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Scientific, Technical and Economic Committee for Fisheries (STECF)

Development of the Ecosystem Approach to Fisheries Management (EAFM) in European seas (STECF-12-12)

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This report was reviewed by the STECF during its' 40th plenary meeting held from 9 to 13 July 2012 in Copenhagen, Denmark

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SCIENTIFIC, TECHNICAL AND ECONOMICCOMMITTEE FOR FISHERIES (STECF)

Development of the Ecosystem Approachto Fisheries Management (EAFM)in European seas (STECF-12-12)

THIS REPORT WAS REVIEWED DURING THE PLENARY MEETING HELD IN COPENHAGEN, DENMARK, 9-13 JULY 2012

Background

The first STECF Expert Working Group on the "Development of the ecosystem approach to fisheries management (EAFM) in European seas" (SGMOS 10-03) met in September 2010. The overall aim of this working group was to provide a practical example of a first attempt at assessment and advice in support of EAFM. It achieved this by i) utilising long time-series of catch and various stock assessment metrics, including the analysis of ecosystem indicators, ii) an analysis of the characterisation of fleets impacts, iii) an analysis of fleets economic performances, iv) an assessment of operational status of ecosystem models to support EAFM. Following the first report, the working group was requested to provide comments and suggestions regarding the best way to improve the EAFM in European waters.

During its 35th plenary meeting (PLEN-10-03), STECF acknowledged the quality and quantity of analyses undertaken by the EWG on EAFM, and supported the conclusions reached by the Group. STECF especially noted that "implementing EAFM is a specific task, that has to be conducted in respect to -and in close collaboration with- the MSFD, but whose purpose is not (or not only) to ensure GES". In addition, EAFM aims to ensure ecological sustainability (including GES), but also economic profitability with an important objective to analyse trade-offs between ecology, economy and social aspects.

STECF recommended that the EWG on EAFM meet again in 2012 with the participation of ecologists, biologists and economists, to improve and to expand the methodological approach established by the first meeting. The working group was asked to make any appropriate comments and recommendations regarding the best way to improve EAFM implementation in European seas.

The report of the Expert Working Group on Development of the Ecosystem Approach to Fisheries Management (EAFM) in European seas (EWG-11-13) was reviewed by the STECF during its 40th plenary meeting. The following observations, conclusions and recommendations represent the outcomes of that review.

Request to the STECF

STECF is requested to review the report of the **EWG-11-13** held from January 16-20, Rennes, France, evaluate the findings and make any appropriate comments and recommendations.

STECF observations

The analyses undertaken and presented in the report were specific to previously defined European regional marine ecosystems (Table 5.1.1 of the PLEN-12-02 report) and included an assessment of trends under the following sub-headings; **i.** total landings and effort, **ii.** synthesis of the stock status and stock trends, **iii**. ecosystem and environmental indicators, and **iv.** fleet based synthesis (integration of economic and ecological indicators).

STECF notes the significance progress made in developing methods for performing an EAFM in European Seas by the EWG-11-13. STECF also observes that the results are usefully integrated and assessed in two ways important for the implementation of EAFM; namely, i. an overall assessment of ecosystem health, presented in the form of a 'traffic light' table (Figure 5.1.1 of the PLEN-12-02 report) and ii. an overall assessment of fleet performance (Figure 5.1.2 of the PLEN-12-02 report)). STECF also notes that several types of validated ecosystem models are available to assess the dynamics of some European regional marine ecosystems. The outputs of such models should be encouraged (where available) to operationally support management advice in the context of EAFM.

STECF observes that there remains a lack of specific economic and social targets against which progress can be assessed with respect to the EAFM. The CFP does not set out specific targets for economic and social sustainability, e.g. COM CFP proposal (Art. 2 COM (2011) 425). However, STECF is aware of several EU FP 7 projects (e.g. MEFEPO, SOCIOEC, MYFISH.) where definitions for specific socio-economic targets have been discussed and are being developed. STECF also noted that, even in the absence of clear economic targets, the fleet segment socio-economic performance comparison provided by EWG 11-13 gives an indication of the variability in the relationship between socio-economic performance and ecological impact of different fleets.

STECF observes that an assessment of baseline conditions and advising on suitable ecosystem management targets was beyond the terms of reference of the working group. However specifying such conditions and targets is an important consideration in developing methods for EAFM.

STECF notes that in some of the ecoregions considered by the EWG 11-13, only a relatively small proportion of the stocks exploited in those ecoregions are assessed. This limited the work that could be done by the WG.

STECF conclusions

1. Given the data and information currently available, the location and scale of the reference list of regional marine ecosystems used in the analysis are appropriate for the purpose of developing and implementing assessment methods for the EAFM. The location and spatial extent of these ecosystems are consistent with RAC areas and MSFD regions. However further consideration needs to be given to consider how the differences in the proposed management areas arising from the STECF EWG 12-04 on fisheries management can be reconciled especially with regard to the West of Scotland (Subarea VI).

2. Long time-series trends (>50 years) of ecosystem state (indicators of ecosystem health and stock-based indicators) are needed in order to define the limits of expected ecosystem variability.

3. Targets for ecosystem state could be addressed (in part) by seeking further policy guidance and reviewing the outcomes of recent relevant R&D projects including the FP 7 projects referred to above.

4. The majority of GES assessment criteria and indicators defined in COM(2010)477 are state metrics and further consideration should be given to the inclusion of pressure indicators linked to the assessed state indicators e.g. VMS pressure indicators which are currently required under the DCF may be suitable candidates.

5. The analyses presented in the report are preliminary and need further development, especially to support changes in the policy environment associated with the implementation of the Marine Strategy Framework Directive (MSFD) and reform of the CFP. Furthermore, the present approach would benefit from a clear method or plan which sets out how to objectively integrate the results describing ecosystem health, fleet segment socio-economic performance and ecological impact, for each of the regional marine ecosystems.

STECF recommendations

Based on the Report of its EWG 11-13, the STECF recommends the following:

1. Further consideration be given to how the exploratory data analysis conducted by the EWG 11-13 should inform the development for a management framework for an EAFM and the data and assessment requirements to support such a framework.

2. A revised DCF should include a requirement to collect data to estimate the values of state and pressure indicators to contribute to the requirements of an EAFM and the MSFD.

3. STECF reiterates its previous recommendation from PLEN 11-03, that a study be undertaken to focus on the disaggregation of economic data below the fleet level to subareas and/or métiers, which, for instance, is relevant in relation to future needs for impact assessments and evaluation of management plans, and also when addressing ecosystem based management.

4. An expert working group to further develop the present fleet-based methodological approach, specifically to incorporate a review and analyses of possible targets, should be established under the auspices of STECF. Such an expert group should concentrate on one or two well-studied and understood ecosystems. The feasibility and usefulness of using ecosystem and/or bio-economic models in an advice oriented EAFM perspective, in relation with the fleet-based approach mentioned above also needs to be addressed. Consideration needs to be given as to whether this could be undertaken by the proposed group or whether a separate meeting would be necessary.

		Land. Y	Effort E	Mortal. F	Biom. SSB	Recr. R	Sust. F*	Survey LFI	Survey MMLw	Survey MTL	Land. MMLw	Land. MTL	% asses.
Baltic Sea		↘	→	↘	↺	→	😐	↺	↺	↺	↘	↘	≈ 95
North Sea		↘	↘	↘	↗	↘	😐	↘	↘	?	Low	low	≈ 85
North western Atlantic waters	West Scot./Irl.	↘	↘	↘	?	↘	😐	?	↘	↘	↘	↘	≈ 90
	Irish Sea	↘	↘	↘	↘	↘	?	→	↗	↘	→	↘	≈ 35
	Celtic Sea	↘	↘	↘	↗	↘	☺	?	?	?	low	↘	≈ 40
South western Atlantic waters	Bay of Biscay	→	?	↘	↗	↘	?	↗	→	→	↗	→	≈ 45
	Iberian Coast	↘	?	↘	↘	↘	?	→	→	↗	→	↘	≈ 40

Figure 5.1.1. Trends over the last years in the main indicators of the Ecosystem health in the seven ecosystems considered as case studies: total landings Y, fishing effort E, mean fishing mortality F, total stock spawning biomass SSB, mean recruitment index R, index of mean sustainable fishing mortality F*, large fish indicator from surveys LFI, mean maximum length MMLw from surveys or from landings, mean trophic level MTL from surveys or from landings, % of landings due to assessed stocks (see section 4 of the EWG-11-13 report for details on indicators definition http://stecf.jrc.ec.europa.eu/reports/strategic-issues).

Table 5.1.1. Reference list of European marine ecosystems suggested by STECF in Atlantic and Baltic Seas.

	Ecosystem	FAO subdivisions	RAC	ICES Eco-regions
1	Baltic sea	ICES IIIb, 22-32	Baltic sea	Baltic sea
2	North sea	ICES IVa-c, IIIa, VIId	North sea (except VIId)	North sea
3a	West Scotland/Ireland	ICES VIa-b, VIIb-c	North western waters	Celtic Sea and West of Scotland
3b	Irish sea	ICES VIIa	North western waters	Celtic Sea and West of Scotland
3c	Celtic sea	ICES VIIe-k	North western waters	Celtic Sea and West of Scotland
4a	Bay of Biscay	ICES VIIIabd	South western waters	Bay of Biscay and Iberian Seas
4b	Iberian coast	ICES VIIIc, IXa	South western waters	Bay of Biscay and Iberian Seas

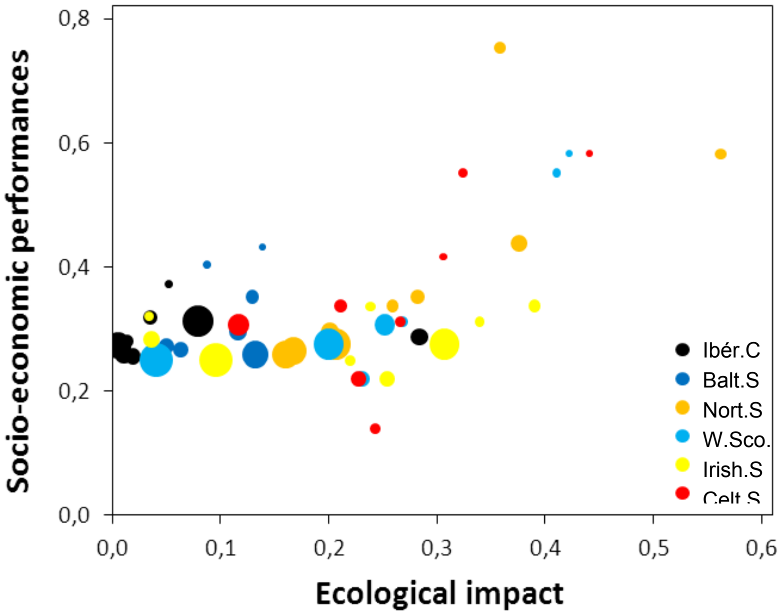


Figure 5.1.2. Ecological impact and economic performances of the major fleet segment operating within each ecosystem. For each fleet segment, the 13 standardized indicators of Table 4.3 have been expressed per vessel; mean ecological impact and socio-economic performance of each fleet refer to averages of the 7 and 6 related indicators. Bubbles size is proportional to the number of vessel per fleet segment.

EXPERT WORKING GROUP REPORT

REPORT TO THE STECF

EXPERT WORKING GROUP ON DEVELOPMENT OF THE ECOSYSTEM APPROACH TO FISHERY MANAGEMENT (EAFM) IN EUROPEAN SEAS (EWG-11-13)

Rennes, France, January 16-20 2012

1 EXECUTIVE SUMMARY

➢ **Accordingly to ToRs 1 to 3**, the main objectives of the STECF 11-13 expert working group on EAFMwas to improve the preliminary approach developed during its first 2010 meeting, and to analyse the feasibility of providing useful adviceon ecosystem health. For each of the seven ecosystems considered as case studies: i) trends in landings since 1950 were examinedwith the objective to provide a comprehensive overviewof the dynamic of the whole fishery (ToR 1); ii) integrated syntheses of the status and trends in fish stocks were built at the ecosystem level (ToR 2); iii) trends in ecosystem and environmental indicators were analysed based on available time series computed before the meeting by ad hoc contracts (ToR 3).

Detailed results for each ecosystem are presented in Chapters 5 to 11 of the current report and summarized for all ecosystems as a whole in chapter 2. From the methodological point of view, the working group concluded that such analyses are still preliminary and need future development, especially in relation with the implementation of the Marine Strategy Framework Directive (MSFD) (see ToR 5 below). In this context, the working group noted the main following aspects:

- Reconstructing long time-series of catch and fishing effort is a desirable step within EAFM. It provides a long term perspective on the exploitation history which should be kept in mind when looking at the ecosystem health in the recent period.
- The “stocks synthesis” appears to be a key part of the EAFM. Using results based on single species assessments to build an ecosystem approach provides an important overview on the best diagnoseswe currently have regarding the fished fraction of the ecosystem.
- Environmental and ecological indicators are not routinely estimated for the European ecosystems in any working group or scientific program. From the knowledge available within the group on recent or current research programs(Image, Mefepo, Indiseas, works of the ICES WGECO, …)and from the test performed during the meeting, the working groupconcluded that the reference list of ecosystem indicators based on Data Collection Framework (DCF) cannot be considered a comprehensive and fully developed set of operational indicators (see ToR 5 below).

➢ **In relation to ToR 4**, the working group concluded that the reference list defined by STECF is an appropriate representation of regional ecosystems.In particular the sub-division of the two large ICES eco-regions (i.e ‘Celtic Sea and West of Scotland’, and the ‘Bay of Biscay and Iberian Seas’; see Table 4.1)appeared pertinent. The feasibility analysis conducted during this working group confirms that these ecosystems represent a good compromise in term of sizeand the appropriate scale:

. to synthesise stock status and analyse trends in the ecosystem indicators,
. to study ecological impacts and economic performances of fleet segments,
. to analyse trade-offs between economy and ecology in order to develop fleet-based management of fisheries.

Such ecosystems also appear to be the right entitiesto develop models devoted to scientific advice onboth ecology and economics,and to define long term management plans at such scale. They form “territories” wheredialogue should be improvedand stakeholders involvedin participative management of fisheries.

➢ **In relation to ToR 5**, related to the indicators-based approach in the context of the MSFD, the working group noted that the Commission Decision for the assessment of Good Environmental Status (GES) (COM(2010)477) specifies that the status of the marine environment should be assessed in relation to 11 criteria and 54 indicators (see Chapter 13).When considering the application of indicators to support the integration of MSFD requirements into EAFM some key points to note are:

- indicators are not required to monitor every impact of fishing and a focused set of indicators may be applied,
- so that appropriate specificfisheries management interventions (measures) can be defined, it is preferable to apply indicators that are sensitive to fishing pressure and capture the predominant

impacts of fishing on the marine environment (rather than applying indicators responsive to all combined anthropogenic activities),

- where possible, it is preferable to use indicators that can be calculated with currently available data.

The working group also noted that the majority of GES assessment criteria and indicators defined in COM(2010)477 are state metrics. To further application it would be desirable to specify, and where necessary develop, a set of pressure indicators that are linked to the state indicators. Simple indicators used by the working group for the fleet-based analyses (especially habitat impact index and the food web impact index) can be seen as a first preliminary step in that direction.

➢ **In relation to ToR 6**, related to the fleet-based synthesis, the working group concluded that assessing both the ecological impacts and the economic or social performances of the major fleets operating within each ecosystem also appears to be a key step towards EAFM. Due to the still poor quality of the data available, results obtained by the working group should be interpreted with care (see Chapters 5 to 11 for detailed results and summary in Chapter 2). Nevertheless, from a methodological point of view the test was successful and several aspects emerge:

- Indicators derived from stock assessment (partial F, standardized F* and B*)highlight significant contrasts between the various fleet segments operating in the ecosystem, in terms of their global (and direct) impact on the fishable fraction of the ecosystem.
- Compared to the work performed during the 2010 working group, the analysis has been improved by taking into account fleetimpacts on seabed habitatsand the impact on the food web. Even if the indices used still need improvements such an approach appeared promising.
- Regarding economic indicators, the working group noted that data availability at the regional level is the key element. Economic analysis at the ecosystem level are clearly required while economic data are currently collected within the DCF are reported at the country level, with reference only to three very large marine areas (see recommendation in Chapter 3).

