INDECO

DEVELOPMENT OF INDICATORS OF ENVIRONMENTAL PERFORMANCE OF THE COMMON FISHERIES POLICY

Project no. 513754

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Development of Indicators of Environmental Performance of the Common Fisheries Policy

Specific Targeted Research Project of the Sixth Research Framework Programme of the EU on 'Modernisation and sustainability of fisheries, including aquaculture-based production systems', under 'Sustainable Management of Europe's Natural Resources'

Final Analysis and Evaluation of the INDECO Indicators

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The INDECO project

The purpose of this Co-ordination Action is to ensure a coherent approach to the development of indicators at EU level, in support of environmental integration within the CFP and in the context of international work on indicators. The principal objectives of INDECO are:

1. to identify quantitative indicators for the impact of fishing on the ecosystem state, functioning and dynamics, as well as indicators for socio-economic factors and for the effectiveness of different management measures;
2. to assess the applicability of such indicators; and
3. to develop operational models with a view to establishing the relationship between environmental conditions and fishing activities.

A consortium of 20 research organisations from 11 EU Member States is implementing INDECO. An Advisory User Group will provide a link between the researchers and policy makers, managers and stakeholders.

More information on INDECO can be found on the project's website:

http://www.ieep.org.uk/research/INDECO/INDECO_home.htm

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1 INTRODUCTION

The achievement of sustainable development and the integration of environmental requirements into sector policies are now established and legally binding objectives on the EU. Based on these objectives and recognising the deteriorating state of the marine environment, specifically fish stocks, the Community agreed on a new framework for managing fisheries and aquaculture activities under the Common Fisheries Policy (CFP) in 2002.

The aim of the resulting 'basic' Regulation (2371/2002) is 'to ensure the long term viability of the fisheries sector through sustainable exploitation of living aquatic resources based on sound scientific advice and on the precautionary approach'. Specifically, the Community:

- shall apply the precautionary approach in taking measures designed to protect and conserve living aquatic resources, to provide for their sustainable exploitation and to minimise the impact of fishing activities on marine ecosystems;
- shall aim at a progressive implementation of an ecosystem-based approach to fisheries management; and
- shall aim to contribute to efficient fishing activities within an economically viable and competitive fisheries and aquaculture industry, providing a fair standard of living for those who depend on fishing activities and taking into account the interests of consumers (Article 2).

The inclusion of ecosystem considerations in the fisheries management process is now a key requirement in the EU. It is thus necessary to understand the interactions between fishing activities and ecosystems and find ways to measure the effectiveness of different management approaches and actions. Well designed indicators are a recognised tool to help assess progress towards policy objectives and should promote action to improve management systems.

INDECO originated in response to a European Commission need. From the outset, it was agreed that INDECO should lead to the identification of 'robust and operational indicators describing the links between fisheries and environment, applicable across a large range of ecosystems and fishing zones'. These indicators should also be useful as 'communication tools to keep the wider public duly informed'.

A preliminary evaluation of the INDECO indicators was undertaken in September 2006 (Piet et al, 2006). This document presents a further evaluation of the list of INDECO indicators with specific consideration of their usefulness, practicability and to what extent they address the policy objectives of the CFP (section 4). The financial, administrative and institutional feasibility of implementing these indicators are discussed in Section 5 and final recommendations are proposed in Section 6 of this report.

2 THE ROLE OF INDICATORS

Indicators are taking a prominent and legitimate role in monitoring, assessing, and understanding ecosystem status, impacts of human activities, and effectiveness of management measures in achieving objectives; and may have a growing role to play in rule-based decision-making (Rice and Rochet, 2005). Many international bodies with an interest in aquatic or marine systems have endorsed indicator-based approaches to management (eg OECD, 1998; World Bank, 2002; FAO, 2002). In Europe, indicators are increasingly used to assess the efficacy of EU policies, including the extent to which environmental aspects are integrated into sectoral policies (INDENT, 2006).

For indicators to become a more effective management tool in European fisheries management, it is agreed that these indicators need to be robust and informative. Substantial efforts have been made to develop fisheries/environment indicators. In the regional context, significant contributions on indicators have been made by STECF, OSPAR, ICES and the EEA. However, most efforts have focussed on quantitative ecosystem indicators for fisheries management to evaluate changes in the marine ecosystems for environmental, ecological and fisheries perspectives and has focussed on the environmental, ecological aspects of fishing in particular with less attention paid to socio-economic indicators. In addition most of the work on indicators in Europe has focussed on northern Member States while efforts to find indicators suitable for the Mediterranean regions have been more limited.

3 INDECO

Based on the project objectives, it was agreed that three technical work packages (WP2, 3 and 4) would focus on the development of a minimum number of indicators that reflect the main properties of the marine ecosystem that could be monitored on a range of scales in time and space while WP 6 would attempt to address the lack of progress on socio-economic indicators. WP 5 would describe methods of modelling potentially useful to generic indicators and methods for their incorporation within a management framework.

At an early stage in the project, it was acknowledged that the lack of specific objectives and targets in the basic Regulation presented problems for the INDECO process, given that policy targets are a primary starting point for indicator identification. However, discussions based on examples external to the EU led to an agreement that INDECO should proceed with the development and selection of indicators drawing on work already underway in international and regional fora. Furthermore, indicators should be developed within the Pressure-State-Response (PSR) conceptual framework (Figure 1)

It was agreed that whilst there were some limitations to the PSR framework, there were a number of merits including:

- The framework supports management and monitoring feedback on a shorter time scale than one based primarily on waiting for responses in the status indicators. For example, if a good scientific understanding of the link between Pressure and State is established (eg via modelling and data analysis), then consequential management interventions to reduce pressure may be taken to induce the status to respond without having to wait for status to show direct responses to management interventions.
- Offers a top-down approach to the adoption of an indicator-based framework for ecosystem based fisheries management such that one may start with objectives and understanding of system behaviour and then identify from a very large pool of candidate indicators ones that are the most appropriate and useful for an ecosystem-based approach to fisheries management.

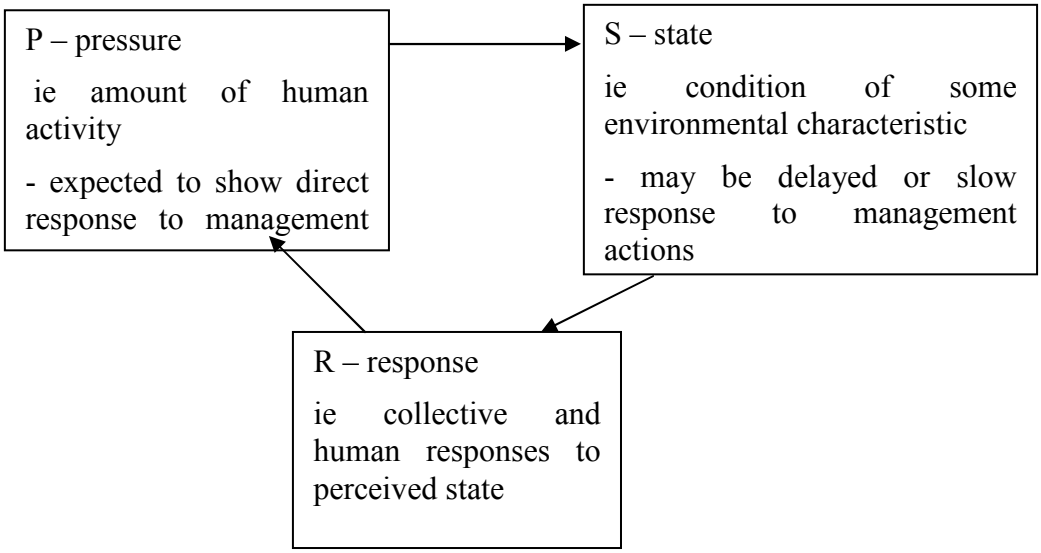

Figure 1 Pressure-State-Response (PSR) conceptual framework (INDECO, 2005)

3.1 Selection of biological indicators (WP2-4)

3.1.1 Methodology for selection of biological indicators

A review of population, community and habitat and ecosystem indicators was undertaken as the **first step** in the process of developing biological indicators in this project. In this review distinction was made between pressure, state and response indicators. Initially, the review of existing indicators was expected to deliver an overview of state indicators that describe the structure and function of the ecosystem at different hierarchical levels (ie at the level population, community and ecosystem). However, having established the relevance of pressure and response indicators within an ecosystem-based approach to fisheries management, and the importance of a thorough understanding of their link with state indicators, the overview was extended to include potential pressure indicators relevant to the CFP. Data sources available by geographical area linked to the types of indicators that they would support was also reviewed.

