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Task Group 3 Report

Commercially exploited fish and shellfish

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PREFACE

The Marine Strategy Framework Directive (2008/56/EC) (MSFD) requires that the European Commission (by 15 July 2010) should lay down criteria and methodological standards to allow consistency in approach in evaluating the extent to which Good Environmental Status (GES) is being achieved. ICES and JRC were contracted to provide scientific support for the Commission in meeting this obligation.

A total of 10 reports have been prepared relating to the descriptors of GES listed in Annex I of the Directive. Eight reports have been prepared by groups of independent experts coordinated by JRC and ICES in response to this contract. In addition, reports for two descriptors (Contaminants in fish and other seafood and Marine Litter) were written by expert groups coordinated by DG SANCO and IFREMER respectively.

A Task Group was established for each of the qualitative Descriptors. Each Task Group consisted of selected experts providing experience related to the four marine regions (the Baltic Sea, the North-east Atlantic, the Mediterranean Sea and the Black Sea) and an appropriate scope of relevant scientific expertise. Observers from the Regional Seas Conventions were also invited to each Task Group to help ensure the inclusion of relevant work by those Conventions. A Management Group consisting of the Chairs of the Task Groups including those from DG SANCO and IFREMER and a Steering Group from JRC and ICES joined by those in the JRC responsible for the technical/scientific work for the Task Groups coordinated by JRC, coordinated the work. The conclusions in the reports of the Task Groups and Management Group are not necessarily those of the coordinating organisations.

Readers of this report are urged to also read the report of the above mentioned Management Group since it provides the proper context for the individual Task Group reports as well as a discussion of a number of important overarching issues.

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EXECUTIVE SUMMARY

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

1. DEFINITION OF TERMS IN DESCRIPTOR, AND SCIENTIFIC UNDERSTANDING OF THE KEY CONCEPTS ASSOCIATED WITH THE DESCRIPTOR

'Populations of all commercially exploited fish and shellfish,..': Commercially exploited populations applies to all living marine resources targeted for economic profit. Fish and shellfish represent all marine vertebrate and invertebrate taxa including bone-fish, elasmobranchs, starfish, crayfish, bivalves, molluscs (including cuttlefish, squid) and extended to also include jellyfish.

For the phrase *'..within safe biological limits..'* we adopted two attributes that are currently used to assess the stocks both in the ICES area as well as in the Mediterranean by GFCM; a stock should be (1) exploited sustainably consistent with high long-term yields and (2) have full reproductive capacity. However, for the assessment of these attributes we differentiate from the current practice in that we now still propose the application of a formal rule that combines the two attributes, i.e. $SSB>B_{pa}$ and $F<F_{pa}$ but now suggest F_{MSY} be used as the reference level for exploitation instead of the precautionary value (i.e. $F<F_{MSY}$). This new reference level should still be used as a limit reference point, not a target.

'..exhibiting a population age and size distribution that is indicative of a healthy stock.' The general consensus is that the health of the stock increases as the age and size distribution consists of more, older fish. This attribute is represented by an indicator best representing the proportion of older and larger fish in the population and because there is no scientifically agreed reference level for this indicator the absence of a degradation gradient was considered the best possible criterion for this attribute.

2. WHAT IS "GOOD ENVIRONMENTAL STATUS" ON THE DESCRIPTOR?

Good environmental status (GES) is achieved for a particular stock only if criteria for all attributes are fulfilled. However since there is broad scientific evidence that this can not be achieved for all stocks simultaneously, a realistic threshold for the proportion of stocks with GES needs to be established above which the descriptor has achieved GES. This is a political rather than a scientific decision.

3. HOW SHOULD "SCALE" BE ADDRESSED WITH THE DESCRIPTOR

For this descriptor the relevance of spatial scale is only apparent in the selection of appropriate stocks for each (sub-)region. For a particular region only those stocks that mostly occur in that region will be selected. The temporal scale is determined by the timing of the analytical assessments or surveys on which the data are based.

4. KEY ATTRIBUTES OF THE DESCRIPTOR

For the commercial species three attributes were identified that determine GES:

1. Exploited sustainably consistent with high long-term yield

2. Full reproductive capacity

3. Healthy age and size distribution

Pertaining to the criteria of the attribute with respect to GES we distinguished two approaches for assessment that differ in terms of their robustness and data requirements. If possible the first approach should be preferred but this can be decided on a stock-by-stock basis depending on the quality of the information available:

- **High robustness and data requirements, b**ased on an analytical stock assessment such as conducted by e.g. ICES, GFCM, ICCAT or STECF. This allows a comparison of the indicator to a reference level..

    1. Are exploited sustainably ($F<F_{MSY}$);

    2. Have full reproductive capacity. The TG was unable to reach consensus on the adoption of appropriate reference levels for this attribute. There were two points of view:

        a. Some members felt that it is necessary and sufficient to use SSB > SSB_{MSY} for x% of the stocks;

        b. Other members however felt that this was not sufficient since it provided no protection for the remaining (100-x)% of the stocks. There should be an additional requirement that SSB for all stocks should be greater than SSB_{PA} to avoid the risk of impairing recruitment for those stocks. Their recommendation is therefore: SSB > SSB_{MSY} for x% of the stocks with an additional requirement that for all stocks SSB > SSB_{pa}

    3. Have a healthy age and size distribution (no degradation gradient of indicator)

- **Low robustness and data requirements**, based on monitoring programmes such as conducted within the Data Collection Regulation. Without information that allows the setting of reference levels only trends are available for an assessment of GES.
    1. Are exploited sustainably (no degradation gradient ratio catch/biomass)
    2. Have full reproductive capacity (no degradation gradient log-transformed abundance)
    3. Have a healthy age and size distribution (no degradation gradient of indicator)

This approach requires either a measure of abundance or biomass based on surveys or commercial catches (attributes 1 and 2) or a length-frequency distribution (attribute 3).

The following indicators were chosen to cover the attributes of this descriptor. In selecting the most appropriate indicators we preferred those that described the attribute best while requiring the least elaborate data thereby increasing the number of stocks for which such information is available.

1. Fishing mortality (F). Indicator of exploitation rate. Outcome of an analytical stock assessment
2. Spawning Stock Biomass (SSB). Indicator of reproductive capacity. Outcome of an analytical stock assessment
3. Ratio catch/biomass. Abundance and/or biomass can be obtained from any consistent CPUE series, preferably based on surveys as this increases the chance of consistency. Catch data (or landings data as a proxy) should also be based on a consistent CPUE series of a fishery that can be expected to deliver a representative time-series.
4. Log(abundance). For this abundance was chosen as a proxy because in combination with the indicator describing the age/size distribution it is considered to sufficiently cover the reproductive capacity attribute. The log-transformed population abundance is used because it is considered to provide a better signal to noise ratio.
5. 95% percentile of the population length distribution. The general consensus is that the health of the stock increases as the age and size distribution consists of more, older fish. The indicator that probably captures this best is the 95% percentile of the population length distribution which, according to literature, provides a good summary of the size distribution of fish with an emphasis on the large fish and is expected to be sensitive to fishing and other human impacts. The indicator can be based on any standard survey that provides a length-frequency distribution.

5. AGGREGATION OF INDICATORS WITHIN THE DESCRIPTOR TO ACHIEVE AN OVERALL ASSESSMENT

For each (sub)region two assessments in relation to GES can be conducted:

1. based on the most robust methodology (comparison of indicators to reference levels and based on stock assessments) but which cover only a limited proportion of the stocks. This measure of GES is most reliable but compromised in terms of the representativity of this assessment (i.e. proportion of the stocks in a region for which this can be determined). A stock can only achieve GES if all three criteria for the attributes are fulfilled. However, when aggregating across stocks only the sustainable exploitation criterion and full reproductive capacity criterion need to be fulfilled by all stocks (i.e. $F<F_{MSY}$ and $SSB>SSB_{pa}$ for 100% of the stocks), Because $SSB>SSB_{MSY}$ cannot be achieved for all stocks simultaneously (e.g. if compared to the current situation where many stocks are at or below the precautionary level the SSB of a predator is increased to SSB_{MSY} it is unlikely that it will also be possible to increase the SSB of its main prey from precautionary to MSY level) and since just by chance one or more stocks can be showing a trend, the other two criteria should apply to a specific proportion of the stocks (i.e. $SSB>SSB_{MSY}$ for x% of the stocks and no degradation gradient for L0.95 for y% of the stocks).

2. based on the less robust methodology (indicator trends based on surveys and catch statistics) but which covers a much larger proportion of the stocks. Even though this assessment can be considered considerably less sensitive it performs better in terms of the representativity of this assessment. A stock can only achieve GES if all three criteria for the attributes are fulfilled. However, since for any of the attributes a proportion of the stocks may be showing a trend just by chance all three criteria should apply to a specific proportion of the stocks (i.e. z% of the stocks).

As there is currently no scientific information available that would allow the setting of the proportions x%, y%, z%, these should probably be based on a political rather than a scientific decision. Pertaining to the x%, however, it should be realized that instead of trying to establish what this proportion should be it could also be left to emerge by applying $F< F_{MSY}$ consistently and on all stocks as this should by definition result in the appropriate proportion of stocks for which $SSB>SSB_{MSY}$ applies.

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6. Emergent messages about monitoring and research, and Final Synthesis

The current framework for GES assessment of this descriptor can be consistently applied in all (sub)regions. However there are considerable differences between (sub)regions in terms of data availability that may compromise the quality of the assessment. For example a first assessment of the proportion of landings of all commercial species for which stock assessments are conducted shows that in the Baltic Sea this is more than 90% on an annual basis while in the central Mediterranean this is approximately

26% on an irregular basis. Surveys that can provide data for the trend-based assessments of many additional species are conducted in each of the (sub)regions. There are, however, region- and survey-specific issues pertaining to suitability that need to be resolved. In general all research and/or monitoring initiatives that provide analytical assessments, additional reference levels or improved indicators for more species will help in improving the quality and representativity of this assessment.

1. Initial interpretation of the descriptor

1.1. Definition / interpretation of the key terms used in the descriptor

The descriptor is phrased as

"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."

The key terms in this descriptor are elaborated further below:

'Populations of all commercially exploited fish and shellfish,..':

"Commercially exploited populations" applies to all living marine resources targeted for economic profit. Fish and shellfish represent all marine vertebrate and invertebrate taxa including bone-fish, elasmobranchs, starfish, crayfish, bivalves, molluscs but this was extended to include cuttlefish, squid, and jellyfish.

For the phrase *'..within safe biological limits..'* we adopted two attributes that are currently used to assess the stocks both in the ICES area as well as in the Mediterranean by GFCM; a stock should be (1) exploited sustainably and (2) have full reproductive capacity. However, for the assessment of these attributes we differentiate from the current practice in that we now still propose the application of a formal rule that combines the two ICES criteria, i.e. $SSB>B_{pa}$ and $F<F_{pa}$ (Piet & Rice 2004) but, following the commitment expressed at the World summit of sustainable development (United-Nations, 2002) to "*Maintain or restore stocks to levels that can produce the maximum sustainable yield with the aim of achieving these goals for depleted stocks on an urgent basis and where possible not later than 2015.",* now suggest F_{MSY} (level of fishing mortality at which maximum sustainable yield can be achieved) to be used as the reference level for exploitation instead of the precautionary value (i.e. $F<F_{MSY}$). This new reference level should still be used as a limit reference point, not a target.

'..exhibiting a population age and size distribution that is indicative of a healthy stock.' The general consensus is that the health of the stock increases as the age and size distribution consists of more, older fish. Even though several indicators exist that characterise the age- and/or size-distribution of a fish stock (Shin et al., 2005) it is unclear what the age- and/or size-distribution of a "healthy" fish stock should look like. The main characteristic of a healthy fish stock is considered to be a full reproductive potential which is often assumed to equate to spawning stock biomass (SSB). The latter is challenged by many studies, as reviewed by (Green and David, 2008), who identified maternal factors (Marshall et al., 1998) such as age, size or condition as often at least equally important sources of variation in recruitment (Nikolskii, 1962) or offspring quality (Gall, 1974) within fish stocks. Specifically, recruitment variation has been shown to increase with decreased female longevity

(Longhurst, 2002), or age variation as represented by a Shannon index (Marteinsdottir and Thorarinsson, 1998). In broad-scale analyses, reproductive effort has been demonstrated to increase with age (Charlesworth and Leon, 1976, Roff, 1991), probably because many physiological, morphological and behavioural traits in fishes change with the progression of time, and therefore, the fish's age (Green and David, 2008). Size and condition are typically related, though not equally predictive of fecundity or other measures of reproductive quality (Koops et al., 2004).

Even though many indices related to size and/or condition exist and have proven or can be expected to influence the quality or quantity of progeny (Green and David, 2008) as yet there appears to be no one indicator that overall performs best in describing the reproductive potential and thus the "health" of the fish stock. Moreover, even for the existing indicators there are no known reference levels that distinguish a "healthy" from an "unhealthy" stock based on its "population age and size distribution". For the two indicators that are currently in use to define SBL it is known that higher SSB and lower F values are linked to a higher abundance of large-sized fish (Ostrovsky, 2005) (Shin and Cury, 2004) but no reference levels are given that relate these indicators to the health of the age and size distribution. Therefore, in order to be able to explicitly incorporate this attribute in the GES assessment an indicator was selected that best represents the proportion of older and larger fish in the population and because no reference level exists for this indicator the absence of a degradation gradient was considered the best possible criterion for this attribute.

1.2. Describe what is covered by this descriptor and what falls outside its scope

Only fish and shellfish species that are commercially exploited are included. Shellfish may include molluscs (including cephalopods) and crustaceans. The selection on which to include will be based on the availability of specific data derived from stock assessments, rather than ecological importance which will be dealt with by Task Group (TG) 4, food-web, or sensitivity which will be dealt with by TG1, biodiversity, while vulnerable benthic shellfish species may be dealt with by TG6, seafloor integrity

1.3. Identification of relevant policies and conventions related to the descriptor

The scope of the MSFD with regards to descriptor 3 is particularly broad. It encompasses the precautionary principle, the ecosystem approach and management to maximum sustainable yield. A number of recent publications already provide reviews of particular issues regarding the precautionary approach (Hilborn et al., 2001; NAFO, 2003; Cadrin & Pastoors, 2008) the ecosystem approach to fisheries (Murawski, 2007; Levin et al., 2009; Marasco et al., 2007) and the use of MSY as a management target (Walters et al., 2005; Quinn & Collie, 2005; Mace, 2001). The scope of this section is therefore restricted predominantly to recent developments in the definition and application of indicators in the field of fisheries management. It outlines

briefly the existing legislation under the CFP and considers recent developments in defining, selecting and applying indicators that can support and facilitate the achievement of management objectives.

1.3.1. Common Fisheries Policy (CFP)

The Common Fisheries Policy (CFP) underwent reform in 2002 when numerous changes were implemented to improve the management system. These included greater focus on long-term objectives, a move towards fleet-specific management approaches, improved enforcement and greater emphasis on Mediterranean fisheries. It has been argued that the failure to implement and enforce management decisions has contributed more to the demise of our commercial fish stocks than have deficiencies in the quality of the management advice (Rice and Cooper 2003) and that the failure to implement sustainable fisheries management in European waters stems from weaknesses in the CFP which some consider still to be dominated by short term economic and political interests (Salomon, in press). Marasco et al. (2007) argue that, where properly used, the single species approach has been effective and that instances of failure in fisheries management have not, for the most part, been the fault of science and management but due to data limitations and a lack of political will. Similarly, Murawski (2000) concludes that significant overfishing scenarios could have been avoided had conservative single species management principles been followed and that management will always be concerned primarily with a subset of species of overriding economic, ecological or social value.

The Commission has started a review of the Common Fisheries Policy to make it more efficient in ensuring the economic viability of the European fleets, conserving fish stocks, integrating with the Maritime Policy and providing good quality food to consumers. The review will be based on an analysis of the achievements and shortcomings of the current policy, and will look at experiences from other fisheries management systems to identify potential avenues for future action. Under the MSFD, measures relating to fisheries management can be taken in the context of the CFP. CFP instruments will be implemented to achieve the goals relating to commercially exploited fish populations and the impacts of fisheries on habitats and sensitive species. To this end decisions taken under the CFP will be guided by the ecosystem approach through an incremental process to address issues of excessive fishing pressure on populations and ecosystems, to minimise impacts on sensitive habitats and to prevent distortions of ecosystem structure and function.

1.3.2. The Ecosystem Based Approach to Fisheries Management

Ecosystem based fishery management (Pikitch et al., 2004) has the overall objective to sustain healthy marine ecosystems and the fisheries they support. Numerous definitions of ecosystem based fishery management (EBFM) or the ecosystem approach to fisheries (EAF) have been developed (Marasco et al., 2007) although they all share a number of common characteristics involving broader stakeholder involvement and evaluation of multiple simultaneous drivers or pressures on ecosystems. Marasco et al. (2007) summarised these

definitions as follows. ”The purpose of the ecosystem approach to fisheries management (EAF) is to plan, develop and manage fisheries in a manner that addresses the multiple needs and desires of societies, without jeopardizing the options for future generations to benefit from the full range of goods and services provided by marine ecosystems.” The definition of EAF therefore is ”an ecosystem approach to fisheries strives 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.”

FAO (2003) outlines guidelines on how to translate the economic, social and ecological policy goals and aspirations of sustainable development into operational objectives, indicators and performance measures. The guidelines have been developed to augment current fisheries management practices in order to take into account the biotic, abiotic and human components of ecosystems in which fisheries operate. They supplement the FAO code of Conduct for Responsible Fisheries and provide recommendations for the practical implementation of the EAF.

Kock et al. (2007) argue that the ’ecosystem approach’ is not well defined and suggest that it may be more appropriate to consider a range of ecosystem-based approaches to fisheries management that take into account the broader impact of specific fisheries on the host ecosystem. Similarly Rice (2008) notes the difficulty to distil a single well defined and well understood concept of the EAF from the literature to date. Amongst the five recommendations for future work areas he lists the need to develop frameworks for bringing ecosystem considerations directly into the analytical frameworks used in developing fisheries management strategies (see ICES, 2007). However, Murawski (2007) contends that although a plethora of definitions of the ecosystem approach exist, this has not been the major impediment to implementation of the approach. Beddington et al. (2007) note that the ecosystem approach will be difficult to implement because of its demands for data. They suggest four key ingredients to successful fisheries management: the identification of biomass reference points, a formally adopted management strategy with predefined rules, strong legal support for those strategies, and incentives for fishers to be involved in the management process. They note that marine protected areas (MPAs) provide a secondary though nonetheless important role in achieving a successful EAF.

1.3.3. The Precautionary Approach

Implementation of the precautionary approach has largely been achieved through application of a system of reference points to provide targets and limits for an indicator (Sainsbury and Summaila, 2003). Cadrin and Pastoors (2008) reviewed the status of exploited stocks in two management systems (ICES and NAFO) since the introduction of a precautionary approach framework. In contrast to the evaluation conducted by Garcia and De Leiva Moreno (2005) they give greater emphasis to the status of individual stocks and the frequency of unknown stock status, the frequency that fishing

mortality rates exceed limit values and the frequency of stocks that fall below threshold biomass levels. They note that although ICES explicitly adopted a precautionary framework for the provision of fishery management advice, there remains some stocks for which reference points have not been defined and that there is no prescriptive advice for fisheries that lack reference point estimates for the precautionary framework. They show that after approximately a decade of applying the precautionary approach the frequency of overfishing has decreased but the effectiveness of rebuilding stocks and avoiding depletion has been equivocal. In conclusion they recommend that a more comprehensive application of the concept must complement control rules with alternative forms of fishery management in order to provide prescriptive conservation measures for those data-poor fisheries and fishery resources for which reference point estimates are not available. Table 1-1 (taken from Cadrin and Pastoors (2008)) shows the proportion of ICES stocks for which estimates of precautionary reference points are available, taken from four annual advisory reports.

Table 1-1 Proportion of ICES stocks that have estimates of precautionary reference points from four annual advisory reports. After Cadrin and Pastoors (2008)

	Assessed stocks	F_{lim}	B_{lim}	F_{pa}	B_{pa}	All
ICES(2001)	163	23	31	32	36	17
ICES(2003)	133	25	35	38	42	20
ICES(2006)	137	24	33	35	40	36
ICES(2007)	137	28	35	34	39	26

Pilling et al. (2008) investigated the impacts of biological variability in spatial distribution, recruitment, growth and maturity on biological and economic management objectives, using the North Sea flatfish fishery as a case study. They explored the consequences of moving from a limit based system of single-species reference points to a multispecies one based on alternative target levels. They found that within the traditional ICES management system, based on PA reference points, the current mortality limit and precautionary reference points for plaice are generally robust to variation in and uncertainty about the biological parameters under investigation. For sole they note that the biological reference levels appear robust to biological uncertainty but that the fishing mortality reference points may, under certain scenarios, lead to potential stock collapse. They note that with a properly applied and managed move towards target reference levels such as those based on MSY, the current limit reference points will become less critical as the stocks move toward more sustainable states. This grey area of caution between target and limit reference points has previously been identified by Quinn and Collie (2005).

