EU FP7 Project CREAM

Coordinating research in support to application of EAF (Ecosystem Approach to Fisheries) and management advice in the Mediterranean and Black Seas

Deliverable 3.1

State of the art on data collection, background and list of potential indicators for an EAF in the Mediterranean and Black seas

Start date of project: 01/05/2011 Duration: 36 months
Due date of deliverable: 31/07/2012
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1. State of the art on data collection

An ecosystem approach to fisheries is now accepted as the necessary framework for ensuring sustainable fisheries (Cochrane and de Young, 2008). There is a critical need for more rapid progress in the implementation of EAF in the Mediterranean marine ecosystem which is being affected and distorted by a number of serious anthropogenic threats. The more important threats include overfishing and other undesirable impacts of commercial and recreational fishing, poorly managed aquaculture operations, pollution, coastal zone development, invasive species and others.

Any fishery management system would be “blind” without a mechanism to collect reliable data on the fishery sector and resources to be analysed by scientists in order to provide a basis for decision-making (Garcia et *al.*, 2003). EAF requires a more comprehensive data collection system and analytical capacity than conventional management to monitor, understand and forecast the behaviour of the fishery, additional components of the fished ecosystem and the other uses of such ecosystem. Areas in which more data are needed include: Improvement of conventional statistics, identification of exploited ecosystems and identification of competitive uses.

EAF requires that conventional monitoring systems (at best using standard fishery statistics) be complemented or strengthened to follow trends of key environmental factors, habitat, endangered species, associated and dependent species, etc. To this aim, Garcia *et al.* (2003) stressed the need to implement environmental, biological and fisheries monitoring.

In the Mediterranean and Black Seas area, routine fisheries monitoring programmes are not implemented in all countries with harmonized protocols. Data collection is mainly driven by the EU DCF (Council Reg. (EC) 199/2008 and EC Reg. 665/2008) for the European countries, and by sub-regional or research projects in the other countries. The GFCM Task 1 has this objective of harmonizing the production of fisheries statistics all around the Mediterranean and Black Seas but currently struggles to gather this information for several reasons. A review of the different methods and data collection programmes in place within GFCM Member Countries is publicly available (GFCM, 2010).The report also details the differences between GFCM Task 1 and the EU Data Collection Framework (DCF) and evaluates the degree of compatibility between the two systems.

In 2010, RAC-SPA (UNEP-MAP RAC/SPA 2010) reported on a roadmap for the implementation of the EAF in central Mediterranean. They listed the main gaps to be addressed before implementing EAF:

- Lack of clear national strategy to systematically inventory marine and coastal biodiversity in many countries. Marine and coastal biodiversity-linked aspects do not have priority in political decisions, as is the case for social aspects.
- The national inventories of marine and coastal species and habitats are not homogeneous. For most countries they are incomplete; the effort made is more focused on the north-western Mediterranean.

- Many Mediterranean sectors and/or ecosystems remain little studied, even at a country level. Prospecting is usually done in areas that are easily accessed. The inventories drawn up in some countries (bibliography, site prospecting, updating etc.) are usually made in sectors concerned by programmes or action plans. Knowledge of the presence, distribution, abundance and conservation status of Mediterranean coastal and marine species is uneven for taxa and regions.
- Deep sea and high seas reference habitats have commonly been little explored.
- Lack of national taxonomic skills for many groups of marine flora and fauna. This inevitably results in dubious identification of species. Experts in taxonomy of most groups are strongly concentrated on a few countries, mostly lying in the northern part of the Mediterranean.
- Little sharing of recent knowledge within scientific circles in the various countries of the northern and southern Mediterranean.
- Absence of programmes for monitoring non-native species in many countries, particularly the countries of the southern Mediterranean.
- Patchy mapping of marine and coastal species and biocenoses, particularly those of conservation interest for the Mediterranean.
- Research done on marine and coastal biodiversity is compartmentalized, restricted to very narrow aspects, and lacks interdisciplinarity.
- Absence of coordinated and cross-border scientific research, probably related to financial and administrative constraints.

RAC-SPA (2010) added that gaps about “impacts and effects on marine and coastal biodiversity” can be observed at several levels: scientific knowledge; legal tools availability; enforcement of existing laws; public awareness; concrete actions and operational plan implementations.

The objective of the present document is to focus on the availability of data all over the Mediterranean and Black Seas and list the potential indicators which could be derived from these data. The quality of these data will be the object of the next deliverable (D3.3), since the quality information received (see Annex I) has not been processed so far.

When inventorying data requirements for EAF, there is a need to structure and to limit the questionnaire to avoid losing energy to unnecessary information and losing the scope of the project. Procedures for such implementation guidelines formally emerged at the 2001 Reykjavık Conference on Responsible Fisheries in the Marine Ecosystem (FAO, 2001, 2003) and were complemented by the output of the IOC-SCOR Working Group 119 on Quantitative Ecosystem Indicators for Fisheries Management.

Garcia *et al*. (2003) expressed that the description of the fishers’ interaction within the ecosystem requires the identification of four main ecosystem compartments: (1) a biotic compartment, including target fish resources, associated and dependent species and the living habitat (seagrass, algal beds, corals); (2) an abiotic compartment, characterized by its topography, bottom types, water quality and local weather/climate; (3) a fishery compartment, in which harvesting and processing activities take place, with a strong technological character, and (4) an institutional compartment, comprising laws, regulations and organizations needed for fisheries governance. Humans are part of the biotic component of the ecosystem from which they draw resources, food, services and livelihood as well as part of the fishery component which they drive. These components interact and are affected by: (i) non-fishing activities; (ii) the global climate; (iii) other ecosystems, usually adjacent, with which they exchange matter and information; and (iv) the socio-economic environment as reflected in the market, relevant policies and societal values. A simplified diagram of the interactions involved in an exploited ecosystem is given in Fig. 1.

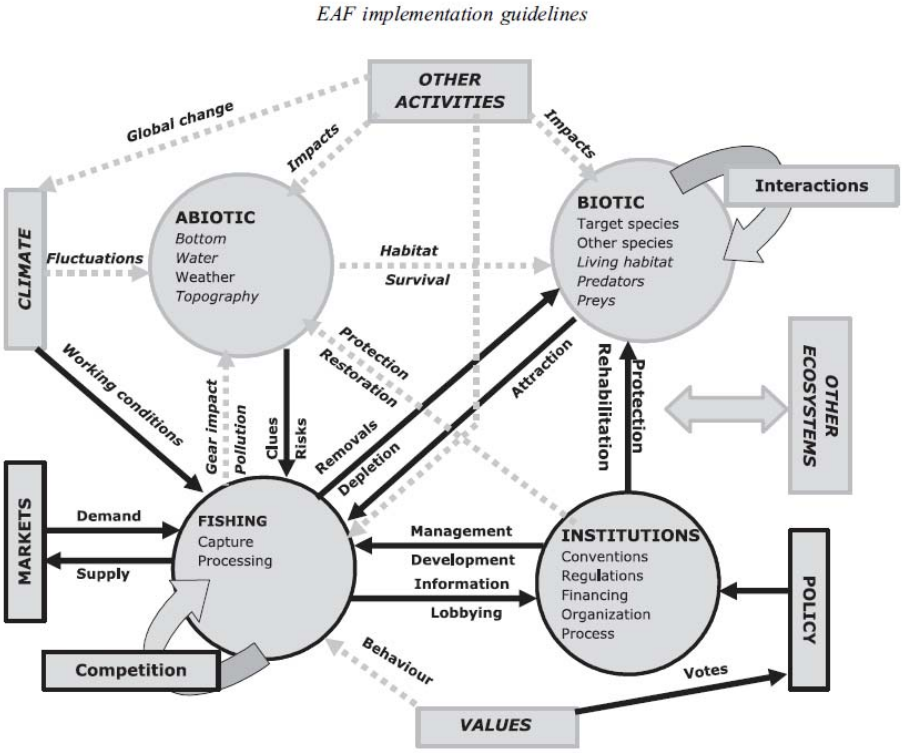

Fig. 1. EAF implementation guidelines.