In **step 2**, indicators were selected using a framework which was developed specifically for the objective selection of a suite of indicators for use in fisheries management (Rice and Rochet 2005). The framework and the review of indicators were used to select a suite of indicators in which pressure and state indicators were distinguished. In addition, a framework for each type of indicator was provided in order to assess the quality of the indicator and representivity of all of the features of the ecosystem to be covered by the indicator. For state indicators, different ecosystem features that need to be conserved in order for the whole ecosystem to be in a healthy state were distinguished and for each of those features an attempt was made to show time-series of potential indicators that reveal the information available.

Finally in **step 3**, a preliminary evaluation of the list of candidate indicators was undertaken with the aim of selecting state and pressure indicators for the RAC regions. The evaluation of the indicators was believed to be the first attempt to explore the Rice and Rochet framework for the evaluation of indicators and therefore the advantages and possible sources of bias were also highlighted as these may be important for future evaluations.

3.1.2 List of Candidate indicators

During the second phase of WP 2-4, it was agreed that candidate indicators should measure the ecosystem status relative to the management objectives. The list of candidate indicators used within this study was developed within deliverables 10, 11 and 12 (see Annex 1) and was based on input from all INDECO partners. The aim was to cover all relevant ecosystem features for the State indicators and matching Pressure indicators, including less informative proxies in case the required information is not available. For this a hierarchy from very broad and general features (eg physical/chemical, fish or other ecosystem components) to more specific features (eg physical environment or abundance of commercial stocks) to the actual indicator (eg 'Proportion of commercial stocks that are within safe biological limits') was chosen. In cases where no specific indicator has been developed for a particular ecosystem feature, a more general phrasing (eg abundance index of selected marine mammal species).

For fish populations there are broadly three categories of indicators: **abundance, biological characteristics and genetic composition** and INDECO made the distinction between the commercial, assessed species and the non-assessed species. For abundance indicators there was broad agreement on the indicator for the commercial species and historical data exist in all ecosystems. Only in the Mediterranean there are issues pertaining to the consistency of the data. For the abundance of the non-assessed species, two groups of indicators can be distinguished: abundance in numbers or weight of a suite of selected species or the decline indicator based on IUCN decline criteria. Both groups of indicators are dependent on Research Vessel monitoring programmes which exist in all European countries and historical data available. The most common indicators on biological characteristics often describe changes in age or size structure where the former can only be determined for the assessed species while the latter can be determined for all species. The same level of availability of historical data applies for these indicators as for the abundance-type of indicators.

For ecosystem functioning several indicators have been put forward that differ as some are based on model output, others on more conventional type of data. Physical/chemical features as well as the plankton will not be directly affected by the fishery but may be of relevance in explaining (part of) the variation in those features of the ecosystem that may be affected by the fishery. Historical data of these features exist for most ecosystems features but notably availability of time-series may be an issue as much of the scientific community traditionally involved in fisheries science does not have direct access to such data and only few regular monitoring programmes exist.

The ultimate indicator for pressure is the **fishing-induced proportion mortality per time** of a specific ecosystem component (eg commercial fish, benthic invertebrate or marine mammal). This type of information, however, is usually only available for commercial fish species. For all other ecosystem components, indicators such as effort per métier or fleet capacity are used as proxies. While data on fleet capacity are available for all ecosystems, for the more informative indicator of fishing effort, historical data are often incomplete, inconsistent or not available for all métiers and countries.

3.1.3 Preliminary evaluation of the indicators

The list of indicators identified (Annex 1) were evaluated at a workshop in London in September 2006. This exercise was intended to deliver a final list of indicators. However, in order for this selection to be representative of societal views, the selection process should take account of all stakeholder groups (managers, politicians, community or environmental groups, economic stakeholders). Unfortunately participation in the meeting in London was limited,

with only scientists able to attend. The selection in this report must therefore be considered preliminary. Nevertheless the evaluation highlighted some important issues.

The analysis highlighted that two groups of generic indicators could be clearly separated from the bulk of the indicators:

1. Physical environment, Chemical environment, Phytoplankton and Zooplankton with very low scores on criteria theoretical basis, sensitivity, responsiveness and specificity
2. Status of Marine reptiles and Ecosystem functioning with very low scores on concreteness, public awareness, historical data, measurement and cost.

For the first group of indicators, there is an inherent problem: they are not directly affected by fishing and should therefore arguably not be part of a suite of indicators to measure the performance of the CFP. However, they were included in the set that was evaluated because they may be indicative of factors other than fishing (eg climate, eutrophication) that may have an impact on the ecosystem features that we are trying to conserve. Thus, they may be helpful in interpreting some of the patterns in the selected indicators and could therefore be useful for management of the fishery. The usefulness of these indicators probably differs between various parts of EU waters. The policy objectives should also guide the decision on whether or not such indicators should be included.

For the second set of indicators, a different set of issues were highlighted. Ecosystem functioning indicators are model-based and hence should have low scores on concreteness. Also the development of most of these ecosystem functioning indicators lagged behind that of most other indicators due to a lack of historical data and this probably led to the low scores on measurement and cost. The status of marine reptiles scored very low in the preliminary evaluation and this could be due to a number of reasons; they do not occur in most EU waters and even in those waters where they do occur, there are no monitoring programmes for data collection and indicators have not been developed.

The evaluation was inconclusive about a final list of indicators. However it raised a number of issues and makes recommendations which are discussed in section 6.

3.2 Selection of socio-economic indicators (WP6)

The objective of Work Package 6 was to review and analyse the utility of socio-economic indicators in fisheries management with reference to the impact on the environment. This review and two case studies (North Sea and Mediterranean), was expected to form the basis for identifying gaps and making recommendations for future development of appropriate methods and their application.

Three key activities were undertaken:

1. A strategic review of existing use of socio-economic indicators was undertaken with a focus on clarifying the relationship between natural and social science views on fisheries and to understand the ways in which natural and social science information has been used in the development of indicators.

2. A comparison of two case studies were undertaken to evaluate existing utility and future possibilities for the use of socio-economic indicators. The first case study was on the French Mediterranean trawler fleet and the second on the Danish pelagic fisheries in the North Sea. The two case studies were selected on the assumption that they are easily identified at the fishery/metier level.

3. On the basis of the outputs from 1 and 2, analysis of the gaps in the usage of socio-economic indicators was undertaken. A series of recommendation to increase the utility of these indicators were identified.

3.2.1 Methodology

The methodology used to identify socio-economic indicators was different from that applied to biological indicators (section 3.1.1). The two case studies were selected to provide insights into the availability of relevant socio-economic indicators and their utility in these EU fisheries setting. The approach adopted within the two case studies was different (INDECO D14a and D14b). The Danish pelagic fisheries case takes the international, European and national fishery policy objectives as the starting point and assess the availability of indicators on the achievements of/towards these objectives at the specific fisheries (metier) level, in this case the Danish pelagic fisheries . The Gulf of Lyons trawl fishery case focuses on the adaptation of the Australian ESD[1] framework to the European scene. However both case studies addressed 'state' indicators.

3.2.2 List of indicators

The adaptation of the Australian ESD framework is supported by the following hypothesis: 'the environmental performance of the CFP partly depends on the capability of the system to perform well at the level of the four sustainability pillars: social, economic, environmental and institutional'. The selected indicators are then presented under each of the pillars.

The environmental pillar is covered in Section 4; the three other pillars that relate to the society side of interactions between nature and society are treated in this section.