1.3.4. Maximum Sustainable Yield

The concept of maximum sustainable yield (MSY) has a long history in fisheries management. It was enshrined in national and international legislation throughout the 1970's and 1980's although by the end of the 1970's the shortcomings of using MSY to set catch levels were already apparent (Beddington & May, 1977; Larkin, 1977; Sissenwine, 1978). Subsequently emphasis shifted to MSY-based reference points such as F_{msy}, B_{msy} and more robust proxies for F_{msy} such as $F_{0.1}$. Several recent studies have expressed caution regarding the wide scale adoption of MSY based targets (F_{msy}, B_{msy}) as a management tool. Pilling et al. (2008) suggest that MSY based targets may not provide robust objectives in the face of uncertainty and variability in the biological processes on which they depend. Kell and Fromentin (2007) also note the difficulties associated with making the MSY concept operational in dynamic and changing fisheries where there may be trends in yield or shifts in selection patterns. Walters et al. (2005) identify problems of applying the single species MSY approach in an ecosystem context.

Nevertheless MSY has been identified as a management goal in numerous management systems including the US Magnuson-Stevens Fishery Conservation and Management Act, the International Commission for the Conservation of Atlantic Tunas, and in the commitments of the World Summit on Sustainable Development. The use of F_{msy} as a target or as a limit reference point is also debated. Mace (2001) considered that treating F_{msy} as a limit reference point was a necessary first step towards EAF because it would result in an overall reduction in fishing mortality rates. However Jennings (2005) notes that EAF is expected to provide greater long-term benefits to society if managers can meet targets rather than avoiding limits. Currently fish stock management in some management systems focuses on maintaining SSB above precautionary limits rather than targeting levels associated with maximum long term yield.

1.3.5. The Data Collection Regulation

Under regulation 1639/2001 the European Commission (partially) pays Member States to collect data on Biological and Economic aspects of many European fisheries. The information derived is then used to inform the Common Fisheries Policy. The data collected under the Data Collection Regulation (DCR) can be split into four main categories: Commercial fisheries data for catch and effort, economic data for fisheries, data derived from scientific surveys and biological data. In 2007, the DCR has been extended by two years (2007 and 2008, 1343/2007) and then reformed in 2008 to the Data Collection Framework (DCF, 199/2008).

2. REVIEW OF SCIENTIFIC LITERATURE AND EXISTING METHODS

In this section we describe three existing assessment methodologies: one applied by ICES mainly in MSFD regions Baltic Sea and NE Atlantic and

recently extended to include the Black Sea, and two applied by FAO and GFCM in the Mediterranean.

In addition to this we will discuss additional reference points that are not regularly used as part of these assessment methodologies.

2.1. Fish stock assessment methods

Assessing where commercial stocks stand relative to GES and how management performs to approach it involves methods for monitoring stock abundance and for specifying reference points. The two aspects are treated separately hereafter.

2.1.1. Monitoring fish stock abundance

2.1.1.1. Catch-at-age analyses

Following the legacy of Beverton & Holt's analytical approach (Beverton & Holt 1957), most assessment methods in use in Europe involve a consideration of the age structure in populations. Given the age composition of commercial catches through time, and an assumption of natural mortality at age, the objective is to estimate stocks numbers and fishing mortality F at age in each year. There is a huge body of literature on age-based assessment methods, and a useful summary of the theoretical bases is provided by (Megrey 1989).

A common problem is that fish stock assessment models are over-parameterised and additional information, such as abundance indices from surveys or from commercial catch rates (CPUE or catch per unit of effort), must be combined to "tune" the assessment. Methods to perform this fall under two broad categories. On the one hand, methods based on Virtual Population Analyses (VPA), use an algorithm to reconstruct the amount of fish in each year class at any time backwards, which is needed to account for subsequent catches and losses due to natural causes, assuming that catches are known exactly (Pope & Shepherd 1985). The commonly used variant for demersal stocks is the eXtended Survivor Analysis (XSA) (Darby & Flatman 1994, Shepherd 1999). On the other hand, methods known as statistical catch-at-age (Fournier & Archibald 1982, Deriso et al. 1985, Kimura 1990), are based on a parametric model for the population, which allows for independent, random error in catches at age (but no auto-correlated or censoring errors). The model must be constrained, usually by specifying the selection pattern (so-called separability assumption) for all or a sub-set of years; this can be relaxed somewhat in variants allowing the selection to change gradually, but this has to be done carefully since the results are highly sensitive to how the selection pattern is set, and notably to its profile for older ages (NRC 1998).

The variant in use at ICES and GFCM, mostly for pelagic stocks is ICA (Integrated Catch-at-age Analysis, (Patterson & Melvin 1996)). In principle, this approach to modelling is statistically sounder than VPA or XSA, with a clear objective function which allows for clean inclusion of a variety of additional information (e.g. biomass surveys, tagging data). The reason why

this class of methods is mostly used for pelagic stocks is perhaps that the relatively homogeneous pelagic fleets have a more consistent selection pattern than the myriad fleets and gears engaged in demersal fisheries (yet it has been used to assess turbot in the Black Sea). In addition the ICA implementation allows an index of total biomass to be used for tuning the assessment, thus enabling the use of relative abundance indices derived from acoustic surveys that are more typically available for pelagic stocks. For applications to anchovy in the Bay of Biscay and the Aegean Sea, the tuning data also include SSB estimates from the Daily Egg Production Method (DEPM), which are treated as absolute. Whichever type of method is used, the end result is always a matrix of population numbers at age in each year, including estimates of annual recruitment (first age), from which one can easily derive estimates of annual biomasses for the total stock or for the spawning fraction, and a matrix of fishing mortality at age.

Because of their long-time use at global level, many authors have explored the properties and limitations of analytical fish stock assessment methods, for which there is a good understanding. Effects of errors in the catch data are well known (Pope 1972) and the impact of erroneous age determination has also been studied (Kimura 1989, Bradford 1991, Reeves 2003, Punt et al. 2008). Studies have looked at the impact of uncertainty in the amount and/or error structure of surveys (Walters & Punt 1994, Myers & Cadigan 1995, Maunder & Starr 2003, Chen et al. 2008). Since the methods all assume that natural mortality M, and possibly its distribution by age and year (see Multispecies VPA), be specified beforehand, many authors have explored the sensitivity of stock estimates to error in input M (Sims 1984, Hilden 1988, Prager & MacCall 1988, Lapointe & Peterman 1991, Schnute & Richards 1995, Mertz & Myers 1997, Clark 1999); the net effect of M over-estimation is to scale all stock estimates upwards (and vice versa for under-estimation). Catch-at-age analyses have won a false reputation of providing absolute estimates of stock size, on the ground that the input catches are themselves absolute; given the difficulty in reliably estimating natural mortality (usually a "guesstimate" is input) and in view of the sensitivity of results to errors in M, some have contended that VPA results are not more than relative values and should be treated accordingly (Cotter et al. 2004).

For some years now, scientists in Europe and North America have been struggling with the vexing problem known as the "retrospective pattern" (Mohn 1999), that is the tendency of stock assessment results for the most recent years to be revised –sometimes considerably– in a given direction with each addition of a new year of data; quite often, stock sizes are revised downwards and thus fishing mortality upwards, but the reverse may also be observed. It is as yet unclear whether this is an effect of biased catches (misreporting), of variability in the true natural mortality, or of change in survey or commercial fleets' catchability, or a combination thereof (ICES 2008). As a consequence, no efficient cure has been proposed. The problem is particularly acute for catch prediction and TAC advice, but also affects the performance of surveillance system as the ability to detect worrisome inflexions in stock abundance can be delayed.

2.1.1.2. Alternative methods

Because they give detailed insight into the evolution of stocks and cohorts, analytical methods are usually considered the more powerful and useful. But this comes at a cost, as the catch data must be disaggregated by age. This implies determinations of ages for a large number of samples each year for each stock or component, representing a significant charge on the budget of fisheries institutes. Moreover, the technical ability to age individuals is still problematic for several species of fish and shellfish. In such cases, a possibility to monitor trends in abundance is to use biomass dynamic (or surplus production) models (Schaefer 1954, Punt & Hilborn 1996). Input data are the total catch each year and an index of abundance (survey or commercial CPUE), but both are just an aggregate of all ages expressed in weight. The result is an estimate of total stock biomass over the years. A strong assumption in this class of models is that changes in stock abundance are solely a response to fishing; recruitment is not an explicit factor in the model, and thus the model interprets variability in recruitment as changes in fishing pressure. Many stocks in the ICES area show wide dynamics in recruitment strength, and that limitation of the model explains why it is seldom used. However, the approach is commonly used in the Mediterranean area, where series of age-structured catch data are often lacking, in its non-equilibrium variant known as ASPIC (Prager, 2005). The software provides estimates of MSY-related reference points (MSY, B_{msy}, F_{msy} and effort f_{msy}). It can be used to perform forecast analyses and to define more precautionary F values than F_{msy}, with account of uncertainty.

Even though some species may be difficult to age, there are cases where the component of catches corresponding to recruits can be easily discriminated from older ages, e.g. by a clear break in the length compositions. This is the niche for the Catch-Survey Analysis (CSA) two-stage model (Collie & Sissenwine 1983). The required input data are the total annual catches in number, and two time series of abundance indices in number, one for the recruits and one for all larger/older fish. The output is a trajectory of stock abundance in number over the years. The method mimics VPA in many respects, notably its response to errors in catch data or natural mortality, or to variations in survey catchability. The stock estimates in absolute value are highly sensitive to the catchability ratio between surveys for recruits and for older fish, which needs to be specified. However, this does not alter the perception of relative changes through time (Mesnil 2003, 2005), hence it is more sensible to treat the results as relative values.

A very different approach to age-based assessments has been attempted in ICES, based on time-series analyses (Gudmundsson 1987, Gudmundsson 1994, Fryer 2002). The method was thought appropriate for estimating missing catches for cases where official catches were corrupted due to mis-reporting or where significant but unreported discards were making a large share of the actual fishery removals. The method requires specialist's skills and has not yet made its way into routine assessment despite its appeal. A new development in the same lineage is called SAM (for a State-space Assessment Model). The general framework is still state-space, with stochastic survival,

and with landings, CPUE and/or survey indices as observations. It uses the random effect module of AD Model Builder to solve high dimensional non-linear likelihood functions with unobserved random effects efficiently. SAM also can inform on the magnitude of missing catches. Test trials look promising, but ICES recommended that further validation tests be conducted on a variety of case studies ICES (2009)

A particular problem facing many assessments of European fish stocks is the appropriate inclusion of discards information. Very often discards observations are available for only a short time period in comparison to the landings data and are of much lower precision due to lower sampling levels. Solutions have included attempts to estimate the historic discard levels in the fishery, as attempted for the assessment of North Sea plaice, although the continuous evolution of fishing gears and fleet behaviour apparent in many fisheries makes this estimation process heavily reliant on a large number of simplifying assumptions. Alternative approaches involve the development of bespoke assessment models such as the age-structured bayesian model used to assess the stock of hake in ICES divisions VIIIc and IXa. The advantage of bespoke assessment models is that they can be tailored to fit the biological characteristics of a given stock and accommodate specific types of data. Their disadvantage is that detailed knowledge of each assessment method can become limited to just a few individuals. This has become a notable problem for the Time Series Analysis method mentioned above (and might also apply to SAM).

Length-based methods, which have been commonly used for some stocks in the ICES area in the past, are widely used in the Mediterranean. The Length Cohort Analysis (LCA) uses catch composition by size class, and possibly by fleet or gear, and growth parameters (to translate size increments into time steps) to produce estimates of fishing mortality by size and gear. However, the approach is constrained by an equilibrium assumption (useful when data series are short). The VIT package adapted to Mediterranean fisheries is used for LCA and yield-per-recruit analyses (Lleonart and Salat 1992, 1997; Franquesa and Lleonart eds., 2001; Rätz et al. 2010.)[1]. It produces estimates of reference points such as Fmax, F0.1, F%SSBo, %Bo (see 2.1.2) and includes a module to forecast yield and biomass under different management regimes.

2.1.1.3. Survey based methods

As indicated in their brief description, all assessment methods above require a precise and complete knowledge of removals (landings and discards) by all fleets. Any omission of catches in the data results in under-estimation of the stock abundance output by the models. In contexts where large parts of the catches are misreported (partly as an effect of management control by TACs and quotas such as in Europe) or where sizable discards go unreported, the bias in assessment results can be considerable and scientific advice inoperative. There is thus interest in turning to fishery-independent methods,

[1] Windows version in http://www.mefisto.info/vit4wind.zip

notably those based on surveys conducted routinely by most EU countries (some are part of programmes coordinated by ICES and GFCM).

Abundance indices from surveys can be used directly to monitor variations in stock abundance (also by age or size category), perhaps with the aid of a vast array of statistical methods designed to detect trends or break-points in time series. Starting with (Cook 1997) a few fishery models have been developed to assess the status of stocks on the basis of survey indices only, and some are in current use for cases where official catch data are unreliable or accidentally missing in some years. Current thinking on the survey-based approach is discussed in papers edited by (Petitgas et al. 2009). A finding of importance here is that survey-based methods for finfish can at best provide relative estimates of stock size (some do it well, though) but not absolute quantities (unless constrained by improbable assumptions). They are also quite useful for independent validation of trends indicated by other methods.

In some instances, particularly benthic species with reduced mobility, survey methods are considered able to provide approximate estimates of total abundance, for example the estimates of Nephrops abundance derived from burrow counts from underwater TV surveys. Estimates of burrow density combined with knowledge of the total area of suitable habitat enable the calculation of absolute estimates of stock abundance. A harvest rate can then be applied to the abundance estimates to determine appropriate catch levels for management advice. Numerous uncertainties in the burrow counting process have been identified including the correct identification of a Nephrops burrow, the occupancy rate of the burrows and the multiple counting of burrows that have more than one entrance/exit. Nonetheless the method is considered to provide more appropriate estimates of stock abundance than previously adopted methods for Nephrops stocks.

Incidentally, a new survey-based method has been published quite recently (Swain et al. 2009) and its applicability for monitoring the state of commercial stocks relative to GES should be investigated.

2.1.2. Reference points

The development of precautionary reference points in ICES was a response to a specific request put down by the European Community in 1996 (quotation from p. 12 in (ICES 1998)):

"The precautionary principle and implementation of a precautionary approach in fisheries management are currently widely discussed. Implementing a precautionary approach implies that some acceptable boundary have to be defined to distinguish 'safe' from 'unsafe' positions. The Commission considers that the international agreements and conventions support the conclusion that keeping stocks at sustainable level implies a level of fishing that carries a low probability of leading to stock collapse. The Commission therefore requests ICES to provide for each stock fishing mortality limits and spawning biomass thresholds that will satisfy medium and long term sustainability of these stocks. The harvest strategy and

corresponding fishing mortalities should have associated high probability of maintaining the stocks above the defined threshold level within defined time periods. The range of probabilities that may be used by ICES and that would satisfy the Commission are 95%, 90% and 80%." [2]

From 1997 to 2003, several meetings of the Study Group on the Precautionary Approach discussed the notions of limit vs. PA (Precautionary Approach) reference points, for both spawning stock biomass and fishing mortality, and the technical procedures to estimate these points. To a large extent, the ability to identify the reference points depends on the availability of an informative and reliable stock-recruitment plot. The procedure finally suggested by ICES to its working groups was specified in the report of the Study Group on Precautionary Reference Points For Advice on Fishery Management (ICES 2003). The report gives specific indications for data-poor cases, short-lived species and spasmodic stocks but, for the general case, the essential guidelines are (from Annex I of that report):

2.1.2.1. Limit reference points :

- B_{lim}
  - For stocks where a change point is evident B_{lim} is estimated on basis of a segmented regression: estimate the change point S* for the chosen set of R-SSB data. Examine the diagnostics for S* and decide if the fit is statistically robust. If this is the case S* is used as a B_{lim} estimate.
  - For other stocks B_{loss} (i.e. the lowest estimate of spawning biomass in the available time series) may be used as a proxy of B_{lim} according to stock type and specific considerations including historical exploitation as described above.
- F_{lim} is then derived from B_{lim} as follows:
  - Calculate R/SSB at B_{lim}, the slope of the replacement line at B_{lim}.
  - Invert to give SSB/R.
  - Use this SSB/R to derive F_{lim} from the curve of SSB/R against F.

2.1.2.2. Precautionary reference points :

- Estimate F_{pa} from F_{lim}
  - Identify the most recent reliable assessment data set to be used as a reference data set (usually the one used to estimate B_{lim}).

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[2] Note that this is one of very rare occasions where managers were that explicit about risk levels.

  - Note the year of the reference assessment, full documentation of the data sources, the assessment method, and the configuration used for the derivation of the new biological reference points.
  - Note the sensitivity of the reference assessment to assumptions (e.g. shrinkage, +group), and document and justify the exploitation pattern, weight and maturity-at-age for the reference assessment.
  - Use the reference data to carry out a set of retrospective assessments within the converged part of the assessment.
  - Tabulate and plot the distributions of realised F across assessment years generated by the TAC corresponding to each intended F.
  - Compare the distributions between intended F values and identify the highest intended F that still carries a low risk that the realised F is above $\mathbf{F}_{lim}$.
- Estimate B_{pa} from B_{lim}
  - Use the set of retrospective assessments to obtain the observed SSB in each TAC year and compare with the 'true' SSB estimated by the reference data set.
  - Plot the pairs of SSB_{obs}/SSB_{true} against SSB_{true}.
  - Draw through the origin the line that leaves α% (where α is the acceptable risk) of the points above the line, whose slope is β in $\mathbf{B}_{pa} = \beta * B_{lim}$.

In the same report, ICES indicates that the next step should be to establish and/or validate reference points through management strategy evaluations (MSE) and has since embarked actively in that field. Recovery plans and management plans for some key species have been evaluated in the MSE framework. This is important to estimate reference points that take due account of the specific biology of each species and also of the type and magnitude of uncertainties in the data and models. In particular, one should check that Fpa has high probability of keeping the stock above Bpa in the long term, and also that target Fs decided by managers are indeed precautionary (or not unduly conservative).

2.1.2.3. MSY-related points

All international conventions stipulate that management should maintain or restore stocks to levels where they can produce the Maximum Sustainable Yield (and not simply to catch MSY); hence the focus is on determining the stock level B_{msy} where productivity is maximum or the fishing mortality F_{msy} enabling this to be achieved on average. Consistent with some international agreements, several authors justify that F_{msy} should be treated as a limit rather than a target (Mace 2001, Quinn & Collie 2005). Clearly, it is more economical to fish at F below F_{msy} (Grafton et al. 2007).

Historically, MSY was associated with surplus production models because it is a direct output of such models. For example, the Schaefer model estimates the intrinsic growth rate r and the carrying capacity K, from which MSY is derived as r*K/4 and B_{msy} as K/2. Analytical models require a more elaborate procedure. Yield-per-recruit (Y/R) analyses using Beverton-Holt (Beverton & Holt 1957) or Thompson-Bell (Thompson & Bell 1934) formulation for growth in weight are a routine product of most assessments, and can be used to locate F_{max}, the abscissa where Y/R is maximum, or F0.1 where the marginal gain is 10% of the gain at the origin (Gulland 1968). However, many years ago, (ICES 1977) has pointed out that Y/R is not a sufficient basis for the determination of F_{msy}; the latter should also consider the effect of fishing on future recruitments: that is, Y/R should be combined with stock-recruitment relationships (SRR, which is tacitly embedded in production models). Technically, this is not too difficult given a Y/R curve and a spawning stock-per-recruit (SSB/R) curve which is produced by the same piece of software. (Sissenwine & Shepherd 1987) describe how the two pieces of information can be combined graphically. When the stock-recruitment relationship is of the Beverton-Holt or of the Ricker type, there are even explicit formulae to derive the equilibrium yield for each F value and hence locate F_{msy}. The real difficulty, however, is that one needs a reliable recruit-spawner plot (i.e. not looking like a shotgun blast).

As a clear relation is often lacking, one can consider approximate values for F_{msy} not requiring SRR considerations. There is a wide consensus in the literature that F_{max} is much too high and risky, and should be avoided as a proxy for F_{msy}. Simulations work has shown that acceptable proxies are either F0.1 or the F where SSB/R is about 35-45% of SSBo, the SSB/R under no fishing (Clark 1991, Mace 1994, Quinn & Deriso 1999). The rule-of-thumb approximation that F_{msy} is close to natural mortality M (i.e. $F/Z \approx 0.5$) may often be acceptable, but is not a universal recipe.