The goals of EAF are ‘‘to balance diverse societal objectives, by taking into account the knowledge and uncertainties about biotic, abiotic, and human components of ecosystems and their interactions and applying an integrated approach to fisheries within ecologically meaningful boundaries (Fig. 1)’’ (FAO, 2003). This structuring of the information in 4 components will guide our description in this report.

2. Data mining

2.1. Material and method

A template document was first elaborated, in coordination with the WP2 leader (see Annex I) and sent to all CREAM partners. A period of 4 months was given for submitting the information and the first outcomes have been discussed in the Varna meeting (April 2012).

Table 1 lists the number of documents received from all partners, and it is noticeable that all documents were sent in full respect of the deadline given.

Table 1. Number of documents received from all partners

Institution	Country	Number of files
CSIC	Spain	2
HCMR	Greece	8
CIBM	Italy	5
UNIROMA	Italy	9
IFREMER	France	8
IRD	France	
IEO	Spain	3
CNR-IAMC	Italy	5
INRH	Morocco	2
INSTM	Tunisie	2
EGE UNIV	Turkey	13
NIMRD	Romania	4
IO-BAS	Bulgaria	4
VNIRO	Russia	7
YugNIRO	Ukraine	10
AU	Egypt	5
IOR	Croatia	2
AUB	Lebanon	9
MRRA	Malta	6
DFMR	Cyprus	6
WEFRI	Georgia	4
	Total	**114**

The 114 files received quickly proved to be difficult to interpret. All fields were filled in with free text and several parameters were often grouped into a single cell. In Varna, it was demanded to resubmit the WP3 forms with fixed entries in the different cells. After one month, only a few countries had resubmitted their data, so the decision was taken to extract by all means, all possible information from the first set of forms.

Recoding all parameters: In order to reduce the number of entries, all variables have been recoded in Excel. All results will be provided based on these recorded variables.

Multiplying the lines of information: R programme has been used to transform all the cells with more than one information into as many cells as necessary. For example, GSA06, 07 was duplicated in 2 rows, one for GSA06 and one for GSA07. The same applied to years, where continuous series were mentioned. For example, oldest date in time series = 1990, most recent date = 2011, created 22 lines corresponding to each year.

In terms of methods for displaying the information, the representation of the temporal information was done using the bubble plots designed within the FLR project (http:/flr-project.org), and the maps were created using the 'spacePlot' function designed within the COST project (http:/wwz.ifremer.fr/cost). The size of the bubbles and the color code for mapping represent the number of individual information received, i.e. the number of lines in the final table. Care must be taken for the interpretation as an ideal situation would be 10's of lines of information available for each topic and GSAs, given that each line corresponds to one year. So yellow or orange colouring in the maps may contain too little information of any use.

2.2. General overview

All CREAM partners have submitted at least one file of information as presented in Fig. 2. The oldest year available was 1864 for Italy, 1950 for Egypt, 1955 for Ukraine, 1970 for Bulgaria but for the clarity of the figures, all bubble plots will begin in 1980. It is only from 2000 onwards that most of the information is available, with some noticeable scarcity of information in some countries.

Figure 3 details the information by GSA and the figure seems more complete than Fig. 2, as some countries are covering several GSAs. It is noticeable that there is a gap in recent years for GSA 20 and 22 due to the stoppage of the DCF programmes by Greece, and the gaps in GSA 18 and 19 to be investigated.

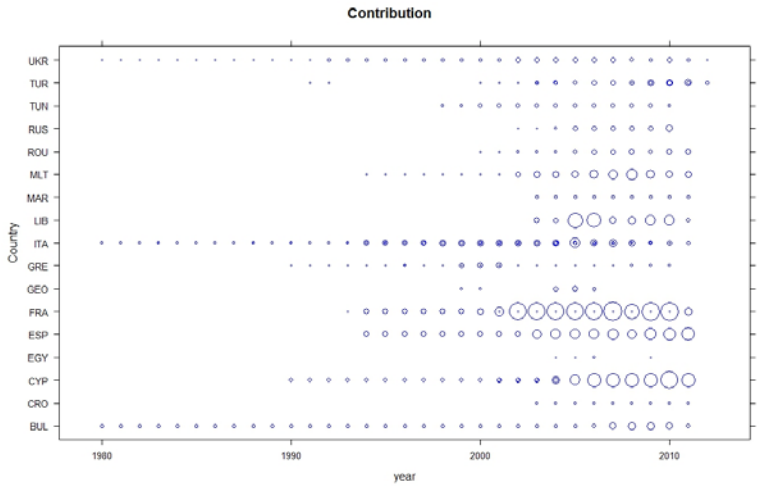

Fig. 2. Relative amount of information received by country and year.

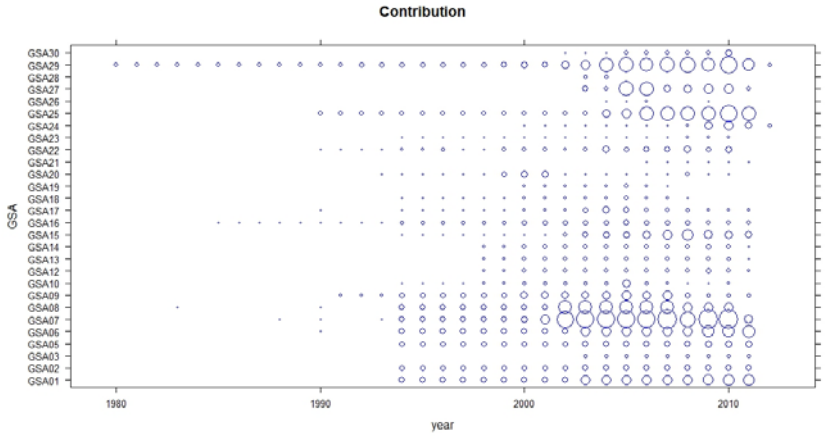

Fig. 3. Relative amount of information received by GSA and year.

The contributors by area are shown in Fig. 4 and the map of the contribution is shown in Fig. 5. No information was received from the GSA around Sardinia (GSA11) and in front of Algeria (GSA04).