This indicative list (Annex 2) is intentionally short and is based on the cases studies (D14a and b). The indicators were chosen on the following criteria:

- same or similar indicators found in both case studies;
- directly measurable indicators: required information is available or indicators are available for another purpose and their use can be extended; and
- indicators of particular interest but still difficult to measure (problem related to the existence or the accessibility of needed data, standardisation issues, etc.).

A reference list, institutionally validated, would require further tests at different scales to conduct specific work on indicator standardisation (Bodiguel et al, 2006).

4 INDICATOR EVALUATION

This section considers the indicators identified in WP 2-6 without reaching conclusions with regard to a suite of indicators. and measures them against the following criteria. These criteria bring together many of the concepts discussed by others:

Criterion A. Contribution to CFP objectives.

The set of indicators need to contribute to understanding whether or not, and to what extent management is contributing to the overall objectives of the Common Fisheries Policy (see Section 1). Based on the conclusions of INDECO deliverable number 4 (A review of the current management framework Policy objectives for which indicators are needed), and on the community action plan to integrate environmental protection requirements into the CFP (Annex 1) we consider here the best formulated objectives to be:

[1]ESD - Ecologically Sustainable Development. The Australian use a framework based on these ESD principles which recognises the need to integrate the short and long-term economic and social and environmental aspects of activities.

1. Sustainable use of natural resources, that is, recovery or maintenance of target stocks
2. Reduction of the impact of fishing activities on non-target species, including: fish, birds and marine mammals
3. Halt of biodiversity loss
4. Reduction of overall fishing pressure
5. Reduction of discards and incidental bycatch
6. Reduction of impact on the sea bed and habitats

Thus we seek indicators relevant to these objectives. An indicator of the state of fish stocks will score more highly than an indicator of plankton communities. All indicators are to an extent of use to the CFP management process in understanding the changes in the marine environment.

Criterion B. Usefulness for fisheries management

This criterion is a combination of sensitivity and, specificity to fishing pressure and responsiveness to management actions. An indicator that is sensitive to fishing and that responds in a timeframe compatible with management will score more highly than an indicator that is primarily responsive to a factor other than management or responds over a long period of time.

Criterion C. Practicality

An indicator that draws upon a good historical time series and can use an existing data collection system will score more highly than an indicator without these features.

Criterion D. Ease of stakeholder understanding

For an indicator to form part of the management structure it needs at least to be understood and preferably accepted by stakeholders, particularly those most directly affected. If fishermen are unlikely to understand the indicator then it has to get a poor rating compared with one than can be easily understood.

Criterion E. Cost-effectiveness

An indicator that is costly to implement (both from a data collection and analysis point of view) will score poorly compared to one that is readily implemented at low cost.

Methodology for evaluation

The indicators considered by INDECO work packages 2-4 (pressure and state) are evaluated below. Most times, these evaluations apply to the whole EU North Atlantic fisheries area but in relevant cases, evaluations are made for each RAC region. The project considered that this was the most suitable level to disaggregate to and seemed likely to be the level at which indicators might be applied in the CFP management framework. In some cases an indicator might be more appropriately applied at a sub-division level of the RACs areas. There is inevitably in this evaluation some duplication of evaluation. The evaluation draws upon the results not only of the INDECO project but also of other related works including INDENT (2006), EUROSTAT and STECF (2006) (Annex 3).

Physical environment

Temperature, NAO

A. Contribution to CFP objectives

Medium. These indicators would be potentially informative of background environmental changes and cannot be managed by CFP mechanisms. Some knowledge exists on the effects of these factors on harvested stocks of fish potentially allowing some adaptation of management to changes in the

physical environment. Further research on the effects of these indicators on the biological environment would enable more sensitive management.

B. Usefulness for fisheries management

Nil. These indicators do not respond to CFP mechanisms.

C. Practicality

High. There are long data series being gathered under existing schemes.

D. Ease of stakeholder understanding

Medium. Although the concept of temperature is easy to grasp, the effects are less obvious. The NAO index is poorly understood outside scientific circles.

E. Cost-effectiveness

Medium. Although current data collection mechanisms exist, the lack of response to CFP mechanisms make these indicators less cost-effective.

Chemical environment

Salinity, Oxygen levels, N and P levels (Eutrophication)

A. Contribution to CFP objectives

Medium. These indicators would be potentially informative of background environmental changes and cannot be managed by CFP mechanisms. Some knowledge exists on the effects of these factors on harvested stocks of fish potentially allowing some adaptation of management to changes in the physical environment. Further research on the effects of these indicators on the biological environment would enable more sensitive management.

B. Usefulness for fisheries management

Nil. These indicators do not respond to CFP mechanisms.

C. Practicality

Medium. There are some data series being gathered under existing schemes.

D. Ease of stakeholder understanding

Low. Although the concepts of salinity and levels of other elements are easy to grasp, the effects are less obvious. Eutrophication may be better known in affected areas, but these are mostly relatively small and in coastal areas

E. Cost-effectiveness

Low. Sample collection mechanisms exist, but the cost of processing samples and getting exploitable data is very high.

Phytoplankton

Primary production, Water transparency, Chlorophyll a

A. Contribution to CFP objectives

Low. These indicators may be potentially informative of background environmental changes and cannot be managed by CFP mechanisms. Little knowledge exists on the effects of these factors on harvested stocks of fish, with the possible exception of chlorophyll a. The timing of blooms of chlorophyll may affect recruitment and growth of herbivorous species. Further research on the effects of these indicators on the biological environment might enable more sensitive management.

B. Usefulness for fisheries management

Nil. These indicators do not respond to CFP mechanisms.

C. Practicality

Medium. There are some data series being gathered under existing schemes.

D. Ease of stakeholder understanding

Medium. Although the concepts of primary production (and thereby levels of chlorophyll a) are relatively easy to understand, the effects are less obvious.

E. Cost-effectiveness

Low. Although some current data collection mechanisms exist, the lack of response to CFP mechanisms make these indicators less cost-effective.

Zooplankton

CPR derived plankton indicators, Zooplankton biomass

A. Contribution to CFP objectives

Low. These indicators are potentially informative of background environmental changes but cannot be managed by CFP mechanisms. Little knowledge exists on the effects of these factors on harvested stocks of fish, although changes in plankton as recorded by the continuous plankton recorder (CPR) have been correlated with changes in planktivorous fish stocks. Further research on the effects of these indicators on the biological environment might enable more sensitive management.

B. Usefulness for fisheries management

Nil. These indicators do not respond to CFP mechanisms.

C. Practicality

Medium. The CPR has collected data in the North Sea and in North –west waters for many years, but further development of an indicator would be required.

D. Ease of stakeholder understanding

Medium. The concept of zooplankton abundance affecting fish stocks is relatively easy to understand.

E. Cost-effectiveness

Low. Although data collection mechanisms exist, the lack of response to CFP mechanisms make these indicators less cost-effective.

Abundance of commercial stocks

Proportion of commercial stocks that are within safe biological limits

A. Contribution to CFP objectives

High. One of the core objectives of the CFP is to maintain commercial stocks within safe biological limits.

B. Usefulness for fisheries management

Medium. Fishing mortality is one of the major drivers on the state of fish stocks, but is not the sole driver. Hence sensitivity and responsiveness should be high, whereas specificity will be medium to low.

C. Practicality

High. A high proportion of current research and assessment effort in the CFP is devoted to fish stock assessment. Evaluation of practicality (good historical time series or existing data collection system) across regions (Piet and Pranovi 2006):

Specific	North Sea	North Western	South Western	Mediterranean	Baltic
Proportion of commercial stocks that are within safe biological limits	High	High	High	Low	High

D. Ease of stakeholder understanding

Medium Stakeholders understand the fish stocks need to be in a safe condition, but they do not necessarily understand the details of stock assessment models, nor the advice as it is given (Prigent and Fontenelle 2006)

E. Cost-effectiveness

Medium. This indicator can use existing work and would need little further development. However, the resource spent do collect data and perform stock assessment is huge. For example, the overall costs covered by European research institutes for the assessment of demersal stocks in North East regions (I, II, III, IV, V, VI, VIId) was estimated to be €25,000,000, whereas €19,065,000 are spent to assess pelagic stocks and tuna (EASE 2005). Generally, national costs largely exceed the landed value from the national fisheries (EASE 2005).