Criticism against MSY is often raised because its true value can be highly unstable, as changes in the environment can alter the growth pattern, the reproduction, the natural mortality (e.g. due to predators) etc. compared to the conditions when it was computed. It is also important to keep in mind that F_{msy} is conditional on the assumed exploitation pattern (distribution of F at age). If the fishery turns to more (or less) selective fishing practice, then a very different F_{msy} would be applicable. Likewise, any major change in the composition of fishing fleets may change the exploitation pattern, and thus F_{msy} (Maunder 2002, Powers 2005).

Two approaches resembling production models can provide useful reference points. Caddy and Csirke (1983) proposed to use time series of estimates of Z and of indices of abundance derived from trawl surveys to fit a non-equilibrium production model, enabling to define Zmbp, the total mortality corresponding to the Maximum Biological Production. Munro (1989) combined information on the spatial distribution of abundance indices with geographical allocation of the fishing effort to fit a composite production model, using Z as a direct index of effort and indices of biomass from trawl surveys. The approach needs some knowledge on the distribution of fleets and

of some assumptions regarding the pristine production in the area and its evolution under changing levels of fishing pressure. With such an approach it is not possible to estimate B_{msy} or MSY, but it is in any case feasible to estimate Zmbp, whose value is always less than Zmsy.

The existing methodology seems appropriate for providing scientifically sensible PA and MSY-related reference points, but only for stocks for which an analytical (that is, age-based) assessment is available and of good quality. However, it leaves a considerable gap for other, so-called "data-poor" regions and/or stocks for which other approaches to defining reference points and GES targets should be considered (Cadrin & Pastoors 2008) (see next paragraph).

2.2. Indicators

A suite of indicators that do not require analytical stock assessments was chosen to cover the main properties of GES of this descriptor for those stocks for which such data were not available. In selecting the most appropriate indicators we preferred those that described the attribute best while requiring the least elaborate data thereby increasing the number of stocks for which the information necessary is available. The three attributes and their indicators are listed below:

1. Are exploited sustainably: Harvesting rate (i.e. ratio catch/biomass) was considered a best proxy (Quinn and Deriso 1999, Haddon 2001). Abundance and/or biomass can be obtained from any consistent CPUE series, preferably based on surveys as this increases the chance on consistency. Catch data (or landings data) should also be based on a consistent CPUE series of a fishery that can be expected to deliver a representative time-series.

2. Have full reproductive capacity: For this abundance was chosen as a proxy because in combination with the indicator describing the age/size distribution it is considered to sufficiently cover this attribute. The log-transformed population abundance is used because it is considered to provide a better signal to noise ratio.

3. Have a healthy age and size distribution: The general consensus is that the health of the stock increases as the age and size distribution consists of more, older fish. The indicator that probably captures this best is the 95% percentile of the population length distribution (L0.95) which, according to (Shin et al. , 2005), (Rochet et al. ICES CM 2007 / D:16), provides a good summary of the size distribution of fish with an emphasis on the large fish and is expected to be sensitive to fishing and other human impacts. The L0.95 can be based on any standard survey that provides a length-frequency distribution. However, if more surveys are available it is recommended to choose the survey that samples the larger sizes best. Even though commercial catches (landings) in general sample the larger sizes better than surveys that often target the smaller sizes, there is an issue with consistency because the fishery is more likely to have changed over time.

Table 2-1 Definition of chosen indicators, required data, and estimators.

Indicator	Definition	Required data	Estimator
Harvest rate	Proxy for exploitation level	Catch data from commercial fisheries Biomass data from consistent sampling program	Harvest rate = Catch/Biomass
$\ln N_i$	Abundance index for species i	Catch haul k stratum j $y_{k,j}$ Swept area $a_{k,j}$ Stratum area A_j	$N_i=\sum_j N_{i,j}=\sum_j A_j \sum_{k=1}^{n_j} y_{k,j} \Big/ \sum_{k=1}^{n_j} a_{k,j}$ $\ln N_i=\ln(N_i)-Var(\ln N_i)/2$ $Var(N_i)=\sum_j \frac{A_j^2}{n_j-1}\sum_{k=1}^{n_j}\left(\frac{y_{k,j}}{a_{k,j}}-\frac{\sum_{k=1}^{n_j} y_{k,j}}{\sum_{k=1}^{n_j} a_{k,j}}\right)^2$ $Var(\ln N_i)=\ln\left(\frac{Var(N_i)}{N_i^2}+1\right)$
$L_{q,i}$ $q = 0.95$	Percentile of the population length distribution	Catch per length class $y_{l,i}$	$L_{q,i}=l_{q,i}\left\| \frac{\sum_{l=1}^{l_q} y_{l,i}}{y_i}=q \right.$ $Var\left[L_{q,i}\right]=\frac{q(1-q)}{y_i\left(y_{l_q,i}/y_i\right)^2}$

2.2.1. *Reference points*

Technically, it is no more difficult to monitor progress of a set of indicators above thresholds or towards targets on a relative scale than it is for (allegedly) absolute values such as those obtained from analytical stock assessments (see e.g. (Trenkel et al. 2007)). The problem with indicators in general and which also applies to the indicators chosen for this descriptor is that thus far no reference points have been identified on scientific grounds. Without these, the real challenge is to reach agreement among stakeholders on the definition of a reference point, e.g. based on a year or period in the history of the stock. It can be a period where people would like indicators to return (high catch rates, good survey indices, good proportion of large fish, general satisfaction in the industry) or years with bad values for the indicators that people want to stay well away from. In the EU Common Fisheries Policy system, it is very unlikely that such agreements can be settled among 27 member states at the Council for hundreds of stocks. However, stakeholders might be more willing to define reference periods at the scale of smaller regions, e.g. in the context of RACs.

The consequence of a lack of scientifically (or otherwise) agreed reference levels for these indicators is that until such reference points are identified and agreed upon the only remaining scientific criteria for GES have to be based on trends where the absence of a degradation gradient is considered the best possible criterion for GES. Clearly such a criterion fails in achieving true GES when the attribute the indicator describes has already deteriorated to a more or less stable (but degraded) status before the beginning of the time-series which is not unlikely for many commercial species. However, unless some reference level is identified this is the only other option to determine whether or not GES is achieved.

In order to illustrate some of the difficulties in finding appropriate studies that have determined such reference levels and how results of studies can be misinterpreted we consider one specific example that was put forward, both within the Task Group as well as by outside parties: Froese et al (2008) allegedly published a reference level for the attribute “healthy age and size distribution” i.e. “average length and average age of the stock should equal the size and age at the maximum growth rate which is about 0.296 W_{inf}”.

However, what this study showed is how a change in the size-selectivity of exploitation towards only fish above 0.296 W_{inf} or 0.67 L_{inf} would give a healthier (as in more similar to pristine) age and size distribution without necessarily compromising yield. What it does not provide is any reference level that distinguishes a “healthy” stock from an “unhealthy” stock in terms of its age and size distribution. Moreover, as the MSFD allows sustainable exploitation, a pristine age and size distribution should not be a requirement to achieve GES.

2.3. Monitoring programs

The suggested indicators require data from monitoring programs, based on Research Vessel (RV) surveys or registration of catches and/or landings. Such programs exist in all (sub)regions. The requirements for these programs are that they should be

- sufficiently representative, i.e. in terms of the area covered as well as the sampling method, both for the (sub)region and species
- capable of delivering appropriate data: i.e. recorded numbers at length for each spec

3. IDENTIFY RELEVANT TEMPORAL/SPATIAL SCALES FOR THE DESCRIPTOR

For this descriptor the relevance of spatial scale is only apparent for assessed species in the selection of appropriate stocks and for the non-assessed species by the choice of the most appropriate survey for each (sub-)region. For a particular region only those stocks that mostly occur in that region will be selected. The temporal scale is determined by the fact that usually both the analytical assessments as well as the surveys are conducted on an annual basis.

In order to use existing stock assessments to determine GES it is necessary to map the existing areas used for stock assessments to the (sub)regions for which GES needs to be determined. Below are figures showing these areas for the MSFD regions.

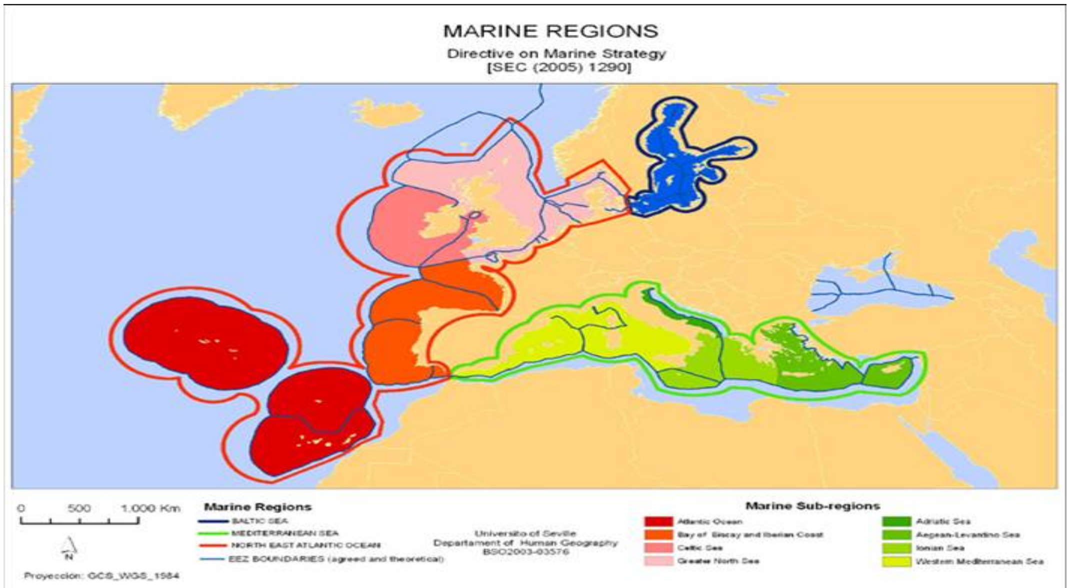

Figure 3-1 MSFD regions

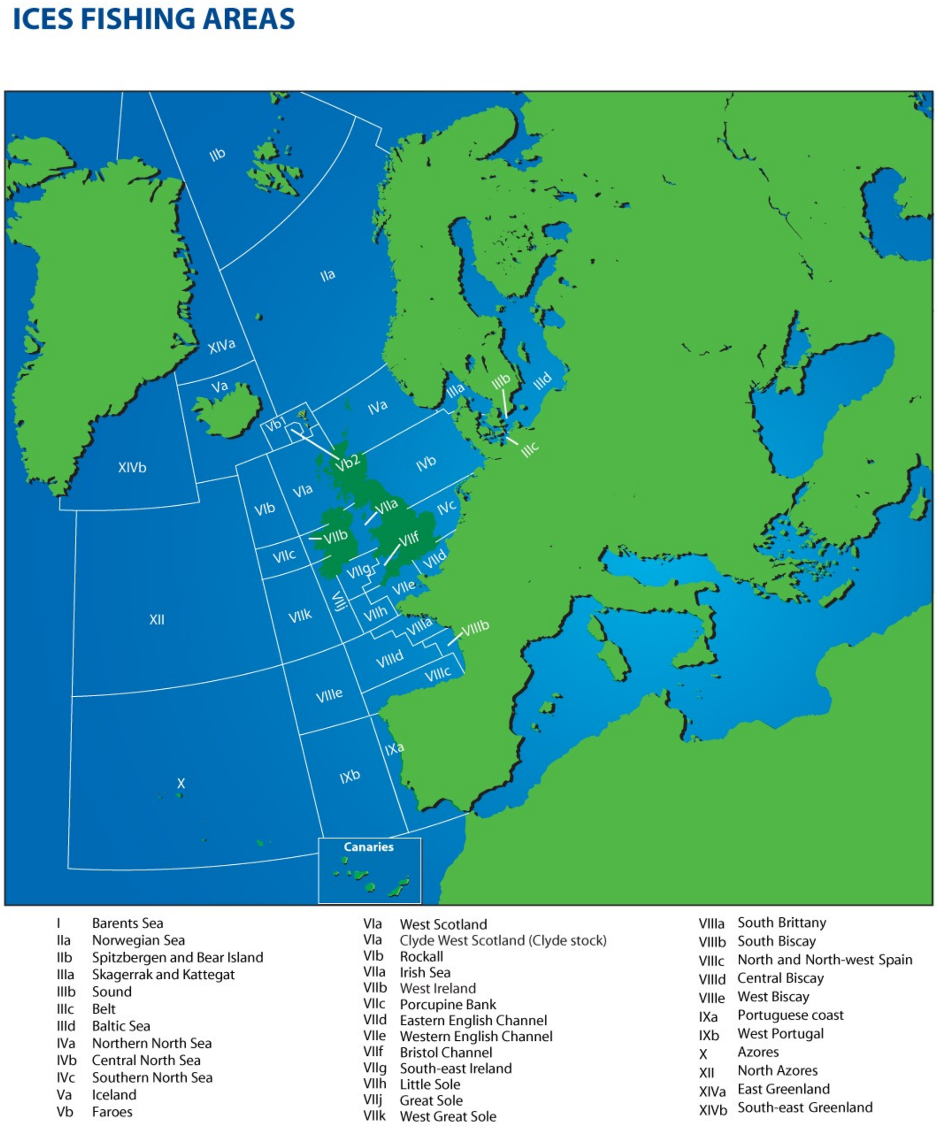

Figure 3-2 ICES areas

Mediterranean

The GSAs (Geographical Subareas) are not useful for assessment and management, for this reason the original name "management unit" was changed to GSA in 2003 or 2004.

The FAO statistics (FISHSTAT) are organized in the following subdivisions of the Mediterranean and Black Sea:

- Adriatic
- Aegean
- Azov Sea

- Balearic
- Black Sea
- Gulf of Lions
- Ionian
- Levant
- Marmara Sea
- Not known (GFCM area)
- Sardinia
- Tunas (GFCM area)

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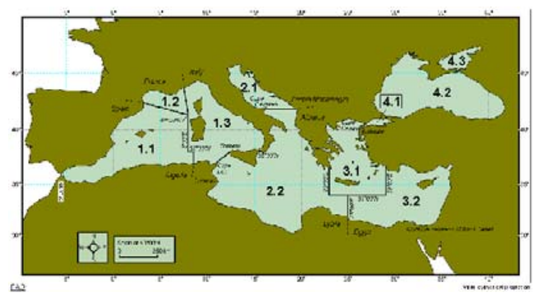

Geographical Subareas Statistical subdivisions

Figure 3-3 Geographical subareas and statistical subdivisions for the Mediterranean Sea.

In general there are minor discrepancies between the existing (e.g. ICES areas, Mediterranean GSAs) areas and the MSFD (sub)regions. In the report we show how this was resolved for each of the regions.

Similarly, existing monitoring programs may not cover all of the various areas and there are issues of how representative a survey is for a specific area. For each (sub)region and indicator it will have to be decided which is the most appropriate source of data to be used.

4. GENERAL FRAMEWORK FOR DESCRIBING ENVIRONMENTAL STATUS

For the commercial species three attributes were identified that determine GES:

1. Exploited sustainably consistent with high long-term yield

2. Full reproductive capacity

3. Healthy age and size distribution

The main characteristic that sets this descriptor apart from most of the other descriptors is the availability of existing assessment frameworks (e.g. analytical stock assessments) conducted in a consistent manner, based on what

can be considered the most robust data available and often with some level of quality assurance. These assessment frameworks are applied on several of the commercially exploited stocks (but not all) and provide consistent assessments of the status of the stocks. For those stocks for which no analytical stock assessments are conducted an alternative source of information is that based on monitoring programs.

Pertaining to the GES criteria of the attributes we distinguished two approaches for assessment that differ in terms of their robustness and data requirements:

High robustness and data requirements, based on an analytical stock assessment such as conducted by e.g. ICES, GFCM, ICCAT or STECF. This allows a comparison of the indicator to a reference level.

1. Are exploited sustainably ($F<F_{MSY}$)
2. Have full reproductive capacity. The TG was unable to reach consensus on the adoption of appropriate reference levels for this attribute. There were two points of view:
    c. Some members felt that it is necessary and sufficient to use $SSB > SSB_{MSY}$ for x% of the stocks;
    d. Other members however felt that this was not sufficient since it provided no protection for the remaining (100-x)% of the stocks. There should be an additional requirement that SSB for all stocks should be greater than SSB_{PA} to avoid the risk of impairing recruitment for those stocks. Their recommendation is therefore: $SSB > SSB_{MSY}$ for x% of the stocks with an additional requirement that for all stocks $SSB > SSB_{pa}$
3. Have a healthy age and size distribution (no degradation gradient of indicator)

- **Low robustness and data requirements**, based on monitoring programmes such as conducted within the Data Collection Regulation. Without information that allows the setting of reference levels only trends are available for an assessment of GES.
    1. Are exploited sustainably (no degradation gradient ratio catch/biomass)
    2. Have full reproductive capacity (no degradation gradient log-transformed abundance)
    3. Have a healthy age and size distribution (no degradation gradient of indicator)

This approach requires either a measure of abundance or biomass based on surveys or commercial catches (attributes 1 and 2) or a length-frequency distribution (attribute 3)

Obviously the first, most robust, approach should be preferred but this can be decided on a stock-by-stock basis depending on the quality of the information available.

The following indicators were chosen to cover the attributes of this descriptor. In selecting the most appropriate indicators we preferred those that described the attribute best while requiring the least elaborate data thereby increasing the number of stocks for which such information is available.

1. *Fishing mortality (F).* Indicator of exploitation rate. Outcome of an analytical stock assessment

2. *Spawning Stock Biomass (SSB).* Indicator of reproductive capacity. Outcome of an analytical stock assessment

3. *Ratio catch/biomass*. Abundance and/or biomass can be obtained from any consistent CPUE series, preferably based on surveys as this increases the chance on consistency. Catch data (or landings data as a proxy) should also be based on a consistent CPUE series of a fishery that can be expected to deliver a representative time-series.

4. *Log(abundance)*. For this abundance was chosen as a proxy because in combination with the indicator describing the age/size distribution it is considered to sufficiently cover the reproductive capacity attribute. The log-transformed population abundance is used because it is considered to provide a better signal to noise ratio.

5. *95% percentile of the population length distribution*. The general consensus is that the health of the stock increases as the age and size distribution consists of more older fish. The indicator that probably captures this best is the 95% percentile of the population length distribution which, according to literature, provides a good summary of the size distribution of fish with an emphasis on the large fish and is expected to be sensitive to fishing and other human impacts. The indicator can be based on any standard survey that provides a length-frequency distribution.

When aggregating the information on each of the three indicators per stock into one measure of GES we propose the following:

For each (sub)region two assessments in relation to GES can be conducted:

1. based on the most robust methodology (comparison of indicators to reference levels and based on stock assessments) but which cover only a limited proportion of the stocks. This measure of GES is most reliable but compromised in terms of the representativity of this assessment (i.e. proportion of the stocks in a region for which this can be determined. A stock can only achieve GES if all three criteria for the attributes are

fulfilled. However, when aggregating across stocks only the sustainable exploitation criterion and full reproductive capacity criterion need to be fulfilled by all stocks (i.e. $F<F_{MSY}$ and $SSB>SSB_{pa}$ for 100% of the stocks), Because $SSB>SSB_{MSY}$ cannot be achieved for all stocks simultaneously (e.g. if compared to the current situation where many stocks are at or below the precautionary level the SSB of a predator is increased to SSB_{MSY} it is unlikely that it will also be possible to increase the SSB of its main prey from precautionary to MSY level) and since just by chance one or more stocks can be showing a trend, the other two criteria should apply to a specific proportion of the stocks (i.e. $SSB>SSB_{MSY}$ for x% of the stocks and no degradation gradient for L0.95 for y% of the stocks).

2. based on the less robust methodology (indicator trends based on surveys and catch statistics) but which covers a much larger proportion of the stocks. Even though this assessment can be considered considerably less sensitive it performs better in terms of the representativity of this assessment. A stock can only achieve GES if all three criteria for the attributes are fulfilled. However, since for any of the attributes a proportion of the stocks may be showing a trend just by chance all three criteria should apply to a specific proportion of the stocks (i.e. z% of the stocks).

As there is currently no scientific information available that would allow the setting of the proportions x%, y% and z% these should probably be based on a political rather than a scientific decision. Pertaining to the x%, however, it should be realized that instead of trying to establish what this proportion should be it could also be left to emerge by applying $F< F_{MSY}$ consistently and on all stocks as this should by definition result in the appropriate proportion of stocks for which $SSB>SSB_{MSY}$ applies.