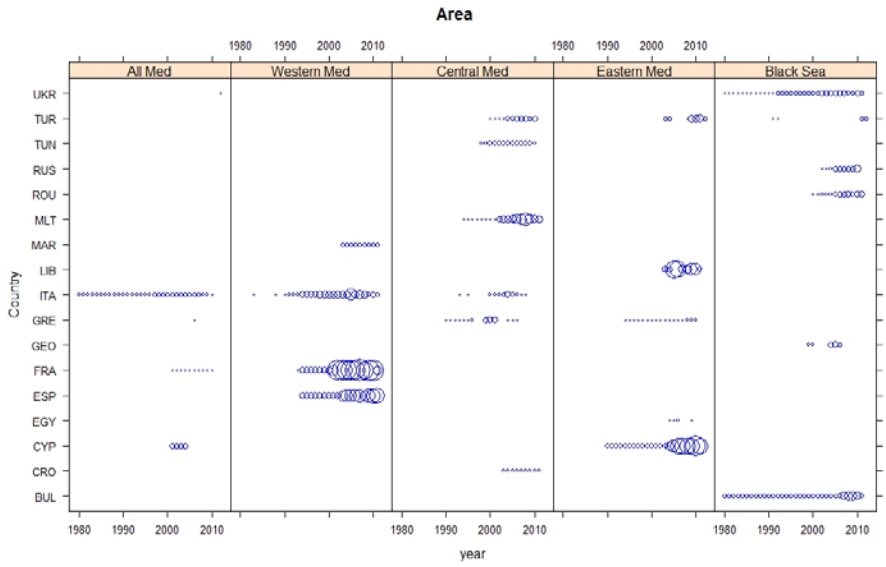

Fig. 4. Relative amount of information received by area and year.

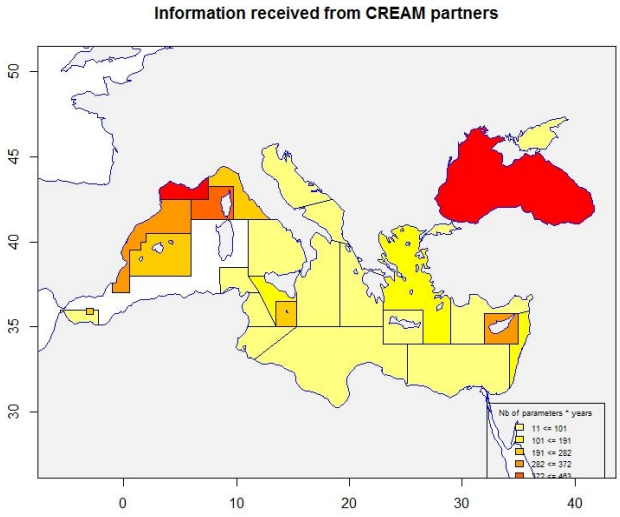

Fig. 5. Location of the information received

2.3. Activities reported

Types of activities as shown in Fig. 6 show the lack of surveys in the Black Sea, the scarcity of information on management. Assessment was reported as monitoring activities in the western and central Mediterranean, so their absence here is misleading.

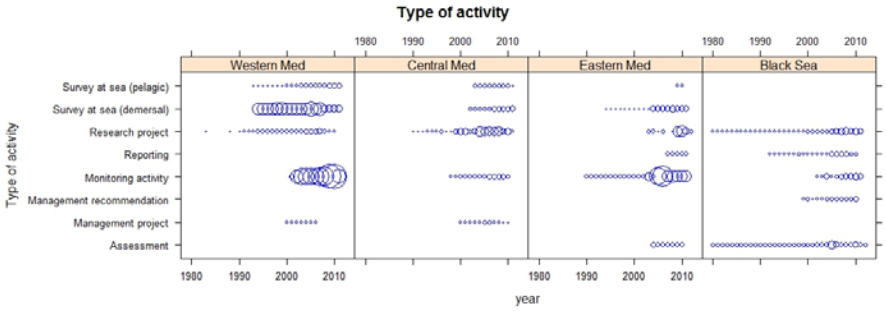

Fig. 6. Relative amount of information received by type of activity and year.

2.4. Type of outcomes

It is noticeable in Fig. 7 that habitat description and impact of fishing activities are very scarce if not absent in the available data. Most of the partners have reported their parameters citing a species or a list of species as an outcome of the described project, which explains the relative importance of this "outcome" in the figure, but cannot be interpreted as such.

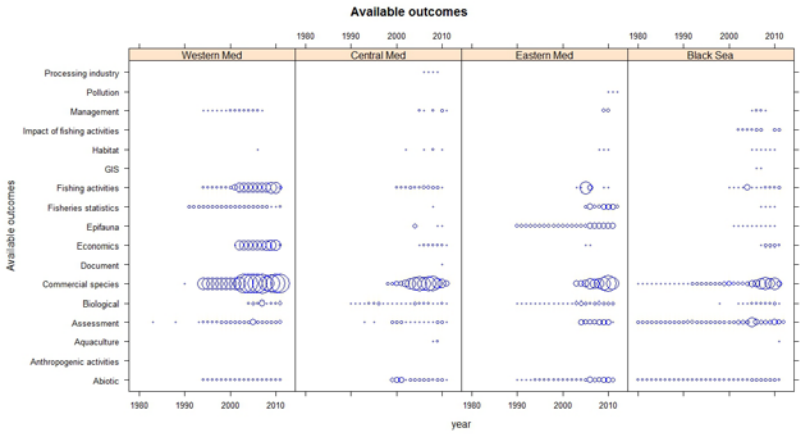

Fig. 7. Relative amount of information received by outcome and year.

The CREAM consortium was of the opinion that, although important for the EAF, the anthropogenic activities other than fishing (aquaculture, pollution, habitat modification), the processing industry and the management considerations were not in the scope of the current data mining. The reasons are that these subjects (i) are too wide and could lead to an enormous amount of literature and data and (ii) are beyond the competence of the consortium.

2.5. Parameters collected

Some parameters presented in Fig. 8 demonstrate that this first data mining is incomplete. This is mainly the case for fleet information where it is known that this information is available in every single country. For the remaining parameters it is clear that when available the historical series hardly extend before 1990.

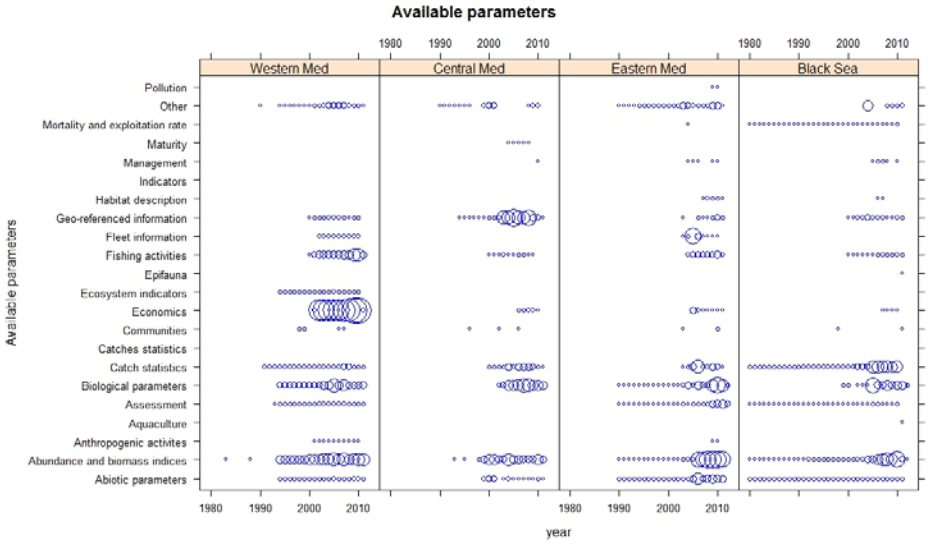

Fig. 8. Relative amount of information received by type of parameter and year.