The STECF group concluded that the fleet-based approaches should contribute moving from a stock-based management to an integrated fleet-based management of fisheries. In such an approach, stock-by-stock assessments will remain essential (and stock–by-stock regulation will certainly remain required), but additional fleet-based tools and regulation will have to be developed.

➢ **In relation to ToRs 7 and 8,** the working group concluded that three key aspects constitute the work that has to be performed on a regular basis to implement a scientific-based EAFM in European Seas:

- Diagnoses on ecosystem healthhave to be defined and regularly updated for each of the 14 European ecosystems.
- Both the environmental impacts and the socio-economic performances of the various fleets operating within each ecosystem have to be assessed and monitored.
- For each European ecosystem, one or a limited set of ecosystem and bio-economic models should be set up and used on a regular basis for advice-oriented purposes.

Obviously, such work will require a substantial reorganisation of the working groups within STECF and possibly within ICES (see recommendations below). Ecosystem-based advice should be considered by stakeholders (including the European Commission) in the definition of management options and especially in the context of long term management plans (which should evolve from a stock-based to an ecosystem-based approach). Such an approach is consistent with the changing demands for scientific support that might be expected following the progressive establishment of a regional seabasin approach to management of EU fisheries within the reformed Common Fisheries Policy.

2 Scientific conclusions of the Working Group

The main scientific results obtained by the working group within each ecosystem are summarized in the current Chapter.

➢ **<u>Diagnosis ofecosystems health.</u>** Even if preliminary, the calculation of the ecosystem indicators used in the report give valuable insights into changes in the ecosystems in relation to the impacts of fisheries, environmental parameters, and the state of fish stocks (Figure 2.1). Several aspects can be noted:

- In the seven considered ecosystems, the fishing mortality index exhibits a decreasing trend over the last years,highlighting a decrease in the mean fishing pressure applied to the assessed stocks.
- At the same time, the spawning biomass of assessed stocks continued to decrease in some ecosystems (Irish sea, Iberian coast), while in others it exhibited an improving trend (North Sea, Celtic Sea, Bay of Biscay). Nevertheless, even in this (favourable) latter case some other indicators of ecosystem healthare decreasing. The working group concluded that the decrease observed in fishing pressure seems to have not been strong enough or not long enough to allow the recovery of ecosystems from a generally depleted state.
- With the exception of the Baltic Sea, the mean recruitment index of assessed stocks appeared to decrease in all ecosystems. Several mechanisms could be involved in such a general trend (climate change, habitats impacts, temporal environmental changes,…), and more work is required to analyse and interpret this preliminary result.
- Some contrasts do exist within ecosystems. For instance, based on available indicators, the Bay of Biscay ecosystem seems in better shape or better trend than others. In contrastmany indicators exhibit deteriorating trends in the West of Scotland and Ireland ecosystem.
- More data and/or longer times series are available in the northern European seas. In particular, stock-based indicators (i.e. F, SSB, R and F*) can be considered representative of the whole fished fraction of ecosystems (in Baltic Sea, North Sea and West Scotland and Ireland), while in others ecosystems a majority of landings are related to non-assessed stocks.

		Land. Y	Effort E	Mortal. F	Biom. SSB	Recr. R	Sust. F*	Survey LFI	Survey MMLw	Survey MTL	Land. MMLw	Land. MTL	% asses.
Baltic Sea		↘	→	↘	↺	→	😐	↺	↺	↺	↘	↘	≈95
North Sea		↘	↘	↘	↗	↘	😐	↘	↘	?	Low	low	≈85
North western Atlantic waters	West Scot./Irl.	↘	↘	↘	?	↘	😐	?	↘	↘	↘	↘	≈90
	Irish Sea	↘	↘	↘	↘	↘	?	→	↗	↘	→	↘	≈35
	Celtic Sea	↘	↘	↘	↗	↘	☺	?	?	?	low	↘	≈40
South western Atlantic waters	Bay of Biscay	→	?	↘	↗	↘	?	↗	→	→	↗	→	≈45
	Iberian Coast	↘	?	↘	↘	↘	?	→	→	↗	→	↘	≈40

__Figure 2.1.__ Trends over the last years in the main indicators of the Ecosystem health in the seven ecosystems considered as case studies: total landings Y, fishing effort E, mean fishing mortality F, total stock spawning biomass SSB, mean recruitment index R, index of mean sustainable fishing mortality F, large fish indicator from surveys LFI, mean maximum length MMLw from surveys or from landings, mean trophic level MTL from surveys or from landings, % of landings due to assessed stocks(see Chapter 4 for details on indicators definition).*

➢ **Fleet-based indicators**. Ecological impacts and socio-economic performances of the major fleet segments operating within each of the seven considered ecosystems were analysed using a set of 13 indicators (see Table 4.3). Radar plots were built to identify contrasts between fleet segments and are presented with details in Chapters 5 to 11. Here, a first attempt to draw a synthesis is presented based on averaged indicators (Figure 2.2). Due to the poor quality of available data and because the methods still need improvement, such a representation has to be considered with care. Nevertheless, it clearly highlights that this approach is able to show contrasts which do exist between fleet segments. Three main general aspects can be noted:

- No fleet segment can be considered as completely "bad" (i.e. with high ecological impact and low economic performance)or completely "good" (with small impact and high economic performance),
- On average, the major fleet segments (in terms of vessels number) have similarsocio-economic performance, but very different ecological impact,
- A few fleet segments have high ecological impact, some with high socio-economic performance (for instance the large British purse seiners operating in the North Sea), while others exhibit rather poor economic performance (for instance the large Belgium beam trawlers).

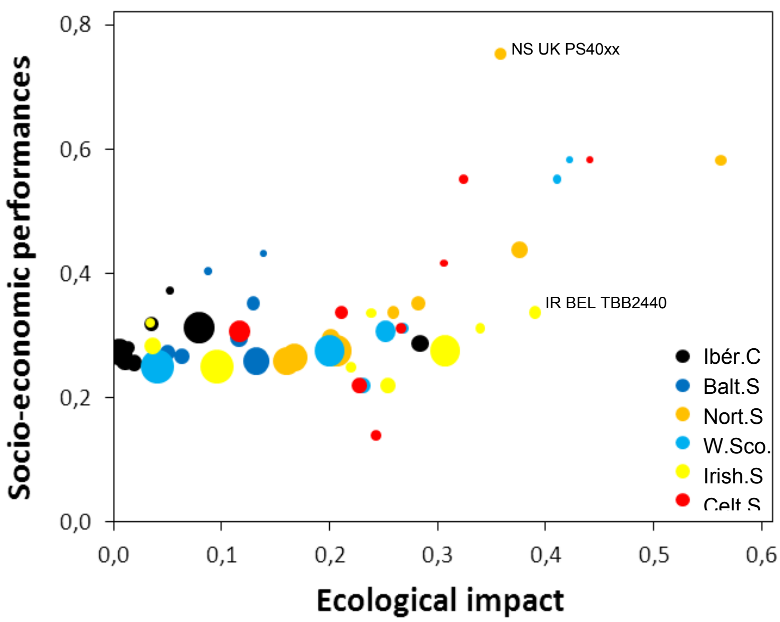


Figure 2.2. *Ecological impact and economic performances of the major fleet segment operating within each ecosystem. For each fleet segment, the 13 standardized indicators of Table 4.3 have been expressed per vessel; mean ecological impact and socio-economic performance of each fleet refer to averages of the 7 and 6 related indicators. Bubbles size is proportional to the number of vessel per fleet segment.*

As stated by the 2010 working group (see also Gascuel et al, 2012) this kind of fleet-based assessment is the pathway for implementation of efficient EAFM in European Seas. In the future, it should clearly be part of a framework used to determine the impacts of fleets - which may then be used in considering what overall fleet structure would be required to achieve management objectives for fisheries production and good environmental status of the marine environment.. Environmental assessments could also be used to guide the definition of long term management plans,including some regulation ofthe fishing effort and fleet-based access rights, or tosupport introduction of economic incentives in order to encourage fleets to improve their fishing practices

3 RECOMMENDATIONS OF THE WORKING GROUP

- **Assessing stocks -** The proportion of landings coming from stocks that are assessed by ICES has decreasedover the last years in several ecosystems (see Figure 2.1). The 2010 STECF working group underlined that assessing all resources that are targeted for exploitation should be considered as a requirement of the EAFM. Thecurrent 2012 working group suggests STECF should recommend that an increasing proportion of the stocks targeted by European fisheries should be assessed by ICES, European programs or national bodies. Such assessments should not necessarily be provided on an annual basis and using the same full set of age-based methods. As for non-targeted species,complete coverageis probably not realistic. Arisk based approachshouldbe defined in order to assess a sufficient number of the key vulnerable species to provide a representative overall assessment of vulnerable species exploited in each ecosystem.

- **Defining and using ecosystem indicators -** The application of indicators of Good Environmental Status to support of the integration of environmental and fisheries management via the Marine Strategy Framework Directive is currently in a state of flux; member states are required to define the indicators and targets they will use to assess GES and to report this to the Commission by 15th October 2012. Once the initial set of indicators being applied by MS have been specified it should be considered how these indicators can be incorporated into the development of EAFM to support achievement of GES.

In this context, it is advised by the current working group that a workshop or working group is established by STECF or ICES before the revision of the DCF in 2013 to provide advice on options to revise and refine the indicators (and their calculation methods) of the impacts of fishing on the marine environment in relation to the requirements of the MSFD.

On the long terms, the STECF working group considers that monitoring ecosystem indicators should be the task of a specific (and probably permanent) working group, whose terms of reference would be to provide the best estimates of ecosystem indicators on a regular basis for all European ecosystems (as defined in the STECF reference list, Figure 4.1). Discussion with the Commission and with ICES should determine the appropriate group to be in charge of this task in the context of the MSFD.

- **Using ecosystems in data collection and research programs -** Defining the reference list of European marine ecosystems was thefirst important step to implement EAFM in European Seas.Two major improvements should now be promoted as the next steps. On one hand, the spatial domain of the ecosystems should be considered in all data collection programs related to fisheries, resources, habitats, etc. This clearly applies to the DCF,and the group recommends that the revised DCF should consider the ecosystem spatial domain for collecting the data according to STECF-defined list of ecosystems. On the other hand, defining these ecosystems as the functional units to be used in ICES and STECF working groups would imply some changes in the organisation or in the terms of reference of several working groups. In many cases, we would expect these to be relatively minor since the ICES Ecoregions align well with the STECF list of ecosystems.

- **Building advice-oriented ecosystem models -**Operational models should be implemented in order to provide scientific advice that can be effectively used in the context of EAFM. The working group considers this could be undertaken in the two following steps:

1. First, a reference model or more plausibly a set of a limited number of reference models (see §15.2.2) should be developed for each one of the 14 European marine ecosystems. The working group suggests this could be done through a specific call for projects possibly managed and sponsored by DG MARE. The terms of reference for such a call should be to implement new models or to adapt existing models whose aim will be: i) to assess the ecological status of ecosystems and the ecological effects of changes occurring in the related fisheries and ii) to simulate biological, economic and social consequences of various management options.

2. A specific and probably permanent working group should be set up to run the reference models every year (or on a regular basis). The STECF EWG on EAFM considers this working group should be in charge of investigating compromises between simultaneous and often incompatible biological objectives and to identify, simulate and analysethe best possible compromises between ecological, economic and social objectives. This group should work closely with ICES working groups, in particular WGSAM (multi-species assessment modelling) where scientific issues relating to the development, validation and performance testing are dealt with.

- **Building a new system for advice on EAFM** - Providing science-based advice for EAFMin European seas cannot be performed by a single working group meeting once a year. Changing from a feasibility phase to an operational EAFM will probably require a substantial reorganisation of the working groups, within STECF and possibly within ICES (see §15.3).

- **Next priorities** - The working group recognizes that such a new scientific advice system cannot be created immediately and that more work is required on methods. As a priority, the group considers that three aspects should be more precisely analysed during the next meetings.

1. A workshop or working group should be established by STECF or ICES before the revision of the DCF in 2013 to provide advice on the revision of the indicators (and their calculation methods) of the impacts of fishing on the marine environment in relation to the requirements of the MSFD.
2. An experimental working group should be organized on the feasibility and usefulness of ecosystem and bio-economic models in an advice-oriented perspective. As a case study, such a working group could consider a specific ecosystem where ecosystem and bio-economic models already exist and could be easily adapted. Its objective would be to test models' ability to provide useful advice in the frameworkof EAFM.
3. The methods used to assess ecological impacts and socio-economic performances on a fleet-segment basis and the establishment of trade-offs between various indicators still requires further development. A specific working group should be organized on these methodological matters under the auspices of STECF. Such a working group should concentrate on a single ecosystem or on a very limited number of ecosystems.

Finally, the STECF working group, being informed that no working group on EAFM will be organized by STECF in 2012, considers that the 2 last meetings on methods could usefully be organized in 2013. At the same time, improvement in the DCF enforcement will take place and coordination and/or complementarity with EAFM should probably be discussed during STECF plenary meetings. The objective would be to organize a further operational and complete advice-oriented system of working groups for EAFM, starting in 2014.

4 INTRODUCTION – GENERAL APPROACH AND METHOD USED

4.1 Terms of Reference

. Background

The first STECF Experts Working Group on the "Development of the ecosystem approach to fisheries management (EAFM) in European seas" (SGMOS 10-03) met in September 2010, in line with the recommendations of the STECF 30th plenary meeting (PLEN-09-01). The overall aim of this working group was to provide a pragmatic example of a first attempt at assessment and advice in support of EAFM. It achieved this by i) utilising long time-series of catch and various stock assessment metrics, including the analysis of ecosystem indicators, ii) an analysis of the characterisation of fleets impacts, iii) an analysis of fleets economic performances, iv) an assessment of operational status of ecosystem models to support EAFM. Based on this first attempt, the working was also requested to provide comments and suggestions regarding the best way to improve EAFM in European waters. It especially achieved this by suggesting several recommendations in order to promote an advice oriented ecosystem approach in various existing STECF and CIEM committees.

During its 35th plenary meeting (PLEN-10-03), STECF acknowledged the quality and quantity of analyses undertaken by the EWG on EAFM, and supported the conclusions reached by the Group. STECF especially noted that "implementing EAFM is a specific task, that has to be conducted in respect to -and in close collaboration with- the MSFD, but whose purpose is not (or not only) to ensure GES. On the other hand, EAFM aims to take into account not only ecological sustainability (and GES), but also economic profitability and social fairness. Its major objective (its specific value-added) is to analyse trade-offs between ecology, economy and social aspects, the tree pillars of the sustainable development of fisheries".

Thus, STECF recommended that the EWG on EAFM meet again in 2012 with the participation of ecologists, biologists and economists, in order to improve and to expend the feasibility approach set up during the previous meeting. Based on this feasibility study, the working group should also make any appropriate comments and recommendations regarding the best way to improve EAFM implementation in European seas.

The STECF experts working group met in Rennes (France), from 16 to 20 January 2012 and was prepared in advance by ad hoc contracts in charge of estimating a suit of ecosystem indicators within each of the studied ecosystem.

. Terms of Reference for EWG-11-13

Based on the approach developed in 2010 (SGMOS10-03) and tacking into account improvement in the methods as suggested by the group itself and by STECF (PLEN10-03), the working group is requested to develop the feasibility approach to provide some useful ecosystem advices. This analysis should consider the seven marine ecosystems defined by STECF in Atlantic and Baltic Sea (Table 1).

Within each ecosystem and where appropriate, the working group is requested to gather existing knowledge and to analyse available data (or identify lack of data and suggest improvement regarding data):

1. To examine trends in total landings and landings by species (and possibly, where data are available and appropriate, trends in fishing effort based on STECF EWG11-11) over the past years, trying to take into account a period of time as large of possible (from 1950 if possible). The objective is to provide a comprehensive framework of the main characteristics and of the dynamic of the whole fishery.

2. To build an integrated synthesis of the stocks status and stocks trends at the ecosystem level. Such representations, based on the aggregation of assessment estimates on an ecosystem basis, should include the degree of stocks dependency to the considered ecosystem, and the representativeness of the considered stocks for fisheries occurring in the ecosystem.

