may have emerged because scientific advice was insufficiently incorporated in decision making.

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Annex 1: Questionnaire

Knowledge and Attitudes of stakeholders to CFP environmental objectives

IEEP is undertaking research for the European Commission to estimate how well the Common Fisheries Policy (CFP) is performing in environmental terms. As part of this, we have developed this questionnaire to estimate the current Knowledge and Attitudes of stakeholders to CFP environmental objectives.

We would be very grateful if you could complete this form, and return it to Yee Chow at IEEP. None of the questions are compulsory. This includes your personal details, although we would appreciate it if you would complete as much as you are happy with in case we have follow up questions. All responses are confidential to the project team and were responses are used in reporting distinguishing data will not be including so that individuals will not be identifiable.

When the results have been compiled we will send those that have responded to the questionnaire a summary of the findings. If you have any questions or comments, please do not hesitate to contact IEEP:

Section 1: Your organisation and involvement in policy

1. What type of organisation do you work for/what job do you do?:

MEP advisor	☐
Environment NGO/interest group	☐
Development NGO/interest group	☐
Consumer NGO/interest group	☐
Fishing industry organisation	☐
Aquaculture industry organisation	☐
Processor/trader industry organisation	☐
Individual fishermen	☐
Individual fish farmer	☐
Individual processor/trader	☐
Other (please specify)	

2. Are you involved in national or European fisheries policy? Select Y or N

(eg responding to consultations, attending committee meetings such as RACs, ACFA, national groups)

Please answer the questions in the following sections by crossing ONE of the boxes using the following scale:

0 = Don't know
1 = Not at all
2 = Low
3 = Good
4 = High

Section 2: Specific CFP environmental objectives

The environmental objectives of the CFP are:

v. protect and conserve living aquatic resources

vi. minimise the impact of fishing activities on marine eco-systems

vii. the application of the precautionary principle

viii. progressive implementation of an eco-system-based approach to fisheries management.

(from the CFP basic Regulation, 2371/2002)

3. In your opinion, how **adequate** is the 'protect and conserve living aquatic resources' **objective**?

Don't know	Not at all	Low	Good	High
☐	☐	☐	☐	☐
0	1	2	3	4

4. If you did not answer 'high' to the above, in what way is the 'protect and conserve living aquatic resources' **objective** not adequate enough?

5. In your opinion, how **adequate** are the **strategies** to meet the 'protect and conserve living aquatic resources' objective?

Don't know	Not at all	Low	Good	High
☐	☐	☐	☐	☐
0	1	2	3	4

6. If you did not answer ‘high’ to the above, in what way are the **strategies** to meet the ‘protect and conserve living aquatic resources’ objective not adequate enough?

7. In your opinion, how **adequate** is the ‘minimise the impact of fishing activities on marine eco-systems’ **objective**?

Don’t know	Not at all	Low	Good	High
☐	☐	☐	☐	☐
0	1	2	3	4

8. If you did not answer ‘high’ to the above, in what way is the ‘minimise the impact of fishing activities on marine eco-systems’ **objective** not adequate enough?

9. In your opinion, how **adequate** are the **strategies** to meet the ‘minimise the impact of fishing activities on marine eco-systems’ objective?

Don’t know	Not at all	Low	Good	High
☐	☐	☐	☐	☐
0	1	2	3	4

10. If you did not answer ‘high’ to the above, in what way are the **strategies** to meet the ‘minimise the impact of fishing activities on marine eco-systems’ objective not adequate enough?

11. In your opinion, how **adequate** is the ‘Precautionary Principle’ **objective**?

Don’t know	Not at all	Low	Good	High
☐	☐	☐	☐	☐
0	1	2	3	4

12. If you did not answer ‘high’ to the above, in what way is the ‘Precautionary Principle’ **objective** not adequate enough?

13. In your opinion, how **adequate** are the **strategies** to meet the ‘Precautionary Principle’ objective?

Don’t know	Not at all	Low	Good	High
☐	☐	☐	☐	☐
0	1	2	3	4

14. If you did not answer ‘high’ to the above, in what way are the **strategies** to meet the ‘Precautionary Principle’ objective not adequate enough?

15. In your opinion, how **adequate** is the ‘ecosystem based approach’ **objective**?

Don’t know	Not at all	Low	Good	High
☐	☐	☐	☐	☐
0	1	2	3	4

16. If you did not answer ‘high’ to the above, in what way is the ‘ecosystem based approach’ **objective** not adequate enough?

17. In your opinion, how **adequate** are the **strategies** to meet the ‘ecosystem based approach’ objective?

Don’t know	Not at all	Low	Good	High
☐	☐	☐	☐	☐
0	1	2	3	4

18. If you did not answer ‘high’ to the above, in what way are the **strategies** to meet the ‘ecosystem based approach’ objective not adequate enough?

Section 4: Personal questions (omit some or all if you prefer)

Name: Position/Job title:

Organisation: email: telephone:

How many years have you been working in this area?:

Gender: Male ☐ Female ☐

Highest level of education: School-leaver ☐ GCSE ☐ A-level ☐ Degree ☐

Advanced Degree ☐ PhD☐ Other, professional qualification ☐

Please feel free to add any other comments you may have, including anything on the questionnaire itself as part of this exercise is to recommend a methodology to the Commission.