5. REGIONAL ASSESSMENTS OF ENVIRONMENTAL STATUS

In this section examples of regional assessments of environmental status will be presented. For each (sub)region this will consist of an assessment of the coverage of the commercial species in terms of their proportion of landings, by analytical stock assessments followed by region-specific assessments of the environmental status. In addition to that we present for three (sub)regions, the Baltic Sea, the North Sea, and the Mediterranean a first assessment of the status of the commercial fish and shellfish based on existing assessments. Because the MSY-based reference levels are not available for most stocks the Baltic Sea and North Sea used the less restrictive precautionary reference points and the Mediterranean used the SAC/GFCM assessment of stock status.

5.1. Baltic Sea

For the Baltic Sea stocks the annual source of stock status information is the regular assessments by the ICES working groups WGBFAS (Baltic Fisheries

Assessment Working Group; ICES 2009a), WGBAST (Working Group on Baltic Salmon and Trout; ICES 2009b) and HAWG (Herring Assessment Working Group South of 62^o; ICES 2009c). All three groups are reporting to ACOM. In addition WGIAB (ICES/HELCOM Working Group on Integrated Assessments of the Baltic Sea) was setup in 2007 as a forum for developing and combining ecosystem-based management efforts for the Baltic Sea. WGIAB main tasks have been 1) to conduct holistic ecosystem assessments based on large multivariate data-sets; 2) to consider the use of ecosystem modelling in the assessment framework and 3) to develop adaptive management strategies for the different Baltic Sea ecosystems.

5.1.1. Recent changes in the Baltic Sea ecosystem

The changes in the Baltic Sea abiotic environment and the food web have been synthesized by the Working Group on Integrated Assessments of the Baltic Sea (ICES, 2009) in Integrated Ecosystem Assessments (IEA) and based on this assessments have been updated for all seven sub-regions of the Baltic Sea: i) the Sound (ÖS), ii) the Central Baltic Sea (CBS), encompassing the three deep basins, Bornholm Basin, Gdansk Deep, and Gotland Basin; iii) the Gulf of Riga (GoR), iv) the Gulf of Finland (GoF), v) the Bothnian Sea (BoS), vi) the Bothnian Bay (BOB), and vii) a coastal site at the Swedish east coast (Subdivision 27) (COAST). The integrated ecosystem analysis is basically multivariate analyses of time-series of the physical, chemical, and biological environment – including all trophic levels and biological diversity – and socio-economic factors and treats fish and fisheries as an integral part of the environment.

All seven sub-regions have shown pronounced structural changes (i.e. regime shifts) in the last two to three decades, related to climate, fisheries, and eutrophication. Regime shifts were identified in all multivariate datasets (Table 5.1.1). The main shift in the regime of the Baltic sub-regions is at the end of the 1980 (mainly between 1987 and 1988). Several sub-regions (Central Baltic Sea, Gulf of Riga, Gulf of Finland, Bothnian Bay) experienced structural change also during the middle of 1990s, probably related to the major inflow in 1993. Indications exist that a recent shift in ecosystem organization occurred in some sub-regions (Central Baltic Sea, Gulf of Finland, coastal area in SD 27) in the early years of this century.

Table 5-1 Summary of regime shifts detected in the seven ecosystems investigated during the WGIAB meeting in 2008. Regime shifts were identified from the whole data set for each ecosystem using chronological clustering (with α=0.01) (WGIAB 2009).

Time-period	The Sound 1979–2005	Central Baltic Sea 1974-2006*	Swedish Coast 1971-2006	Gulf of Riga 1973-2006	Bothnian Sea 1979–2006	Bothnian Bay 1979–2006	Gulf of Finland 1979-2007
A			1976/77		1982/83		
B	1987/88	1987/88	1987/88	1988/89	1988/89	1987/88	1988/89
C	1995/96	1994/95		1997/98		1993/94	1995/96
D			2004/05				2002/03

*incl. Cod RV

5.1.2. Human impact on the ecosystem and fish communities

In the Central Baltic cod and sprat spawn in the same deep basins and have partly overlapping spawning seasons. However, their reproductive success is largely out of phase. Hydrographic-climatic variability (i.e., low frequency of inflows from the North Sea, warm temperatures) and heavy fishing during the past three decades have led to a shift in the fish community from cod to clupeids (herring, sprat) by first weakening cod recruitment (Jarre-Teichmann et al., 2000) and subsequently generating favourable recruitment conditions for sprat, thereby resulting in increased clupeid predation on early life stages of cod (Köster and Möllmann, 2000b; Köster et al., 2003b; MacKenzie and Köster, 2004). The shift from a cod- to a sprat-dominated system may thus be explained by differences in the reproductive requirements of both species in a changing marine environment. Additionally, the dominance shift was supported by the continued high fishing pressure on cod (Jarre-Teichmann, 1995).

Coastal commercial and recreational fisheries have also influenced ecosystem structures (Hansson et al., 1997). This impact is generally more local than that of the offshore fishery, however, since most of the coastal fish species are relatively stationary.

The total amount of by-catch of fish in the Baltic fisheries is presently unknown. The EU has supported several very recent studies of by-catch, the results of which have been compiled by ICES. These studies primarily concern the major fisheries for cod, herring, and sprat and these have rather low by-catches. The less important smaller coastal fisheries can have a rather high proportion of by-catch in some cases (Helcom, 2002).

Seals have been recorded caught in fyke nets, set nets, and in the past in salmon driftnets, but although the recorded data almost certainly underestimate the total number of seals in the by-catch, the added mortality does not appear to restrain the seal populations from increasing (Helander and Härkönen, 1997). Fisheries with static gears (e.g. gill nets) on coastal areas represent a threat to seabirds and to harbour porpoise especially in the western Baltic Sea. A recent study by Zydelis et al. (2009) assessed that more than 75.000 seabirds are annually by-caught in selected areas of the Baltic Sea. The

highest by-catch mortality of harbour porpoises in the gill net fisheries occurs in the western Baltic waters.

Fishing activities will also affect the seabird community through the discarding of unwanted catch and fish offal. Studies indicate, for example, that over 50% of the offal discarded in the Baltic is consumed by seabirds (ICES, 2000).

Human society uses the Baltic for many purposes including shipping, tourism, and mariculture. Overviews are given in HELCOM (2002, 2003) and Frid et al. (2003). Shipping may pose threats to the commercial species due to transport and release of hazardous substances (e.g., oil) and non-indigenous organisms. The former would likely have only relatively short-term effects (e.g., direct mortality of individuals in a restricted time and area), whereas the latter are more likely to have longer-term and more widespread effects (e.g., influences on energy flows or species interactions in food webs).

5.1.3. The assessment and the state of the fish stocks

For the Baltic Sea stocks the appropriate source of information is the regular assessments by ICES Assessment Working Groups reporting to ACOM (WGBFAS, WGBAST and HAWG). The Baltic Sea as defined for the MSFD includes the whole of ICES Divison IIId (the whole Baltic Sea) and for western Baltic herring also division IIIa (Kattegat and Skagerrak). The Baltic Sea stocks assessed regularly are presently as follows:

Table 5-2 Assessed Baltic Sea stocks and candidates for calculation of the indicators for the Baltic Sea.

Stock	Stock code	Stock details
Cod SD 22-24	**cod-2224**	Cod in the western Baltic; Subdivisions 22-24
Cod SD 25-32	**cod-2532**	Cod in the eastern Baltic; Subdivisions 25-32
Her Div. IIIa and SD 22-24	**her-3a22**	Herring in the western Baltic and Kattegat/Skagerrak; Division IIIa and subdivisions 22-24, autumn spawners
Her SD 25-29, 32 excl. GoR	**her-2532-Ex-Go**	Baltic herring in the Main Basin; Subdivisions 25-29 and 32 excluding Gulf of Riga (GoR); spring spawners
Her GoR	**her-riga**	Baltic herring in the Gulf of Riga; spring spawners
Her SD 30	**her-30**	Baltic herring in the Bothnian Sea; Subdivision 30
Her SD 31	**her-31**	Baltic herring in the Bothnian Bay; Subdivision 31

Stock	Stock code	Stock details
Spr 22-32	**spr-2232**	Sprat in the whole Baltic; Subdivisions 22-32
Sal 22-31	**sal-2231**	Baltic salmon in the Baltic Main Basin and the Gulf of Bothnia; Subdivisons 22-31
Sal-32	**sal-32**	Baltic salmon in the Gulf of Finland; Subdivision 32

The criteria for indicators for the Baltic Sea stocks excluding Baltic salmon are according to method by (Piet & Rice 2004) as follows:

- The stock should be assessed so that annual values for the indicators SSB and F are available for the assessment
- The chosen reference levels should be known (SSBpa and Fpa). In case of some of the Baltic Sea stocks there are serious doubts about the usefulness of present reference points because of the regime shift and thus some of the reference points in use have been removed (this should be discussed in the group)
- The stock area need to overlap sufficiently with the MSFD region for which the assessment is done. The criteria that determine which stocks are appropriate for the region and why others are excluded need to be explicitly stated.
- Only stocks for which SSB ≥ SSBpa and F ≤ Fpa are considered to be "within SBL" and hence having GES.

For Baltic salmon stocks in the Main basin and Gulf of Bothnia (SD 22-31), the criteria mentioned above do not apply. In order to better support the management of wild salmon stocks, ICES use five assessment units for the Baltic Main Basin and the Gulf of Bothnia (ICES 2009b). The division of stocks into units is well defined and it is based on management objectives and biological and genetic characteristics of the stocks.

For the evaluation of the current state of the wild salmon stocks, the smolt production relative to the level of natural smolt production capacity on a river-by-river basis is used and this should be used in the evaluation of GES as well.

There is a concensus to use ***Potential Smolt Production Capacity*** (PSPC) relative to the 75% level of the natural production capacity on a river-by-river basis and for evaluation the effects of fisheries in 2010 to the smolt production in 2015 (i.e. spawned 2010, hatching 2011, 2-3 years in the river plus one year in the sea makes year 2015) the criteria of relative to the 75% level of the natural production capacity apply. Reaching at least 75% of the PSPC has been suggested by ICES if the plan is to recover salmon populations to the MSY level. The PSPC estimates therefore form the basis of the current reference points for the assessment of the Baltic salmon stocks.

The salmon stocks are considered ***very likely*** to reach the reference point in case the probability is more than 90%. They are ***likely*** to reach the reference

point in case the probability is between 70% and 90% and ***uncertain*** when the probability lies between 30% and 70%. When the probability of reaching the reference point is less than 30%, it is considered ***unlikely.***

Presently from the 27 assessed rivers, 10 are likely to reach the 75% target in 2010 (Table. 5.1.3.2) 11 rivers are uncertain and 6 rivers are unlikely to reach the 75% targets. The reference points of the natural production capacity are more likely to be met in productive rivers especially in the Northern Baltic Sea area while the status of less productive wild stocks is poor.

Table 5-3 Overview of the status of the Gulf of Bothnia and Main Basin stocks in terms of their probability to reach 75% of the smolt production capacity by 2010. Stocks are considered very likely to reach this objective in case the probability is more than 90% and unlikely in case the probability isles than 30%. When the probability of reaching the objective lies between 30 and 70% it is considered uncertain if they will reach the objective in 2010.

		Probability to reach 75% of the smolt production capacity			
Assessment unit		Very likely	Likely	Uncertain	Unlikely
Unit 1					
	Tornionjoki			X	
	Simojoki			X	
	Kalixälven		X		
	Råneälven			X	
Unit 2					
	Piteälven		X		
	Åbyälven			X	
	Byskeälven		X		
	Rickleån				X
	Sävarån			X	
	Ume/Vindelälven		X		
	Öreälven				X
	Lögdeälven			X	
Unit 3					
	Ljungan			X	
Unit 4					
	Emån				X
	Mörrumsån			X	
Unit 5					
	Pärnu				X
	Salaca		X		
	Vitrupe		X		
	Peterupe			X	
	Gauja			X	
	Daugava				X
	Irbe		X		
	Venta		X		

Assessment unit	Probability to reach 75% of the smolt production capacity			
	Very likely	Likely	Uncertain	Unlikely
Saka			X	
Uzava		X		
Barta		X		
Nemunas				X
Total:		10	11	6

The data on Baltic salmon in the Gulf of Finland is insufficient for an analytical assessment. However, it is known that the state of the wild salmon stocks in the Gulf of Finland is poor (Figure 5.1.3.1). Natural smolt production in Estonian, Finnish, and Russian rivers in the Gulf of Finland area has been estimated at about 27 000 in 2008 and at the same time the hatchery reared smolt releases were 777 000 smolts. The smolt releases in the region has increased in the last ten years (Figure 5.1.3.1) but no recovery on wild salmon stocks nor smolt production has been observed.

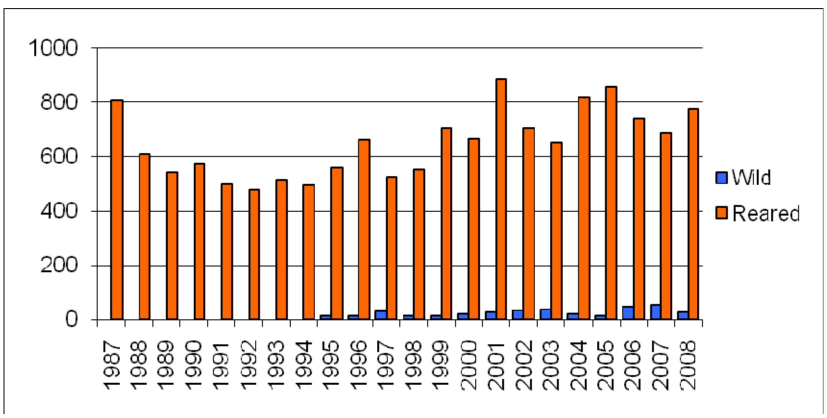

Figure 5-1 Annual production of wild and reared smolts in the Gulf of Finland. No information on the wild production is available before 1995.

	Precautionary				Target	Management	
Stock	B_{lim}	B_{pa}	F_{lim}	F_{pa}	F_y	F_{mgt}	**Comments**
cod-2224	Not defined	23 000 t MBAL	Not defined	Not defined	Not defined	0.6 EU management plan 2007	(unchanged since: 2008)
cod-2532	Not defined	Not defined	0.96 Fmed estimated in 1998	0.6 5th percentile of Fmed	0.3-0.4 AGLTA 2005, WKREFBAS 2008, simulations	0.3 EU management plan 2007	
Her3a22	Not defined	Not defined	Not defined	Not defined	Not defined	Not defined	ACOM not in a position to define appropriate reference points
Her-2532-Ex-Go	Not defined	Not defined	Not defined	0.19 F_{med} (assessment 2000)	Not defined	Not defined	(unchanged since: 2000) Recent simulations indicate that the Fpa needs revision
her-riga	Not defined	Not defined	Not defined	0.19 Medium term projections	Not defined	Not defined	(changed in: 2008)
her-30	Not defined	Not defined	0.30 Floss (in 2000)	0.21 Fmed (in 2000)	Not defined	Not defined	(changed in: 2009)
her-31	Not defined	Not defined	Not defined	Not defined	Not defined	Not defined	
spr-2232	Not defined	Not defined	Not defined	0.40 Fmed estimate in 1998, allowing for variable natural mortality.	Not defined	Not defined	(changed in 2008)

Table 5-4 The analytical assessments and estimates available for various stocks and various time periods.

	Parameter				
Stock	**Landings**	**SSB**	**Total biomass**	**Reference F**	**Comments**
cod-2224	1970-2008	1970-2008	1970-2008	1970-2008	Assessment method: SAM
cod-2532	1966-2008	1966-2008	1966-2008	1966-2008	Assessment method: XSA
Her3a22	1991-2008	1991-2008	1991-2008	1991-2008	Assessment method: XSA
Her-2532-Ex-Go	1974-2008	1974-2008	1974-2008	1974-2008	Assessment method: XSA
her-riga	1977-2008	1977-2008	1977-2008	1977-2008	Assessment method; XSA
her-30	1973-2008	1973-2008	1973-2008	1973-2008	Assessment method: XSA
her-31	1980-2008	1980-2008	1980-2008	1980-2008	Assessment not accepted
spr-2232	1974-2008	1974-2008	1974-2008	1974-2008	Assessment method: XSA
sal-2231	1985-2008	Smolt production by assessment units 1985-2008			Assessment method: A Bayesian approach to statistical inference

Table 5-5 The present stock status (ACOM 2009)

Stock	**Spawning biomass in relation to precautionary limits**	**Fishing mortality in relation to precautionary limits**	**Fishing mortality in relation to high long term yield**	**Fishing mortality in relation to agreed target reference points**	**Comment**
cod-2224	Increased risk	Undefined	Overexploited	Above target	EU Management plan implemented in 2008 with target fishing mortality of 0.6
cod-2532	Undefined	Harvested sustainably	Appropriate	Below target	EU management plan implemented in 2008 with a target fishing mortality of 0.3.
her-3a22	Undefined	Undefined	Overfished	NA	
her-2532-Ex-Go	Undefined	Increased risk	Overexploited	NA	
her-riga	Undefined	Harvested sustainably	Overexploited	N/A	
her-30	Undefined	Harvested sustainably	Appropriate	N/A	
her-31	Undefined	Undefined	Undefined	Undefined	
spr-2232	Undefined	At risk	Overexploited	NA	

Only two out of 8 regularly assessed stocks are considered “within SBL”. However, there is no basis for most of the stocks to define their state in relation to biological reference point, because most of those are not usable considering the present “regime shift” state of the Baltic Sea.

Representativity

In order to assess the representativity of the indicator we determined what proportion of all landed fish and shellfish consisted of assessed stocks. For this we used the ICES catch statistics in the Baltic from 1983-2007 as they occur in the FAO Fishstat database. The sub-areas used were sub-divisions 22-32 except for western Baltic herring where also division IIIa was included.

Over the last 5 years (2003-2007) there were about 70 different species- or species-groups landed and reported. The exact number is very difficult to determine as there was overlap between groups and some overlapping of areas as well as different species aggregated in one group (e.g. Freshwater species). In the period 2003-2007 there were 26 species (25 fish, 1 invertebrate) that contributed more than 0.1% of the landings. Together these species made up 82% of the landings consisting of approximately 95% fish and about 5% invertebrates.

When representativity was calculated as the proportion of landings of the stocks selected specifically for the Baltic Sea in relation to all recorded landings for the Baltic Sea about 90 % of the landed species consists of assessed species (table 5.x.x). Of these sprat, herring and cod form more than 95 %.

Table 5-6 All major species- and species-groups in the Baltic (>0.1% of the total landings, period 2003-2007), their total landings and relative contribution. Indicated is whether the species are assessed (A) or non-assessed (NA) as well as fish (F) or invertebrate (I).

Species	Assessed	Type	Total landings	Relative
European sprat	A	F	1842928	50.6
Atlantic herring	A	F	1132720	31.1
Atlantic cod	A	F	301634	8.3
Blue mussel	NA	I	111388	3.1
European flounder	NA	F	71924	2.0
European perch	A	F	26057	0.7
Roach	NA	F	12490	0.3
Northern pike	NA	F	11234	0.3
Freshwater bream	NA	F	8517	0.2
European plaice	NA	F	8467	0.2
Vendace	A	F	7952	0.2
Pike-perch	NA	F	6966	0.2
Common dab	NA	F	5172	0.1
Flatfishes (others)	NA	F	4997	0.1
European whitefish	NA	F	4775	0.1
Whiting	NA	F	3765	0.1
Atlantic horse mackerel	NA	F	3576	0.1
European smelt	NA	F	3166	0.1
Freshwater fishes (others)	A	F	2612	0.1
Cyprinids (others)	NA	F	2415	0.1
Sea trout	NA	F	1949	0.1
Atlantic salmon	A	F	1878	0.1

5.2. North-east Atlantic Ocean

5.2.1. North Sea

For the North Sea stocks the appropriate source of information is the regular assessments by the ICES Working Groups reporting to ACOM. The ‘‘North Sea’’ as defined for the MSFD includes the whole of ICES Area IV (the geographic North Sea), IIIa, b (the Skagerrak and

Kattegat), VIId, e (Eastern and Western Channel), and part of VIa (North and West of Scotland).

The stocks that were selected to calculate the indicator for the North Sea are shown with the code used in Table 5-8)

Table 5-7 Assessed stocks and their codes used to calculate the indicator for the NS

Code	Stock
cod-347d	Cod in Subarea IV (North Sea), Division VIId (Eastern Channel) and IIIa West (Skagerrak)
cod-scow	Cod in Division VIa (West of Scotland)
had-34	Haddock in Subarea IV (North Sea) and Division IIIa West (Skagerrak)
had-scow	Haddock in Division VIa (West of Scotland)
her-47d3	Herring in Subarea IV and Divisions IIIa and VIId (North Sea autumn spawners)
ple-eche	Plaice in Division VIId (Eastern Channel)
ple-nsea	Plaice Sub-area IV (North Sea)
sai-3a46	Saithe in Sub-area IV (North Sea) & Division IIIa (Skagerrak)
sol-eche	Sole in Division VIId (Eastern Channel)
sol-kask	Sole in Division IIIa (Skagerrak-Kattegat)
sol-nsea	Sole in Sub-area IV (North Sea)
whg-47d	Whiting Sub-area IV (North Sea) & Division VIId (Eastern Channel)

The years the selected stocks were assessed are shown in Table 5-9. This shows that the suite of stocks on which the indicator is based changed (expanded) considerably over time (see Figure 5-2).