Table 4.1. *Reference list of European marine ecosystems suggested by STECF in Atlantic and Baltic Seas (see Figure 4.1)*

	Ecosystem	FAO subdivisions	RAC	ICES Eco-regions
1	Baltic sea	ICES IIIb, 22-32	Baltic sea	Baltic sea
2	North sea	ICES IVa-c, IIIa, VIId	North sea (except VIId)	North sea
3a	West Scotland/Ireland	ICES VIa-b, VIIb-c	North western waters	Celtic Sea and West of Scotland
3b	Irish sea	ICES VIIa	North western waters	Celtic Sea and West of Scotland
3c	Celtic sea	ICES VIIe-k	North western waters	Celtic Sea and West of Scotland
4a	Bay of Biscay	ICES VIIIabd	South western waters	Bay of Biscay and Iberian Seas
4b	Iberian coast	ICES VIIIc, IXa	South western waters	Bay of Biscay and Iberian Seas

3. To analyse trends in ecosystem and environmental indicators computed before the meeting by ad hoc contracts (see above and list in Annexe).

4. To undertake a comparative analysis for the results obtained in the various marine ecosystems belonging to the same ICES eco-regions (i.e. 3a/3b/3c on one hand, and 4a/4b on the other hand), in order to assess if considering such sub-divisions appears pertinent.

5. To discuss how to improve indicators-based approach in the context of MSFD. The major aim of this should be to have a more integrative approach of the whole fishing impact on the ecosystem and *vice versa*, but also to assess other impacts on GES. The EWG should especially check if and what could be integrated from MSFD in future works dealing on EAFM... and also suggests any feedback: what could be useful from the "STECF" indicators list in the context of MSFD.

6. To build a fleet-based synthesis, using fleet segment as defined by DCF. Such synthesis should include descriptors (and possibly for a subset of ecosystems and fleet segments, trends analysis over the recent years) of: the fleets economic performance (based on the indicators used in AER; e.g. gross revenues, gross value added, net profit, …), and their respective contribution to the fishing mortality of each stock, and their economic dependency on stocks.

7. To suggest a general format that could be used for the publication by STECF of an annual EAFM report and to suggest an organizational structure that would be responsible for addressing future ecosystem analyses (including ecosystem and bio-economic modelling approaches).

8. More generally, based on this feasibility study, the working group is invited to comment regarding the best way to improve EAFM implementation in European waters.

4.2 Data used

To implement an ecosystem approach to fisheries in European ecosystems several types of data were required and a specific STECF-EAFM 2012 Access database was specifically set up prior to the STECF-EWG 11-13working group meeting (and updated during the meeting). This database aggregates various tables which were made available before the meeting.

4.2.1 Long term trends in landings and fishing effort

The ICES Statlant database was used to analyze trends in landings from 1950 to 2010. This international database on fisheries landings is coordinated by ICES. It includes landings of fish and shellfish from 20 countries, for each species at the spatial resolution of ICES divisions or subdivisions. It provides a comprehensive catalogue of reported landings for a large number of species. Unfortunately this data is not broken down in to catches by fleet. The coordinating Working Party on Fishery Statistics (CWP) organizes the collection of these statistics under the Statlant programme. ICES has published these data in the Bulletin Statistique des Pêches Maritimes from 1903 to 1987 and from 1988 onwards in ICES Fisheries Statistics. From 1973 to2009, the Statlant database contains landings by ICES subdivision. ICES is working on digitizing the data and electronic data back to 1950 is now available (at the ICES division level).

Prior to the STECF 11-13 working group, this ICES Stalant database was included as a specific table within the STECF-EAFM 2012 Access database used by the group. Landings per subdivision were aggregated by ecosystem according to the limits defined in Table 4.1 and shown on Figure 4.1. Note that until 1972 some landings were reported at the ICES division level, or for a pool of several subdivisions, and thus could not be distributed among ecosystems. This affects landings from subdivision VII and VIIIand from VIIe+d (English Channel). As a consequence, landings before 1973 are incomplete for the following ecosystems: West of Scotland, Celtic Sea, Bay of Biscay and Iberian coast, and related results should be interpreted with care.

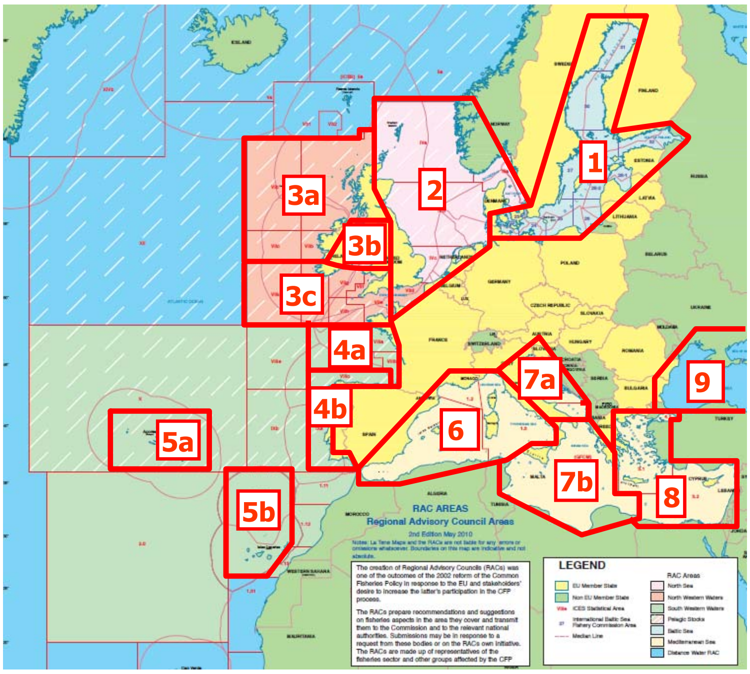


Figure 4.1. *European Marine Ecosystems as suggested by STECF. The current report refers to ecosystem 1 to 4b (see Table 4.1)*

Regarding fishing effort, the working group was not able to identify any source of information allowing for a reconstruction of long term trends. Data collected under the Data Collection Framework (DCF) or it predecessor the Data Collection Regulation(DCR) only cover the very last years. It is likely that scientific research or data related to specific fisheries and/or specific periods of time probably exist in the literature, but the working group lacked of time to collect and analyze such information. This could be the goal of a specific research project (possibly under the auspice of the ICES-SGHIST study group). As a first step, the working group analyzed the fishing effort derived from the JRC economic database (see below) which is available for 2002-2010 for several ecosystems and for a shorter time period for others.

4.2.2 Data related to assessed stocks

Data related to assessed stocks (Catches, Spawning Stock Biomass, fishing mortality, Recruitment index, limits values for F and B) are available for the 2011 assessment (which takes into account catches until 2010) from the ICES website. This data was imported in the Access STECF-EAFM2012 database used by the working group together with the data issued from the previous assessments(from 2005 to 2010). These older assessments(provided to the working group by the ICES database manager, Henrik Kjems-Nielsen) were used for stocks which no assessment was availablein 2011; in such cases, the last available assessment was considered.

An Access table was created to specifyover which ICES subdivisions (and ecosystems) each stock is located (according to assessment). In case where a stock is distributed over several ecosystems, catches and biomass estimated from the assessment were also distributed at the ecosystemlevelaccording to the mean 2000-2010ratio of the landings of this stock in the ecosystem over thetotal landings.

4.2.3 Landings per fleet segment and economic data

The economic data used is the latest EU fleet economic performance data that was used to produce the 2011 AER[1] on the EU fishing fleet. The database contains the 2002-2009 economic data (costs and earnings, employment, enterprises, profitability indicators) and the 2002-2010 transversal data (vessels, GT, kW, days, GT days, kW days, trips, other effort measures) and the volume and value of landings by species. The data segmentation is by Member State, gear type, length class, supra region (economic and capacity) or sub area (effort and landings by species). The data is publicly available on JRC data collection website http://stecf.jrc.ec.europa.eu/reports/economic

Concerning the latest economic data, several landings'values were missing (by species for Spain and forthe pelagic fleets for Germany and Poland due to confidentiality). Severalsegments have effort data but no landings' value and vice versa. Several landings volumes do not match landings values within specific sub-areas, however these occurrences are relatively low and insignificant. Data is missing for several variables fromvarious countries in 2010 and in earlier years. Due to clustering, several clustered segments contain economic performance data but no effort or landings' data.

Furthermore, some points are worth noting concerning the quality of economic data:

– Danish effort and landings data prior to 2008 was not provided at the correct disaggregation level (all Baltic Sea data coded as North Sea) so that the distribution of these data among ecosystems needed to be accounted for.

– Different aggregation levels (FAO sub regions 1-4) were used over time for transversal data by several Member States. Particular issues are due to the switch from DCR to DCF (2007 to 2008) when data was requested at a higher resolution level. For example for the Baltic Sea time series which starts in 2002, it was necessary to include the data related to the entire division 27.3 (including the Kattegat and Skagerrak) even though 27.3.a belongs to the North sea ecosystem region.

– For the DCR data (prior to 2008), effort and landings provided by Member States were not always reported at the ecosystem levels, causing problems when producing time series of days at sea, kW days, volume (Figure 4.1) and value of landings by ecosystem region.

– Changes in length class and gear type codes from DCR to DCF also caused time series disruptions in relation with length class 0-12m (0-10m and 10-12m from 2008 onwards) and PTS (TM and PS from 2008 onwards).

[1] The communication from DG MARE on usage of data submitted to JRC during data calls specifies the conditions required to use such data. As a result, this data is fully available for the STECF-EAFM working group, but can only be used during the working group itself and deleted hereafter. Results based on the analysis of these data can be published only after they have been presented in the report of the working group.

Annex X- contains a description of the connection of DCR-DCF needed to calculate time series by DCF fleet segment definition by each ecoregion from 2002 onwards (see Economic data mapping.docx)

– The economic performance data was available for DCF years (2008 onwards) at the level of the supra region 27, while no supra region data is available previously(DCR).

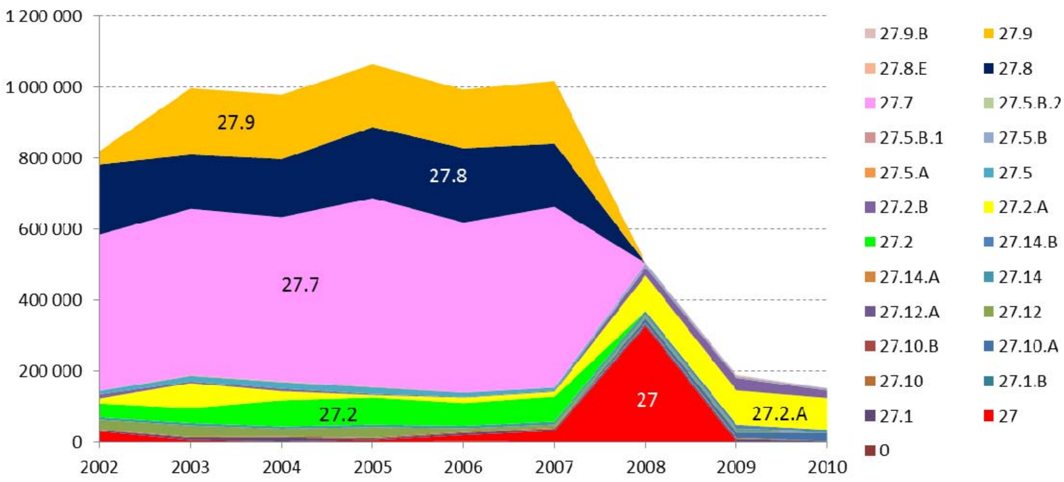


Figure 4.1. *Landings (in tons) and their associated area from JRC database which have not been attributed to the sevenstudied ecosystems in this report (corresponding to 30% of the overall landings in 2002 and 6% in 2010).*

4.2.4 Comparison of data sources

Working on the ecosystem approach to fisheries requires to bring together information about stocks (biological component) and fleets (economic component), i.e. to use several of the previous databases (included in the STECF-AEFM2012) to compute some indicators. Before doing so, we compared the landings between the databases in order to be sure that they were comparable (see Figure 4.2). In the previous report (STECF-SGMOS-10-03), some differences between ICES Statlant landings and landings used in stock assessments were already highlighted (see previous report, p 16-17). Indeed, landings coming from assessment include both an estimated part of discards and the unallocated landings, making these catches higher than landings coming from ICES Statlant database. This conclusion is confirmed at the ecosystem level: for some ecosystems where most important stocks are assessed (e.g. Baltic Sea and Western Scotland / Ireland), the catches of all assessed stocks is even higher than the total landings. Indeed, even if total catches of assessed species are calculated using a small number of species, the discards and unallocated landings that are included are greater thanthe landings of the numerous non-assessed stocks.

For the six first years of economic data (2002-2007), the overall landings were smaller than the landings derived from the ICES Statlant database, notably because up to 30% of the landings of JRC database could not be distributed in the different ecosystems (see before). However for the latter years, and particularly for 2009, the landings coming from the JRC database are quite similar to those comings from European landings in the ICES Statlant database.

The conclusion of this comparison of data is that, concerning economic data, only the year 2009 was used in our analyses as it is the only year that is representative of the European landings (according to ICES database). Furthermore, due to the difference of absolute values in landings among data sources, we made sure that the ratios used in all analyses were calculated using the same data. Thus, when addressing the percentage of landings that is assessed, the list of species assessed was derived from the stocks database but the two terms of the ratio of assessed landings over the total landings were derived from the ICES database.

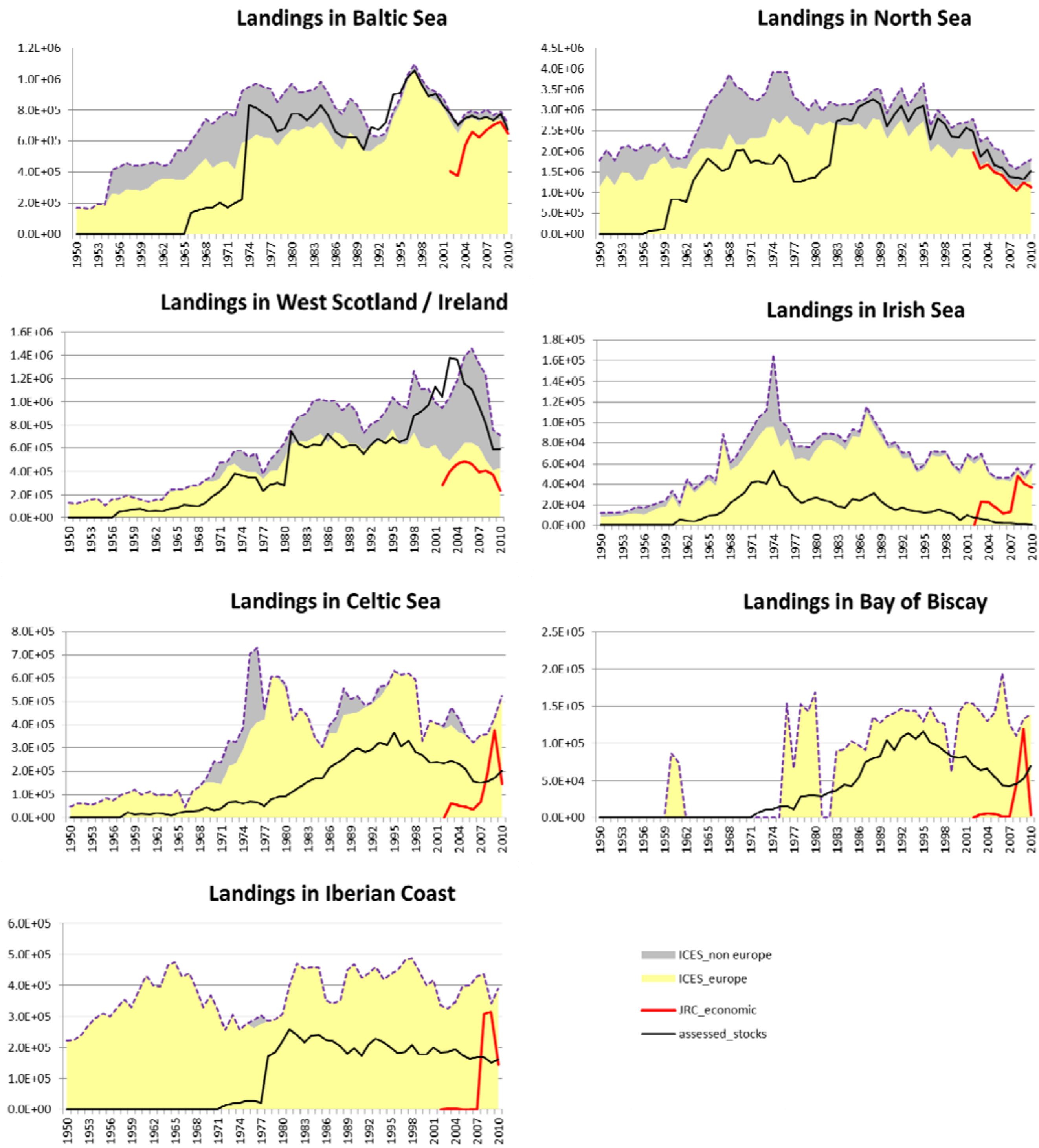


Figure 4.2.*Landings' time series coming from the ICES Statlant database (divided into european countries versus non-european countries) and from the JRC database (only 2002-2010) and catch time series derived from stock assessments for the sevenstudied ecosystems in this report.*

4.3 Methods

. ToR 1. Long term trends in catches and fishing effort

The study group examined the trends in total landings and landings by species using the ICES Statlant database integrated into the STECF-EAFM2012 database in order to aggregate landings by ecosystem (see above). Landings of the most important species are drawn while landings of minor species are pooled for clarity in an "other" group. When data was not available by ecosystem, other sources of information were used (such as the dataset from the Sea Around Us project www.searoundus.org).