THANK YOU VERY MUCH FOR YOUR TIME. PLEASE NOW RETURN THE QUESTIONAIRE TO Yee Chow at IEEP ychow@ieeplondon.org.uk

Annex 2: Questionnaire in online format

Institute for European Environmental Policy

IEEP Fisheries Questionnaire

Knowledge and Attitudes of stakeholders to CFP environmental objectives

IEEP is undertaking research for the European Commission to estimate how well the Common Fisheries Policy (CFP) is performing in environmental terms. As part of this, we have developed this questionnaire to estimate the current knowledge and attitudes of stakeholders to CFP environmental objectives.

As a stakeholder, we would be very grateful if you could complete this short online questionnaire. There are seven pages in total and should take no more than 15 minutes to complete. All responses are confidential to the project team and where responses are used in reporting, distinguishing data will not be included so that individuals will not be identifiable.

When the results have been compiled we will send those that have responded to the questionnaire a summary of the findings. If you have any questions or comments, please do not hesitate to contact me:

Yee Chow
ychow@ieeplondon.org.uk
www.ieep.org.uk

Thank you in advance for your time.

Next Quit

IEEP Fisheries Questionnaire

Section 1: Your Organisation and involvement in policy (page 1/7)

Please choose from one of the following options:

*** Q1. What type of organisation do you work for/what job do you do?**

- ○ MEP/MEP advisor (fisheries)
- ○ MEP/MEP advisor (environment)
- ○ MEP/MEP advisor (other)
- ○ Environment NGO/interest group
- ○ Development NGO/interest group
- ○ Consumer NGO/interest group
- ○ Fishing industry organisation
- ○ Aquaculture industry organisation
- ○ Processor/trader industry organisation
- ○ Individual fishermen
- ○ Individual fish farmer
- ○ Individual processor/trader
- ○ Other (Please Specify)

***Q2. Are you involved in national or European fisheries policy? (e.g responding to consultations, attending committee meetings such as RACs, ACFA, national groups)**

○ yes ○ no

Section 2: Specific CFP Environmental Objectives (page 2/7)

***Q3. In your opinion, how adequate are the following CFP environmental objectives? Please select ONE of the boxes for each objective.**

	Don't know	Not at all	Low	Good	High
i. Protect and conserve living aquatic resources	○	○	○	○	◉
ii. Minimise the impact of fishing activities on marine eco-systems	○	○	○	◉	○
iii. The application of the precautionary principle	○	○	○	○	◉
iv. Progressive implementation of an eco-system-based approach to fisheries management.	○	○	○	◉	○

Additional Comments (page 3/7)

If you did not answer 'high' for any of the environmental objectives in Question 3, please comment further on why you feel the objectives are not adequate enough. This section is optional but it will be very helpful to our analysis if you could comment on them.

i. If you did not answer 'high' to the 'protect and conserve living aquatic resources' objective, in what way is the objective not adequate enough?

ii. If you did not answer 'high' to the 'minimise the impact of fishing activities on marine ecosystem' objective, in what way is the objective not adequate enough?

iii. If you did not answer 'high' to the 'application of the precautionary principle' objective, in what way is the objective not adequate enough?

iv. If you did not answer 'high' to the 'progressive implementation of an ecosystem based approach to fisheries management' objective, in what way is the objective not adequate enough?

Section 3: Strategies in meeting the specific CFP environmental objectives (page 4/7)

***Q4. In your opinion, how adequate are the strategies in meeting the following CFP objectives? Please select ONE of the boxes for each objective.**

	Don't know	Not at all	Low	Good	High
i. Protect and conserve living aquatic resources	○	○	○	○	○
ii. Minimise the impact of fishing activities on marine eco-systems	○	○	○	○	◉
iii. The application of the precautionary principle	○	○	○	○	○
iv. Progressive implementation of an eco-system-based approach to fisheries management.	○	○	○	○	○

Additional Comments (page 5/7)

If you did not answer 'high' for any of the strategies in meeting the environmental objectives in Question 3, please comment further on why you feel the strategies currently in placed are not adequate enough. This section is optional but it will be very helpful to our analysis if you could comment on them.

i. If you did not answer 'high' to the strategies on meeting the 'protect and conserve living aquatic resources' objective, in what ways are the strategies not adequate enough?

ii. If you did not answer 'high' to the strategies on meeting the 'minimise the impact of fishing activities on marine ecosystem' objective, in what ways are the strategies not adequate enough?

iii. If you did not answer 'high' to the strategies on meeting the 'application of the precautionary principle' objective, in what ways are the strategies not adequate enough?

iv. If you did not answer 'high' to the strategies on meeting the 'progressive implementation of an ecosystem based approach to fisheries management' objective, in what ways are the strategies not adequate enough?

Section 4: Personal Information (page 6/7)

This section is optional

Name

Position/Job title

Organisation

Email

Telephone

How many years have you been working in this area?

Gender:

- ○ Male
- ○ Female

Highest level of education:

- ○ School leaver
- ○ Secondary school
- ○ Degree
- ○ Advanced Degree
- ○ PhD
- ○ Other Qualifications (Please Specify)