Abundance of fish stocks that are not regularly assessed

Abundance (numbers) index of selected species, Biomass index of selected species, Decline (threat) indicator

A. Contribution to CFP objectives

High. The CFP objectives explicitly include maintaining non-target species in a safe condition. These include species (eg elasmobranches) that are only commercially valuable when caught as bycatch (in other words that are sufficiently scarce that they cannot be targeted directly in an economic fishery), species that have no value at all yet, and endangered or threatened species.

B. Usefulness for fisheries management

Medium. Fishing mortality is one of the major drivers on the state of fish stocks, but is not the sole driver, and less so for non-target than for target species. Since most fisheries for most of these species are not being managed directly or as a priority, response will not necessarily follow from management measures.

C. Practicality

Medium. Full catch (landed and discarded) reporting is required to understand the effects of fishing, and is generally not yet available as time-series. This should be improved by forthcoming changes to the Data Collection Regulation (DCR), which requires total catch to be sample onboard fishing vessels. In the meantime, research vessel information is available, and useful, for those species which are reasonably sampled by (usually bottom trawl) surveys. Evaluation of practicality (good historical time series or existing data collection system) across regions (Piet and Pranovi 2006):

Specific	North Sea	North Western	South Western	Mediterranean	Baltic
Abundance (numbers) index of selected species (eg elasmobranchs)	High (IBTS)	High (EVHOE)	High (EVHOE)	High (MEDITS)	High (BITS)
Biomass index of selected species (eg elasmobranchs)					

D. Ease of stakeholder understanding

High. Stakeholders understand simple indicators like biomass indices (Prigent and Fontenelle 2006).

E. Cost-effectiveness

Medium. Catch information available is insufficient yet in geographical coverage, number of species and length of time-series. Many survey data are available, of which collation is required. Survey data are expensive, *eg* the cost of the MEDITS bottom trawl survey is estimated to be 226,500 euros for 19 days at sea in the Gulf of Lions (Piet and Pranovi 2006), and this has to be repeated annually with a large geographical coverage.

Size/Age structure of a fish species

Average length of selected species, Average weight of selected species, Average age of selected species

A. Contribution to CFP objectives

High. CFP aims at minimising fishing impacts on both target and non-target species, which clearly include effects on fish populations' size structure (Hall 1999). Fishing mortality obviously impacts average age of target species, this is the core of all the current stock assessment system.

B. Usefulness for fisheries management

Medium. Size is known to be very sensitive to fishing (Shin *et al.* 2005), but to other factors as well, so specificity and responsiveness will not be high.

C. Practicality

High, at least for size and weight, which are available from a large number of scientific surveys (but see comments on abundance of fish stocks which are note regularly assessed). Age, length and weight in the landings are also available from fisheries statistics, or in the catch from sampling onboard fishing vessels. However, these indicators do not carry the same information and would be indicators of fishing pressure rather than population state. Evaluation of practicality (good historical time series or existing data collection system) across regions (Piet and Pranovi 2006):

Specific	North Sea	North Western	South Western	Mediterranean	Baltic
Average length of selected species	High (IBTS)	High (EVHOE)	High (EVHOE)	High (MEDITS)	High (BITS)
Average weight of selected species					
Average age of selected species	High	High	Medium	Low	

D. Ease of stakeholder understanding

High. Stakeholders understand simple indicators like average length in the catch (Prigent and Fontenelle 2006).

E. Cost-effectiveness

Medium. See comments on abundance of fish stocks which are note regularly assessed.

Genetic composition of a fish species

Maturation norm

A. Contribution to CFP objectives

High. CFP aims at minimising fishing impacts on commercial stocks, and fishing is likely to exert a strong selection pressure on exploited population, leading to fishing-induced evolution which is an increasing concern (eg Conover 2000; Stokes and Law 2000).

B. Usefulness

Low. There is no sensible indicator of fishing-induced evolution in fish stocks yet. The maturation reaction norm is not proved to be an indicator of evolution alone and could be influenced by population density and potentially other environmental drivers. This is still much worse for size-at-age, another candidate indicator, which fluctuates under the influence of many factors.

C. Practicality

Low. Data time series for maturation reaction norms are very scarce. Time series of size-at-age are used in stock assessment working groups but track was not necessarily kept of individual variability, which is key for an indicator of genetic composition. . Evaluation of practicality (good historical time series or existing data collection system) across regions ;

Specific	North Sea	North Western	South Western	Mediterranean	Baltic
Maturation norm	Medium (IBTS)	Low	Low	Low	Low

D. Ease of stakeholder understanding

Low. Understanding selection pressure exerted by fishing and its evolutionary consequences requires a background in Darwinian reasoning. It would require an intensive education program for stakeholder to grasp these concepts.

E. Cost-effectiveness

Low. Providing time-series of maturation reaction norms for a significant number of species would be very costly, as it implies sampling high numbers (>100) of individuals for maturity in each age class (Barot *et al.* 2004).

Size structure of the fish community

Mean weight, Mean length, Proportion of large fish

A. Contribution to CFP objectives

High. Size structure of the fish community, as a summary of the size structure of all species, will contribute to the aim of maintaining fish stocks and reducing the impact of fishing activities on non-target species. In addition, it provides information at a higher organisation level, thus is a step towards ecosystem functioning monitoring. Size diversity is also an element of ecosystem diversity, which is a high priority objective.

B. Usefulness for fisheries management

Medium to High. Mean length and proportion of large fish have been shown to be sensitive to fishing, although not completely specific, whereas mean weight might vary more in response to

environmental fluctuations (Shin *et al.* 2005). Responsiveness was less investigated, however, it might be low because higher levels of organisation respond on longer time frames.

C. Practicality

High. These indicators are available from a large number of scientific surveys (but see comments on abundance of fish stocks which are note regularly assessed). Evaluation of practicality (good historical time series or existing data collection system) across regions (Piet and Pranovi 2006):

Specific	North Sea	North Western	South Western	Mediterranean	Baltic
Mean weight	High (IBTS)	High (EVHOE)	High (EVHOE)	High (MEDITS)	High (BITS)
Mean length					
Proportion of large fish					

D. Ease of stakeholder understanding

High. Stakeholders understand simple indicators like average length in the catch (Prigent and Fontenelle 2006) and would probably easily understand its generalisation to the fish community in the sea.

E. Cost-effectiveness

Medium. See comments on abundance of fish stocks which are note regularly assessed.

Species composition including biodiversity of the fish community

Mean maximum length, Biodiversity indicators (Hill's N0, N1, N2), Proportion of target species

A. Contribution to CFP objectives

High. This will directly contribute to the high priority of halting biodiversity loss

B. Usefulness for fisheries management

Medium. Good indicators of the impact of fishing on biodiversity are not yet available, as the biodiversity indicators are not very sensitive to fishing (Rochet and Trenkel 2003). Mean maximum length would be a good indicator of the change in the species composition from larger to smaller species, and is recognised as a good indicator of fishing impact (Shin *et al.* 2005).

C. Practicality

High. Biodiversity indicators can easily be calculated from survey data (see comments above) and many time-series are available. Mean maximum length is difficult to estimate because maximum length is not well defined in most species, due to the high variability of size-at-age and the difficulty of getting samples for older age-classes. Proportion of target species might be difficult to define because criteria to define target species are not obvious, and target species change over time. Evaluation of practicality (good historical time series or existing data collection system) across regions (Piet and Pranovi 2006):

Specific	North Sea	North Western	South Western	Mediterranean	Baltic
Mean maximum length	High	High	High	Medium	High
Biodiversity indicator (Hill's N0)	High (IBTS)	High (EVHOE)	High (EVHOE)	High (MEDITS)	High (BITS)
Biodiversity indicator (Hill's N1)					
Biodiversity indicator (Hill's N2)					
Proportion of target species	Medium				

D. Ease of stakeholder understanding

Medium. It would require some education for stakeholders to understand the value of keeping diverse fish communities.