. ToR 2. Stocks synthesis

The proportion of exploited species for which stock assessment are available reflects the current knowledge about the fishable fraction of the ecosystem. The proportion was computed using ICES Statlantlandings compiled in the previous section. The proportion of stocks assessed compared to total landings was computed for the 1950-2010 period. For all stocks subjected to an assessment, mean fishing mortality (F), recruitment index (R), total catches and spawning stock biomass were estimated to produce a synthesis of multiple stocks trajectories. Mean F and recruitment index R were averaged over the adequate number of species using a geometric mean, while landings and biomass were summed. The recruitment index is computed for each stock as the ratio of R in year y over the average recruitment for years that are in common toall species.

The current status of the assessed stocks was summarized using two reference points for fishing mortality: the precautionary reference point (F_{pa}) and the point at maximum sustainable yield (F_{MSY}). For biomass, only the precautionary biomass was used (B_{pa})because on one hand uncertainties exist on $B_{MSY}$and,on the other hand, B_{MSY} is currently not considered as a target for stock management in European waters and thus is often not provided by assessment groups. These two reference points were found in the ICES stock assessment reports and included in the STECF-EAFM2012 database. The current status of each stock is that of the latest available assessment (between 2005 and 2010) depending on species. Results from the assessments(F and B estimates) were presented adapting the synoptic method developed by Garcia and de Leiva Moreno (2005), for all stocks for which F_{MSY}, F_{pa} and B_{pa} limits were estimated by ICES. The current F is compared to reference points (here F_{MSY} and F_{pa}) by estimating a normalized index of fishing mortality as: $F^* = (F_{current} - F_{MSY})/(F_{pa}-F_{MSY})$. The normalized biomass is $B^* = (B_{current})/(B_{pa})$. Trends in the overall stocks status were obtained calculating the weighted (by landings) average F* and B* of each year and for all assessed stocks (for which target limits are known).

These indicators F* and B* allows to represent on the same graph the current status and the mean trajectory of all the assessed stock (see Figure 4.3 as an example). On such a graph, the horizontal line (labelled 'Bpa') refers to B* equal to 1 (when B=Bpa), while the vertical lines (labelled Fmsy and Fpa) refer to F* equal to 0 and 1 respectively.

A limit appeared concerning the method when computing these relative values. This standardization can actually lead to very high computed F* when the precautionary F (F_{pa}) is very close to F_{MSY}, as it is the case for mackerel stock (mac-nea) where F_{MSY} is estimated to be 0.22 y^{-1} and F_{pa} is 0.23 y^{-1}. Therefore, when looking at all stocks on the same graph, the mackerel appears to be very far away from the other stocks. This extreme standardized F* is not an issue when looking at stocks state, but becomes a problem when looking at the trajectory of the ecosystem. Indeed, the overall trajectory is calculated as the mean of stocks F*. In that case, the very high value of mackerel F* drives the ecosystem signal to the right (see Figure 4.3). In order to limit the importance of this extreme value, we computed the trajectory of the ecosystem without including the mackerel stock.

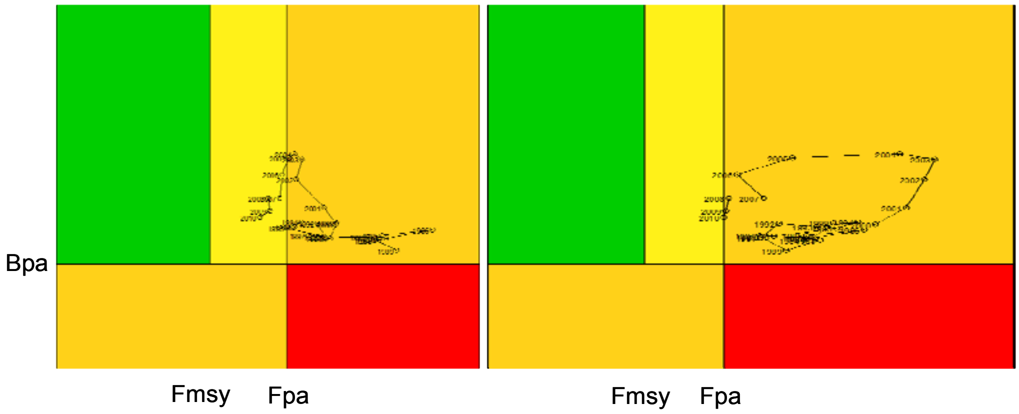


Figure 4.3. *Trajectory of the ecosystem according to F* and B* limits based on all assessed stocks (on the right) and for all the stocks except mackerel (on the left). North Sea case study.*

. Tor 3. Ecosystem indicators

Within each of the seven ecosystems, times series of seven environmental indicators (list below) were calculated prior to the meeting through ad-hoc contracts (see background documents available on the the EWG-11-13 meeting's web site on: http://stecf.jrc.ec.europa.eu/meetings/2011).

These indicators are based on:
. Trawl survey data extracted from DATRAS (ICES WebSite), for indicators 1 to 4,
. Data issued from the DCF data call on the fishing effort regime for indicator 5,
. The ICES hydrographic database to derive indicators 6 and 7 on hydrological and chemical condition (see MSFD Descriptor 6, 5 and 1 indicators).
Additional indicators based on landings (from the ICES Statlant database) were calculated during the working group.

- *Preliminary work: Identification of available homogeneous series of surveys (indicators 1 to 4)*

As long as possible, time series were identified for each ecosystem taking into account demersal trawl surveys with a similar protocol (e.g. the time period used in the North Sea starts in 1983, year in which all areas of the IBTS survey were conducted with a similar GOV trawl). Only surveys covering a large part of the ecosystem were considered (i.e. local costal surveys were excluded). Indicators 1 to 4 of the list below were calculated for each survey, taking into account the stations located within the studied ecosystem. In case where several heterogeneous surveys occurred each year in the same ecosystem, using for instance distinct protocols or gears or vessels, distinct estimates were calculated for each indicator (possibly covering distinct periods of time).

- *1.Conservation status of fish species (CSF)*

The conservation status of vulnerable fishes is an indicator that reports on the condition of the fish community by focusing on the large fish, i.e. the usually most impacted by fishing. According to EC (2008)187, two indicators of the biodiversity of vulnerable fish species can be calculated: CSFais an indicator of the biodiversity of vulnerable fish species that responds to changes in the proportion of contributing species that are threatened and CSFbis an indicator of the biodiversity of vulnerable fish species that tracks year-to-year changes in the abundance of all contributing species. Both indicators assume that the survey catch rate provides an index of abundance.

Calculation of the “Conservation Status of Fish” (CSF) indicators has to be based on trawl survey data that reports CPUE of species by length. For each ecosystem, the two indicators CSFa and CSFb were calculated using the method described in Annexe 3 of the STECF-SGMOS 10-03 report.

Unfortunately, analyses conducted during the working group showed that interpretation of these two indicators appeared to be in practice very difficult, if not impossible, leading to confuse and incoherent signals. Therefore, estimates are presented in Annex 17.1 and 17.2 but the working group decided to not use them in the present report. More work seems to be required before such indicators could be used to assess the conservation status of fish species within each ecosystem and efficiently contribute to set up a diagnosis on ecosystems health (see discussion at the end of this report).

- *2. Large fish indicator (LFI)*

According to EC (2008)187 (see Annexe 3 of the above mentioned STECF-SGMOS 10-03 report), the proportion of large fishor “large fish indicator” (LFI) was calculated from data surveys as:

$LFI = W_{>40cm} / W_{total}$, where $W_{>40cm}$ is the weight of fish greater than 40 cm in length and $W_{Total}$is the total weight of all fish in thesample.

- *3. Mean maximum length of fishes (MML)*

According to ICES (2009), the mean maximum length of fishes was calculated as the mean ultimate body length (similar to the mean maximum length but based on asymptotic total length ($L\infty$) as opposed to *L*max) according to:

$MMLn = \Sigma(N_s . L\infty_s) / \Sigma N_s$, where $L\infty_s$ is the von Bertalanffy ultimate body length of each species *s* (from FishBase), and N_s is the total number of individuals of species s caught during the survey.

A second index was calculated based on the weight of fish in the sample, using:

$MMLw = \Sigma(W_s . L\infty_s) / \Sigma W_s$, where W_s is the total weight of species scaught during the survey

- *4.Mean trophic level (MTL)*

The mean trophic level of all animals caught during each survey was calculated as:

$MTL = \Sigma(TL_s . W_s) / \Sigma W_s$, where TL_s is the trophic level of species s (from Fishbase)

- *5.Rate of discarding*

The rate of discarding of commercially exploited species in relation to the total landings (in tons and in value) for the whole fisheries and by fishing gears, by species (for the main species landed) on a yearly basis and for each ecosystemshould have been calculated prior to the meeting. Estimates of mean rates by ecosystem and by gear were provided by the scientist in charge of this ad-hoc contract (see Annexe 17.3), but not the time series. Thus, the working group was not able to properly use this indicator to analyse trends and characterise the ecological impact by fleet segment. Therefore, rate of discarding was not further considered in the analysis performed by the group.

- *6 and 7. Hydrological and chemical condition*

An annual indicator for each ecosystem was derived from the variables which define the hydrological condition of marine habitats (as specified by MSFD Descriptor 1). This includes salinity, temperature, suspended inorganic matter and water movements (including those driven by waves, tides, atmospheric forcing and thermohaline circulation). An annual indicator was also derived from the variables which define the chemical condition of marine habitats (as specified by MSFD Descriptor 1 and 5). This includes pH, nutrient concentrations (nitrate, nitrite, phosphate, silicate), nutrient ratios, oxygen and chlorophyll content.

The primary source of data for the compilation of these environmental indicators was the ICES Oceanographic Database (http://ocean.ices.dk/HydChem/HydChem.aspx?plot=yes) which gathers the records associated with various national programmes of oceanographic CTD sampling. Only determinants which correspond most closely to the MSFD environmental indicators were downloaded, e.g. describing the hydrological and chemical conditions, namely i) temperature (deg. C), salinity, and indices of the North Atlantic Oscillation (NAO) and the Atlantic Multidecadal Oscillation (AMO), which have been shown to influence sea water temperatures and the transport of seawater between regions (ESF, 2010), and ii) pH, nutrient concentrations (ammonia, nitrate, nitrite, phosphate, silicate), oxygen and chlorophyll, respectively.

In the following chapters, results are systematically presented for each region (unless there was insufficient data), including: temporal trends in temperature and salinity (5-year moving average as a single figure), temporal trends in temperature, the AMO and NAO (5-year moving average), Principal Components Analysis (PCA) and ordination of all data to form (when possible) continuous time-series, PCA of hydrological data and PCA of chemical data.

Methods and raw results are presented with details in Annexe 17.4.

- *Indicators from landings*

Three ecosystem indicators were calculated from landings using the same equation as the indicators from the surveys: the mean maximum length of fish, the mean trophic level of all landings including invertebrates, and the marine trophic index MTI, which is the mean trophic level of landings, estimated for species whose trophic level is higher thanor equal to 3.25 (Pauly and Watson, 2005). Landings per species were extracted from the ICES Statlant database, while trophic level and asymptotic length per species were extracted from the online free database FishBase (www.fishbase.org). Trophic level of invertebrates were all roughly assumed equal to 2.5

These indicators reflect both the ecosystem structure and the fishing activities. They may reveal changes occurring in the ecosystem functioning, especially in terms of trophic biodiversity, but are also influenced by fishing strategies and fisheries management, which lead to complex interactions that are difficult to interpret. Undoubtedly, from a theoretical point of view, indicators based on surveys are more powerful to analyse changes of ecosystem health than those based on fisheries data. But the survey-based indicators are mainly limited quite often by restricted short time series due to the availability of survey data. In contrast, landings are usually known for longer periods. Especially in the current analysis, surveys usually started in the late 1980s or 1990sdepending on the ecosystem, while landings are available since 1950.Therefore in practice, indicators based on landings appear very meaningful to draw long term trends on ecosystems and fisheries while survey-based indicators shall reflect ecosystem changes in the last two or three decades.

. Tor4 - STECF ecosystems / ICES eco-regions

The experts working group was asked to undertake a comparative analysis for the results obtained in the marine ecosystems belonging to the same ICES eco-regions (i.e. 3a/3b/3c on one hand, and 4a/4b on the other hand). This was done through simple graphs comparing results and discussions between experts. No specific method has to be mentioned here.

. Tor5 - DCF indicators / MSFD indicators

The experts working group was asked to discuss how to improve indicators-based approach in the context of MSFD. This was done through discussions between experts and no specific method has to be mentioned here. The EWG especially checked if the MSFD could be integrated (and what from it) in the future workin relationwith EAFM.

. ToR 6. Fleet-based synthesis - Economic and ecological indicators

The expert working group was asked to build a fleet-based synthesis following the fleet segmentation defined by the DCF. This segmentation takes into account the gear, the vessel length and the country of origin. Within each ecosystem, the main fleet segments in terms of landings' value in 2009 were selected. In line with the 2010 previous STECF EWG on EAFM, a set of indicators were calculated in order to assess the economic performances and the ecological impact of each selected fleet segment.

- *Economic indicators*

The economic indicators for the selected fleet segments were extracted from the AER (2011) and from the economic database provided by JRC. The economic data for 2008-2010 were collected following the new fleet segmentation in the DCF. A slightly different segmentation was used in the DCR (2002 – 2007), which makes difficult to show trends in economic performance for the fleet segments (See also Annex 17.7 on Economic data mapping). Moreover data provided by the 2011 data call for AER includes data for the last 2010 year which appeared to be incomplete. The economic subgroup therefore decided to use the 2009 data only and only results for 2009 are presented in this report.

The following economic and social indicators were selected and used:

Economic Indicators	Unit
Income	(mEUR)
Gross Value Added	(mEUR)
Cash-flow	(mEUR)
Profits / losses	(mEUR)
Subsidies	(mEUR)
Social indicators	
Employment	(FTE)
Wage per FTE	(EUR)
Capacity	
Weight of landings	(1000t)
Fleet number	(number)
Fleet GT	GT
Fleet kW	KW

Since 2010, the Annual Economic Report includes a regional approach for the Baltic Sea, North Sea and Eastern Arctic, North Atlantic, Mediterranean and Black Sea and other regions. Days at sea, landings' volume and value by country and region are described. The economic performances of the main fleets operating in these areas are also discussed. However economic performances are available for the fleets by country and it is to be noticed that these fleets may operate in several regions. The economic performance provided by fleet and country are therefore not directly related to a specific region or ecosystem.

In the current report, we considered that the economic performances estimated for a given fleet segment related to a region is representative of that fleet segment in the studied ecosystem. Additionally, two indicators were calculated:

i. The group looked at the species and stocks composition of the landings of those segments and calculated for the five main species the percentage of these species or stocks over the total landings (in value). This was done to assess **the dependency of the selected fleet segments on certain stocks**.
ii. The value of landings from a particular ecosystem was compared to the total value of landings of the fleet segment. This information allows calculating **the dependency of the fleet segment on the studied ecosystem**.