2.6. Nature of the data

The availability of data in a structured database is the best situation at the moment for answering any demand. Information in Excel file is often not structured and lacking agreed reference entries, but the data is usually workable. It is not the case when the information is given in text format. Figure 9 shows that databases is the main source of information in the western Mediterranean and Excel files is the norm for the other 3 areas.

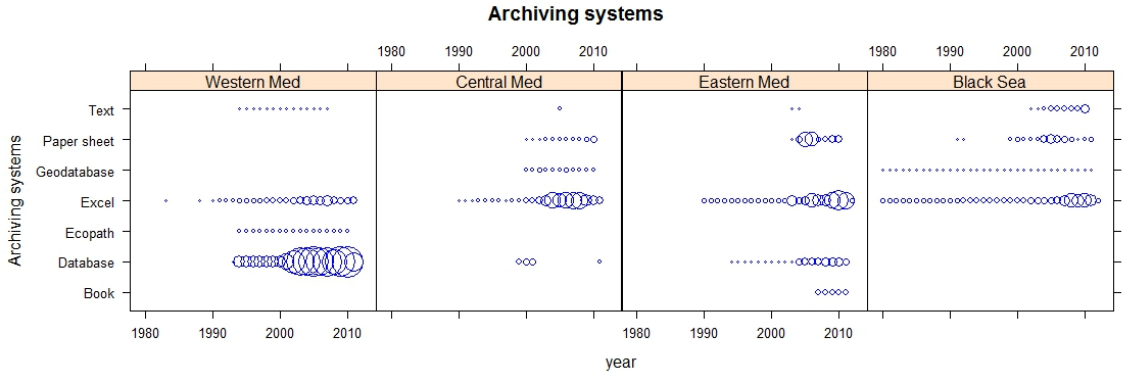

Fig. 9. Relative amount of information received by archiving system and year.

3. List of potential indicators

Fisheries publications on ecosystem indicators, or ecological indicators, have flourished over recent years. The ideas of an ecosystem approach to fisheries, and of indicators as tools for fisheries management, were already discussed in the 70s, whereas their close association emerged during the 90s (Rochet *et al*., 2007). This association is now widely accepted, justifying for example the organization of a whole Symposium on 'Quantitative ecosystem indicators for fisheries management' in 2004 (Curry and Christensen, 2005). Proposing a list of potential indicators is therefore an exercise which cannot be complete and comprehensive. The reader will thus attach more importance to the classification/headlines and the methodology to construct an indicator and take the potential list as guidance for potential indicators.

At the first stage, it may be informative to find a definition of indicator. In the FAO fisheries glossary[1] one definition is proposed and seems to cover most of what can be found in the literature '*A device for showing the operating condition of some system. A number or ratio (a value on a scale of measurement) derived from a series of observed facts. Can reveal relative changes as a function of time. In the sustainable development framework, variable attributes of the criteria that can be used to track the state (represent trends) of a system component and the degree of implementation of the principle, the performance of governance. Indicators are usually directly connected to operational objectives. They convey a simple, useful message but may aggregate more than one element of information. In relation to the criteria listed above, indicators could be: (i) biomass and catch rates (for abundance); (ii) species diversity and average trophic level (for composition); (iii) coefficient of variation of catch or biomass (for variability*).'

3.1. EU projects and ecosystem indicators

The analysis proposed here is not an exhaustive review of EU projects dealing with ecosystem indicators, but a selection of key projects directly relevant to the CREAM project.

3.1.1. IMAGE

The objectives of IMAGE (Anon, 2010), were

1. To develop an operational framework of candidate indicators (ecological, economic, social) that can support ecosystem-based fisheries management on the regional and pan-European scale.
2. To elaborate these indicators in comprehensive dashboards (e.g. current values, trends, reference levels).
3. To develop methodology to integrate this information into tools supporting the decision-making process.
4. To develop a framework that can evaluate management strategies based on indicators.
5. To advise on how indicators can be used to support EBFM in selected regional case studies based on the new RAC areas (including Mediterranean).

[1] http://www.fao.org/fi/glossary/

The indicators chosen within this project are listed in Tables 1 and 2 in Annex II.

Several considerations determine the choice of the number of selected indicators. The first is determined by the number of ecosystem components and attributes that are considered necessary to describe the ecosystem sufficiently comprehensive while acknowledging that it is not possible to fully describe this ecosystem in all its complexity. The second consideration is that we need indicators for state, pressure and response (Jennings 2005). A minimum requirement for the ecosystem indicators would be that at least one headline indicator with a specific indicator is selected for each ecosystem component and attribute for which operational objectives are formulated.

In EAF management advice, indicators may serve different purposes (Rochet *et al.,* 2007). For example, they can be used in control rules based on reference points that trigger management actions. This approach adopted for the Convention on the Conservation of Antarctic Marine Living Resources (Constable *et al.*, 2000) necessitates the setting of reference points for both prey and predator species. In many instances interactions may be more complex and would need to integrate several criteria. In this case, weighting and combination rules are needed, increasing the difficulty as the number of indicators rises.

Rochet *et al.* (2007) defined three types of indicators, with examples given in Table 3 in Annex II.

1. A control indicator is a variable which summarizes a process or pattern of interest in an exploited ecosystem. A structured suite of control indicators will reveal important changes or differences to decision makers. Control indicators are control tools used for giving science-based advice to management bodies.
2. A performance indicator is a variable which quantifies how well a fishery is managed, in relation to specified objectives. A performance indicator typically has an audit function.
3. A spread indicator summarizes complex phenomena to reveal important changes or differences to stakeholders. Spread indicators are tools dedicated to the communication with a wide audience.

3.1.2. MESMA

MESMA[2] is an ongoing EU project focusing on marine spatial planning and aiming to produce integrated management tools (concepts, models and guidelines) for monitoring, evaluation and implementation of Spatially Managed Areas (SMAs). The project results will support integrated management plans for designated or proposed sites with assessment methods based on European collaboration. The project is not making use of indicators as such, but geospatial and meta data, and thus, must be seen as a means to archive, exchange and display the international information. As a product of EU project MESMA, Katsanevakis *et al.* (2012) provides insights on effective monitoring of populations and communities with the aim of assisting marine biologists and managers to understand the limitations and pitfalls associated with some approaches and to select the best available methods for their monitoring needs. The marine components considered are fish populations, the endobenthos, epibenthos, hyperbenthos, zooplankton, marine mammals, seabirds, marine turtles.