E. Cost-effectiveness

Medium. Refer to comments on abundance of fish stocks which are not regularly assessed

Abundance of the fish community

Total numbers, Total biomass

A. Contribution to CFP objectives

High. Sustained fishing activities require healthy and productive community, so obviously this will contribute to the CFP objectives.

B. Usefulness for fisheries management

Medium. Target and bycatch species will see their total number and total biomass decreased by fishing, but some other (eg prey) species might benefit from this and increase in abundance, so that the effect of fishing on community total abundance is more difficult to predict, and little theory is available yet (Rochet and Trenkel 2003).

C. Practicality

High. Indices of community numbers and biomass are available from survey data time-series. . Evaluation of practicality (good historical time series or existing data collection system) across regions (Piet and Pranovi 2006):

	North Sea	North Western	South Western	Mediterranean	Baltic
Total numbers	High (IBTS)	High (EVHOE)	High (EVHOE)	High (MEDITS)	High (BITS)
Total biomass					

D. Ease of stakeholder understanding

High. As stakeholders are very sensitive to fish biomass (Prigent and Fontenelle 2006), they would probably easily understand that an abundant community is good for them.

E. Cost-effectiveness

Medium. See comments on abundance of fish stocks which are note regularly assessed.

Marine mammals

Abundance index of selected marine mammal species

A. Contribution to CFP objectives

Low. Although the status of marine mammals needs to be safeguarded, links to the CFP are not simple.

B. Useful for fisheries management

Low. The abundance of marine mammals may be affected by CFP management and it is possible that marine mammals might affect fish stocks, but the understanding of any links is poor (and unlikely to improve).

C. Practicality

Medium. North Sea: Grey seals in the North Sea are already well monitored and there are good time series. Common seals are monitored but counts have a lower accuracy than grey seals. Monitoring of cetaceans is less well developed.

North-west waters: Seals in parts of the north-west waters regions are well monitored. Cetaceans in these waters are less well known and considerable development would be needed to implement an indicator for this group of species.

D. Ease of stakeholder understanding

High. Although not necessarily appreciated by fishers, understanding of the abundance of marine mammals is high, both amongst fishers and the wider public.

E. Cost-effectiveness

Medium. Seal monitoring is already undertaken and cetacean surveillance is required under the EU's Habitats Directive.

Seabirds

Abundance index of selected seabird species

A. Contribution to CFP objectives

Low. Although the status of seabirds needs to be safeguarded, links of their abundance to the CFP are not simple.

B. Usefulness for fisheries management

Low. The abundance of seabirds may be affected by CFP management and it is possible that seabirds might affect inshore fish stocks, but the understanding of any links is poor (and unlikely to improve).

C. Practicality

High. Seabirds breeding in the North Sea are already well monitored and there are good time series. These time series could usefully be collected together. Seabird monitoring in north-west waters is not as extensive as in the North Sea, but data are already gathered onto a single database.

D. Ease of stakeholder understanding

High. Although not necessarily understood by fishers, understanding of the abundance of seabirds is high among the wider public.

E. Cost-effectiveness

High. North Sea and north-west waters: Extensive monitoring of breeding seabirds is already undertaken.

Marine reptiles

Abundance index of selected species

A. Contribution to CFP objectives

Nil. Not relevant as marine turtles are only vagrant to the North Sea and are rare in north-west waters.

B. Usefulness for fisheries management

Nil. Not relevant as marine turtles are only vagrant to the North Sea and are rare in north-west waters.

C. Practicality

Nil. Not relevant as marine turtles are only vagrant to the North Sea and are rare in north-west waters.

D. Ease of stakeholder understanding

Nil. Not relevant as marine turtles are only vagrant to the North Sea and are rare in north-west waters.

E. Cost-effectiveness

Nil. Not relevant as marine turtles are only vagrant to the North Sea and are rare in north-west waters.

Benthos

Abundance index of sensitive benthic species, Epibenthos community indicator, Infauna community indicator

A. Contribution to CFP objectives

Medium. Benthos communities need to be conserved and the links to certain fisheries activities are reasonably well understood.

B. Usefulness for fisheries management

High. Likely to respond well to appropriate management (removal of direct impact by towed gears).

C. Practicality

Low. Some data available, but none at a sufficiently wide scale in any waters. Indicators could be developed to be applied in specific areas where towed gear excluded.

D. Ease of stakeholder understanding

Medium. The need to conserve certain seabed communities is understood if not necessarily appreciated by the fishing community. Conservation of these communities is reasonably well understood by the general public.

E. Cost-effectiveness

Medium. No schemes in place at present and indices would need to be developed. Implementation costs would depend on the scale of any scheme.

Sensitive Habitat

Area coverage of highly sensitive habitats

A. Contribution to CFP objectives

Medium. Sensitive habitats need to be conserved and the links to certain fisheries activities are reasonably well understood.

B. Usefulness for fisheries management

High. Likely to respond well to appropriate management (removal of direct impact by towed gears).

C. Practicality

Medium. Some data available. Indicators could be developed to be applied in specific areas where towed gear excluded.

D. Ease of stakeholder understanding

Medium. The need to conserve certain habitats (eg mearl beds, Lophelia reefs) is well understood if not necessarily appreciated by the fishing community. Conservation of these habitats is reasonably well understood by the general public.

E. Cost-effectiveness

Medium. No schemes in place at present and indices would need to be developed.

Ecosystem functioning including trophic level

Ecosystem functioning including trophic level, Primary production required, Catch ratios, Mean transfer efficiency, Trophic level, Fishing in Balance index, Finn Cycling Index

A. Contribution to CFP objectives

High. It is important for the CFP that the ecosystem functions effectively, and that harvesting at one level of the ecosystem does not unduly affect harvesting or functioning at other levels.

B. Usefulness for fisheries management

Medium. The links between fisheries and changes in some potential indicators are reasonably well understood, but if all fish stocks are maintained within safe biological limits then some of these indicators may not add greatly to information already available to managers.

C. Practicality

Medium. Although some indicators are apparently well developed (eg trophic level), many of these rely on assumptions about the trophic level that a species is feeding at, a feature that may well change through time as the ecosystem changes or as the year class balance of any particular species changes. Other indicators require greater data collection and development.

D. Ease of stakeholder understanding

Low. Although broad concepts may be understood, the likely understanding of the precise meaning of any of these indicators is low.

E. Cost-effectiveness

Low. Most of these indicators require costly survey data (see above) and additional more costly data like stable isotope measurements to determine the trophic level of many organisms. The cost is expected to be high.

Fleet capacity

Fleet capacity (number of vessels)

A. Contribution to CFP objectives

High. Maintaining fleet capacity in balance with available resources is a key objective of the CFP.

B. Usefulness for fisheries management

Medium. The removal or addition of vessels from/to the fleet does not have a direct effect on fishing pressure due to latent capacity (unused time at sea) of the fleet and rapid change in fishing power (the ability to catch fish by individual vessels).

C. Practicality

High. Information on the larger vessels has been available for many years. The small boat sector is not particularly important in the North Sea, but is much more important in north-west and south-west waters. Evaluation of practicality (good historical time series or existing data collection system) across regions (Piet and Pranovi 2006):

	North Sea	North Western	South Western	Mediterranean	Baltic
Fleet capacity (number of vessels)	High				

D. Ease of stakeholder understanding

High. Stakeholders are very sensitive to the size of the fleet, especially when foreign vessels join the fishery they go for (Prigent and Fontenelle 2006).

E. Cost-effectiveness

High. Data already present and collated. Some further information collection on the small boat/part-time sector would be relatively easy to undertake.

Fishing effort per métier and its spatial and temporal distribution

Days-at-sea or hours fished per spatial unit (eg ICES rectangle) per time

A. Contribution to CFP objectives

High. Reduction of overall fishing pressure is a key objective of the CFP

B. Useful for fisheries management

High. Days-at-sea are currently the most appropriate measure of fishing pressure on the environment, despite some variability between métier due to variation in depth of knowledge of effects on components of the marine environment.). Evaluation of practicality (good historical time series or existing data collection system) across regions (Piet and Pranovi 2006):

	North Sea	North Western	South Western	Mediterranean	Baltic
Days-at-sea or hours fished per spatial unit (eg ICES rectangle) per time	Medium to High	Medium	Low	Low	

C. Practicality

High. Would require collation in a standard, accessible, format of VMS data linked to métier in use on each vessel. Further widening of the VMS scheme also required (or some equivalent proxy measure).