- *Ecological indicators*

Six indicators were calculated in order to assess the ecological impacts of each fleet segment:

i. For all stocks assessed by ICES, the contribution of each fleet segment to the total fishing mortality applied to this stock was calculated. The partial F is deduced from the total F estimated by ICES working groups, according to the proportion of the total catch due to the considered fleet segment. This indicator is a measure of the specific impact of the fleet segment on the related stocks. The sum of all the partial F applied by a given fleet to all the assessed stocks is considered to be **an index of the direct impact of the fleet segment on the main stocks present in the ecosystem.** This index only measures the global fleet impact on the exploited and assessed stocks. It thus becomes more reliable as the number of stocks assessed by ICES increases (i.e. if an increasing part of the exploited biomass is assessed). Nevertheless, we will see that the proportion of assessed stocks is usually high and thatthe total partial F by fleet can be consideredto be an index of the pressure applied by the fleet to the fishable part of the ecosystem.

ii. For each fleet segment, **two indices of the fleet sustainability** were calculated. One is the weighted average of the normalized fishing mortalities F* for all stocks that are exploited by the fleet and assessed by ICES. The other is the weighted average of the normalized B* for the same stocks (see above in method section on ToR2 on how F* and B* are calculated for each stock, in comparison to the F_{MSY}, F_{pa} and B_{pa} reference points). For both F* and B* cases, the average is weighted by the values of the 2009 landings per stock. The sustainability index is thus an indicator of the mean status of the stocks exploited by the fleet. It allows assessing if a fleet segment is economically dependent on stocks that are globally in good or bad shape, compared to the reference points defined by ICES. Here too, the index reliability depends on the proportion of stocks that are assessed.

iii. An index of the impact of each fleet segment on the food web was calculated. This index, hereafter called **the food web impact index,** is defined as the primary production required for sustaining the landings of a given fleet segment and is estimated as follows (Pauly and Christensen, 1995):
$PPR_f = \Sigma_s Y_{sf} \cdot 10^{TL_s-1}$, where Y_{sf} is the landing of species *s* by the fleet segment *f*, and $TL_s$is the trophic level of species *s*. Such an index takes into account the total amount of biomass extracted from the ecosystem by the fleet segment, but also the trophic level of landings, leading to an estimate of the primary production which has been required to produce the total landings of the fleet (under the assumption of a mean trophic efficiency of 10 % between trophic levels of the exploited food web).

iv. As a test, the working group calculated an index of the impact of each fleet segment on the seabed. This index, hereafter called **the Seabed habitat impact index,** is derived from the scoring defined in the US fisheries by Chuenpagdee et al. (2003), each type of gear being characterized by an index of its specific impact on habitat, from 0 (no impact) to 100 (see Table 4.2). The habitat impact index was calculated for each selected fleet segment multiplying the gear score by the 2009 fishing effort (in kW.day) of the fleet.

Table 4.2. *Scoring of the gear impact on seabed. Values from Chuenpagdee et al (2003) applied to gears defined under the DCF.*

Gear code	Gear name	Scoring
DFN	Drift and/or fixed netters	63
DRB	Dredgers	67
DTS	Demersal trawlers and/or demersal seiners	91
PTS	Pelagic trawl and/or pelagic seiners	4
FPO	Vessels using pots and/or traps	38
HOK	Vessels using hooks	4

MGP	Vessels using polyvalent active gears only	79
PG	Vessels using passive gears only for vessels < 12m	19
PGO	Vessels using other passive gears	19
PGP	Vessels using polyvalent passive gears only	19
PMP	Vessels using active and passive gears	50
PS	Purse seiners	4
TM	Pelagic trawlers	4
TBB	Beam trawlers	91

v. The fuel efficiency is an indicator included in the list defined by STECF in the frame of the DCF. This indicator was calculated for each fleet segment as the ratio of the fuel consumption of the fleet (from the AER data call) divided by their landings in volume. Thus the fuel efficiency index is a measure of the fuel consumption per ton of landings.

- *Building synthetic graphs on indicators*

Economic and ecological indicators were analysed as such, in order to assess the fleet performances within each ecosystem. A more general overview is provided at the fleet segment level using radar plots. As a test, 13 indices were considered for each fleet segment:

. 2 social indices: employment (Full time employment, FTE) and mean crew wages (wage/FTE) from AER,
. 5 economic indices: direct subsidies, total incomes, gross value added, operating cash flow, and profits/loses
. 6 ecological indicators: fuel efficiency, F* sustainability, B* sustainability, Fishing pressure (partial F), Food web impact index, habitat impact index.

Radar plots preliminary require a standardisation for all indices included on the graph. The indicators were rescaled between 0 and 1, level 1 being attributed to the highest observed value of the related indicatorfor the selected fleet segment in the studied ecosystem (Table 4.3). Therefore on the graph, the maximum quote 1 highlights the fleet segment which has the highest economic performance and/or the highest ecosystem impact. The more the radar plot of a given fleet segment is oriented on the right part of the graph the better this fleet segment is assessed (low ecological impact, high socio-economic performance).

Table 4.3. Social, economic and ecological indicators used in radar plots for each selected fleet segment

Indicator	Figure caption	Value in 0	Value in 1
Employment	FTEs	0	max.observed
Wage per FTE	Wage/Fte	0	max.observed
Subsidies	No.Subsid.	min. observed	max.observed
Income	Income	0	max.observed
Gross Value Added	GVA	0	max.observed
Operating cash-flow	OCF	0	max.observed
Profits / losses	Profit	min .observed	max.observed
Energy consump. / ton landed	Energy	0	max.observed
F* sustainability	Unsust.F*	min .observed	max.observed
B* sustainability	Imp.B*	min .observed	max.observed
Partial F	Fish.pres.	0	max.observed
Food Web impact indexe	Imp.FoWeb	0	max.observed
Habitat impact index	Imp.Habit.	0	max.observed

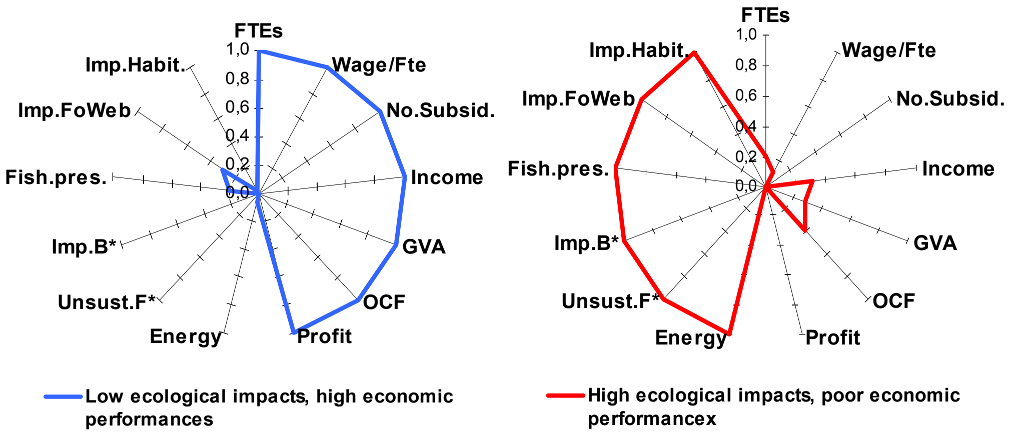


Figure 4.4. Interpretation of radar plots: representation of two theoretical contrasted fleet segments.

. Tor7 - General format of an EAFM annual report and Tor8 - General comments on EAFM implementation

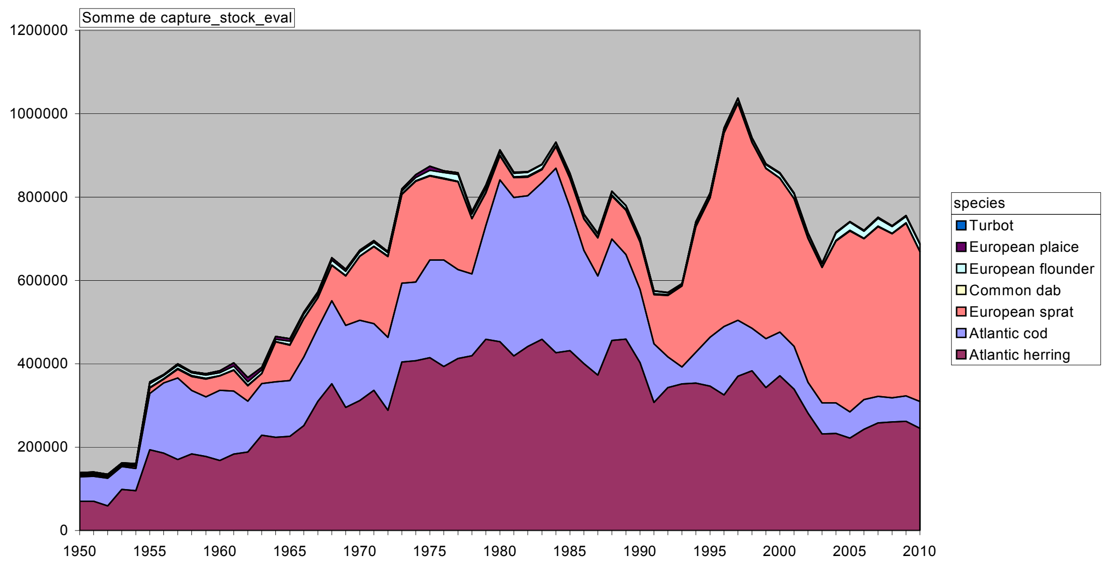
These two terms of reference were analyzed through the discussions between experts and no specific method has to be mentioned here. Conclusions are presented in Chapter 12 and 13

5 Baltic Sea

5.1 Long term trends in landings and fishing effort

5.1.1 Trends in landings

Since the start of the 1970's the Baltic Sea has supplied approximately 600 000 - 900 000 tonnes of fish each year with a peak above 1 million tonnes landed in the mid-1990's (Figure 5.1a). In the most recent period from 2005 and onwards the total landings of assessed species have been at a level around 750 000 tonnes of fish each year from the three main sectors; pelagic, demersal and industrial, in order of size. Non-assessed landings do only contribute to 20 – 65 000 tonnes (Figure 5.1b).



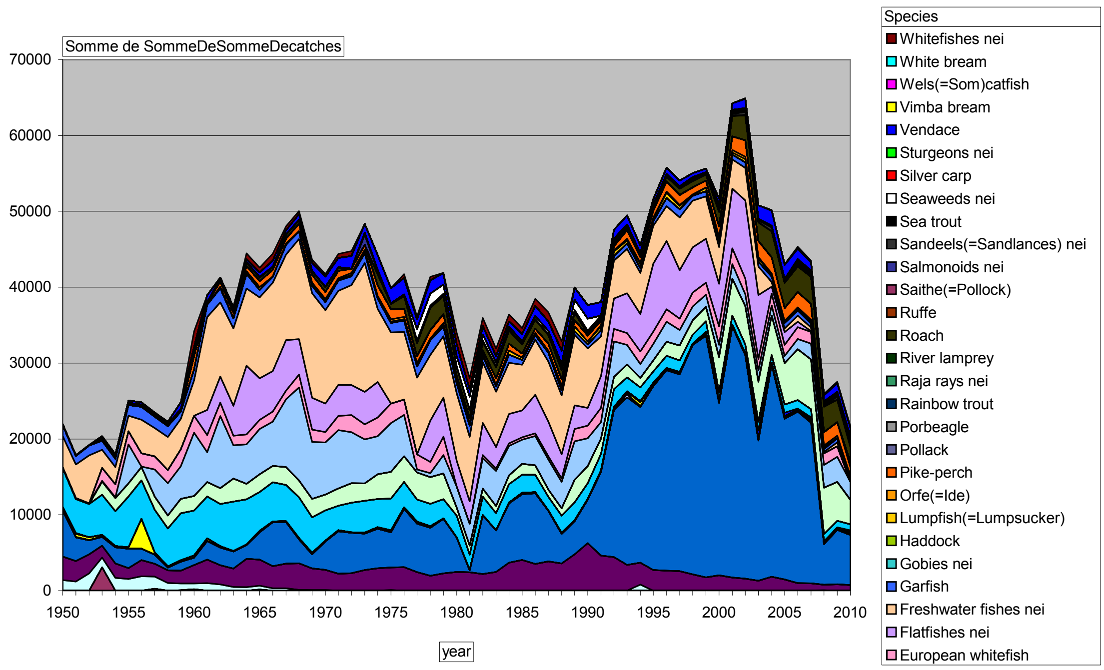


Figure 5.1. *Annual landings (in tons) per species: a (top) for stocks assessed by ICES; b (bottom) for non-assessed stocks (from ICES Statlant data bases).*

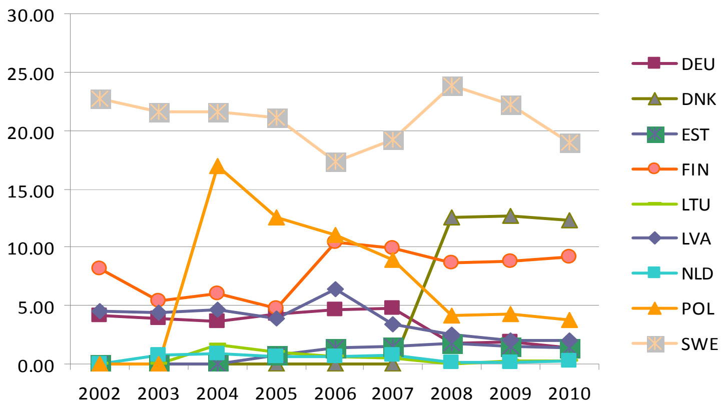
The Baltic demersal fisheries target roundfish species such as cod (*Gadus morhua*) and flatfish species such as flounder (*Platichthys flesus*), plaice (*Pleuronectes platessa*), sole (*Solea solea*) and turbot

(*Psetta maxima*). The blue mussel (*Mytilus edulis*) fishery is important in the South-western Baltic and important catches of *nephrops* (*Nephrops norvegicus*) also occur in the Kattegat. Pelagic fisheries in the Baltic target mainly herring (*Clupea harengus*) and sprat (*Sprattus sprattus*), for reduction purposes (industrial fishery) and for human consumption.

The general trends in yield derived from the Statlant database for the main species (herring *Clupea harengus*, sprat *Sprattus sprattus* and cod *Gadus morhua*) show a rather different pattern after the period of steady increase in 1950-1970s. Herring and cod are decreasing since the 80s while sprat landings are increasing. Total landings are smaller than 800 000 t since 2000. The total yield of the non-assessed species shows clear decreasing trend since 2003 from around 66 000 t to 20 000 t. This last trend is mostly driven by the increasing blue mussel fishery.

5.1.2 Trends in effort

All Baltic countries participate in the Baltic Sea fisheries where the main effort is conducted by Sweden, Denmark, Poland, and Finland (and Russia outside the EU) (Figure 5.2). The overall fishing effort (kW days at sea) indicates a decreasing trend in the very last years 2008-2010. The sharp increase shown in total effort in 2008 can be at least partly explained with the inclusion of the Danish data into the data set.



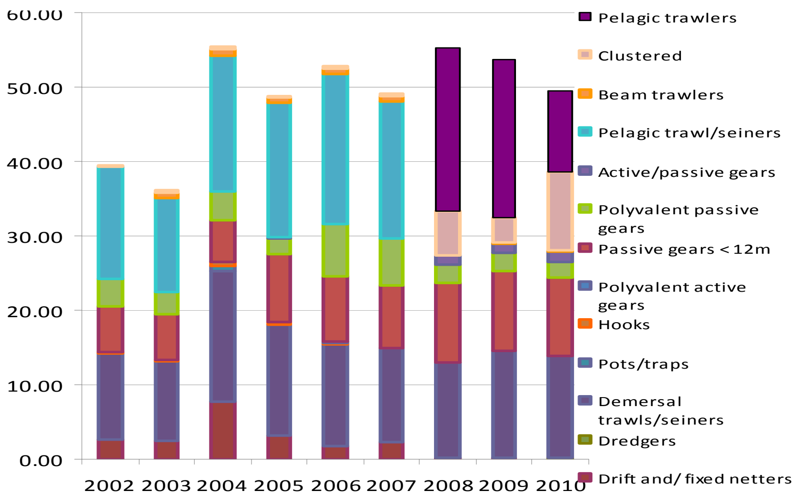


Figure 5.2. *Trends in fishing effort (kW days at sea in millions) in 2002-2010: top, by nation; bottom, by gear types.*

Pelagic trawls, demersal trawls and passive gears used by the fleet segment <12 m gillnets are the dominating gear types in the Baltic Sea fisheries. Note that the apparent increase in effort of pelagic trawls and the clustered gear segment observed in the recent period is due to a change in the fleet segmentation in the database.

5.2 Stock synthesis

This section presents indicators on the fishable fraction of the Baltic Sea ecosystem, based on aggregation of the data available for all stocks assessed by ICES within this ecosystem.