Table 5-8 Years the selected stocks were assessed. For stock codes see Table 5-8.

Year	cod-347d	cod-scow	had-34	had-scow	her-47d3	ple-eche	ple-nsea	sai-3a46	sol-eche	sol-kask	sol-nsea	whg-47d
1957							X				X	
1958							X				X	
1959							X				X	
1960					X		X				X	
1961					X		X				X	
1962					X		X				X	
1963	X		X		X		X				X	
1964	X		X		X		X				X	
1965	X		X		X		X				X	
1966	X		X		X		X				X	
1967	X		X		X		X	X			X	
1968	X		X		X		X	X			X	
1969	X		X		X		X	X			X	
1970	X		X		X		X	X			X	

Year	cod-347d	cod-scow	had-34	had-scow	her-47d3	ple-eche	ple-nsea	sai-3a46	sol-eche	sol-kask	sol-nsea	whg-47d
1971	X		X		X		X	X			X	
1972	X		X		X		X	X			X	
1973	X		X		X		X	X			X	
1974	X		X		X		X	X			X	
1975	X		X		X		X	X			X	
1976	X		X		X		X	X			X	
1977	X		X		X		X	X			X	
1978	X	X	X	X	X		X	X			X	
1979	X	X	X	X	X		X	X			X	
1980	X	X	X	X	X	X	X	X			X	
1981	X	X	X	X	X	X	X	X			X	
1982	X	X	X	X	X	X	X	X	X		X	
1983	X	X	X	X	X	X	X	X	X		X	
1984	X	X	X	X	X	X	X	X	X	X	X	
1985	X	X	X	X	X	X	X	X	X	X	X	
1986	X	X	X	X	X	X	X	X	X	X	X	
1987	X	X	X	X	X	X	X	X	X	X	X	
1988	X	X	X	X	X	X	X	X	X	X	X	
1989	X	X	X	X	X	X	X	X	X	X	X	
1990	X	X	X	X	X	X	X	X	X	X	X	
1991	X	X	X	X	X	X	X	X	X	X	X	
1992	X	X	X	X	X	X	X	X	X	X	X	
1993	X	X	X	X	X	X	X	X	X	X	X	
1994	X	X	X	X	X	X	X	X	X	X	X	
1995	X	X	X	X	X	X	X	X	X	X	X	X
1996	X	X	X	X	X	X	X	X	X	X	X	X
1997	X	X	X	X	X	X	X	X	X	X	X	X
1998	X	X	X	X	X	X	X	X	X	X	X	X
1999	X	X	X	X	X	X	X	X	X	X	X	X
2000	X	X	X	X	X	X	X	X	X	X	X	X
2001	X	X	X	X	X	X	X	X	X	X	X	X
2002	X	X	X	X	X	X	X	X	X	X	X	X
2003	X	X	X	X	X	X	X	X	X	X	X	X
2004	X	X	X	X	X	X	X	X	X	X	X	X
2005	X	X	X	X	X	X	X	X	X	X	X	X
2006	X	X	X	X	X	X	X	X	X	X	X	X
2007	X	X	X	X	X	X	X	X	X	X	X	X
2008	X	X	X	X	X	X	X	X	X	X	X	X

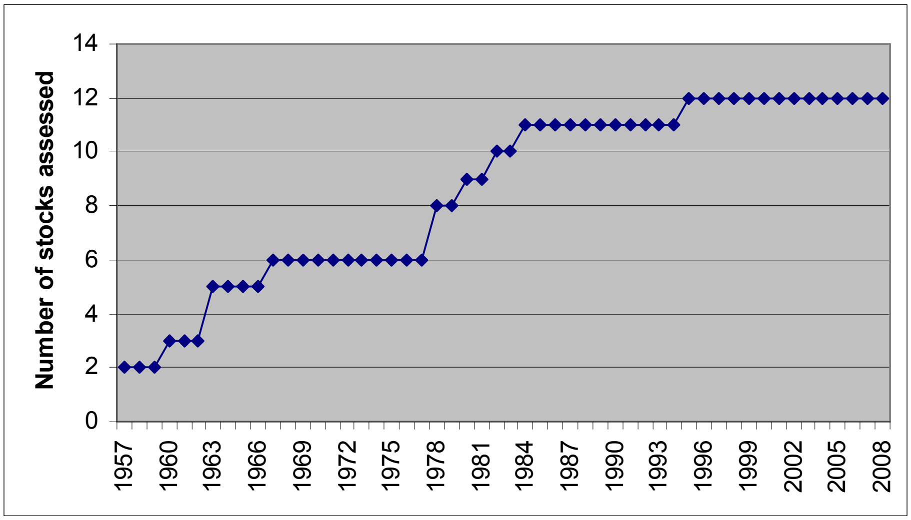

Figure 5-2 Number of North Sea stocks assessed over time

The time-series of the indicator "proportion of stocks within SBL shows a strong decrease from 100% at the start in 1957 when only based on two stocks (plaice and sole) to about 20% in the early 1970s to about 10% in the 1990s (Figure 5-3). In recent years there appears to be a slight increase to about 30%. A comparable trend is observed for the other indicator, "proportion of landings within SBL" which also decreases strongly over the 1960s remaining mostly below 20% and showing a slight increase in recent years (Figure 5-4).

To some extent the decrease at the beginning of the time-series may be caused by the change in the composition of the suite of stocks on which the indicator is based. As the indicator was based on a consistent suite of stocks from 1995 onwards the increase in recent years appears to be genuine.

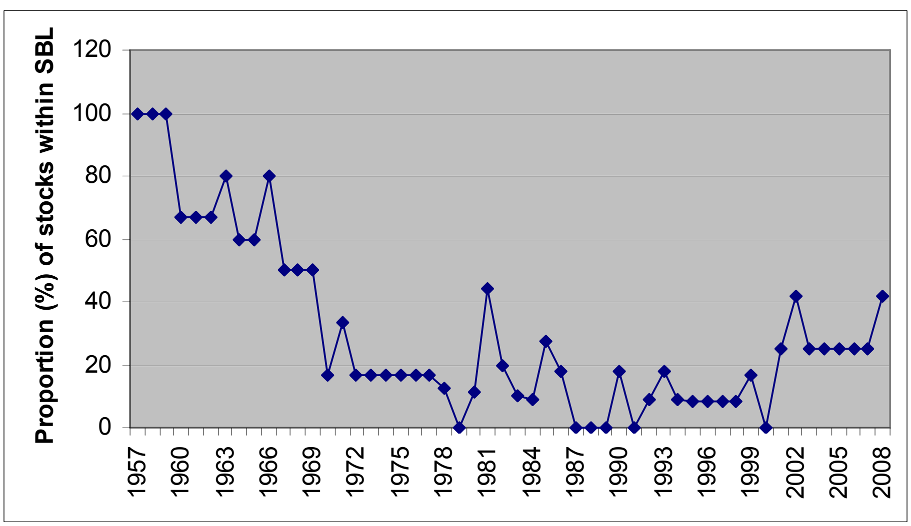

Figure 5-3 Proportion of assessed North sea stocks within Safe Biological Limits (SBL) over time

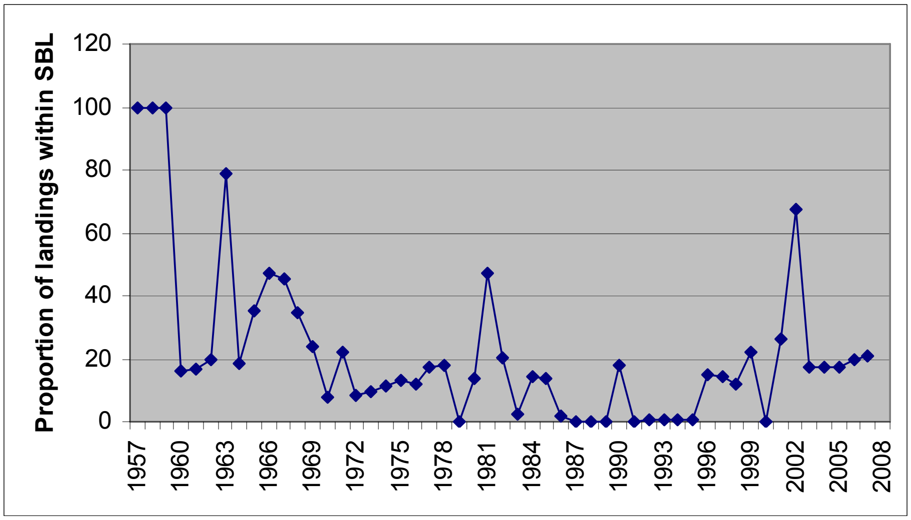

Figure 5-4 Proportion of landings from assessed North sea stocks that are within Safe Biological Limits (SBL) over time

Representativity

In order to assess the representativity of the indicator we determined what proportion of all landed fish and shellfish consisted of assessed stocks. For this we used the ICES catch statistics 1973-2007 as they occur in the FAO Fishstat database. The divisions shown in Table 5-10 were attributed to the North Sea as defined in the MSFD and landings per species were aggregated for that region.

Table 5-9 Divisions in the FAO Fishstat database attributed to the MSFD North Sea region

Area 27 Sub-area IIIa
Area 27 Sub-area IIIa+IVa+b
Area 27 Sub-area IV
Area 27 Sub-area IV a+b
Area 27 Sub-area IVa
Area 27 Sub-area IVb
Area 27 Sub-area IVc
Area 27 Sub-area VIa
Area 27 Sub-area VIId

Over the last 5 years (2003-2007) there were almost 300 different species- or species-groups landed. The exact number was difficult to determine as there was overlap between groups (e.g. Anglerfish and Anglerfishes nei) as well as different species aggregated in one group (e.g. "Dogfishes and hounds" or "Cuttlefish, bobtail squids"). In the period 2003-2007 there were 41 species (31 fish, 10 invertebrate) that contributed more than 0.1% of the landings. Together these species made up 98% of the landings (approximately 89% fish and less than 9% invertebrates).

When representativity was calculated as the proportion of landings of the stocks selected specifically for the North Sea in relation to all recorded landings for the North Sea about 30-40% of the landed species consists of assessed species (Figure 5-5), or rather assessed species for which both reference levels are known. However, this outcome is flawed since species that contribute an important part of the landings are assessed but because of their wide range of

distribution cannot be considered specific for the North Sea region (i.e. Mackerel, Blue whiting and Horse mackerel) and were therefore not included. If these species were included the representativity would increase to about 65%. Alternatively if these species were not included in the total North Sea-specific landings the representativity would be about 56%. Two other species that are characterised as non-assessed are sandeel and sprat. Both species, however, are assessed but both reference levels are not reported and hence the stocks could not be included in the indicator. If these two stocks could be included, representativity would increase up to 84%.

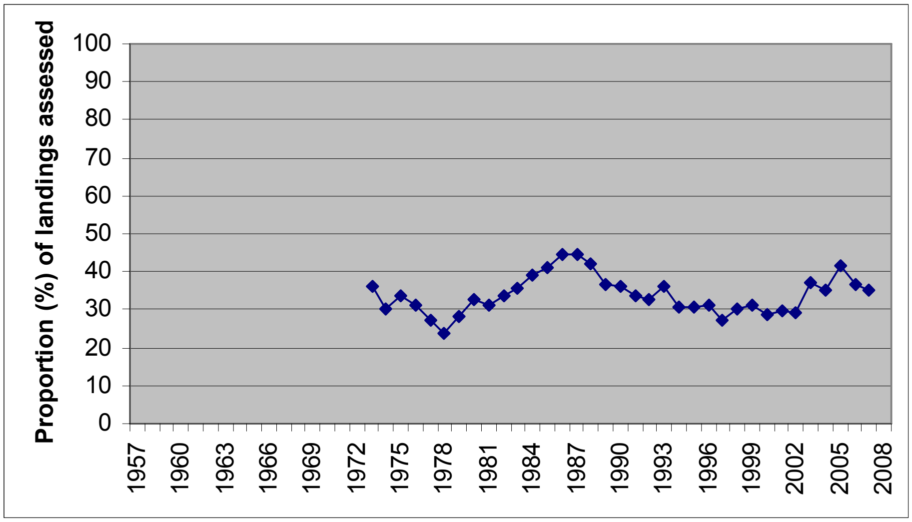

Figure 5-5 Proportion of the total landings in the North Sea region consisting of assessed species.

Table 5-10 All major species- and species-groups (>0.1% of the total landings, period 2003-2007), their total landings and relative contribution. Indicated is whether the species are assessed (A) or non-assessed (NA) as well as fish (F) or invertebrate (I)

			Landings	
Species	**Assessed**	**Type**	**Total**	**Relative**
Atlantic herring	A	F	2783653	21.5
Blue whiting(=Poutassou)	NA	F	1899827	14.7
Atlantic mackerel	NA	F	1830193	14.1
Sandeels(=Sandlances) nei	NA	F	1445138	11.2
European sprat	NA	F	1052670	8.1
Saithe(=Pollock)	A	F	560700	4.3
Atlantic horse mackerel	NA	F	423721	3.3
European plaice	A	F	348293	2.7
Blue mussel	NA	I	297343	2.3
Haddock	A	F	217233	1.7
Common shrimp	NA	I	194042	1.5
Norway lobster	NA	I	180637	1.4
Atlantic cod	A	F	153572	1.2
Edible crab	NA	I	121705	0.9
Great Atlantic scallop	NA	I	117624	0.9
Norway pout	NA	F	115552	0.9
Common sole	A	F	106008	0.8
Whiting	A	F	89451	0.7

			Landings	
Species	**Assessed**	**Type**	**Total**	**Relative**
Northern prawn	NA	I	69692	0.5
Common edible cockle	NA	I	63178	0.5
European pilchard(=Sardine)	NA	F	60876	0.5
Angler(=Monk)	NA	F	58166	0.4
Common dab	NA	F	54997	0.4
Ling	NA	F	54926	0.4
Roundnose grenadier	NA	F	46193	0.4
Whelk	NA	I	35895	0.3
European hake	NA	F	33451	0.3
Cuttlefish,bobtail squids nei	NA	I	24767	0.2
European flounder	NA	F	23637	0.2
Lemon sole	NA	F	22877	0.2
Raja rays nei	NA	F	20896	0.2
Various squids nei	NA	I	19579	0.2
Greater argentine	NA	F	19347	0.1
Turbot	NA	F	19025	0.1
Red mullet	NA	F	16075	0.1
Tusk(=Cusk)	NA	F	15435	0.1
Witch flounder	NA	F	15161	0.1
Blue ling	NA	F	14747	0.1
Pouting(=Bib)	NA	F	14314	0.1
Picked dogfish	NA	F	13748	0.1
Black scabbardfish	NA	F	13675	0.1

5.2.2. Celtic Seas

For this analysis the Celtic Sea was defined as the ICES areas VII e-k. Data have been analysed for the reference year 2005. In total 247 fish and shellfish species have been reported in the FAO statistics FAO Stat. According to the FAO landing data the most important fish and shellfish species are Atlantic herring, Atlantic horse mackerel, Atlantic mackerel, Great Atlantic Scallop and European pilchard.

The landings in the Celtic Sea are characterized by a high diversity of fish and shellfish species. Thirty-six species constitute 90% of the total landings. Nevertheless even the species, which represent a very small portion of the overall landing weights, are playing an important role in the ecosystem of the Celtic Sea. For example a number of elasmobranchs, which only represent a small fraction of the landing weights have been reported to be in an unfavourable conservation status and are listed as threatened and declining by OSPAR (e.g Picked dogfish, Leafscale gulper shark, Angel shark, Portuguese dogfish, Gulper shark, Porbeagle, Thornback ray, Spotted ray). Therefore it is important to consider these species in the evaluation of the good environmental status of commercial exploited species.

Table 5-11 Fish and shellfish species representing more than 0.1% of the overall landing weights

Species	Landing 2005 (t)	Relative	Cumulative
Atlantic herring	67439	13.0	13.0
Atlantic horse mackerel	65761	12.7	25.7
Atlantic mackerel	38579	7.4	33.1
Great Atlantic scallop	37637	7.3	40.4
European pilchard(=Sardine)	21524	4.2	44.5
Whelk	17508.5	3.4	47.9
Whiting	17199	3.3	51.2
European hake	15736	3.0	54.2
Tangle	13755	2.7	56.9
Blue mussel	13421	2.6	59.5
Cuttlefish,bobtail squids nei	11799	2.3	61.7
Blue whiting(=Poutassou)	11457	2.2	63.9
Monkfishes nei	11009	2.1	66.1
Edible crab	9690.5	1.9	67.9
Megrims nei	9269	1.8	69.7
Norway lobster	7861	1.5	71.2
Common sole	6969	1.3	72.6
Haddock	6407	1.2	73.8
Pouting(=Bib)	5823	1.1	74.9
European sprat	5808	1.1	76.0
Common European bittersweet	5637	1.1	77.1
Albacore	5486	1.1	78.2
Raja rays nei	5455	1.1	79.2
European plaice	5408	1.0	80.3
Angler(=Monk)	5266	1.0	81.3
Red gurnard	5088	1.0	82.3
Small-spotted catshark	4735	0.9	83.2
Pollack	4509	0.9	84.0
Various squids nei	4383	0.8	84.9
Atlantic cod	4233	0.8	85.7
Queen scallop	3991.5	0.8	86.5
Seaweeds nei	3724	0.7	87.2
European conger	3554	0.7	87.9
Spinous spider crab	3379	0.7	88.5
Ling	3352	0.7	89.2
Lemon sole	2844	0.6	89.7
Red mullet	2824	0.5	90.3
European seabass	2641	0.5	90.8
Black seabream	2478	0.5	91.3
Anglerfishes nei	2476	0.5	91.7
Witch flounder	2097.5	0.4	92.1
John dory	1870	0.4	92.5

Species	Landing 2005 (t)	Relative	Cumulative
Cuckoo ray	1790	0.3	92.8
Smooth-hounds nei	1786	0.3	93.2
Picked dogfish	1745	0.3	93.5
Megrim	1733.5	0.3	93.8
North Atlantic rockweed	1376	0.3	94.1
Common edible cockle	1366	0.3	94.4
Common dab	1239	0.2	94.6
Greater forkbeard	1148	0.2	94.8
Tub gurnard	1140	0.2	95.1
Common cuttlefish	1130	0.2	95.3
Turbot	1089	0.2	95.5
Rays, stingrays, mantas nei	1050.5	0.2	95.7
Gurnards, searobins nei	1048	0.2	95.9
Warty venus	1008	0.2	96.1
Spotted ray	927	0.2	96.3
Marine fishes nei	918	0.2	96.4
European lobster	915	0.2	96.6
Brill	890.5	0.2	96.8
Dogfish sharks nei	874	0.2	97.0
Variegated scallop	812	0.2	97.1
European flat oyster	775	0.2	97.3
Common squids nei	661	0.1	97.4
Saithe(=Pollock)	599	0.1	97.5
Thornback ray	573	0.1	97.6
Solid surf clam	511	0.1	97.7
Northern shortfin squid	489.5	0.1	97.8
North European kelp	464	0.1	97.9
Banded carpet shell	452	0.1	98.0
Blackbelly rosefish	428	0.1	98.1
Mullets nei	402	0.1	98.2
Tope shark	318	0.1	98.2
European flying squid	315.5	0.1	98.3
Demersal percomorphs nei	294	0.1	98.3
Dogfishes nei	290	0.1	98.4
Octopuses, etc. nei	277	0.1	98.4
Atlantic pomfret	272	0.1	98.5
Dogfishes and hounds nei	266	0.1	98.5
Cardinalfishes, etc. nei	265	0.1	98.6
European flounder	262	0.1	98.6
Orange roughy	248	0.1	98.7
Rays and skates nei	243	0.1	98.7
Blue skate	242	0.1	98.8
Squids nei	238	0.1	98.8
Portuguese dogfish	234	0.1	98.9

In order to assess the representativity of the indicator we determined what proportion of all landed fish and shellfish consisted of assessed stocks.

The number of species in the Celtic Sea area that are under analytical assessment is relatively small (<20% of the total). Assessed stocks accounted for about 60% of the landed catch in 2005. Analytical assessment and reference levels are available for stocks of mackerel, horse mackerel, herring, blue whiting, hake, cod, sole, plaice, *Nephrops*, scallops, haddock and whiting. From several other species and stocks some qualitative assessments of stock status is given by ICES e.g. anglerfish, megrim, elasmobranches, deepwater species.