D. Ease of stakeholder understanding

High. The indicator is well understood by both fishers and the wider public.

E. Cost-effectiveness

High. A high initial cost of establishing/extending the current scheme would be offset by low long term costs.

Fishing impact including catch, by-catch and habitat destruction

Fishing-induced proportion mortality of commercial fish species, of non-assessed fish species, of benthic species, of marine mammals, of other vulnerable and/or protected species, Proportion of catch discarded, Proportion of area of (sensitive) habitat impacted

A. Contribution to CFP objectives

High. Reduction of overall fishing pressure, reduction of discards and incidental bycatch and reduction of impact on the sea bed and habitats are priority objectives of the CFP.

B. Usefulness for management

High. .All these indicators will be very sensitive to fishing, and not to other factors, and they will respond quickly to most management measures.

C. Practicality

Medium. **to Low**. The proportion of mortality due to fishing will be difficult to estimate for commercial fish species, and almost impossible for the other groups, because it requires large amounts of data and a careful analysis (Rijnsdorp *et al.* 2006). The proportion of catch discarded requires extension of existing observer schemes, but is probably the most practical and achievable of these indicators in the short term. Proportion of habitat impacted requires detailed mapping of sea bottoms, and close monitoring of fishing activities, all of which is not yet available. Evaluation of practicality (good historical time series or existing data collection system) across regions (Piet and Pranovi 2006):

	North Sea	North Western	South Western	Mediterranean	Baltic
Fishing-induced proportion mortality of commercial fish species	Medium to High	Medium	Low	Low	
Fishing-induced proportion mortality of non-assessed fish species	Low				
Fishing-induced proportion mortality of benthic species	Low				
Fishing-induced proportion mortality of marine mammals	Medium	Medium	Low		
Fishing-induced proportion mortality of vulnerable and/or protected species	Low				
Proportion of catch discarded	Medium to High	Low, but improving		Low	
Proportion of area of (sensitive) habitat impacted	Medium	Medium	Medium	Low	

D. Ease of stakeholder understanding

Medium to High. The proportion of catch discarded and of habitat impacted are well understood by both fishers and the wider public. By contrast, proportion of fishing-induced mortality is an abstract concept that might be difficult to explain.

E. Cost-effectiveness

Medium to low. A high initial cost of establishing/extending the current 'discard monitoring' scheme would be offset by lower long term costs. Similarly, high initial cost of bottom mapping and establishing fishing activities monitoring would be offset by lower long term costs. On the other hand, the cost of estimating partial mortalities will probably remain very high.

5 DISCUSSION

Although the objective of INDECO was to derive a recommended suite of indicators, this has not been done for the reasons highlighted in the introduction to this section. Nevertheless some indicators look much more promising from a scientific point of view, and for their potential usefulness to evaluating the performance of the CFP than others.

In general, it is obvious from the evaluation that indicators of when, where and with what metier fishing is occurring coupled with a full record of all parts of the ecosystem caught (or affected without being caught) are essential for evaluating the effects of fishing. This is also needed for establishing indicators of those effects and of the success of the CFP in constraining unwanted effects. This shows through in the generally higher scores given to indicators of fishing effort, fleet capacity, fishing impact and state of commercially targeted (assessed) fish stocks.

Other potential indicators gaining a higher score were state of non-assessed stocks, size of fish, abundance of fish and indicators for seabirds. In all of these cases the higher scores were due primarily to an existing history of data collection, collation and analysis. Thus these indicators could be implemented more readily than those without such a history. Seabird population abundance scored poorly in their relationship to the CFP as abundance appears to be affected more by other factors than fishing.

As noted earlier, indicators for effects on reptiles are not recommended at present, despite these taxa being specially protected in EU legislation and being known to be affected by fisheries bycatch. A programme to improve this situation could be bought in alongside any other planned improvements in catch and impact reporting. At present, indicators for ecosystem functioning and for genetic impacts appear to require more research and development (partly to understand links to fisheries effects) and appear unready to be used to evaluate CFP performance.

6 CONCLUSION AND RECOMMENDATIONS

The clear articulation of policy objectives within a systematic management framework should be the starting point for the development of indicators and is thought by many to be the most important element in the process of pursuing sustainable development (FAO, 1999; Garcia and Staples, 2000; Garcia *et al*, 2000; Degnbol and Jarre, 2004). Objectives articulate what decision-makers are trying to achieve and their specificity will depend upon the scale or level at which management measures are implemented. Setting appropriate objectives should make indicator and reference point development almost self-evident in many cases (Garcia *et al*, 2000).

In Piet and Pranovi (2006) it was highlighted that at present there are no detailed operational objectives within the CFP for anything other than some commercial stocks subject to recovery

or management plans. The lack of such operational objectives prevents a proper identification and evaluation of the indicators

At present the use of indicators to measure the impact of fishing on marine ecosystems is still developing. There is much work to be done to identify and selecting the best indicators. In addition, there is need to establish reference limits before indicators can be incorporated into an ecosystem based approach to fisheries management. In the interim, it is important that indicator studies are designed with a clear objective, that the objective is translated into a testable hypothesis based in sound theoretical knowledge to ensure that the indicators are robust (Orr et al, 2005).

In terms of evaluation, INDECO has concluded that too many indicators will aggravate the evaluation process. It is therefore advised to start with a limited suite of indicators. For some ecosystem features, there exists several concrete indicators while for others none. INDECO addressed this by distinguishing two levels of indicators: one generic, the other specific. While this was intended to resolve the discrepancy between the types of indicators available, the feedback of (notably non-scientific) respondents showed that for an evaluation by different stakeholders it is probably better to have them evaluate the generic ecosystem features. The specific indicators are often meaningless, making their evaluation by non-scientists difficult or impossible. The evaluation and selection of specific indicators within a generic ecosystem feature can be done by scientists who are sufficiently familiar with the merits of each of the different candidates. Even then it is advisable to provide these scientists all the information available to guide the scoring prior to the actual scoring as we observed that the sharing and making available of information could cause respondents to change their scoring which would often result in a convergence of the scores.

It is important to determine screening criteria and use them, since using criteria and sub-criteria makes the scoring process more transparent. A direct scoring of the indicators will be affected by differences between respondents who each scored against their own implicit set of criteria. This highlights the issue of expertise mentioned in 3.1.3 in the evaluations undertaken, there were marked differences in scoring between the respondents which we assume are partly determined by the differences in the level of expertise. Making the relevant information available prior to the scoring and allowing an exchange of viewpoints would considerably reduce the variation and bias in the scoring. If more information is available on the indicators and known and discussed within the group of respondents then more criteria can be used and the scoring exercise is more likely to deliver the best results. With the current level of expertise and information available only a few indicators could be distinguished reliably from a large body of indicators. The assumption is that with increasing level of expertise and information available it should also be possible to further differentiate within this large body of indicators.

INDECO agreed that we need indicators for both state and pressure. A minimum requirement for the ecosystem state indicators would be that for all relevant ecosystem features represented by a generic indicator at least one specific indicator is selected. Here the relevancy is determined by whether or not that particular ecosystem component occurs in a region (eg marine reptiles may not be relevant in all EU waters), to what extent different features of the same ecosystem component are complementary or redundant and if this feature is likely to be affected by fisheries. This minimum selection may be expanded by also including ecosystem features that may affect the core ecosystem features but are not necessarily affected by the fishery. Finally, there is the choice to have more than one specific indicator for one or more of the generic indicators. Again, this should be determined by how much additional information this new specific indicator provides. The considerations in the previous step could be easily translated into suggested approaches to combine indicators such

as the 'hierarchical' approach or the 'headline' indicator approach (Jennings, 2005). In the end, however, the number of indicators that are selected and how they are combined will not only be determined on scientific grounds but also by the requirements of the manager who needs to work with them.