5.2.1 Proportion of landings covered in the assessments and dependency of stocks of the ecosystem

The assessed Baltic fish stocks fully belong to the Baltic Sea ecosystem. The Baltic ecosystem, however, is clearly dominated by herring (6 stocks), sprat (1 stock) and cod (2 stocks). All these stocks are analytically assessed by ICES. The share of total Baltic landings from assessed stocks exceeds 90% since the 70s (Figure 5.3). In other words, indicators based on assessed stocks will be representative of the whole fishable part of the ecosystem.

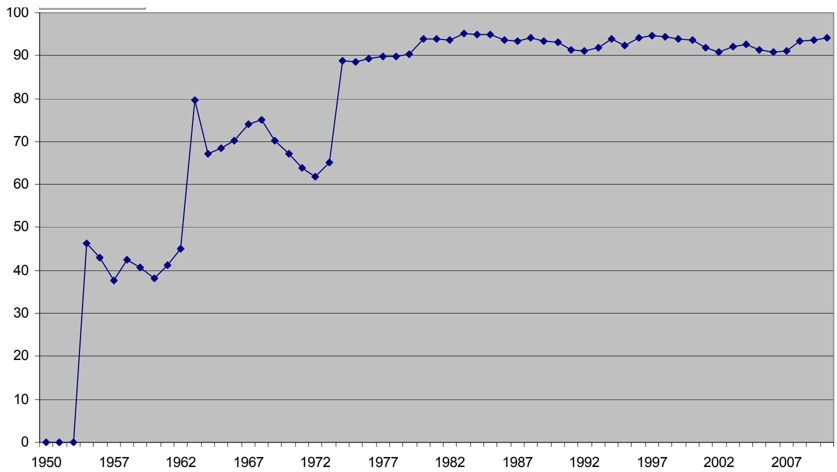


Figure 5.3. *Share of landings from assessed Baltic Sea stocks.*

All the 12 assessed stocks in the Baltic Sea (related to cod, dab, herring, plaice, turbot and sprat) are uniquely associated and assessed within the Baltic Sea (Figure 5.4) and therefore none of these stocks are shared with other regions. However, it should be noticed that there is noassessment for whiting in the Western and Central Baltic Sea for which there might be connections to the Division IIIa (Skagerrak-Kattegat) stocks. Sole in Kattegat and in the Western Baltic Sea is also mainly associated to the Baltic Sea, however, there might be linkswith the North Sea sole stock.

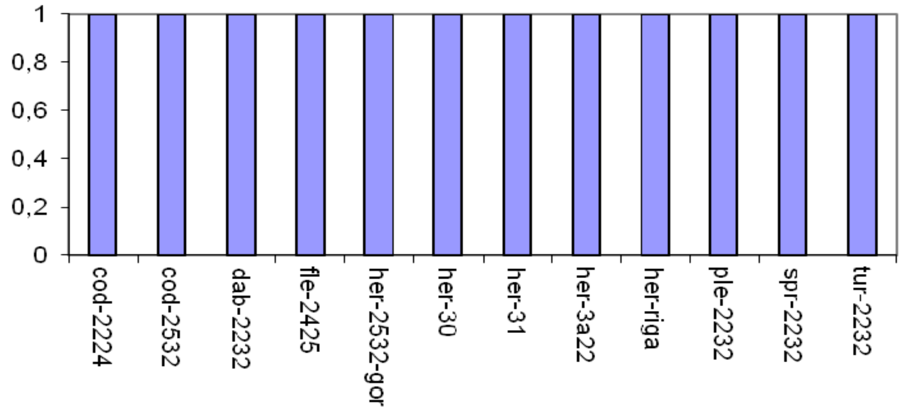


Figure5.4. *The dependencies of different ecosystems of the stocks found in the Baltic Sea ecosystem*

5.2.2 Trends in landings, spawning stock biomass, recruitment index and mean fishing mortality

Trends in total landings (Ytot), total spawning stock biomass (SSBtot), recruitment index (Rindex), mean fishing mortality (Fmean) have been computed for the four stocks assemblages (Table 5.1) as they are the stocks for which sufficient data was available. The more stocks included in the assemblage, the shorter the period for which data are available. The two-stocks index represents ca. 31% and the four-stocks index around 80% of the total landings for the respective periods.

Table 5.1. *List of stocks used for the computation of total SSB, total catches, mean F and recruitment index according to the period considered.*

Number of stocks in the assemblage	Period considered	Stocks included
2	1973-2010	Cod in Sub-disvisions 22-24; Herring in Sub-division 30
4	1974-2010	Cod in Sub-divisions 25-32; Herring in the Sub-divisions 25-32-GoR; Herring in Sub-division 30; Sprat in Sub-divisions 22-32
7	1980-2005	Cod in Sub-divisions 25-32; Cod in Sub-divisions 22-24; Herring in the Sub-divisions 25-32-GoR; Herring in Sub-division 30; Herring in Subdivision 31; Herring in Gulf of Riga
9	1991-2004	Cod in Sub-divisions 25-32; Cod in Sub-divisions 22-24; Herring in the Sub-divisions 25-32-GoR; Herring in Sub-division 30; Herring in Subdivision 31; Herring in Gulf of Riga; Flounder in Sub-divisions 24-25; Western Baltic herring

The time series of the total spawning stock biomass (four-stocks index) show high values in the beginning of the period 1970-2010 as a result of high biomass of pelagic stocks (herring and sprat) (Figure 5.5). Hereafter the total SSB has displayed a decline until 1990 except the short increase in the early 1980s which can be explained by the substantial increase in cod biomass (two-stocks index). The SSB increase can be traced also in the dynamics of landings. The following decrease (until 1990) can also be attributed to the respective dynamics in cod stocks. The following high SSB increase until 1997-1998 was mostly induced by the fast increase in sprat stock while the cod remained at low level. Later on, along the decrease on sprat and herring stocks, the combined SSB also decreased and reached the smallest values over the period in the early 2000s. The most recent (and limited) increase in combined SSB was caused by the respective change in SSB of cod (sd.23-32) and herring (sd.30).

The mean fishing mortality shows no clear trend in the 1970-1980s. The decrease of F observed in 1993 reflects the effect of an exceptionally low F estimate for herring in Sub-division 30 on the same year. After 1994, the mean F increased rapidly to the peak valuearound 0.5 in the late 1990s-early 2000s. Since that period, the overall fishing pressure seems to markedly decrease with mean F values around 0.3 in the last years. The most recent decrease in F can be at least partly attributed to restrictive measures of the cod management plan.

The average recruitment index has been fluctuating without any major trend variability over the whole 1970-2000s period. In the late 1980s, the recruitment index decreased as a result of cod recruitment failure, while in the early 1990s the index increased reflecting mainly developments of the sprat stock. The most recent increase in recruitment can be attributed to the Eastern Baltic cod and the herring in Sub-division 30.

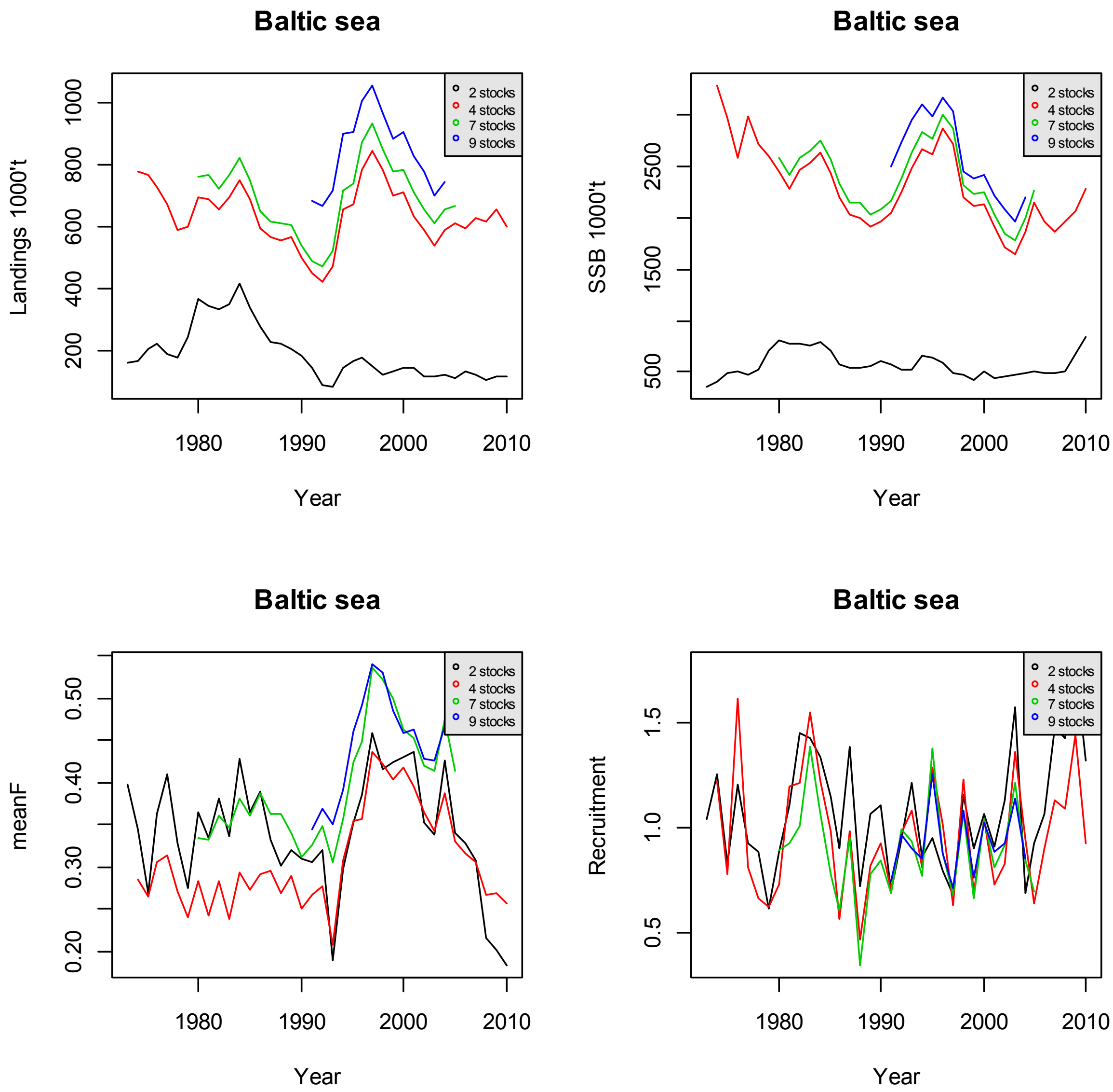


Figure 5.5. *Main developments in landings, SSB, mean F and Recruitment in the Baltic Sea stocks.*

5.2.3 Current status of stocks and mean trajectories

For three stocks (herring in Sub-division 30, herring in the Gulf of Riga and cod in Sub-divisions 22-24), the current status and the assessment limits Fpa, Bpa, and Fmsyhave been estimated by ICES. All three stocks are above Bpa (Figure 5.6). However, both Gulf of Riga herring and cod in Sub-divisions 22-24 are outside precautionary limits with current fishing mortality exceeding F_{PA}. On the other hand, herring in Sub-division 30 is currently at safe position with SSB above twice theBpa and F below F_{MSY}.

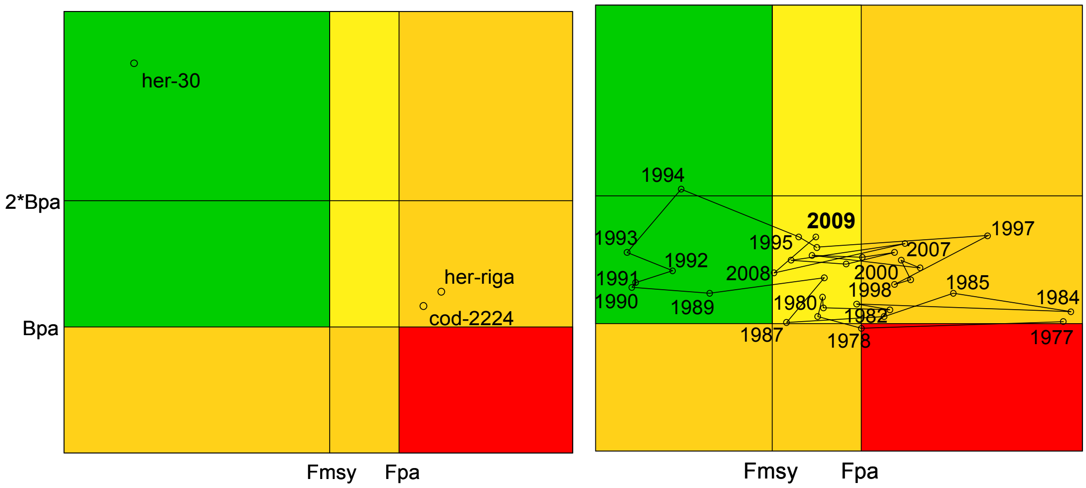


Figure 5.6. *Left: current position of three stocks of the Baltic Sea compared to the precautionary approach (PA) and MSY reference levels; Right: temporal trajectory for the same three stocks from 1977 to 2009.*

The mean trajectory of the average state of the set of assessed stocks indicates(Figure 5.6 right) that the system has been generally in the "safe zone" in terms of B_{PA} throughout the period of observation. The fishing mortality has however exceeded the F_{MSY} for most of the considered time-series, except for the short period between 1989 and 1994. The exploitation pressure on the system then increased rapidly and became far above the Fpain 1997. The situation seemed to improve slightly over the last period with a mean fishing mortality fluctuating between F_{MSY} and F_{PA} in the most recent years.

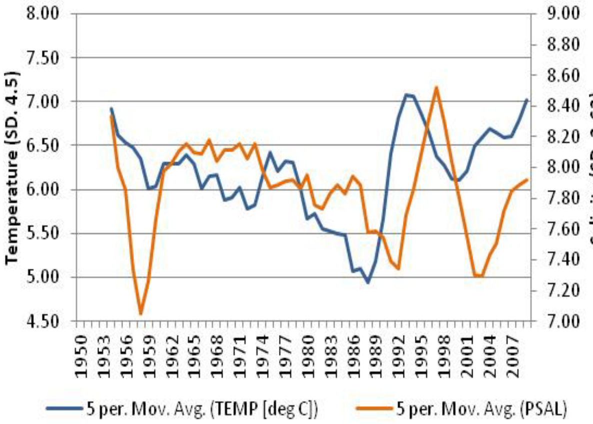
5.2.4 Conclusion of the stock synthesis

The previous indicators show a fluctuating state of the Baltic Sea ecosystem from the 1970s and onwards. It is a period at which the ecosystem has been experiencing high exploitation rates and environmental changes. The overall state in terms of spawning stock biomass has been relatively unchanged, fluctuating around 2- 2.5 million tonnes. However, the SSB of different components of the ecosystem have shown quite a different pattern. Indeed, after the second half of 1980s, the share of cod dramatically decreased whereas that of pelagic species (especially sprat) increased. This has followed the respective trends in recruitment. The indices also show that there is a high fishing mortality, mostly exceeding $F_{MSY.}$ A decrease in the mean fishing pressure is observed over the last decade, probably as a consequence of management measures (especially linked to the cod management plan). During the same period the SSB markedly decreased and reached its lowest value in 2003, but the trend seems to change in the very last years.