5.2.3. Bay of Biscay and Iberian coast

For this sub-region Fishstat Area 27 Sub-area VIII and IX were used. The table shows that there are 118 species- or species groups that contribute more than 0.1% to the landings. These species together make up more than 98% of the landings. The assessed species representative for the sub-region make up approximately 50%. But this excludes migrating pelagics such as Blue whiting that make up another 10% of the landings.

Table 5-12 All major species- and species-groups (>0.1% of the total landings in 2005), their total landings and relative contribution. A indicates assessed species.

Species	Landing 2005 (t)	Relative	Cumulative	Assessed
European pilchard(=Sardine)	117058	21.7	21.6800	A(Ib)
Blue whiting(=Poutassou)	48888	9.1	30.7300	mp
Scomber mackerels nei	36815	6.8	37.5500	A
Atlantic horse mackerel	32639.5	6.1	43.6000	A
Jack and horse mackerels nei	30131	5.6	49.1800	
Atlantic mackerel	29754	5.5	54.6900	A
Albacore	27203	5.0	59.7300	
European hake	19296.5	3.6	63.3000	A
Chub mackerel	15313	2.8	66.1400	
Octopuses, etc. nei	13498	2.5	68.6400	
Monkfishes nei	6312	1.2	69.8100	A
Pouting(=Bib)	6153	1.1	70.9500	
European conger	5724	1.1	72.0100	
European anchovy	5552	1.0	73.0400	A
Northern bluefin tuna	5503	1.0	74.0600	mp
Common sole	4891	0.9	74.9700	A
Striped venus	4779	0.9	75.8600	
Cuttlefish,bobtail squids nei	4681	0.9	76.7300	
Finfishes nei	4633	0.9	77.5900	
Raja rays nei	4585.5	0.9	78.4400	
Norway lobster	4492	0.8	79.2700	A
Common edible cockle	4430	0.8	80.0900	
European seabass	3733	0.7	80.7800	A
Common octopus	3477	0.6	81.4200	
Atlantic pomfret	3302	0.6	82.0300	
Black scabbardfish	3294.5	0.6	82.6400	A
Groundfishes nei	3203	0.6	83.2300	
Common cuttlefish	3183.5	0.6	83.8200	
Squids nei	3161	0.6	84.4100	

Species	Landing 2005 (t)	Relative	Cumulative	Assessed
Marine fishes nei	3009	0.6	84.9700	
Bigeye tuna	2443	0.5	85.4200	
Edible crab	2372	0.4	85.8600	
Megrims nei	2335	0.4	86.2900	A
Blue shark	2327	0.4	86.7200	
Whiting	2173	0.4	87.1200	A
Anglerfishes nei	2068	0.4	87.5000	A
Tangle	1880	0.4	87.8500	
Lemon sole	1844.5	0.3	88.1900	
John dory	1764.5	0.3	88.5200	
Pollack	1755.5	0.3	88.8500	
Various squids nei	1698	0.3	89.1600	
Spinous spider crab	1585.5	0.3	89.4500	
Solid surf clam	1581	0.3	89.7400	
Red mullet	1536	0.3	90.0200	
Venus clams nei	1476	0.3	90.2900	
Meagre	1427.5	0.3	90.5500	
Mullets nei	1282	0.2	90.7900	
Atlantic saury	1281.5	0.2	91.0300	
Mediterranean horse mackerel	1273	0.2	91.2700	?
Common squids nei	1263.5	0.2	91.5000	
Black seabream	1239.5	0.2	91.7300	
Cuckoo ray	1174	0.2	91.9500	
Small-spotted catshark	1081	0.2	92.1500	
Blue jack mackerel	1080.5	0.2	92.3500	
Great Atlantic scallop	996.5	0.2	92.5300	A
Northern shortfin squid	972.5	0.2	92.7100	
Swordfish	875	0.2	92.8700	
Wedge sole	843	0.2	93.0300	
Tunas nei	830	0.2	93.1800	
Bullet tuna	790.5	0.2	93.3300	
Donax clams	785	0.2	93.4800	
Ling	771	0.1	93.6200	
Bogue	762.5	0.1	93.7600	
Axillary seabream	719.5	0.1	93.8900	
Pullet carpet shell	692	0.1	94.0200	
Rays and skates nei	682	0.1	94.1500	
Leafscale gulper shark	648	0.1	94.2700	
Pandoras nei	631.5	0.1	94.3900	
Gurnards, searobins nei	613.5	0.1	94.5000	
Surmullets(=Red mullets) nei	613.5	0.1	94.6100	
Deep-water rose shrimp	611	0.1	94.7200	
Portuguese dogfish	609	0.1	94.8300	
Rays, stingrays, mantas nei	589.5	0.1	94.9400	
Blackspot(=red) seabream	588	0.1	95.0500	

Species	Landing 2005 (t)	Relative	Cumulative	Assessed
Catsharks, nursehounds nei	572	0.1	95.1600	
Sandeels(=Sandlances) nei	568	0.1	95.2700	
Smooth-hounds nei	566.5	0.1	95.3700	
Gurnards nei	531.5	0.1	95.4700	
White seabream	511	0.1	95.5600	
Gilthead seabream	463.5	0.1	95.6500	
Frigate and bullet tunas	460	0.1	95.7400	
Shortfin mako	460	0.1	95.8300	
Tope shark	452	0.1	95.9100	
Solea spp	446.5	0.1	95.9900	A
Sea urchins, etc. nei	445	0.1	96.0700	
Common two-banded seabream	438.5	0.1	96.1500	
Silver scabbardfish	420	0.1	96.2300	A
Scorpionfishes nei	417.5	0.1	96.3100	
Thornback ray	411.5	0.1	96.3900	
Thickback soles	386	0.1	96.4600	
Croakers, drums nei	373	0.1	96.5300	
European plaice	368.5	0.1	96.6000	
Catsharks, etc. nei	354	0.1	96.6700	
Marine crustaceans nei	343	0.1	96.7300	
Salema	337	0.1	96.7900	
Forkbeards nei	333	0.1	96.8500	
Gelidium seaweeds	332	0.1	96.9100	
Horned octopus	319.5	0.1	96.9700	
Sargo breams nei	308	0.1	97.0300	
Variegated scallop	304	0.1	97.0900	
Seabasses nei	300.5	0.1	97.1500	
Sand steenbras	299	0.1	97.2100	
Porbeagle	297.5	0.1	97.2700	
Lefteye flounders nei	294	0.1	97.3200	
Comber	292	0.1	97.3700	
Silversides(=Sand smelts) nei	292	0.1	97.4200	
Sand sole	291	0.1	97.4700	
Smooth callista	291	0.1	97.5200	
Greater forkbeard	282.5	0.1	97.5700	
Wrasses, hogfishes, etc. nei	275.5	0.1	97.6200	
True tunas nei	275	0.1	97.6700	
Green crab	274	0.1	97.7200	
Splendid alfonsino	274	0.1	97.7700	
Turbot	272.5	0.1	97.8200	
Atlantic bonito	270	0.1	97.8700	
Lusitanian toadfish	257.5	0.1	97.9200	
Red gurnard	254.5	0.1	97.9700	
Garfish	243	0.1	98.0200	

5.2.4. Atlantic Ocean

For this sub-region Fishstat Area 27 Sub-area X, Canaries/Madeira insular, Northern coastal, Northern oceanic were used. The tunas were aggregated over all CECAF areas.

Table 5-14 shows that there are about 100 species- or species groups that contribute more than 0.1% to the landings. These species together make up almost 100% of the landings. Which species were assessed was not known.

Table 5-13 All major species- and species-groups (>0.1% of the total landings in 2005), their total landings and relative contribution.

Species	Landing 2005 (t)	Relative	Cumulative
Skipjack tuna	132189	41.3000	41.3000
Yellowfin tuna	78809	24.6200	65.9200
Bigeye tuna	46821	14.6300	80.5500
Little tunny(=Atl.black skipj)	8382	2.6200	83.1700
Tuna-like fishes nei	6125	1.9100	85.0800
Blue shark	4980	1.5600	86.6400
Atlantic bonito	4612	1.4400	88.0800
Albacore	4263	1.3300	89.4100
Swordfish	4065	1.2700	90.6800
Black scabbardfish	3567	1.1100	91.7900
Frigate tuna	2803	0.8800	92.6700
Atlantic bluefin tuna	2768	0.8600	93.5300
Chub mackerel	1557	0.4900	94.0200
Atlantic sailfish	1514	0.4700	94.4900
Blackspot(=red) seabream	1459.5	0.4600	94.9500
Blue marlin	1353	0.4200	95.3700
Blue jack mackerel	1223	0.3800	95.7500
Marine fishes nei	961	0.3000	96.0500
Frigate and bullet tunas	879	0.2700	96.3200
Sharks, rays, skates, etc. nei	816	0.2500	96.5700
Roundnose grenadier	799	0.2500	96.8200
West African Spanish mackerel	771	0.2400	97.0600
Shortfin mako	512	0.1600	97.2200
Jack and horse mackerels nei	505	0.1600	97.3800
Natantian decapods nei	447.5	0.1400	97.5200
Red porgy	446	0.1400	97.6600
European pilchard(=Sardine)	409	0.1300	97.7900
Common cuttlefish	385	0.1200	97.9100
Alfonsino	357	0.1100	98.0200
Wahoo	347	0.1100	98.1300
European conger	333	0.1000	98.2300
Wreckfish	302.5	0.0900	98.3200
Marlins,sailfishes,etc. nei	302	0.0900	98.4100
Veined squid	272	0.0800	98.4900

Species	Landing 2005 (t)	Relative	Cumulative
Atlantic redfishes nei	260	0.0800	98.5700
Octopuses, etc. nei	238	0.0700	98.6400
Blackbelly rosefish	212.5	0.0700	98.7100
European lobster	166	0.0500	98.7600
Parrotfish	161	0.0500	98.8100
Plain bonito	156.5	0.0500	98.8600
Forkbeard	137	0.0400	98.9000
Splendid alfonsino	134	0.0400	98.9400
Orange roughy	131	0.0400	98.9800
Various sharks nei	115.5	0.0400	99.0200
Atlantic white marlin	109	0.0300	99.0500
Common dentex	92	0.0300	99.0800
Pargo breams nei	91	0.0300	99.1100
Bogue	85	0.0300	99.1400
Leafscale gulper shark	79	0.0200	99.1600
True tunas nei	79	0.0200	99.1800
Gastropods nei	72	0.0200	99.2000
Amberjacks nei	71	0.0200	99.2200
Combers nei	71	0.0200	99.2400
Common mora	70	0.0200	99.2600
Mackerel sharks,porbeagles nei	68	0.0200	99.2800
Snake mackerels, escolars nei	68	0.0200	99.3000
West African goatfish	66	0.0200	99.3200
Finfishes nei	65	0.0200	99.3400
Groupers nei	65	0.0200	99.3600
Oilfish	64	0.0200	99.3800
Pandoras nei	63	0.0200	99.4000
Morays	62	0.0200	99.4200
Porbeagle	56	0.0200	99.4400
Croakers, drums nei	55	0.0200	99.4600
Barracudas nei	54	0.0200	99.4800
Offshore rockfish	52	0.0200	99.5000
Thornback ray	48	0.0100	99.5100
Tope shark	47	0.0100	99.5200
Dentex nei	41	0.0100	99.5300
White seabream	41	0.0100	99.5400
Red mullet	40	0.0100	99.5500
European anchovy	39	0.0100	99.5600
Red scorpionfish	38	0.0100	99.5700
Brown moray	36	0.0100	99.5800
Groupers, seabasses nei	36	0.0100	99.5900
Salema	34	0.0100	99.6000
Scalloped hammerhead	34	0.0100	99.6100
Silver scabbardfish	32	0.0100	99.6200

Species	Landing 2005 (t)	Relative	Cumulative
Black seabream	31	0.0100	99.6300
Thicklip grey mullet	31	0.0100	99.6400
Alfonsinos nei	30	0.0100	99.6500
Common octopus	30	0.0100	99.6600
Rays, stingrays, mantas nei	30	0.0100	99.6700
Common sole	27	0.0100	99.6800
Demersal percomorphs nei	26	0.0100	99.6900
Surmullets(=Red mullets) nei	25	0.0100	99.7000
Whelk	25	0.0100	99.7100
White trevally	25	0.0100	99.7200
Atlantic pomfret	24	0.0100	99.7300
Sargo breams nei	24	0.0100	99.7400
Triggerfishes, durgons nei	23	0.0100	99.7500
White grouper	23	0.0100	99.7600
Greater forkbeard	22	0.0100	99.7700
Smooth hammerhead	22	0.0100	99.7800
Gulper shark	20	0.0100	99.7900
Requiem sharks nei	20	0.0100	99.8000
Northern bluefin tuna	19	0.0100	99.8100
Round sardinella	17	0.0100	99.8200
Thresher	17	0.0100	99.8300
European seabass	16.5	0.0100	99.8400
John dory	16.5	0.0100	99.8500

5.3. Mediterranean Sea

Fischer *et al*. (1987) gives a list of 1213 species (includes all taxa, from algae to mammals) of interest to fisheries in the Mediterranean and Black Sea.

The number of species with reported catch in Mediterranean and Black Sea since 1970 is, according to FISHSTAT, 241.

The statistics of Catalonia (NW Mediterranean) report a number of 193 species that have been identified and commercialized in the local markets since 2000.

The GFCM identified 42 "priority species" using several different selection criteria; in the SCSA (Subcommittee on Stock Assessment) 2007 a number of contributions regarding these criteria were presented[3].

5.3.1. Stock assessments

Most of the demersal stock assessments available for this region are located in the western part of the Mediterranean; In general these assessments suggest that fishing mortality should be reduced significantly, sometimes by a large amount, as some of these stocks may be

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[3] http://www.icm.csic.es/rec/projectes/scsa/Subcommittee_2007/Documents/Priority species.zip

approaching a critical state. This suggests that probably fishing mortality should also be reduced in many other areas of the Mediterranean because of the similarities in demersal fisheries in the region. While the wording “significantly” cannot always be quantified, the “reference direction” to follow for the Mediterranean demersal fisheries is clear: fishing mortality should be decreased. It is known that other assessments have been done, particularly in the Black Sea, but not presented to GFCM.

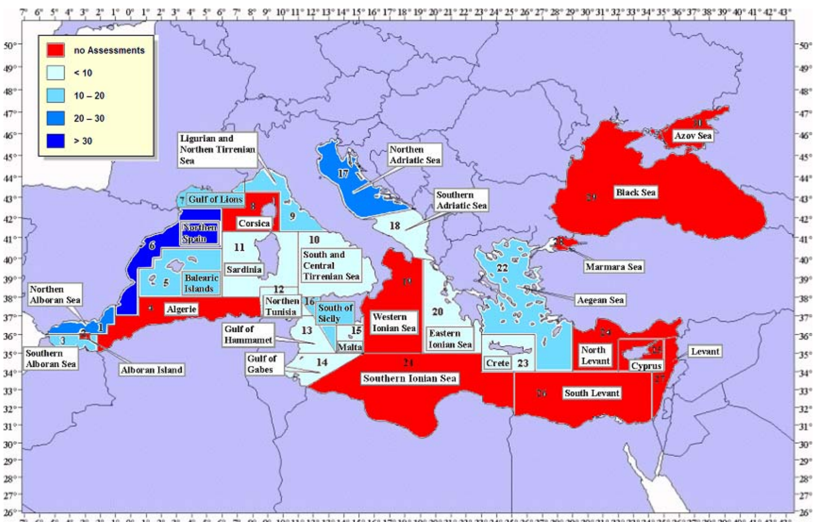


Figure 5-6 Stock Assessments (2001-2008) presented to SAC/GFCM - Data Map Coverage

Table 5-14 SAC/GFCM Management advice for demersal species

GSA	Stock	Stock status	SAC management advice
01 Northern Alboran Sea	**Red mullet** (*Mullus barbatus*)	Moderately exploited Y/R very close to the maximun	Not to increase the fishing effort
05 Balearic Islands	**Hake** (*Merluccius merluccius*)	Fully exploited Moderate fishing mortality Intermediate abundance	Not to increase the fishing effort Enforce the 40-mm square mesh
05 Balearic Islands	**Striped red mullet** (*Mullus surmuletus*)	Moderate fishing mortality Intermediate abundance Fully xploited (Y/R very close to the maximum and Bnow is about 37 percent Bvirgin)	Not to increase the fishing effort, especially in the trawl fishery
05 Balearic Islands	**Red mullet** *(Mullus barbatus)*	Moderately exploited to fully exploited Moderate fishing mortality Intermediate abundance Current Y/R very close to the maximum and Bnow being 21percent to 25 percent of Bvirgin	Not to increase the fishing effort
05 Balearic Islands	**Norway Lobster** *(Nephrops norvegicus)*	Fully exploited Moderate fishing mortality Intermediate abundance	Not to increase the fishing effort Enforce at least 40-mm square mesh
05 Balearic Islands	**Red shrimp** *(Aristeus antennatus)*	Fully exploited; Moderate fishing mortality Intermediate abundance	Not to increase the fishing effort

GSA	Stock	Stock status	SAC management advice
06 Northern Spain	**Hake** (*Merluccius merluccius*)	Overexploited High fishing mortality Low abundance	Reduction of fishing effort of trawl Enforce at least the 40-mm square mesh size in the cod end in bottom trawl Establish temporal closures for long line and gillnet during the period of maximum spawning Protect the spawning grounds through the implementation of MPA
06 Northern Spain	**Red mullet** *(Mullus barbatus)*	Overexploited. The fishery is being exploited at above a level which is believed to be sustainable in the long term, with no potential room for further expansion and a higher risk of stock depleion/collapse High fishing mortality Low abundance	Reduce effective fishing effort of 20 percent by reducing time at sea from 5 to 4 days per week Enforce at least the 40-mm square mesh in the cod-end
06 Northern Spain	**Deep-water rose shrimp** (*Parapenaeus longirostris)*	Depleted Catches are well below historical levels, irrespective of the amount of fishing effort exerted High fishing mortality Depleted	Need for recovery plan
07 Gulf of Lions	**Hake** (*Merluccius merluccius*)	Overexploited High fishing mortality Low abundance	Reduction of 20 percent of the fishing mortality by reducing time at sea, number of fishing boats, engine power, Bollard pull and/or trawl size, etc.) Enforce at least the 40-mm square mesh size in the cod-end Closing nursery areas, at least temporally (possibly identified by trawl surveys) Protecting spawners during the period of maximum spawning (winter and spring) by closing on the continental slope the areas where the spawners live
09 Ligurian	**Hake** (*Merluccius merluccius*)	Overexploited High fishing mortality Low abundance	Drastic reduction of the fishing mortality (40–80 percent)
15 and 16 Malta and South of Sicily	**Hake** (*Merluccius merluccius*)	Overexploited	Reduction of the fishing effort at least 40 percent
16 South of Sicily	**Deep-water rose shrimp** (*Parapenaeus longirostris)*	Overexploited High fishing mortality Low abundance	Reduction of the fishing mortality by 30 percent (decreasing of fishing capacity and activity) Enforce at least the 40-mm square mesh

GSA	Stock	Stock status	SAC management advice
17 Northern Adriatic Sea	**Common Sole** *(Solea vulgaris)*	Overexploited High fishing mortality Low abundance	Reduction of 10 percent of the fishing pressure applied by rapido trawlers (in terms of number of vessels and/or fishing time) (to reach Fmax) or of 50 percent about (to reach F0.1) A two-months closure for rapido trawling inside 6 nm offshore along the Italian coast, after the biological fishing stop (August) The safeguard of spawning areas (both in spatial and temporal terms) to prevent a possible future exploitation might be crucial for the sustainability of the Adriatic sole stock

The Commission requested STECF to define the status of the main Mediterranean stocks and evaluate the exploitation levels with respect to their biological and economic production potentials and the sustainability of the stock. A Sub-group consisting of Mediterranean scientists involved in stock assessment was created, which became operational in 2006. Results of assessments produced are intended to be presented to the Scientific Advisory Committee of GFCM.