Finally, for the final selection of indicators the scoring of indicators against screening criteria can offer the information needed to guide the final selection of indicators provided that the shortfalls mentioned previously are resolved. A possible refinement of the approach could be to conduct this in two stages: a first stage where generic indicators are scored against (a subset of) the criteria by different stakeholders and a second stage where for each generic indicator one or more specific indicators are evaluated against (a more detailed or extended set of) screening criteria by specialists including biologists, ecologists, social scientists and economists (Piet et al, 2006). However, ultimately it is important that indicators are understandable and accepted by all stakeholders and managers to ensure legitimacy.

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ANNEX 1 SUITE OF BIOLOGICAL INDICATORS SELECTED BY INDECO

Physical/chemical

- Physical environment:
  - Temperature
  - NAO
- Chemical environment
  - Salinity
  - Oxygen levels
  - N and P levels (Eutrophication)

Plankton

- Phytoplankton
  - Primary production
  - Water transparency
  - Chlorophyll a level
- Zooplankton
  - CPR derived plankton indicators
  - Zooplankton biomass

Fish

- Abundance of commercial stocks
  - Proportion of commercial stocks that are within safe biological limits
- Abundance of populations that are not regularly assessed
  - Abundance (numbers) index of selected species (eg elasmobranches)
  - Biomass index of selected species (eg elasmobranches)
  - Decline (threat) indicator
- Size/Age Structure of a fish species
  - Average length of selected species
  - Average weight of selected species
  - Average age of selected species
- Genetic composition of a fish species
  - Maturation norm
- Size structure of the fish community
  - Mean weight
  - Mean length
  - Proportion of large fish
- Species composition including biodiversity of the fish community
  - Mean maximum length
  - Biodiversity indicator (Hill's N0)
  - Biodiversity indicator (Hill's N1)
  - Biodiversity indicator (Hill's N2)
  - Proportion of target species
- Abundance of the fish community
  - Total numbers
  - Total biomass

Other ecosystem components

- Status of marine mammals
  - Abundance index of selected marine mammal species
- Status of Seabirds
  - Abundance index of selected seabird species
- Status of marine reptiles
  - Abundance index of selected species
- Status of benthos
  - Abundance index of sensitive benthic species
  - Epibenthos community indicator
  - Infauna community indicator
- Status of sensitive habitat
  - Area coverage of highly sensitive habitats

Ecosystem

- Ecosystem functioning including trophic level
  - Primary production required
  - Catch ratios
  - Mean transfer efficiency
  - Trophic level
  - Fishing in Balance index
  - Finn Cycling Index

Fishing pressure

- Fleet capacity
- Fishing effort per métier and its spatial and temporal distribution
  - Days-at-sea or hours fished per spatial unit (eg ICES rectangle) per time (eg year or month)
- Fishing impact including catch, by-catch and habitat destruction
  - Fishing-induced proportion mortality of commercial fish species
  - Fishing-induced proportion mortality of non-assessed fish species
  - Fishing-induced proportion mortality of benthic species
  - Fishing-induced proportion mortality of marine mammals
  - Fishing-induced proportion mortality of vulnerable and/or protected species
  - Proportion of catch discarded
  - Proportion of area or (sensitive) habitat impacted

ANNEX 2 SUITE OF SOCIO-ECONOMIC INDICATORS IDENTIFIED BY INDECO

Indicators	North Sea	Med Sea	Purpose of indicators	Existing or easily accessible Indicators	Information issues
ECONOMY OF FISHING UNITS					
Landings per vessel and / employment	**X**	**X**	**Measuring of productivity**	**X**	
Prices			Measuring of competitiveness	X	
% fuel cost			External dependency and contribution to the effect of green house	X	
Age of vessels			Age of vessel is a factor of sustainability of the fishery in the sense that older vessel generates conditions of exploitation that are not always as competitive (level of equipment, fuel consumption, motors...) or as optimal as far as on board security is concerned (higher risk of injuries).	X	Age of vessel is a data easily accessible but not always representative of the state of a vessel. It does not reflect modernisation efforts or changes in motorization.
Invested Capital			Measuring of financial profitability	X	The diversity of the modalities used across Europe to evaluate the invested capital lowers the capabilities to standardise this indicator. The best indicator would be the insurance value but this data is at this time very difficult to access to.
% Subsidies	X		Measuring of profitability	Additional indicators	It is difficult to have an exhaustive state of subventions given to fisheries. They can be indirect or not individualised (eg collective equipment). They can be exceptional subvention in case of crisis or not specific to the sector or, at the opposite, specific to one

Indicators	North Sea	Med Sea	Purpose of indicators	Existing or easily accessible Indicators	Information issues
					segment or one region. Subvention is thus difficult to identify.
Corrected economic return (economic return calculated without fuel subsidies)		X	These indicators would adjust the picture of competitiveness and viability between the different fishing fleets.	Additional indicators	The Economic return is calculated in the Concerted Action on economic performance of selected European fishing fleet (2001-2004). Fuel consumption is also available and enters in the calculation of this indicator. A corrected economic return reintegrating real fuel cost without subsidies is potentially measurable. The main difficulties will come from the heterogeneity of level of subsidies through time, per segment of fleet and/or regions.
Return on investments	**X**	**X**	**Measuring of financial profitability**	**Additional indicators**	
ECONOMY OF THE FISHING SECTOR					
% added value / GDP			Relative importance of the fisheries sector	X	It would be valuable in a management perspective to calculate this indicator at the regional or local scale, but may be costly.
Foreign trade			Dependency on external production	X	
Economic Resource Rent		X	Rent is an indicator of Sustainable Economic efficiency : - economic efficiency of natural resource usage (ratio between the current economic rent and the potential resource rent) and, - economic sustainability of natural	Additional indicators	The rent is a calculated indicator. It is the difference between the revenue and total cost. It can be calculated without the management cost but ideally, it these costs should be integrated. A specific effort to measure management cost

Indicators	North Sea	Med Sea	Purpose of indicators	Existing or easily accessible Indicators	Information issues
			resource usage because the optimum economic potential in terms of level of exploitation is almost always situated below the biological optimum. This type of indicator is particularly pertinent in term of sustainable management.		is specifically required (cf also the section on cost of regulations and D8, in particular the section on institutional indicators).
SOCIAL ISSUES RELATED TO THE FISHING SECTOR					
Number of fishermen	**X**	**X**	**Measuring of employment**	**X**	**For a number of fisheries a potentially significant level of informal employment exists (not declared) which is difficult to evaluate. It is also necessary to take into consideration forms of multi activities that can be important in certain fisheries (eg small scale fisheries).**
Number of unemployed	**X**	**X**	**Measure on the level of pressure to enter the fisheries sector**	**X**	**The main issue is related to comparison of unemployment statistics across countries dependant on counting modalities. Furthermore, it is not necessarily the case that the number of unemployed fishermen is available at all. This is for instance the case in DK where there is fishermen's union but a Seamen's' union. The rate of unemployment among those who consider themselves fishermen is thus unknown.**
Wages	X		Distribution of revenues from fishing		Some problems arise when calculating this indicator: - Differences of forms of wage across EU

Indicators	North Sea	Med Sea	Purpose of indicators	Existing or easily accessible Indicators	Information issues
					countries ; - Premium or non salary revenue considered or non in the revenue - Prevalent forms of wages change over time with changes in management systems, potentially disrupting time series.
% informal employment (not declared)			Social security cover of employment		
% Wages / Added value		X	Equity of repartition at the enterprise level		It is in certain cases difficult to establish the level of revenue because an important part of the revenue is distributed as a premium.
Age of vessels			Risk of vessel accidents and injuries		
Age of fishermen			Level of fishermen 'recruitment' and state of the community.		
Number of women			Measurement of women participation in the fishing enterprises and access to social security cover		
Work injuries	**X**	**X**		?	**Systematic census of injuries per level of gravity is lacking**
SOCIAL ISSUES RELATED TO CONSUMERS					
% consumption and transformation	X		Consumer access to fish product		
Traceability of fish product	X	X	Impact on consumer health		Information may be available but not registered in a centralised manner
Quality (level of heavy metals)			Impact on consumer health		There are no systematic at stock or fishery levels data
Relative fish price (variation of fish		X	Access to fish product.		This indicator would give the trend of fish