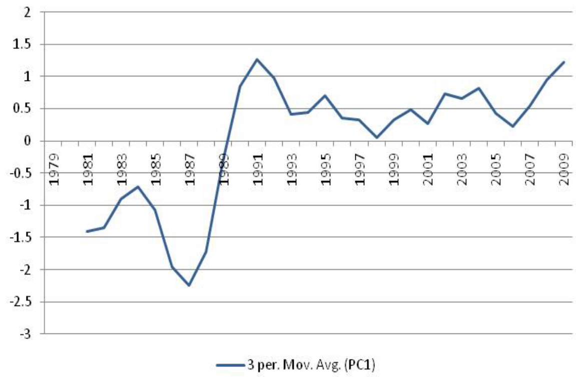
5.3 Environmental and ecosystem indicators

5.3.1 Environmental indicators

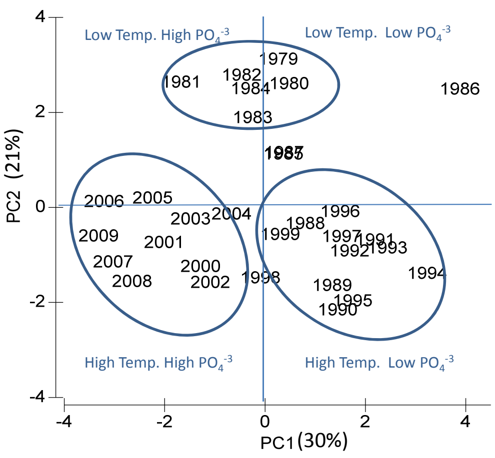
A description of the trends in environmental conditions of the Baltic Sea is presented with details in Annex 17.4 (report prepared by Kenny, 2012). The environmental trends show that changes occurred for both the hydrological and chemical conditions in the Baltic Sea over the period (Figure 5.7). The trend in thehydrology, dominated by temperature and NAO, clearly shows a significant change of state of the Baltic Sea in 1989,e.g. from a ‘negative’ hydrological condition (low temperature and low NAO index) to a ‘positive’ hydrological condition (high temperature and high NAO index, Fig. 5.7b and c). The trend in chemical conditions, dominated by phosphate and silicate, show a significant change of state in 1986 and 2000, e.g. from a ‘positive’ chemical conditions (high phosphate and silicate contents) in the mid 1980’s to a ‘negative’ chemical conditions (low phosphate and silicate contents) between 1987 and 1999, and back to a ‘positive’ chemical conditions between 2001 and 2009 (Fig. 5.7d).



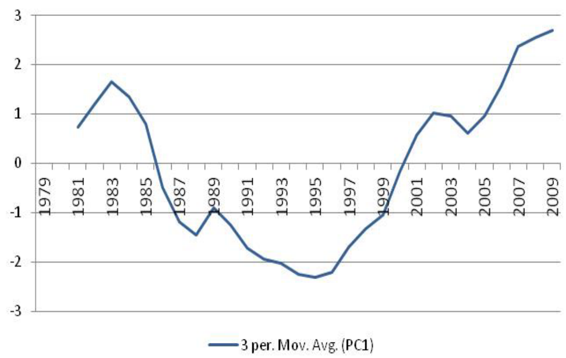
*- **a** - Trends in salinity and temperature using a 5-year moving average fitted to the raw annual averages*



*- **b** -Hydrological condition: plot of a 3-year moving average of PC1 scores, from PCA of the standardised hydrological condition.*



*- **c** - Plot of PC1 scores as a 3-year moving average derived from a PCA of determinant characteristic of hydrological condition in the Baltic Sea.*



*- **d** - Chemical condition: plot of a 3-year moving average of PC1 scores derived from a PCA of determinant characteristic of chemical condition.*

Figure 5.7. *Trends in environmental indicators, hydrological and chemical conditions in the Baltic Sea (see Annex17.4 for details on methods).*

These trends are in general agreement with those described independently for the Baltic Sea by Olsonen (2008). It has also been shown that the Baltic cod spawning volume associated with frequency of inflows of North Atlantic water to the Baltic Sea is an important driver of the hydrography in the Baltic Sea and of cod recruitment (Köster et al., 2005). The hydrology (which integrates the NAO, AMO, temperature and salinity) shows in that basin a significant change of state between 1987 and 1991 when the combined index went from a negative to a positive phase. It is worth noting that this change in the hydrology correspond to significant changes in the cod and sprat stocks (both including recruitment).

Moreover sprat recruitment and temperature alone are strongly correlated in agreement with Mackenzie et al., 2003, 2004. For example, the temperature increase between 1989 and 1995 corresponds to the peak in sprat SSB and landings. This peak corresponds more closely to temperature alone than to the combined hydrological conditions. In parallel, a synergetic pattern of high sprat SSB and low cod abundance seems to occur potentially resulting from more predation on cod eggs by sprat andless cod predation on sprat.

The cod stock appears not only to respond to changes in temperature and/or salinity, but also to the others hydrological conditions(NAO and AMO indices). From the comparison of the cod recruitment time series for the two assessed stocks, recruitment is shown to sharply decline between 1986 and 1992 (e.g. the 1-group cod) together with cod landings (2+-group) and SSB (3+-group) both the latter between 1985 and 1992.

The trend in the combined chemical conditionsin the Baltic Sea observed between 1983 and 1992 shows a decline (mainly of phosphates) driven by an increasing primary production (chl-a) resulting in relatively lower oxygen levels, below the euphotic zone. In parallelthe cod stocks significantly declined mainly due to low recruitment. In contrast, in the period between 1995 and 2009 there was an increase in the combined chemical conditions with an increasing phosphate content and increasing primary production (chl-a), all of which may have contributed to maintaining low cod recruitment during this period although the precise mechanisms by which such trends are related are complex and not necessarily uni-directional (Köster et al., 2005).

5.3.2 Ecosystem indicators

The patterns of change in the indicators of environmental conditions and stock synthesis are also supported by the trends observed in the ecosystem indicators based on surveys' data (Figure 5.7). For example, the ecosystem indicators described by the large fish index (LFI), mean maximum length (MMLn and MMLw) and the mean trophic level (MTL) show an increase between 1990 and 1996 which may be attributed to a short-term increase in cod recruitment after the 1993 inflow event. A high recruitment of sprat occurred in parallel but this has no effect on the ecosystem indicators which are based on demersal surveys. From about 2006, the increase in the ecosystem indices can be attributed to a recent overall increase in cod recruitment, but the trend need to be confirmed in the coming years.

Indicators based and landings provide a wider picture taking into account demersal and pelagic species and a longer period starting in 1950 (Figure 5.8). A clear and strong decreasing trend is observed over the whole period in the mean TL index (from 3.7 to 3.2) and in the mean maximum length (from 70 cm to less than 30 cm). This trend is mostly driven by the decrease of cod landings (representing almost 50 % of total landings in the 1950s and less than 10 % in the 2000s) and by the huge increase in sprat landings (from less than 5 % to more than 50 %of total landings). An increase in landings is also observed for some low trophic level species, such as bivalves (e.g. mussel, roach), while landings of whiting -a high TL species- are decreasing over the period. Note that the high cod recruitments occurring in the early 1980s temporarily interrupt the long-term decrease of the two indices which accelerates in the following years.

The MTI index (mean TL of landings for species whose TL is higher than 3.25 only) is remarkably stable over the whole period. In this ecosystem, landings of high TLs are almost exclusively based on cod and cannot really reveals changes in the high trophic level community.

The decreasing trend observed in mean TL and MML indices may result both from fishing down the marine food web (in relation to changes occurring in the ecosystem itself) and from fishing through the food web (due to changes in the fishing strategy).

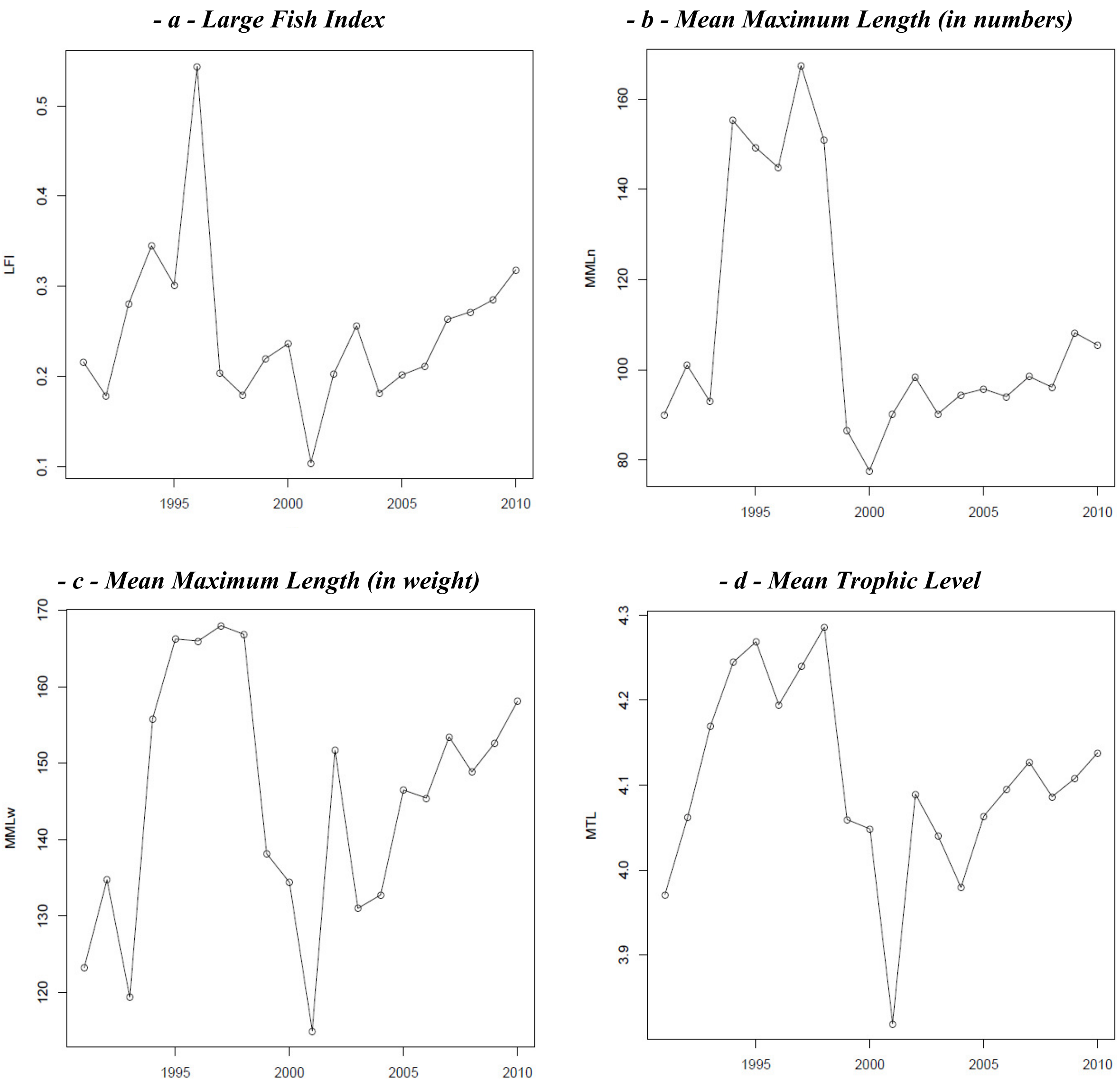


Figure 5.7. *Trends in ecosystem indicators based on surveys data (Q4) in the Baltic sea*

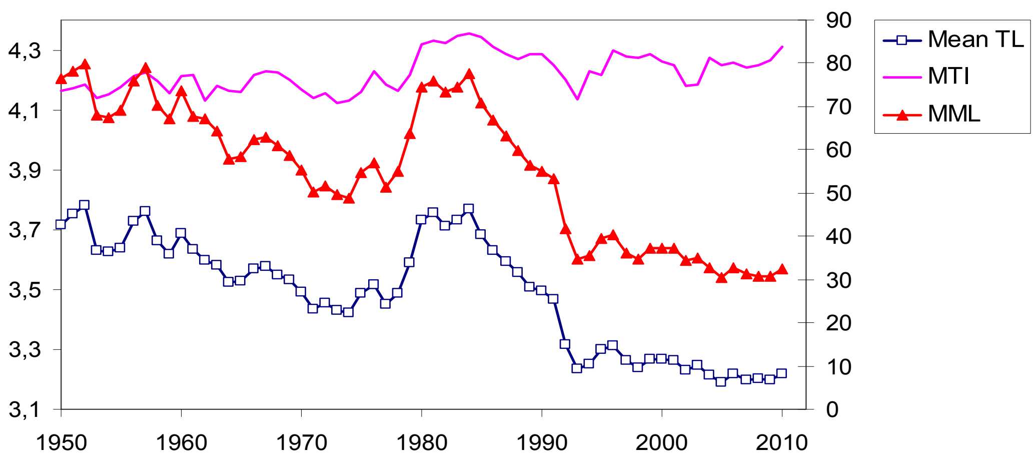


Figure 5.8. Trends in ecosystem indicators based on landings in the Baltic sea:mean trophic level, marine trophic index (MTI) and mean maximun length (MML in cm)

5.4 Fleet-based synthesis

5.4.1 General results of fleets operating in the Baltic Sea – Selection of the major fleet segments

The Baltic Sea area considered in this section includes the ICES Subdivisions 22-32. Landings by Russia are not available at DCF level and, therefore, not included in the analysis. The Danish fleet represents the most important EU fleet in the Baltic Sea in terms of total landing value, followed by fleet from Sweden (Figure 5.9). Note that Danish statistics are available from the database since 2008 only.

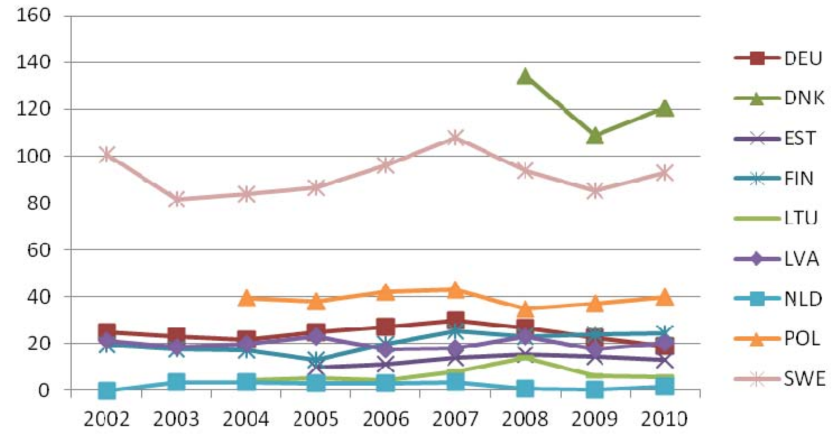


Figure 5.9 Total landing value by country in the Baltic Sea(in millions of €)

In 2010, the pelagic trawlers (TM) and the small scale fishing sector using passive gear (PG) are still the most important segments in terms of volume of landings with combined 60% of the total landings (Table 5.2). Together with the demersal trawlers (DTS) the three gear types represent 76.5% of all landings volume. In terms of landings value demersal trawlers are the most important segment with over 34% of the total value.

***Table 5.2**Landing in volume and value by gear, in the Baltic Sea (see gear codes in Annex 17.5)*

Gear type	2007 Volume (1000 tons)	2007 Value (€ mln.)	2008 Volume (1000 tons)	2008 Value (€ mln.)	2009 Volume (1000 tons)	2009 Value (€ mln.)	2010 Volume (1000 tons)	2010 Value (€ mln.)
DFN	6,7	11,0	7,3	9,2	5,8	6,0	5,5	7,0
DRB	0,0	0,0	8,6	1,7	8,9	1,4	8,8	1,7
DTS	89,2	82,3	115,0	108,9	136,0	104,1	122,6	116,9
HOK	0,0	0,1	0,1	0,1	0,4	1,4	0,6	1,5
NONACTIVE	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
PG	40,3	39,0	52,5	44,7	51,2	41,8	156,9	57,8
PGP	8,2	6,7	12,7	24,6	11,4	18,7	11,1	19,8
PMP	0,0	0,0	6,4	11,2	7,1	9,0	9,7	11,5
PTS	520,3	105,3	0,0	0,0	0,0	0,0	0,0	0,0
TBB	2,6	4,1	0,6	1,2	0,4	0,6	1,3	1,8
TM	0,0	0,0	579,6	131,9	577,6	116,1	278,6	68,7
Clustered gears	1,6	1,5	25,1	32,9	11,5	17,6	131,4	51,6
All Member States	**669,0**	**249,9**	**808,0**	**366,3**	**810,2**	**316,8**	**726,6**	**338,2**

The ten most important segments represent over 50% of the total landings value in the Baltic Sea (Table 5.3). Over 10% of the total landings value comes from the Danish demersal trawler segment VL 1218.