The diagnosis of the assessments can be presented in two different ways:

- Unidimensional FAO descriptors. The seven FAO (2005) descriptors:
    - **?** (or blank) = Not known or uncertain. Not much information is available to make a judgment;
    - **U =** Underexploited, undeveloped or new fishery. Believed to have a significant potential for expansion in total production;
    - **M =** Moderately exploited, exploited with a low level of fishing effort. Believed to have some limited potential for expansion in total production;
    - **F =** Fully exploited. The fishery is operating at or close to an optimal yield level, with no expected room for further expansion;
    - **O =** Overexploited. The fishery is being exploited at above a level which is believed to be sustainable in the long term, with no potential room for further expansion and a higher risk of stock depletion/collapse;
    - **D =** Depleted. Catches are well below historical levels, irrespective of the amount of fishing effort exerted;
    - **R =** Recovering. Catches are again increasing after having been depleted or a collapse from a previous high.
- Bidimendisonal. The descriptors based on two independent criteria (exploitation – abundance) usual in RFBs other than GFCM (i.e. ICES, NAFO) are also used and implemented in the assessment forms, as follows:
    - Exploitation rate
        - No or low fishing mortality

    - Moderate fishing mortality
    - High fishing mortality
    - Uncertain / Not assessed
  - Stock abundance
    - Virgin or high abundance
    - Intermediate abundance
    - Low abundance
    - Depleted
    - Uncertain / Not assessed

5.3.2. Monitoring programs

The MEDITS survey (Mediterranean International Trawl Survey) is organized to monitor the demersal resources in the Mediterranean. It intends to produce relevant information to support the fishery policy by collecting abundance data and biological parameters of fish, crustaceans and cephalopods species

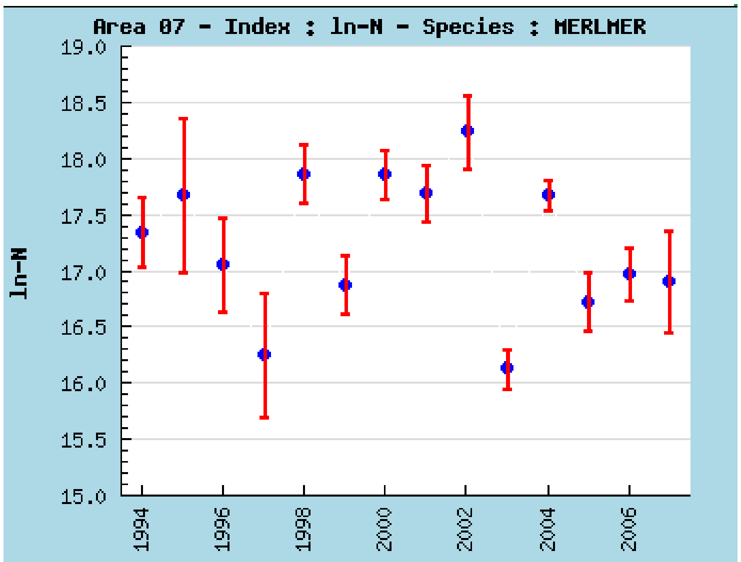
The hauls are positioned following a depth stratified sampling scheme with random drawing of the positions within each stratum. The hauls are made in the same position from year to year. The following depths are fixed in all areas as strata limits: 10 – 49 m, 50 - 99 m, 100 - 199 m, 200 - 499 m, 500 - 800 m. The series began in 1994 and was continuously carried out with one yearly survey during the May-July period. For the time being, the fully standardized MEDITS survey covers shelves and upper slopes of 17 GFCM-GSAs (No 1, 5-11, 15-20, 22-23, 25). Results from the survey are available at http://www.ifremer.fr/Medits_indices/.

To access to this information, the MEDITS project has established a website (http://www.ifremer.fr/Medits_indices/) which includes the following indices for all the selected species:

- Natural Logarithm of abundance: Log(N) (Natural Logarithm of the number of individuals in the area)
- Total biomass in the area (W)
- Average individual weight in the population (Wbar)

<u>And only for the species for which individual length is collected</u>:

- Mean length in the population (Lbar)
- Length at the fifth percentile of the length distribution (L 0.05)
- Length at the twenty-fifth percentile of the length distribution (L0.25)
- Length at the seventy-fifth percentile of the length distribution (L0.75)
- Length at the ninety- fifth percentile of the length distribution (L0.95)
- Sampling variance of length (Lvar)



Area	Index	Species	Year	Estimation	Standard deviation	CV
07	ln-N	MERLMER	1994	17.35	0.16	0.01
07	ln-N	MERLMER	1995	17.67	0.35	0.02
07	ln-N	MERLMER	1996	17.06	0.21	0.01
07	ln-N	MERLMER	1997	16.26	0.28	0.01
07	ln-N	MERLMER	1998	17.87	0.13	0.01
07	ln-N	MERLMER	1999	16.88	0.13	0.01
07	ln-N	MERLMER	2000	17.86	0.11	0.01
07	ln-N	MERLMER	2001	17.69	0.13	0.01
07	ln-N	MERLMER	2002	18.24	0.17	0.01
07	ln-N	MERLMER	2003	16.13	0.09	0.01
07	ln-N	MERLMER	2004	17.68	0.07	0
07	ln-N	MERLMER	2005	16.73	0.13	0.01
07	ln-N	MERLMER	2006	16.97	0.12	0.01
07	ln-N	MERLMER	2007	16.91	0.23	0.01

Figure 5-7 An example of the Natural Logarithm of abundance calculated from the MEDITS surveys for hake in the gulf of Lions (GFCM GSA 7)

Table 5-15 Species landed in the Western Mediterranean, ranked by catch. Only species which catch represent more than 0.1% of the total catch are included, according to FAO/FISHSTAT in the year 2005. (Sb =trawl surveys catch rates in number and biomass, Sl= length frequencies available, A=proper assessments have been performed for the species.

Species	Data	Landings (t)	Relative	Cumulative
Sardina pilchardus	A	134599	36.43%	36.43%
Trachurus spp	Sl Sb	31294	8.47%	44.90%
Sardinella spp	Sb	27683	7.49%	52.40%
Osteichthyes		22632	6.13%	58.52%
Engraulis encrasicolus	A	20973	5.68%	64.20%
Boops boops	Sb	12291	3.33%	67.53%

Species	Data	Landings (t)	Relative	Cumulative
Scomber scombrus	Sb	11284	3.05%	70.58%
Merluccius merluccius	A	10832	2.93%	73.51%
Octopodidae	Sb	9084	2.46%	75.97%
Scomber japonicus	Sb	6105	1.65%	77.63%
Micromesistius poutassou	Sb Sl	4439	1.20%	78.83%
Parapenaeus longirostris	A	4068	1.10%	79.93%
Octopus vulgaris	Sb Sl	3679	1.00%	80.92%
Mullus spp	A	3264	0.88%	81.81%
Sepiidae, Sepiolidae	Sb	3237	0.88%	82.68%
Mullus surmuletus	A	3145	0.85%	83.53%
Lophius piscatorius	Sb Sl	2850	0.77%	84.31%
Pagellus erythrinus	Sb Sl	2671	0.72%	85.03%
Mullus barbatus	A	2665	0.72%	85.75%
Loligo spp	Sb	2413	0.65%	86.40%
Trisopterus minutus	Sb	2321	0.63%	87.03%
Aristeus antennatus	A	2214	0.60%	87.63%
Eledone spp	Sb	2136	0.58%	88.21%
Spicara spp	Sb	2006	0.54%	88.75%
Todarodes sagittatus	Sb	1902	0.51%	89.27%
Mugilidae	Sb	1791	0.48%	89.75%
Squilla mantis	Sb Sl	1786	0.48%	90.24%
Rajiformes	Sb Sl	1683	0.46%	90.69%
Pagellus spp	Sb	1620	0.44%	91.13%
Bivalvia		1489	0.40%	91.53%
Sparidae	Sb	1437	0.39%	91.92%
Solea solea	Sb	1363	0.37%	92.29%
Aristeidae	A	1323	0.36%	92.65%
Diplodus spp	Sb	1308	0.35%	93.00%
Seriola dumerili		1231	0.33%	93.34%
Triglidae	Sb	1175	0.32%	93.65%
Pomatomus saltatrix	Sb	1137	0.31%	93.96%
Sparus aurata	Sb	1084	0.29%	94.25%
Scorpaenidae	Sb	1063	0.29%	94.54%
Conger conger	Sb	1043	0.28%	94.83%
Nephrops norvegicus	A	982	0.27%	95.09%
Natantia		930	0.25%	95.34%
Sepia officinalis	Sb Sl	902	0.24%	95.59%
Brachyura		835	0.23%	95.81%
Mollusca		781	0.21%	96.02%
Sphyraena spp	Sb	745	0.20%	96.23%
Pleuronectiformes	Sb	613	0.17%	96.39%
Dicentrarchus labrax	Sb	540	0.15%	96.54%
Sarpa salpa	Sb	512	0.14%	96.68%
Phycis blennoides	Sb	446	0.12%	96.80%
Aspitrigla cuculus	Sb Sl	434	0.12%	96.91%
Loliginidae,	Sb	425	0.12%	97.03%

Species	Data	Landings (t)	Relative	Cumulative
Ommastrephidae				
Spicara maena	Sb	383	0.10%	97.13%
Lepidopus caudatus	Sb	375	0.10%	97.23%
Chamelea gallina		370	0.10%	97.34%
Pagrus spp	Sb	365	0.10%	97.43%
Diplodus sargus	Sb	360	0.10%	97.53%
Gobiidae	Sb	359	0.10%	97.63%

Table 5-16 Species landed in the Central Mediterranean, ranked by catch. Only species which catch represent more than 0.1% of the total catch are included, according to FAO/FISHSTAT in the year 2005. (Sb =trawl surveys catch rates in number and biomass, Sl= length frequencies available, A=proper assessments have been performed for the species.

Species	Data	Landings (t)	Relative	Cumulative
Engraulis encrasicolus	A	66572	18.09%	18.09%
Sardina pilchardus	A	35776	9.72%	27.81%
Osteichthyes		35448	9.63%	37.44%
Sardinella spp	Sb	19804	5.38%	42.82%
Chamelea gallina		14710	4.00%	46.82%
Merluccius merluccius	A	13351	3.63%	50.45%
Parapenaeus longirostris	A	12248	3.33%	53.78%
Trachurus spp	Sb	11136	3.03%	56.80%
Mytilus galloprovincialis		10062	2.73%	59.54%
Mullus barbatus	A	9643	2.62%	62.16%
Mullus surmuletus	A	8739	2.37%	64.53%
Boops boops	Sb	8515	2.31%	66.84%
Scomber japonicus	Sb	7778	2.11%	68.96%
Sepiidae, Sepiolidae	Sp	7098	1.93%	70.89%
Sparidae	Sb	6717	1.83%	72.71%
Scomber spp	Sb	6645	1.81%	74.52%
Eledone spp	Sb	6152	1.67%	76.19%
Sepia officinalis	Sb	6098	1.66%	77.85%
Octopus vulgaris	Sb	5897	1.60%	79.45%
Squilla mantis	Sb Sl	5747	1.56%	81.01%
Mugilidae	Sb	5233	1.42%	82.43%
Nephrops norvegicus	Sb Sl	4221	1.15%	83.58%
Spicara spp	Sb Sl	3536	0.96%	84.54%
Epinephelus spp	Sb	3399	0.92%	85.46%
Todarodes sagittatus	Sb	3391	0.92%	86.38%
Penaeus kerathurus	Sb	3262	0.89%	87.27%
Pagellus erythrinus	Sb	2335	0.63%	87.90%
Solea solea	A	2325	0.63%	88.54%
Mollusca		2320	0.63%	89.17%
Loligo spp	Sb	2294	0.62%	89.79%
Merlangius merlangus	Sb	2063	0.56%	90.35%
Aristeidae	Sb	1851	0.50%	90.85%

Species	Data	Landings (t)	Relative	Cumulative
Scomber scombrus	Sb	1782	0.48%	91.34%
Lophius piscatorius	Sb Sl	1671	0.45%	91.79%
Metapenaeus monoceros	Sb	1554	0.42%	92.21%
Triglidae	Sb	1393	0.38%	92.59%
Micromesistius poutassou	Sb Sl	1341	0.36%	92.96%
Rajiformes	Sb Sl	1319	0.36%	93.32%
Coryphaena hippurus	A	1221	0.33%	93.65%
Sparus aurata	Sb	1213	0.33%	93.98%
Trisopterus minutus	Sb	1210	0.33%	94.31%
Sarpa salpa	Sb	1141	0.31%	94.62%
Mugil cephalus	Sb	1110	0.30%	94.92%
Atherinidae		1109	0.30%	95.22%
Trachurus mediterraneus	Sb Sl	1096	0.30%	95.52%
Mustelus spp	Sb Sl	1086	0.30%	95.81%
Pagellus spp	Sb	1050	0.29%	96.10%
Squalidae	Sb Sl	948	0.26%	96.35%
Dicentrarchus spp	Sb Sl	875	0.24%	96.59%
Diplodus spp	Sb	855	0.23%	96.82%
Conger conger	Sb	824	0.22%	97.05%
Lithognathus mormyrus	Sb	784	0.21%	97.26%
Cephalopoda		771	0.21%	97.47%
Seriola dumerili		729	0.20%	97.67%
Ruditapes decussatus		621	0.17%	97.84%
Crustacea		563	0.15%	97.99%
Scorpaenidae	Sb	497	0.14%	98.13%
Mullus spp	Sb Sl	417	0.11%	98.24%
Serranidae	Sb	408	0.11%	98.35%
Trachurus trachurus	Sb Sl	371	0.10%	98.45%
Gobiidae	Sb	370	0.10%	98.55%
Belone belone		362	0.10%	98.65%
Pagrus pagrus	Sb	351	0.10%	98.74%

Table 5-17 Species landed in the Eastern Mediterranean, ranked by catch. Only species which catch represent more than 0.1% of the total catch are included, according to FAO/FISHSTAT in the year 2005. (Sb =trawl surveys catch rates in number and biomass, Sl= length frequencies available, A= proper assessments have been performed for the species)

Species	Data	Landings (t)	Relative	Cumulative
Sardina pilchardus	A	25683	12.94%	12.94%
Sardinella spp		16422	8.27%	21.21%
Osteichthyes		16326	8.22%	29.43%
Engraulis encrasicolus	A	15269	7.69%	37.12%
Boops boops	Sl Sb	9699	4.88%	42.00%
Mugilidae	Sl Sb	9626	4.85%	46.85%
Natantia		7153	3.60%	50.45%
Atherinidae		6156	3.10%	53.56%

Species	Data	Landings (t)	Relative	Cumulative
Trachurus mediterraneus	Sb Sl	5278	2.66%	56.21%
Scomber japonicus	Sl Sb	5071	2.55%	58.77%
Mullus spp	A	3590	1.81%	60.58%
Spicara spp	Sl Sb	3426	1.73%	62.30%
Octopus vulgaris	Sl Sb	3280	1.65%	63.95%
Merluccius merluccius	A	3247	1.64%	65.59%
Penaeus kerathurus	Sl Sb	3068	1.55%	67.13%
Micromesistius poutassou	Sl Sb	3025	1.52%	68.66%
Sepia officinalis	Sb Sl	2740	1.38%	70.04%
Brachyura		2484	1.25%	71.29%
Mollusca		2433	1.23%	72.51%
Mugil cephalus		2414	1.22%	73.73%
Pagrus pagrus		2386	1.20%	74.93%
Sparus aurata		2336	1.18%	76.11%
Alosa spp		2320	1.17%	77.28%
Trachurus trachurus	Sb Sl	1983	1.00%	78.27%
Dicentrarchus labrax	Sb Sl	1894	0.95%	79.23%
Sphyraena spp	Sl Sb	1843	0.93%	80.16%
Sepiidae, Sepiolidae	Sl Sb	1795	0.90%	81.06%
Solea solea	Sb Sl	1700	0.86%	81.92%
Mullus barbatus	A	1675	0.84%	82.76%
Mullus surmuletus	A	1576	0.79%	83.55%
Pomatomus saltatrix		1539	0.78%	84.33%
Epinephelus spp		1478	0.74%	85.07%
Synodontidae		1430	0.72%	85.79%
Loligo spp	Sl Sb	1303	0.66%	86.45%
Diplodus spp	Sl Sb	1274	0.64%	87.09%
Argyrosomus regius		1260	0.63%	87.73%
Lophius piscatorius	Sb Sl	1174	0.59%	88.32%
Scomber scombrus	Sl Sb	1002	0.50%	88.82%
Octopodidae	Sl Sb	964	0.49%	89.31%
Elasmobranchii	Sl Sb	933	0.47%	89.78%
Siganus spp	Sl Sb	918	0.46%	90.24%
Pleuronectiformes		915	0.46%	90.70%
Loliginidae, Ommastrephidae		847	0.43%	91.13%
Conger conger	Sl Sb	822	0.41%	91.54%
Trichiurus lepturus		782	0.39%	91.94%
Sparidae	Sl Sb	767	0.39%	92.32%
Caranx spp		732	0.37%	92.69%
Scorpaenidae	Sl Sb	727	0.37%	93.06%
Seriola dumerili		703	0.35%	93.41%
Dicentrarchus punctatus	b	640	0.32%	93.73%
Eutrigla gurnardus	Sb Sl	612	0.31%	94.04%
Sarpa salpa	Sl Sb	611	0.31%	94.35%
Clupeoidei		580	0.29%	94.64%
Mustelus spp		525	0.26%	94.91%

Species	Data	Landings (t)	Relative	Cumulative
Lichia amia		505	0.25%	95.16%
Serranidae	Sl Sb	501	0.25%	95.41%
Diplodus sargus	Sl Sb	500	0.25%	95.66%
Pagellus spp	Sl Sb	480	0.24%	95.91%
Merlangius merlangus		448	0.23%	96.13%
Dicentrarchus spp		437	0.22%	96.35%
Oblada melanura		433	0.22%	96.57%
Triglidae	Sl Sb	424	0.21%	96.78%
Gobiidae	Sl Sb	420	0.21%	96.99%
Dentex macrophthalmus		394	0.20%	97.19%
Carangidae		380	0.19%	97.38%
Spicara maena	Sl Sb	371	0.19%	97.57%
Nephrops norvegicus	Sb Sl	366	0.18%	97.76%
Dentex dentex	Sl Sb	362	0.18%	97.94%
Scombridae	Sl Sb	320	0.16%	98.10%
Raja clavata	Sb Sl	290	0.15%	98.25%
Crustacea		270	0.14%	98.38%
Epinephelus marginatus		259	0.13%	98.51%
Raja spp	Sb Sl	259	0.13%	98.64%
Chamelea gallina		248	0.12%	98.77%
Zeus faber	Sb Sl	239	0.12%	98.89%
Spondyliosoma cantharus	Sl Sb	197	0.10%	98.99%
Pagrus spp	Sl Sb	194	0.10%	99.08%

5.4. Black Sea

The evolution of the Black Sea ecosystem from the 1950s until present is quite characteristic of inland seas subject to land-based pollutions and other human influences. The environment of the Black Sea has deteriorated dramatically in terms of its biodiversity, habitats, fisheries resources, aesthetic and recreational value and water quality. In a period of only there decade, the Black Sea has suffered the catastrophic degradation of a major part of its natural resources. Increasing loads of nutrients from rivers caused overproduction of tiny phytoplankton which in turn blocked the light reaching the sea grasses and algae, essential components of the sensitive ecosystem of the north-western shelf. The entire ecosystem began to collapse. This problem coupled with pollution and irrational exploitation of fish stocks, started a sharp decline in fisheries resources. To make matters worse in the mid of 1980s, a jellyfish-like species (*Mnemiopsis leidyi*), which was accidentally introduced from the ecosystem seaboard of America in the ballast water of a ship, invaded the Black Sea. Its diet included fish larvae and tiny animals.

Fishery was the most affected sector by the dramatic changes of the Black Sea ecosystem. On the other hand, fishing activities contributed themselves to the worsening of the ecological situation and for the depletion of the fish stocks through: open access to resources; management regime applied individually by each coastal country; overfishing and illegal fishing; and the use of destructive harvest technique.

In the period 1960-1970 there were 26 commercial fish species which were caught resulting in landings of tens or even hundreds of thousands of tons annually. In the 1980s, only 6 species have commercially significance (sprat, anchovy, horse mackerel, whiting, turbot,

bonito). By the end of 1970s, commercial fishing of mackerel, bonito, bluefish, as well as tuna practically disappeared. As consequence of the sharp decline of the predator populations, stocks of small pelagic fish, such as anchovies and sprat, increased and became target of intense fishing. In a short time, small pelagic species contributed to up to 80% of total catches in the Black Sea.

In spite of an increase in capacity and thus fishing effort catches dramatically declined by up to a factor three at the end of 1980s when the outbreak of the alien jellyfish occurred. The lack of an adequate management in the Black Sea fisheries is also evidenced by the fact that in spite of evident decline of stocks, the fishing effort continued to increase. Today, there are more than 50 threatened fish species included in Black Sea Red Data Book, some of them once commercially exploited such as: e.g. sturgeons, tuna, sole, and turbot. The anadromous species, especially sturgeons are endangered due to both the overfishing and the deterioration of the environmental conditions of their native rivers, spawning grounds and benthic area in the Black Sea. Changes in the ichthyofauna composition of the Black Sea have primarily involved alterations in the number of individuals in specific populations. For many species, fish populations have declined so sharply that they have lost their importance for commercial fishing, and remain within the Black Sea ichthyofauna only as zoological representatives of the species (Zaitsev, 1992). Beside fish, red algae, brown algae, snail, clam and mussel stocks are declining in many areas due to overharvesting and hypoxia.