Indicators	North Sea	Med Sea	Purpose of indicators	Existing or easily accessible Indicators	Information issues
price/ variation of retail price index)					price compared to other consumables. Using a national retail price index would be more pertinent to asses the economic access to fish at citizen level. This indicator gives general information on economic access, but does not discriminate the origin of fish consumed.
GOVERNANCE					
Market take-out by POs	X		This indicator gives an idea of the level of organisation of the sector. As such it contributes to inform on the management capabilities.		Data are available per species but not always per fishing unit. Both components would be interesting to follow up. However one must realise that it can be more difficult in the case of mixed fishing units.
Violations of regulation	**X**	**X**	**This is an indicator of *management efficiency* which is assessed on the basis of management success at reaching its goals.**	**X**	**A number of violations of CFP rules are followed by the EU (CFP Compliance Scoreboard)**
Cost of management			This is an indicator of *decision-making efficiency* which is related to the degree to which policy process are timely delivered and adapted to their objectives.		The evaluation of public budget spent is often the major component of management cost analysis. However to measure the total cost, cost related to policy implementation should be added, what integrates (i) cost related to salaries and functioning of state services and communities but also (ii) cost related to research and follow up activities directly related to management functions and decisions. These elements are not easily delimited.

Indicators	North Sea	Med Sea	Purpose of indicators	Existing or easily accessible Indicators	Information issues
					It can be noted as an example that the OCDE (2003) analysis which integrates the cost of management institutions. In this study, public management policies' costs are estimated at around 2.5 millions US$ for the OECD countries (36% of public transfer to the fishery sector), relatively equally shared between enforcement (39.6%), research (34%) and strictly management (26.4%) (cf. Rey-Valette et al, 2005)
Amount of Subsidies	X		Support to the sector		This is part of the preceding indicators
Number of fishermen in local institutions			Local representation of the sector		Data are not collected at this time.
Number of women in agencies/institutions/organisations in charge of fishery management			Equal opportunities		Data are not collected at this time.
Diffusion of information by management agencies (web sites, observatories…)			Transparancy and access of information (cf. Aarhus Convention)		Appropriate qualitative indicators need to be built

ANNEX 3 SUMMARY OF KEY EU REPORTS ON INDICATORS

INDECO	STECF Indicators and indicator grouping SGRN (2006)	Anon (2006) Project FISH/2004/12	Huntington et al (2003) Project Fish/2002/13	Eurostat	European Environment Agency	
	The STECF SGRN identified indicators based INDECO, INDENT and previous SGRN work. Two types of indicators were recommended as being needed: indicators of the state of the marine environment; and indicators of the pressure that affects state.	A European Commission initiated report to quantify CFP environmental performance indicators. Indicators were quantified, evaluated and then screened for evaluation.	A European Commission initiated report to identify environmental indicators for monitoring by the data collection Regulation. Six variables were considered of sufficient importance to warrant data collection programmes to establish their impact and change over time.	Annual reports summarise: catches by fishing region; aquaculture production, on total production; landings in EEA ports; trade in fishery products; supply balance sheets; the EEA fishing fleet; and the number of fishers.	The EEA reports, on its website, on a series of fisheries indicators. These are related to policy questions and divided into core indicators and other indicators.	
	Conservation status of vulnerable fishes according to IUCN decline criterion	*Category 1: Informative indicators which can be made operational with little or no additional effort*	1. Fishing effort and its spatial and temporal distribution *Key variable: Fishing effort in terms of fishing time, weighted by fishing technique for a specific area and time period.*	Total production	Question	Indicator
	Abundance of vulnerable marine mammals, reptiles or seabirds	Proportion of commercial stocks that are within safe biological limits	2. Assemblage composition and function *Key variable: Species diversity measured by relative abundance (individuals or biomass) per square kilometre.*	Aquaculture production	*Core set of indicators*	
	Mean weight and mean maximum length of fish assemblage	Relative abundance of a set of populations that are not regularly assessed but which	3. Impact of Fishing on Indicator Species: • Impact of fishing on	Catches (total and by region)	1. Is the current level of aquaculture sustainable?	Aquaculture production: Tonnage

INDECO	STECF Indicators and indicator grouping SGRN (2006)	Anon (2006) Project FISH/2004/12	Huntington et al (2003) Project Fish/2002/13	Eurostat	European Environment Agency	
		are decreasing in number.	sensitive species. • Impact of fishing on unwanted species. • By-catch of marine mammals, seabirds and turtles. *Key variable: Proportion of population impacted by fishing. Where populations cannot be established, the pressure in terms of rate of removal and change in terms of relative proportion of the catch.*			production by Member State and nutrient production
	Proportion of sensitive habitats impacted	Average size (length and weight) in the community	4. Killing of marine mammals and seabirds *Key variable: Total number of animals killed by species and location*	Landings • Quantity • Value	2. Is the size and capacity of the European fishing fleet being reduced?	Fishing fleet capacity: Fleet tonnage and power by Member State
	Abundance of sensitive benthos species	Mean maximum length	5. Loss of defined habitat area *Key variable: Area of specific habitat types lost over time*	Foreign trade: Imports • Quantity • Value Exports • Quantity • Value	3. Is the use of commercial fish stocks sustainable?	Status of marine fish stocks: Spawning stock biomass
	Age and size at maturation of exploited fish species	Biodiversity indicators	6. Genetic integrity of wild populations *Key variables: Genetic fitness and resultant*	Trade balance: • quantity • value	*Other indicators*	

INDECO	STECF Indicators and indicator grouping SGRN (2006)	Anon (2006) Project FISH/2004/12	Huntington et al (2003) Project Fish/2002/13	Eurostat	European Environment Agency	
			changes in growth, age of maturity and survival.			
	Spatial and temporal distribution of fishing effort	Total aquaculture production and total area occupied by aquaculture installations		Fishing fleet • Number • Total tonnage • Total power	4. What is the impact of fisheries on habitats, benthos, mammals, birds, and turtles?	Accidental by-catch: birds, mammals and turtles: Numbers of bycatch and proportion of populations
	Catch and discard rates	Scientific advice in decision making		Employment	5. Are we achieving sustainable aquaculture?	Aquaculture production
		Category 2: Informative indicators which require further development before they can be made operational		Per capita supply	6. Are we achieving sustainable marine fishing?	Catches by major species and areas Total landings, tonnes
		Trends in abundance of sensitive benthos species.			7. Is the use of commercial fish stocks sustainable?	Fish stocks outside Safe Biological Limits in 2002: Spawning stock biomass in relation to SBL
		Effective fishing capacity			8. Is good surface	Fisheries

INDECO	STECF Indicators and indicator grouping SGRN (2006)	Anon (2006) Project FISH/2004/12	Huntington et al (2003) Project Fish/2002/13	Eurostat	European Environment Agency	
		(adjusted fishing effort) and its spatial and temporal distribution			water ecological status being achieved and the deterioration of aquatic ecosystems and habitats prevented?	impact habitats and ecosystems
		Mapping of effort distribution over the sensitive areas			9. EU policies aim through appropriate management of fisheries for sustainable fishing, over a long period of time within a sound ecosystem, while offering stable economic and social conditions for all those involved in the fishing activity.	Fishing fleet – trends
		Oil consumption as a proxy for CO2 production.			10. Is the use of commercial fish stocks sustainable?	The North Sea Cod stock
		Unwanted by-catches of protected species and discards				
		Level of imposition of punishment				
		Attitudes and awareness of stakeholders towards CFP environmental goals				
		Total quantity of funds				

INDECO	STECF Indicators and indicator grouping SGRN (2006)	Anon (2006) Project FISH/2004/12	Huntington et al (2003) Project Fish/2002/13	Eurostat	European Environment Agency
		allocated to relevant research and distribution of research funds			
		Number of violations (assuming that inspection is efficient)			