[2] http://www.mesma.org/default.asp?ZNT=S0T1O733

3.1.3. INDISEAS

The indicators proposed within the EU project INDISEAS[3] were selected to address four specific management objectives: Conservation of Biodiversity (CB), ecosystem Stability and Resistance to perturbations (SR), Ecosystem structure and Functioning (EF) and Resource Potential (RP). In the review of existing ecosystem indicators, several categories of indicators were distinguished (Cury and Christensen 2005): size-based, species-based, and trophodynamic indicators. The eight indicators outlined in Annex III, Table 1 were selected based on the above criteria, and are proposed as a minimum set of indicators for diagnosing the status of an ecosystem. Six of the indicators were used to measure the state (S) of the ecosystem and six were used to measure trends (T) over time. Data for the indicators are derived primarily from fisheries independent surveys and commercial fisheries data, with auxiliary information where indicated.

A minimal list of ecosystem indicators corresponding to management objectives is presented in Table 1 of Annex III. A more detailed list of indicators proposed by Shin *et al.* (2010) is presented in Table 2 of Annex III.

3.2. EU MSFD and DCF indicators

The EU Marine Strategy Framework Directive (MSFD) adopted in July 2008 aims at achieving or maintaining a good environmental status by 2020 at the latest. It is the first legislative instrument in relation to the marine biodiversity policy in the European Union, as it contains the explicit regulatory objective that "biodiversity is maintained by 2020", as the cornerstone for achieving good environmental status. It enshrines in a legislative framework the ecosystem approach to the management of human activities having an impact on the marine environment, integrating the concepts of environmental protection and sustainable use. In order to achieve the objective the Member States have to develop Marine Strategies which serve as Action Plans and which apply an ecosystem-based approach to the management of human activities.

The Commission Decision on criteria and methodological standards on good environmental status (GES) of marine waters in the framework of Article 9 (3) of the MSFD contains a number of criteria and associated indicators for assessing good environmental status, in relation to the 11 descriptors of good environmental status laid down in Annex I of the Directive.

1. Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.
2. Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems.
3. Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock.
4. All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity.

[3] http://www.indiseas.org/

5. Human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters.
6. Sea-floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.
7. Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems.
8. Concentrations of contaminants are at levels not giving rise to pollution effects.
9. Contaminants in fish and other seafood for human consumption do not exceed levels established by Community legislation or other relevant standards.
10. Properties and quantities of marine litter do not cause harm to the coastal and marine environment.
11. Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.

The indicative list of characteristics, pressures and impacts proposed in the Directive is presented in Annex IV. Criteria and methodological standards are given in the Commission Decision 2010/477/EU (European Union, 2010).

It is important to notice that the EU MSFD is structuring all data collection systems in European countries and that, in support to the Barcelona Convention for the implementation of the ecosystem approach, UNEP-MAP (UNEP-MAP, 2012) agreed that, as a starting point, the 11 EU MSFD descriptors will be used as a basis for defining the Mediterranean ecological objectives taking into account the regional specificities.

The EU DCF (European Union, 2010) in force since 1st of January 2009 in all EU countries with a fishing industry, included 9 ecosystem indicators as being mandatory to process each year. These indicators result from two STECF expert workshops held in 2006[4] and the approach was to identify indicators based on work in several EU-funded projects (i.e. INDECO, INDENT) as well as previous STECF reports. The 9 indicators are presented in Annex V.

3.3. Indicators from international organisations

FAO has long developed guidelines for the implementation of EAF (Garcia, 2003), and has set up a reference webpage[5] on the EAF toolbox. The indicators and performance measure selection are developed in Step 3 – Development of the EAF management system. In the ensuing source of information, each document proposes different sets of indicators from socio-economic to ecosystem indicators. Perry *et al.* (2010) summarizes the most recent findings and proposes a core or minimal list of indicators (Table 1 in Annex VI).

Also relevant to EAF is the Mediterranean Action Plan (MAP) of the Barcelona Convention, which was created under the auspices of the United Nations Environment Programme (UNEP) and MAP. MAP and the Barcelona Convention have led to the development and entry into force of the Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean Sea.

[4] http://stecf.jrc.ec.europa.eu/documents/43805/122924/06-06_SG-RN+06-01+-+Ecosystem+approach_SECxxx.pdf

[5] http://www.fao.org/fishery/eaf-net/topic/166272/en

The Convention on Biological Diversity[6], the SEBI programme[7] and UNEP-MAP[8] have all developed a list of indicators for biodiversity monitoring and ecosystem approach. Levrel *et al.* (2010) made a comprehensive comparative description of these indicators. He underlined that most indicators were not related to a specific conceptual framework and rather associated to broad topics, and that most indicators were less focused on the component of biodiversity itself than on the anthropogenic pressures and the ecosystems services that biodiversity delivers to human society. He concluded that a great number of these indicators were not used, nor implemented.

Only the core set of indicators for assessing progress towards the 2010 Biodiversity Target as presented in CBD decision V111/15 (2006) is given in Annex VII. These are issued from a workshop convened by the UNEP World Conservation Monitoring Centre (UNEP-WCMC) in cooperation with the Convention on Biological Diversity (CBD) held in 2010 in order to propose biodiversity indicators (UNEP-WCMC, 2010).

4. Implementation and use of the indicators

All indicators presented in annexes of this document need to be pooled into categories, scored following agreed methodology and prioritised for implementation. In order to prepare for this in the CREAM project, a rich literature exists on good practice and experiences over the world. One key forum was the symposium on “Quantitative Ecosystem Indicators for Fisheries Management” held in Paris during the spring 2004. The symposium was centred on using ecosystem indicators for fisheries management (Cury and Christensen, 2005).

The development of ecosystem approaches to environmental management implies the need to account for multiple pressures on ecosystems (Rochet *et al.*, 2010). Trends in multiple metrics that respond differently to changes in major environmental pressures need to be combined to evaluate the impacts of fishing and environmental changes on fish communities.

Conception of an operational EAF faces many issues, ranging from the high cost of the science required to the practical difficulties of changing the governance system and processes. From a scientific perspective, difficulties are related to: (i) defining proper long-term, ecosystem-related, objectives; (ii) determining meaningful indicators and reference values for desirable or undesirable ecosystem states; and (iii) developing appropriate data collection, analytical tools, and models (Cury *et al.*, 2005).

Rice and Rochet (2005) proposed steps necessary to select wisely from the long list of diverse, potential indicators for use in fisheries management. The framework encompasses eight steps, and provides guidance on pitfalls to be avoided at each step.

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[6] http://www.cbd.int/ and the list of indicators: http://www.cbd.int/2010-target/framework/indicators.shtml and http://www.cbd.int/indicators/testedindicators.shtml

[7] SEBI: Streamlining European 2010 Biodiversity Indicators (http://ec.europa.eu/environment/nature/knowledge/eu2010_indicators/index_en.htm)

[8] United Nations Environment Programme – Mediterranean Action Plan for the Barcelona Convention. http://www.unepmap.org/index.php

- Step 1: identify user groups and their needs, featuring the setting of operational objectives.
- Step 2: develop a list of candidate indicators.
- Step 3: assigns weights to nine screening criteria for candidate indicators: concreteness, theoretical basis, public awareness, cost, measurement, historic data, sensitivity, responsiveness, and specificity.
- Step 4: score the indicators against the criteria.
- Step 5: summarize the results.
- Step 6: decide how many indicators are needed.
- Step 7: make the final selection of complementary suites of indicators.
- Step 8: presentation to all users of the information contained.