From an estimated total of about 140 fish species in the Black Sea, the following table presents the main species based on their recent landings.

Table 5-18 Species landed in the Black Sea, ranked by catch. Only species which catch represent more than 0.1% of the total catch are included, according to FAO/FISHSTAT. (A= proper assessments have been performed for the species)

Species	Data	Landings (t)	Relative	Cumulative
Engraulis encrasicolus	A	150837	41.04%	41.04%
Sprattus sprattus	A	53668	14.60%	55.64%
Clupeonella cultriventris		19373	5.27%	60.92%
Pomatomus saltatrix		17490	4.76%	65.68%
Gobiidae		13277	3.61%	69.29%
Trachurus trachurus		12606	3.43%	72.72%
Mollusca		12595	3.43%	76.14%
Mytilus galloprovincialis		12458	3.39%	79.53%
Trachurus mediterraneus	A	10934	2.98%	82.51%
Chamelea gallina		10847	2.95%	85.46%
Merlangius merlangus	A	8212	2.23%	87.70%
Mugilidae		7828	2.13%	89.83%
Mugil soiuy		6843	1.86%	91.69%
Osteichthyes		5953	1.62%	93.31%
Sardina pilchardus		5008	1.36%	94.67%
Natantia		3552	0.97%	95.64%
Micromesistius poutassou		2164	0.59%	96.23%
Alosa spp		1581	0.43%	96.66%

Species	Data	Landings (t)	Relative	Cumulative
Mullus barbatus		1225	0.33%	96.99%
Sander lucioperca		906	0.25%	97.24%
Spicara spp		882	0.24%	97.48%
Psetta maxima	A	879	0.24%	97.71%
Mullus surmuletus		862	0.23%	97.95%
Rapana spp		752	0.20%	98.15%
Rajiformes		703	0.19%	98.34%
Atherina boyeri		677	0.18%	98.53%
Belone belone		540	0.15%	98.68%
Rhopilema spp		502	0.14%	98.81%
Atherinidae		430	0.12%	98.93%
Mustelus spp		405	0.11%	99.04%

There is information more precise on the species assessed than reported in FishStat. Furthermore some species sustaining important Black Sea fisheries only represent catches below 0.1% and do not appear in the previous table.

Table 5-19 Data availability for species in the Black Sea

Species	analytical assessment	survey	catches	cpue
Acipenser gueldenstaedti colchicus Marti, 1940			x	
Acipenser stellatus Pallas, 1771			x	
Alosa caspia nordmanni Antipa, 1906				
Alosa fallax nilotica (Geoffroy, 1808)			x	
Alosa pontica pontica (Eichwald, 1838)			x	
Atherina (Hepsetia) boyeri Risso, 1810			x	
Clupeonella cultriventris (Nordmann, 1840)			x	
Engraulis encrasicolus (L., 1758)	x	x	x	x
Huso huso (L., 1758)			x	
Liza aurata (Risso, 1810)			x	
Liza saliens (Risso, 1810)			x	
Merlangius merlangus euxinus (Nordmann, 1840)	x	x	x	x
Mugil cephalus L., 1758			x	
Mugil so-iuy Basilewsky, 1855			x	
Mullus barbatus ponticus Essipov, 1927			x	
Mullus surmuletus L., 1758			x	
Pomatomus saltatrix (L., 1766)			x	
Psetta maxima maeotica (Pallas, 1811)	x	x	x	x

Species	analytical assessment	survey	catches	cpue
Sarda sarda (Bloch, 1793)			x	
Scomber scombrus L., 1758			x	
Sprattus sprattus (L., 1758)	x	x	x	x
Squalus acanthias L., 1758			x	
Trachurus mediterraneus ponticus Aleev, 1956	x	x	x	x

Sprat - *Sprattus sprattus* L.,1758

The most important regular research surveys were performed by the former USSR in collaboration with Bulgaria and Romania and stock abundance estimates from mid-water trawl surveys were used by the soviet scientists as absolute indices of abundance for fisheries assessment and management advice. Regular pre-recruit surveys have been carried out by the former USSR (now Ukrainian) institute YugNIRO, Kerch from early 1960's to 1993 (Tkacheva and Benko, 1979; Arkhipov, 1993), and in the last 15 years by Romania (Radu, 2008). International stock assessments are based on catch-at-age models (Daskalov *et al.* 1996; Daskalov 1998, Daskalov *et al.* 2007b). The biomass of sprat stock shows cyclic dynamics with lows and highs over decades. Maxima of recruitment and biomass occurred in the mid 1970s and mid 1980s. Maximum catch was recorded in 1989 (>100,000tons), leading to highest fishing mortality after that the stock collapsed. In the mid 1990s the sprat stock started to recover and reached previous peak-levels recorded in the 1980s, but catches stayed relatively low because of the stagnated economies of Bulgaria, Romania and Ukraine. However, in 2006-2007 decreasing CPUE and mean size in Bulgarian and Romanian fisheries are indicating that the fishing pressure might be too strong for the present level of exploited stock biomass, and further catch limitations may be needed. The analysis of the main population parameters (abundance, catch, and fishing mortality) shows that the sprat stock has recovered from the depression in the 1990s due to good recruitment in 1999-2001 and the biomass and catches have gradually increased over the 1990s and early 2000s. The stock estimates, however, confirm the cyclic nature the sprat population dynamics. The year with relatively strong recruitment were followed by years of low to medium recruitment which leads to a relative decrease of the Spawning Stock Biomass (SSB). High fishing mortalities (F_{1-3}) were observed in 1990-1994, 1998, and 2003. In the recent period SSB has again decreased due to lower recruitment and high fishing mortality. Landings have initially (in 2001-2005) reached levels comparable to the 1980s but dropped again in 2006-2007.

According to the results of the production model the MSY is estimated to be in the range of 44,442 t. Fmsy (ages 1-3) amounts to 0.53. Bmsy appears to be in the range of 128,000 t. Thus, the present level of fishing mortality is close to the equilibrium Fmsy but catches exceed the equilibrium level.

Turbot- *Psetta maxima* *maeotica* (Pallas, 1814)

In all the Black sea countries turbot is one of the most valuable fish species. Its target fisheries is conducted with bottom (turbot) gill nets in the waters of Bulgaria, Georgia, Romania, Russian Federation, Ukraine and Turkey (Prodanov *et al.*, 1997; Tonay, Öztürk, 2003), as well as with bottom trawls with minimum mesh 40 mm in the waters of Turkey. Turbot as a by-catch is harvested during target fisheries of other species with trawls, long-lines and purse seines. According to M. Zengin (2003) turbot fishing in Turkish waters of the Black Sea has namely been carried out by 72% bottom gill nets, 26% trawls and 2% is the by-catch from

purse seines. In 2000 – 2008 turbot stocks were exploited intensively in the waters of all the Black Sea countries without any exception. This results from absence of limits for admissible catches and fishing efforts as well as absence of effective enforcement and surveillance of the regulation measures undertaken.

Beginning with 2008, for Bulgaria and Romania, the EC established a turbot TAC of 100 tons; According to the assessments of Prodanov *et al.*, 1997 on the grounds of cohort analysis of the length composition of catches between 1989 and 1992 turbot biomass in the waters of Turkey reduced 3.1 times, and this tendency agrees well with assessments by M. Zengin (2000). According to his data turbot biomass reduced 3.9 times in those years. Composition of Turkish catches (consisting of ages 0^+, 1^+, 2+ and 3^+ amounting to more than 60% in the period 1990 – 2000 was evidence of capture of immature turbot and small turbot in spite of stricter management aimed at increasing commercial length of turbot. Coefficient of commercial fishing mortality of turbot was assessed at F = 0.55-0.71 in 1990 – 1995, and from F = 0.41-0.44 in 1996 – 2000. Such coefficient of the commercial fishing mortality exceeds all the known assessments of $F_{0.1}$ for stocks of the Black Sea turbot and directly points to its overexploitation.

The Black Sea STECF SG BLACK SEA 09-02 performed assessment of historic stock parameters for the period 1970 – 2008 using XSA (VPA 3.1, Lowestoft), based on landings at age data of turbot from Bulgaria, Romania, Ukraine and Turkey, which were agreed as representative for the total Black Sea area. Data for the period after 1988 processed by the STECF SG BLACK SEA 09-02 during the previous three meetings were combined with landings at age data from Prodanov et.al (1997). During the meeting the SG BLACK SEA discussed concerns that the official landings are misreported to an unknown extent, and decided to interpret the assessment results only as relative and indicative for the trends in the stock. Recent data from national statistics by countries for the period 1988 – 2008 were added to the historic catch at age data set compiled during the previous meetings from Prodanov et al. (1997) for the period 1970 – 1988. Both Romanian and Ukrainian series indicate that the recent estimates of the most important age groups 2-5 slightly increase in recent years and Bulgarian and Turkish – slightly decrease respectively. According to the analysis the recruitment has two peaks in 1971 – 1978 and 1988 – 1994 and increase of recruitment after 2001. Correspondingly, SSB attained higher values up to 18,000 t during the period 1976 – 1983 and very low values after 2000. Since 2004 slight increase in SSB was observed. Fishing mortality F_{4-8} has a peak in 2000-2001.

The STECF SG BLACK SEA 09-02 considers these results as a useful and indicative of trends in turbot abundance in the Black Sea. Gradual increase of SSB is observed after the historic low in 2002 but biomass still remains quite low compared to the stock size in the 1970 and 1980s. The present results cannot be used for the aims of the management advice and prediction of stock size. The turbot SSB during recent years is at low level compared to historical abundance. In 2002 and 2003 the SSB has been at the absolute minimum since 1970. Relative abundance estimates are confirmed by CPUE data. Catches have also dropped since 2002. A gradual recovery in the SSB and catches is observed since 2004. Recruitment was at minimum in 2000-2001 and started to increase since 2002. The increase in recruitment since 2002 has positively influenced the SSB but given that many small and immature turbots are caught by the fisheries such a positive influence may not propagate in the next years. Fishing mortality has peaked in 2000-2001 due to relatively high catches provided the low biomass of the stock.

Anchovy - *Engraulis encrasicolus* (L., 1758)

Anchovy biomass and catches were largest during the 1980s – the maximum catch reaching ~0.6 million tons with major contribution to the total catch by Turkey and the former USSR. The high catches were maintained by the relatively large reproductive stock. The total anchovy catch was progressively increasing since 1980 to 1988, when maximum yield was obtained (606,401t) then decreasing up to a minimum of 102,904 t in 1990 (excepting 1988), 90% from this quantity being obtained by Turkey. The anchovy stock (largely constituted by juveniles of age 0.5 year) showed upward trend in abundance during that period, increasing from 800 to 1600-1800 thousand tons. The rate of removal did not exceed 50% of the stock (Prodanov *et al*., 1997).

In 1990-1991 the Turkish catch of anchovy fell to 13-15% of the 1985-1986 level. On the Northwest Shelf the anchovy catch declined at least tenfold, and after 1989, anchovy fishing ceased in the Azov Sea. The annual rate of stock reduction was 25% for 1987 and 44% for 1988, on average 29% for 1987-1988. In the subsequent years until 1991 there was a steady downward trend in the anchovy stock. In 1990 the anchovy stock was below 300 thousand tons - the lowest level over the period 1967-1993.

YugNIRO assessment results showed that after the 1981/82 fishing season, the limit fishing mortality for safe exploitation ($F_{0.1}$) has been systematically overrun (Shlyakhov *et al*., 1990), causing a average annual reduction of 7% over 1981-1986. The high catches were maintained by the relatively large reproductive stock. First signs of overfishing appeared after 1984 (Shlyakhov *et al*., 1990) when anchovy shoals were difficult to be found and the fishery enterprises incurred losses. However, the real catastrophe happened after 1986, when in two subsequent years the stock shrunk from 1200 to 500 thousand tons.

During the 1990/1991 fishing season an unprecedented situation arose: no fishable aggregations were found off Georgia and the catch was only 2.3 thousand tons. First signs of overfishing appeared after 1984, when anchovy shoals were difficult to be found and the fishery enterprises incurred losses. The stock finally collapsed in 1987-1988, when biomass and catches decreased ~ 5 times, with catches dropping below 100 thousand t in 1990-1991. The fishing effort and fishing mortality also dropped subsequently because of decreasing profitability of fishing. During the collapse phase the -size/age structure of the catch shifted toward a predominance of small, immature individuals and precocious maturation of young-of-the year fish.

In 1995-2006 the stock partially recovered and the catch rose to 300,000-400,000 t, but fishing effort and catch remaining relatively high, the exploited biomass could not reach levels as high as in the 1980s. The stock has been monitored by egg, larvae, and juvenile surveys; adult stock surveys using pelagic trawl and hydroacoustics, and the Spawning Stock Biomass (SSB) has been a subject of experimental assessments using the "egg production method" in the USSR, Bulgarian, and Romanian waters (main reproductive area) in 1987-1991 (Arkhipov *et al*., 1991), and after that by Romania. Total biomass in the Black Sea until 1993 has been assessed based on catch-at-age data using VPA and the modified Baranov method (Prodanov *et al*. 1997). Recent trend in anchovy SSB was estimated using a linear regression between logarithmically transformed SSB and CPUE data of the Turkish purse seine fleet (Daskalov *et al*. 2007b). An approximate fishing mortality after 1993 was estimated as a ratio between the landings and SSB. Sharp reductions in biomass and catch in the early 1990s can be described as a stock collapse.

Horse mackerel - *Trachurus mediterraneus ponticus* Aleev, 1956

The horse mackerel fishery operates mainly on the wintering grounds in the southern Black Sea using purse seine and mid-water trawls. The horse mackerel of age 1-3 years generally

prevails in the commercial catches. Scientists (Bryantsev *et al*., 1994; Chashchin, 1998) believed that the intensive fishing in Turkish waters in 1985-1989 has led to overfishing of horse mackerel population and reduction of the stock and catches in the next years. A drastic decline in stock abundance occurred after 1990 when the stock diminished by 56%. In 1991 the horse mackerel stock dropped to a minimum of 75 thousand tons and the catch dropped to 4.7 thousand tons that is a twenty fold reduction compared to the average annual catch in 1985-1989.

In contrast to anchovy and sprat, the horse mackerel stock still remains in a depressed state. There was no fishing for horse mackerel by the former USSR countries in 1992-1998 because no fishable aggregations were found on the wintering grounds. Small quantities of horse mackerel were caught with trap-nets in the coastal areas of the Crimea and Caucasus. In Turkish waters, horse mackerel catches in 1994-2006 were 9-11 thousand tons, i.e. at the level of the years 1950-1975 before the start of industrial fishing. The total catch, taken predominantly by Turkey in 2000-2007 remains ~10 thousand t, similar to the pre-industrial period 1950-1975.

No major study on the horse mackerel biomass wintering off Anatolian coasts was undertaken in the past decade. In a study conducted by Bengil et al. (1996) early in the 1990s, Shaefer's (1954) "Residue Yield Model (MSY) (Sparre and Venema, 1992) was employed, and the optimum amount of catch was estimated at 80,000 tons. Landings in the subsequent years, however, never reached that amount remaining far below that level.

Whiting - *Merlangius merlangus euxinus* (Nordmann, 1840)

In Bulgaria, Georgia, Romania, the Russian Federation, and Ukraine whiting is very rarely the target species for fisheries. It is a by-catch during trawl fisheries for other fish species or from non-selective fisheries with fixed nets in the coastal sea areas. Official statistics in all Black Sea countries do not reflect the true capture of whiting which is much higher than reported one.

Turkey is the only country in the region, where the annual target trawling fisheries for this fish is conducted. Trawling is permitted only in the season between September and April, in the open areas outside the 3 miles zone from the coast. In 1996 – 2005 its annual catches varied from 6 thousand tons to 19 thousand tons, making on average 10.8 thousand tons. As compared with 1989 – 1995, when mean annual catch of whiting was equal to 17.6 thousand tons, the tendency towards reduction of both its catches and CPUE is observed. In 1996 – 2005 in the grounds of intensive Turkish trawl fisheries reveal a reduction of mean length of fishes equal to or even less than in Ukrainian waters. It is not quite typical and in our opinion it is the evidence of excessive intensity of fishery. Turkish scientists came to the same conclusion. Thus, according to materials of 2000 Genç *et al.* (2002) applying methods of LCA and Thompson and Bell found that actual whiting fisheries in the waters of Turkey is conducted with excessive fishing power due to trawls with mesh size less than 22 mm. İşmen (1995, 2006) estimates existing fishing intensity as F=1.24 and considers possible to achieve optimal exploitation of whiting by means of decrease in fishing intensity or enforcement of a minimum allowable total length. Thus, whiting stock in the waters of Turkey may be characterized as excessively exploited.

5.5. Synthesis

- The tables of the main commercial species per (sub)region and the information available in those (sub)regions shows that there are considerable differences between (sub)regions in terms of:

- the number of commercial species that are responsible for the bulk of the landings. For example in the Baltic three species make up approximately 90% of the landings while in the Bay of Biscay this consists of 44 species),

- the proportion of landings for which analytical assessments are conducted, e.g. this varies between more than 90% on an annual basis in the Baltic to 26% on an irregular basis in the Eastern Mediterranean (see Table 5-21).

Table 5-20 Number of species and species groups as recorded in the Fishstat database and the proportion that are assessed.

Region	Sub-region	# Fishstat specs >0.1% of landings	90% of the landings	% Assessed
Baltic Sea		22	3	91
North-east Atlantic	North Sea	41	16	84[1]
	Celtic Sea	25	37	
	Bay of Biscay	86	44	61[2]
	Atlantic	101	9	
Mediterranean	Western	58	27	50[3]
	Central	63	31	41[3]
	Eastern	77	41	26[3]
Black Sea		30	13	61

[1] This is the proportion assessed but also includes species for which not both reference levels are given or migrating pelagics that are not considered specific for the North Sea

[2] This is the proportion assessed but also includes migrating pelagics

[3] These estimate includes every species that at some point in time has been assessed. These are not annual assessments

These differences between (sub)regions highlight the potential issues of representativity depending on the (sub)region, when determining GES based only on analytical stock assessments. At this stage it is impossible to give any guidance on what a reasonable proportion of the stocks should be. Moreover, it probably needs to be determined for each (sub)region separately if the stock that are currently assessed are sufficiently representative for all “commercial fish and shellfish” in that (sub)region. Considering the fact that hardly any of the exploited shellfish species are assessed, this is not very likely.

The preliminary assessments on the status of the commercial stocks conducted in the Baltic and North Sea showed that even when only two of the GES attributes are used and considerably less restrictive reference levels (F_{pa} as opposed to F_{MSY}) only about 20-25% of the stocks would be within safe biological limits. Also in the Mediterranean the majority of the stocks is overexploited or depleted and for most stocks abundance is considered low. At

present it is unknown how the implementation of MSY-based reference levels will affect these assessments of stock status but certainly the proportion of stocks that are considered to have GES will be considerably less. This indicates that severe measures will be required in order to achieve GES.

6. MONITORING AND RESEARCH NEEDS

The current framework for GES assessment of this descriptor can be consistently applied in all (sub)regions. However there are considerable differences between (sub)regions in terms of data availability that may compromise the quality of the GES assessment. For example a first assessment of the proportion of landings of all commercial species for which stock assessments are conducted shows that in the Baltic Sea this is more than 90% on an annual basis while in the central Mediterranean this is approximately 26% on an irregular basis. Surveys that can provide data for the trend-based assessments of many additional species are conducted in each of the (sub)regions. There are, however, region- and survey-specific issues pertaining to suitability of existing data sources that need to be resolved. In general all research and/or monitoring initiatives that provide additional reference levels or improved indicators for more species will help in improving the quality and representativity of this assessment. Notably shellfish emerge as one of the groups of species for which the data to determine GES appear to be lacking.

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Abstract

The Marine Strategy Framework Directive (2008/56/EC) (MSFD) requires that the European Commission (by 15 July 2010) should lay down criteria and methodological standards to allow consistency in approach in evaluating the extent to which Good Environmental Status (GES) is being achieved. ICES and JRC were contracted to provide scientific support for the Commission in meeting this obligation.

A total of 10 reports have been prepared relating to the descriptors of GES listed in Annex I of the Directive. Eight reports have been prepared by groups of independent experts coordinated by JRC and ICES in response to this contract. In addition, reports for two descriptors (Contaminants in fish and other seafood and Marine Litter) were written by expert groups coordinated by DG SANCO and IFREMER respectively.

A Task Group was established for each of the qualitative Descriptors. Each Task Group consisted of selected experts providing experience related to the four marine regions (the Baltic Sea, the North-east Atlantic, the Mediterranean Sea and the Black Sea) and an appropriate scope of relevant scientific expertise. Observers from the Regional Seas Conventions were also invited to each Task Group to help ensure the inclusion of relevant work by those Conventions. This is the report of Task Group 3 Commercially exploited fish and shellfish.

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