Ordinarily, these steps should be done interactively with the users of the indicators, thus providing guidance on process rather than technical approach. Within the CREAM project, this approach is highly relevant, and should be the basis of the selection of indicators for the EAF in the Mediterranean and Black Seas.

5. Conclusions

The reception of 114 files of information by all partners proved that all CREAM partners were committed to extract the information demanded from their archives and routine monitoring programmes.

The spatial gaps identified are from countries which are not part of the consortium like Libya and Algeria, or region (Sardinia, East of Italy) not covered by CREAM partners.

In terms of temporal information, only the last 20 years can be used, and apart from some exceptions it will be impossible to create indicators prior to the 90's. There are some gaps also in the most recent years, in particular linked to the fact that Greece ceased to collect data from 2008 onward.

In general all data available are in Excel files, which could lead to inconsistencies in references used when compiled at a supra-national level. In the Western Mediterranean, a major part of the data are stored in structured database which is usually synonymous of better quality. Lots of information were based on reports and outcomes of research projects and even a book. This kind of information is much more difficult to process.

There was an extensive amount of information provided by seaDataNet to the project for the abiotic component. This information collected by buoys or other data collection electronic devices should find a usage when implementing EAF, in particular in the elaboration of abiotic indicators. It is expected that the outcomes of project LaMed will contribute to the knowledge of the institution component of the EAF. More details on which indicators to use from these two projects will be included in deliverable D3.3 planned to be submitted at M24 of the project (spring 2013).

The anthropogenic activities (other than fishing) are an essential part of the understanding of the trends and status of ecosystems. These activities are, amongst others, aquaculture, pollution, construction, modification of habitats, etc… Several partners listed some of these activities, but it was agreed among the group that without guidance on what information is important, we should not seek for this kind of data. This may be the object of further discussion since Garcia *et al.* (2003) expressed that a complete inventory of competitive uses of the fishery resources and environment, including sources of land-based pollution and degradation, need to be developed.

The gaps identified by RAC-SPA (2010) are often confirmed. For example, it is confirmed that the national inventories of marine and coastal species and habitats are not homogeneous. For most countries they are incomplete; but when RAC-SPA says that the effort made is more focused on the north-western Mediterranean, this current data mining suggests that it is more in the eastern Mediterranean and the Black Sea. This is not surprising knowing the specificities of the region with countries' economies ranging from low-income food-deficit to highly developed; their coastlines from deserted to heavily urbanised; and their fisheries from unindustrialized and labour intensive to modern and capital intensive. Although often overlooked in the statistics, these fisheries play important livelihood, food security, cultural, and recreational roles (Cochrane and de Young, 2008).

The next stage for data mining will be to better describe the bulk of information received and proceed to a quality evaluation. The next deliverable is planned for month 24 and will be a report on the Overview of data available in support of an EAF in the Mediterranean and Black seas, and evaluation of their quality (D3.2). The report will also include a proposal for a logical organisation of the data and statistics.

The lists of potential indicators presented in annexes of this document are to be considered as examples of indicators. Specific indicators will need to be developed in the context of the Mediterranean and Black Seas, probably developing upon data-limited situations. Indicators will need to be clustered, evaluated with a scoring system before making a choice. This work will be prepared by correspondence and finalise with all the partners during a workshop. The outcomes will serve the needs of the report on proposed indicators, models, methodologies and reference points for the EAF in the Mediterranean and Black Seas (D3.3).

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Annexes

Annex I. Form used to gather the information

CREAM

Coordinating research in support to application of Ecosystem Approach to Fisheries (EAF) and management advice in the Mediterranean and Black Seas

(KBBE20101.4.08 – Contract no. 265648 20112014)

Work Package 3 - Data needs, quality, harmonization, methodologies and models for EAF

Identifying data needs for an EAF: existing data (EC DCF, GFCM Task), quality and harmonization, definition of standard templates for describing the methodologies; data gaps (time and spatial coverage; identifying additional data collection programs and EC, Regional and National research priorities).

Information provided by (Partner code and partner name):

1. GENERAL INFORMATION	
Title of the activity:	
Type of activity: Research Project, Monitoring activity, Stock assessment, Modelling, Other (Indicate)	
Leader Institution:	
Coordinator Name:	
Partners:	
Relevance to EAF (low, medium, high)	

2. DATA INFORMATION

Available outcomes (fishing activities, species, biological, economics, abiotic, legal, …)	**Observed/ measured parameters**	**Status of the data** (Raw, Aggregated, Estimates, Report)	**Nature of the data** (File, Text, Other (specify)	**Archiving support** (Excel, paper sheet, Oracle, …	**Geographical coverage** (country, GSA, …)	**Oldest date in archive** (year)	**Most recent date in archive** (year)	**Continuous time series** (Yes / No)	**Comment**

3. DATA QUALITY	Comments
Completeness / historical series	Is there any gap in the time series, or years with incomplete information
Data validation / error checking	Routine data validation to check for completeness of data items and invalid data entries
Reliability	the data are recorded in a consistent way using standardised definitions
Methodology / protocol	Availability of an agreed methodology (short description (max 500 words), or link to a website
Accuracy	Is there any source of **bias** that could affect the results. Is **precision** of the results available (CVs, standard errors, ...)
Accessibility	Public, Not available, Available under certain conditions (time delay; specific agreement), Restricted (see next bullet)
Entity that can release the authorization for data use	
Free comment	

Annex II. Indicators proposed by EU project IMAGE

Industry indicators (community-scale information to be gathered annually via existing data collection routines)	
Profitability	Costs/earnings per sector General local economic performance
Fisheries-related activity	Number of business Full-time employment by gender, age, nationality per sector % total local employment
Economic value	Economic value per local sector %economic value relative to total sector %local GDP from fisheries
Community indicators (qualitative data to be gathered annually via community for a)	
Population (fisheries/general)	Community size Community diversity Community skills Employment/training opportunities
Social well-being (fisheries/general)	Job satisfaction Cost of living (qualitative) Perception of choice community-identify fit
Institutional Arrangement Indicators (qualitative data to be gathered annually via community for a)	
Social policy	Accessibility of advice, support and funds Degree of advice, support and funds
Fisheries governance	Understanding of fisheries management Perception of fleet restrictions Legitimacy of fisheries management Participative opportunities in fisheries management

Table 1: Seven headline socio-economic indicators and their specific indicators spanning industry, community and institutional aspects.

Headline indicators	Specific indicator
Physical environment	Temperature NAO
Chemical environment	Salinity Oxygen concentration N and P levels
Phytoplankton	Primary production Water transparency Chlorophyll a
Zooplankton	CPR-derived plankton indicators Zooplankton biomass
Abundance commercial stocks	Proportion within safe biological limits
Abundance other populations	Numerical abundance selected species Biomass selected species Measure of decline
Size/Age structure species	Average length selected species Average weight selected species Average age selected species
Species composition community	Mean maximum length Biodiversity – Hill's N0 Biodiversity – Hill's N1 Biodiversity – Hill's N2 Proportion of target species
Abundance community	Total numbers Total biomass
Status marine mammals	Abundance selected marine mammal species
Status seabirds	Abundance selected seabirds species
Status marine reptiles	Abundance selected marine reptile species
Status benthos	Abundance sensitive benthic species Epibenthos community Infauna community
Status sensitive habitat	Area coverage sensitive habitats
Ecosystem functioning	Ecosystem functioning Primary production Catch ratios Mean transfer efficiency Trophic level

Headline indicators	Specific indicator
	Fishing in balance index
	Finn Cycling Index
Fleet capacity	Fleet capacity (Number vessels)
Fishing effort	Fishing effort (hours fishing)
Fishing impact	Mortality commercial species
	Mortality other fish species
	Mortality benthic species
	Mortality marine mammals
	Mortality vulnerable species
	Proportion catch discards
	Proportion area affected

Table 2: Selected indicators after application of a selection criteria

Type of indicator	Units	Pressure	State	Response
Performance	Objective 1	F on each target stock		
	Objective 2	Total amount of discards; Surface area trawled / year	Biodiversity of the benthos and fish communities; a 'large fish' indicator	
Control	Target stocks	F, ratio discards/catch	SSB	TAC, compliance Minimum landing size, compliance
	Non-target species	Number discarded	Survey-based: abundance, total mortality, length indicators	
	Fish community	Total catch, Surface area trawled / year	Survey-based: total abundance & biomass, length and diversity indicators	Legal mesh size, boxes (% area closed, % area with specific measures)
	Fleets	Landings per target species, effort spatial distribution, days-at-sea and fishing days / year, diversity of fishing practices, total discards		Effort regulation, compliance
	Fleet × target stock matrix	Exploitation diagram	Production	
Spread	Fleets	Ratio discards / target landings, Surface area trawled / year	Production	

Table 3: Example of performance, control and spread indicators (in Rochet *et al*. 2007)

Annex III. Indicators proposed by EU INDISEAS

Indicators	Headline label	Calculation, notations, units	Used for (S)tate, (T)rend	Expected Trend	Manage-ment Objectives	Management Direction
Total biomass of surveyed species	biomass	B (tons)	T	D	RP	Reduction of overall fishing effort and quotas
1/(landings /biomass)	inverse fishing pressure	B/Y retained species	T	D	RP	Reduction of overall fishing effort and quotas
Mean length of fish in the community	fish size	$\overline{L} = \frac{\sum_i L_i}{N}$	S,T	D	EF	Reduction of overall fishing effort and fishing effort on large fish species
TL landings	trophic level	$\overline{TL}_{land} = \frac{\sum_s TL_s Y_s}{Y}$	S,T	D	EF	Decrease fishing effort on predator fish species
Proportion of under and moderately exploited stocks	% sustainable stocks	number (under+moderately exploited species)/total no. of stocks considered	S	D	CB	Decrease fishing effort on overexploited species. Diversify resource composition
Proportion of predatory fish	% predators	prop predatory fish= B predatory fish/B surveyed	S,T	D	CB	Decrease fishing effort on predator fish species
Mean life span	life span	$\frac{\sum_s (age_{max} B_s)}{\sum_s B_s}$	S,T	D	SR	Decrease fishing effort on long-living species
1/Coefficient of variation of total biomass	biomass stability	mean(total B for the last 10 years) /sd(total B for the last 10 years)	S	D	SR	

Table 1: Minimal list of ecosystem indicators with corresponding management objectives (L: length (cm), i: individual, s: species, N: abundance, B: biomass, Y: catch (tons), D=decline over time, RP = Resource Potential, EF = Ecosystem structure and Functioning, CB=Conservation of Biodiversity, SR = Ecosystem Stability and Resistance to Perturbations.

Headline indicators	Specific indicator
Size-based indicators	Mean length/weight in community Maximum length in community Mean maximum length in community Slope of size spectrum Slope of diversity size spectrum Proportion of large fish Proportion of large species
Trophodynamic indicators	TL landings TL community Fishing in-balance index Proportion of predatory fish Pelagic to demersal fish biomass ratio Piscivorous to zooplanktivorous fish biomass ratio
Species-based indicators	Species richness Shannon and Hill's index of diversity K-dominance, ABC curves, W-statistic Ration of endangered to unendangered species Ratio of target to non target species Proportion of sustainability or under / moderately exploited stocks Mean lifespan
Pressure indicators	Overall fishing mortality rate Exploited fraction of ecosystem surface Mean distance of catches from the coast Catch rate by community Discard rate
Biomass-related indicators	Total community biomass Coefficient of variation in biomass

Table 2: Initial list of candidate indicators

Annex IV. EU MSFD Indicative lists of characteristics, pressures and impacts

Headline indicators	Specific indicator
Physical and chemical features	Topography and bathymetry of the seabed, Annual and seasonal temperature regime and ice cover, current velocity, upwelling, wave exposure, mixing characteristics, turbidity, residence time, spatial and temporal distribution of salinity, spatial and temporal distribution of nutrients (DIN, TN, DIP, TP, TOC) and oxygen, pH, pCO2 profiles or equivalent information used to measure marine acidification.
Habitat types	The predominant seabed and water column habitat type(s) with a description of the characteristic physical and chemical features, such as depth, water temperature regime, currents and other water movements, salinity, structure and substrata composition of the seabed, identification and mapping of special habitat types, especially those recognised or identified under Community legislation (the Habitats Directive and the Birds Directive) or international conventions as being of special scientific or biodiversity interest, habitats in areas which by virtue of their characteristics, location or strategic importance merit a particular reference. This may include areas subject to intense or specific pressures or areas which merit a specific protection regime
Biological features	A description of the biological communities associated with the predominant seabed and water column habitats. This would include information on the phytoplankton and zooplankton communities, including the species and seasonal and geographical variability, information on angiosperms, macro-algae and invertebrate bottom fauna, including species composition, biomass and annual/seasonal variability, information on the structure of fish populations, including the abundance, distribution and age/size structure of the populations, a description of the population dynamics, natural and actual range and status of species of marine mammals and reptiles occurring in the marine region or subregion, a description of the population dynamics, natural and actual range and status of species of seabirds occurring in the marine region or subregion, a description of the population dynamics, natural and actual range and status of other species occurring in the marine region or subregion which are the subject of Community legislation or international agreements, an inventory of the temporal occurrence, abundance and spatial distribution of nonindigenous, exotic species or, where relevant, genetically distinct forms of native species, which are present in the marine region or subregion.
Other features	A description of the situation with regard to chemicals, including chemicals giving rise to concern, sediment contamination, hotspots, health issues and contamination of biota (especially biota meant for

Headline indicators	Specific indicator
	human consumption), a description of any other features or characteristics typical of or specific to the marine region or subregion
Physical loss	Smothering (e.g. by man-made structures, disposal of dredge spoil), sealing (e.g. by permanent constructions).
Physical damage	Changes in siltation (e.g. by outfalls, increased run-off, dredging/disposal of dredge spoil), abrasion (e.g. impact on the seabed of commercial fishing, boating, anchoring), selective extraction (e.g. exploration and exploitation of living and non-living resources on seabed and subsoil).
Other physical disturbance	Underwater noise (e.g. from shipping, underwater acoustic equipment), marine litter.
Interference with hydrological process	Significant changes in thermal regime (e.g. by outfalls from power stations), significant changes in salinity regime (e.g. by constructions impeding water movements, water abstraction).
Contamination by hazardous substances	Introduction of synthetic compounds (e.g. priority substances under Directive 2000/60/EC which are relevant for the marine environment such as pesticides, antifoulants, pharmaceuticals, resulting, for example, from losses from diffuse sources, pollution by ships, atmospheric deposition and biologically active substances), introduction of non-synthetic substances and compounds (e.g. heavy metals, hydrocarbons, resulting, for example, from pollution by ships and oil, gas and mineral exploration and exploitation, atmospheric deposition, riverine inputs), introduction of radio-nuclides.
Systematic and/or intentional release of substances	Introduction of other substances, whether solid, liquid or gas, in marine waters, resulting from their systematic and/or intentional release into the marine environment, as permitted in accordance with other Community legislation and/or international conventions.
Nutrient and organic matter enrichment	Introduction of other substances, whether solid, liquid or gas, in marine waters, resulting from their systematic and/or intentional release into the marine environment, as permitted in accordance with other Community legislation and/or international conventions.
Biological disturbance	Introduction of other substances, whether solid, liquid or gas, in marine waters, resulting from their systematic and/or intentional release into the marine environment, as permitted in accordance with other Community legislation and/or international conventions.

Annex V. EU DCF Definition of environmental indicators to measure the effects of fisheries on the marine ecosystem

Indicators (a)	Definition	Data required	Precision
(1) Conservation status of fish species	Indicator of biodiversity to be used for synthesizing, assessing and reporting trends in the biodiversity of vulnerable fish species	Species, length and abundance from fisheries- independent research survey(s) for relevant marine region. Accurate reporting of these indicators requires that all species that contribute to the indicator are consistently and reliably identified. Survey catches shall be fully sorted (not sub-sampled) to ensure that all individuals of every species that contributes to the indicator are recorded but sub sampling is allowed in length measurements where duly justified.	Research survey should cover largest proportion of the marine region over the longest available time period. The indicator would be survey specific. The methods require that surveys are conducted annually in the same area with a standard gear.
(2) Proportion of large fish	Indicator for the proportion of large fish by weight in the assemblage, reflecting the size structure and life history composition of the fish community.		
(3) Mean maximum length of fishes	Indicator for the life history composition of the fish community		
(4) Size at maturation of exploited fish species	Indicator of the potential 'genetic effects' on a population	Individual measurements of age, length, sex and maturity from fisheries-independent research survey(s) for relevant marine region.	At least 100 individuals per age class but more fish will improve the power of this indicator.
(5) Distribution of fishing activities	Indicator of the spatial extent of fishing activity. It would be reported in conjunction with the indicator for 'Aggregation of fishing activity'.	Position and vessel registration data based on VMS Available within two months of position reports being received, with all positions linked to the level 6 for the *metier* classification (see Appendix IV (1-5)). This does not include vessels below 15 m.	Preference for position reports every half hour.
(6) Aggregation of fishing activities	Indicator of the extent to which fishing activity is aggregated. It would be reported in conjunction with the indicator for 'Distribution of fishing activity'.		
(7) Areas not impacted by mobile bottom gears	Indicator of the area of seabed that has not been impacted by mobile bottom fishing gears in the last year. It responds to changes in the distribution of bottom fishing activity resulting from catch controls, effort controls or technical measures (including MPA established in support of conservation legislation) and to the development of any other human activities that displace fishing activity (e.g. wind farms).		
(8) Discarding rates of commercially	Indicator of the rate of discarding of commercially exploited species in	Species, length and abundance of catches and discards based on respectively logbooks and observer	As specified in this Community Programme for

Indicators (a)	Definition	Data required	Precision
exploited species	relation to landings	trips processed separately. Data linked to the level 6 for the *metier* classification (see Appendix IV (1-5)).	discards
(9) Fuel efficiency of fish capture	Indicator of the relationship between fuel consumption and the value of landed catch. It will provide information on trends in the fuel efficiency of different fisheries.	Value of landings and cost of fuel. Value calculated as the product of landings by species and prices. Cost of fuel as defined in this Community Programme. The indicator should be calculated for each *metier* based on the level 6 for the *metier* classification (see Appendix IV (1-5)) by region, quarter and year.	As specified in this Community Programme.

(a) See Commission Staff Working Document (SEC 2008/449) for specification and calculation of the indicators.

Annex VI. FAO toolbox – Core set of consensus indicators for ecosystem-based fisheries management

Headline indicators	**Specific indicators**
Relative biomass	Example of gelatinous zooplankton, cephalopods, small pelagics, scavangers, demersals, piscivores, top predators
Biomass ratios	Piscivore: planktivore Pelagic: demersal Infauna: epifauna
Habitat-forming taxa	e.g. proportional area covered by these epifauna and/or macrophytes
Size spectra	Slopes of community size spectra and their changes can be particularly strong indicators of community level changes
Taxonomic diversity (richness)	e.g. based on species counts
Total fishery removals	Catch + discards + bycatch
Maximum (or mean) length	Maximum (or mean) length across all species in the catch
Size-at-maturity	Example of main target species, bycatch, and top predators
Trophic level or trophic spectrum of the catch	Average trophic level or spectra of the catch (e.g. Gascuel *et al.* 2005) (may require that diet data be updated periodically)
Biophysical characteristics	e.g. temperature, salinity, sea ice (where present), chlorophyll a, primary production, atmospheric indices (e.g. PDO)

Table 1: Core set of consensus indicators for ecosystem-based fisheries management (from Fulton *et al.* 2004; Link,2005).

Annex VII. CBD Provisional indicators for assessing progress towards the 2010 Biodiversity

Headline indicators	Specific indicators
Status and trends of the components of biological diversity	Trends in extent of selected biomes, ecosystems, and habitats Trends in abundance and distribution of selected species Coverage of protected areas Change in status of threatened species Trends in genetic diversity of domesticated animals, cultivated plants, and fish species of major socioeconomic importance
Sustainable use	Area of […] aquaculture ecosystems under sustainable management Proportion of products derived from sustainable sources Ecological footprint and related concepts
Threats to biodiversity	Nitrogen deposition Trends in invasive alien species
Ecosystem integrity and ecosystem goods and services	Marine Trophic Index Water quality of freshwater ecosystems Trophic integrity of other ecosystems Connectivity / fragmentation of ecosystems Incidence of human-induced ecosystem failure Health and well-being of communities who depend directly on local ecosystem goods and services Biodiversity for food and medicine
Status of traditional knowledge, innovations and practices	Status and trends of linguistic diversity and numbers of speakers of indigenous languages Other indicator of the status of indigenous and traditional knowledge
Status of access and benefit-sharing	Indicator of access and benefit-sharing
Status of resource transfers	Official development assistance provided in support of the Convention Indicator of technology transfer

Table 1: Provisional indicators for assessing progress towards the 2010 Biodiversity Target as presented in CBD decision V111/15 (2006)