***Table 5.3.** The ten most important fleet segments in the Baltic Sea in terms of total landings value (in 2009)*

Country	Gear	Vessel length	Value of landings (1000 €)	%
DNK	DTS	VL 1218	35536	10,51%
DNK	DTS	VL 1824	28047	8,29%
SWE	TM	VL 40XX	18066	5,34%
DNK	TM	VL 2440	17460	5,16%
POL	TM	VL 2440	16691	4,93%
SWE	DTS	VL 1824	16099	4,76%
LVA	TM	VL 2440	13885	4,11%
SWE	TM	VL 1824	13607	4,02%
SWE	DTS-PMP-PS	VL 1218	13469	3,98%
FIN	PG	VL 2440	12581	3,72%
Other segments			152798	45,17%
Total			338239	100,00%

Over the 10 selected fleet segments, 9 are highly dependent on the Baltic Sea with more than 68 % of their fishing days at sea and more than 64 % of their total value landed coming from this ecosystem (Table 5.4). The dependency to the Baltic Sea is especially high for the Polish and Latvian pelagic trawlers, whose all landings come from the Baltic sea, and for the small Danish and Swedish demersal trawlers (DNK DTS VL1218 and SWE DTS VL1824), with a dependency higher than 85 %. Only the large Danish pelagic trawlers (DNK TM VL2440) are exceptions. This fleet segment operates in the Baltic sea seasonally and is catching there 33 % of its total yearly landings.

5.4.2 Economic performance of the selected fleet segments

Economic indicators reported in the AER 2011 (data from 2009) for the main EU fleet segments operating in the Baltic Sea allow for a comparison among the selected fleet segments (Table 5.4).

Table 5.4 *Economic indicators of the selected fleet segments regarding highest value of landings in the Baltic Sea following the 2011 Annual Economic Report (AER 2011)**

FLEET SEGMENT	Number of vessels	FTEs	Energy consump-tion	Baltic Sea days at sea	Baltic days at sea as % of total	Baltic Sea volume landed	% of total volume landed	Baltic Sea value landed	% of total value landed
DNK DTS VL1218	177	269	10 965	20 098	91%	31 610 078	60%	30 523 911	86%
DNK DTS VL1824	77	226	12 588	8 378	68%	23 599 881	44%	23 036 514	64%
DNK TM VL2440	46	260	24 469	4 539	43%	28 295 313	21%	17 207 705	33%
LVA TM VL2440	60	360	934	5 338	100%	62 198 110	100%	11 972 449	100%
POL TM VL2440	61	452	7 355	8 286	100%	101 015 695	100%	16 447 051	100%
SWE DTS VL1824	58	138	5 254	6 183	98%	15 359 519	98%	14 089 076	96%
SWE TM VL1840	16	93	4 717	3 081	93%	54 556 432	85%	13 066 333	77%
SWE TM VL40XX	13	99	9 543	3 157	92%	75 134 412	81%	16 624 472	67%

FLEET SEGMENT	Direct subsidies	Total income	Crew wages	Gross value added (GVA)	Operating cash flow (OCF)	Profit / Loss	Average wage per FTE
DNK DTS VL1218	15 232	37 663 359	8 362 094	19 487 366	11 140 504	-7 558 845	31 081
DNK DTS VL1824	4 858	38 612 830	10 573 147	20 790 248	10 221 958	-3 837 060	46 714
DNK TM VL2440	0	52 627 702	13 767 760	27 952 881	14 185 121	-2 185 683	52 874
LVA TM VL2440	1 594 724	15 964 706	1 985 981	8 392 576	8 001 318	4 806 242	5 517
POL TM VL2440	3 387 548	19 999 996	3 751 392	8 232 434	7 868 590	6 403 787	8 298
SWE DTS VL1824	0	16 524 406	2 321 152	7 784 576	5 463 424	1 244 686	16 839
SWE TM VL1840	0	22 878 364	2 777 134	11 602 032	8 824 898	5 929 198	29 807
SWE TM VL40XX	0	30 004 627	1 407 605	13 752 847	12 345 242	2 179 677	14 160

*For the segments FIN PG and SWE DTS-PMP-PS no economic data is available.

Even though the highest level of revenues from Baltic Sea landings is obtained by Danish Demersal Trawlers with a length of 12-18 m, there is one fleet segment showing a higher income: the Pelagic Trawlers 24-40 m which have only 1/3 of their value of landings from the Baltic Sea. All three Danish segments, however, reported losses in 2009.

Other important fleet segments in terms of Gross Value Added (GVA) and Operating Cash Flow (OCF) are represented by the other pelagic trawler segments 18-40 m and over 40 m from Latvia, Poland and Sweden. These fleet segments reported the highest level of profits between 2 and 6.4 Million of €.

The Polish and Latvian TM segments received a relatively high amount of direct subsidies comparably to all other segments. These segments have the lowest average wage per FTE of all segments but the highest profit.

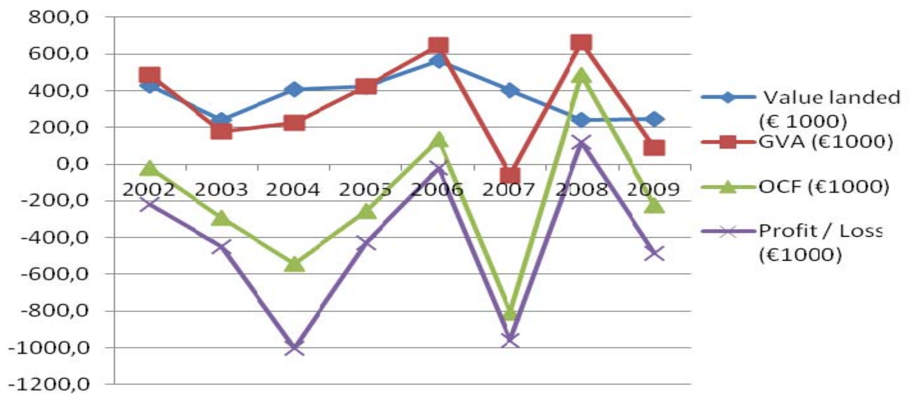
There are 22 fleet segments with 50% or more of their volume of landings from the Baltic Sea. Six from the 10 segments with the highest value of landings are also part of this group.

Table 5.5 *Economic indicators of the selected fleet segments reporting over 50% of their volume of landings in the Baltic Sea following the 2011 Annual Economic Report (AER 2011)*

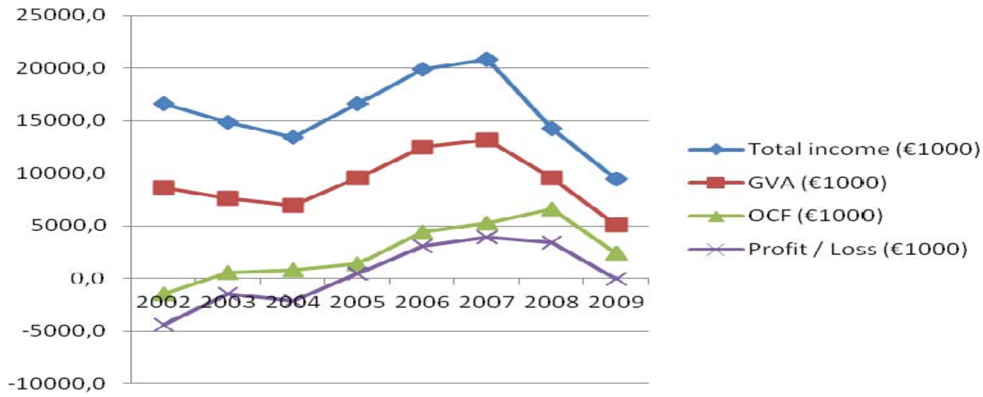
FLEET SEGMENT	Number of vessels	FTEs	Baltic Sea volume landed (1000 t)	Volume landed as % of total volume landed	Baltic Sea value landed	Value landed as % of total volume landed	Direct subsidies (1000 €)	Total income (1000 €)	Crew wages (1000 €)	GVA (1000 €)	OCF (1000 €)	Profit / Loss (1000 €)
FIN TM VL2440	15	72	833898	100%	121244	100%	0	129697	36217	58474	22257	-12677
POL DFN VL1218	25	88,11	18984	100%	18273	100%	6019	24471	3894	12421	14546	12959
POL DTS VL1824	22	61,89	47655	100%	19302	100%	9065	28569	6213	8179	11032	8327
POL DTS VL2440	10	59,78	49172	100%	16593	100%	3288	20048	3044	8129	8372	6026
DEU DTS VL0012	15	9	18369	100%	6970	100%	26	10202	3197	910	-2260	-4862
FIN DFN VL1218	13	1	1482	100%	3100	100%	8	1974	0	1036	1044	-1969
FIN TM VL1824	16	15	173132	100%	22566	100%	3	20908	3046	12444	9401	-1063
LVA DFN VL2440	23	127	23353	100%	26580	100%	3015	30356	5637	11407	8785	-1372
LVA TM VL1218	23	69	112276	100%	20307	100%	13676	36118	6120	7469	15025	7047
LVA TM VL2440	60	360	621981	100%	119724	100%	15947	159647	19860	83926	80013	48062
POL DTS VL1218	52	138,46	69552	100%	44015	100%	18585	62827	11140	27506	34951	30296
POL HOK VL1218	37	81,8	3252	100%	13900	100%	26309	40330	8065	7625	25869	23594
POL TM VL2440	61	452,06	1010157	100%	164471	100%	33875	120000	37514	82324	78686	64038
FIN TM VL1218	22	6	72757	100%	9494	100%	42	7917	1184	4587	3444	-2978
DEU DTS VL1218	39	34	67138	100%	29801	99%	142	36025	8195	16584	9804	-1331
SWE DTS VL1824	58	137,84	153595	98%	140891	96%	0	165244	23212	77846	54634	12447
SWE TM VL1840	16	93,17	545564	85%	130663	77%	0	228784	27771	116020	88249	59292
SWE TM VL40XX	13	99,41	751344	81%	166245	67%	0	300046	14076	137528	123452	21797
DNK DTS VL1218	177	269,04	316101	60%	305239	86%	152	376634	83621	194874	111405	-75588
SWE DTS VL2440	31	85,97	81939	88%	113652	82%	0	181852	14680	81178	66498	18104
DNK PMP VL1218	46	53,28	47436	69%	48636	77%	0	70211	9149	31552	22403	-15723
DEU DFN VL1218	16	17	9436	82%	7612	44%	509	17827	3638	13486	10357	6663

For a deeper analysis of trends we can choose three representative segments with available data from 2002-2009 in the Baltic Sea (Figure 5.11). First segment is the German Demersal Trawl VL 0012 as part of the small scale fishing sector. Only in one year this segment shows profits and even operating cash flow is only positive in two years. This shows that this segment is not able to generate enough revenues to cover investment costs. As OCF and profits (following the common method in the AER) include opportunity costs of capital they can only operate as long as an investment in a new vessel is not necessary.

DEU DTS VL 0012



DEU DTS VL 1224



SWE DTS VL 2440

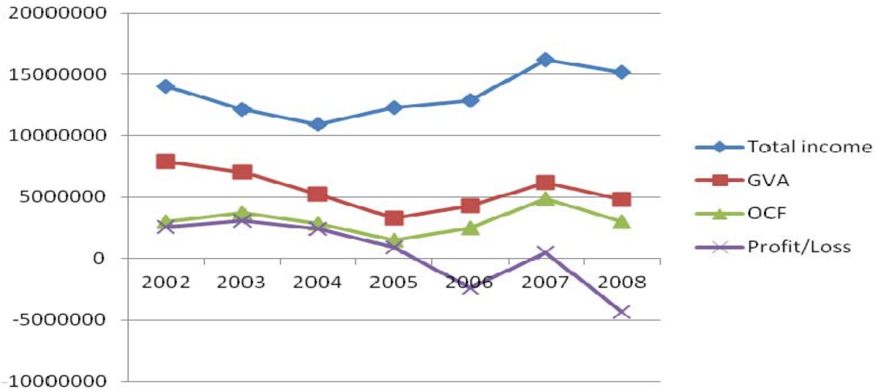


Figure 5.11 *Trends in main economic indicators for three fleet segments of the Baltic sea (from AER 2010)*

The following DEU DTS VL 1224 segment shows a different picture. There was a steady improvement in OCF and profit over the years and only 2009 show a downfall with low cod and herring landings and increasing fuel costs. As the third segment the Swedish segment DTS VL 2440 was selected as sufficient data for 2002 to 2008 are available. This segment shows a comparable development than the German DTS segment. From 2004-2007 the total income increased significantly but profit deteriorated and in 2006 and 2008 the vessels reported losses.

5.4.3 Ecological indicators of fleet segments

- Partial F: contribution to the fishing mortality of assessed stocks

The partial fishing mortality by fleet segment was estimated for each of the assessed stocks on the basis of landings of the fleet segment compared to total landings of that stock in the area. The sum of partial F by fleet reflects the fleet impact on assessed stocks and can be considered as an indicator of the global impact of the fleet on the exploited part of the Baltic Sea ecosystem (Figure 5.12).

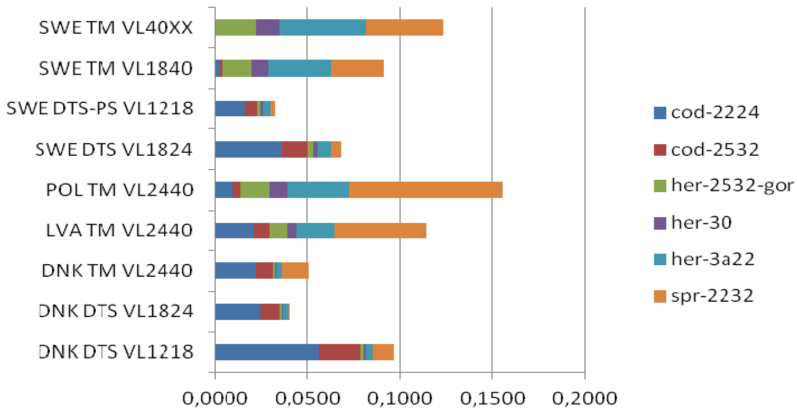


Figure 5.12. *Partial F applied by the selected fleet segments with the highest value of landings from the Baltic Sea*

Total values of induced fishing mortality by each of the selected EU fleets are lower than 0.2.Fleet segments inducing the highest impact on Baltic Sea resources are: the Polish pelagic trawlers (due to their impact on sprat), the Swedish and Latvian Pelagic trawlers >40 m and 24-40 m (mainly due to their impact on herring and sprat) and the Danish demersal beam trawlers (due to impact on both cod stocks).

- Sustainability index of the selected fleet segments

The sustainability index of fleet segments operating in the Baltic Sea are based on three stock assessments only, taking into account less than 20 % of the landings in value for these fleets (Figure 5.13). Good indices (high B* and low F*) observed for Swedish and Polish pelagic trawlers therefore reflect a high proportion of Baltic herring in the landings, whose situation is currently considered as good (see Figure 5.10). In opposition, Danish bottom trawlers exhibit the worse sustainability indices F* an B* due to high catches of cod-2224 which is a more intensively exploited stock compared to herring.

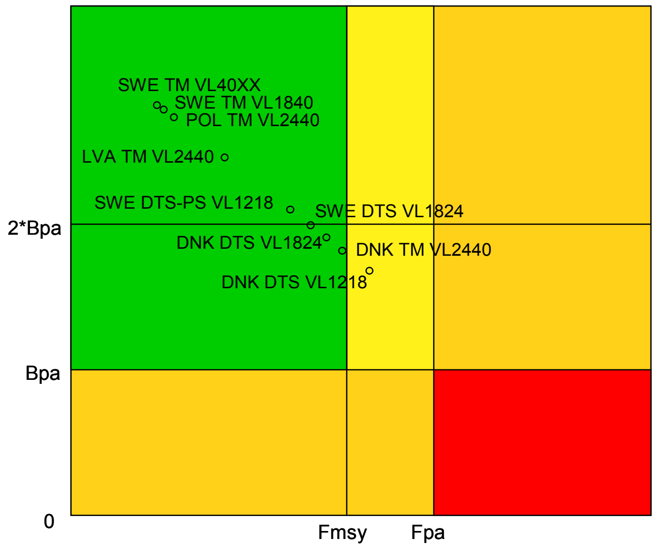


Figure 5.13.*Sustainability index of the selected fleets operating in the Baltic Sea: standardized fishing mortalities F* and biomass B* for the assessed stocks (referred in figure 5.6)*

- Index of the fleet segments impact on the food web and habitat

Among the selected fleet segments, the highest impact on the food web (estimated using the required primary production) is from the Danish bottom trawlers because of their large catches of high trophic level species (mainly cod, Figure 5.14 left). Although the Polish pelagic trawlers land lower trophic level species (mainly sprat), the food web impact index of this segment is also high due to the importance of landings.The habitat impact index shows that, as expected, only bottom trawlers have a significant impact on the sea floor. The highest value of that index is estimated for the Danish small trawlers in relation with a high fishing effort (in kW.day).

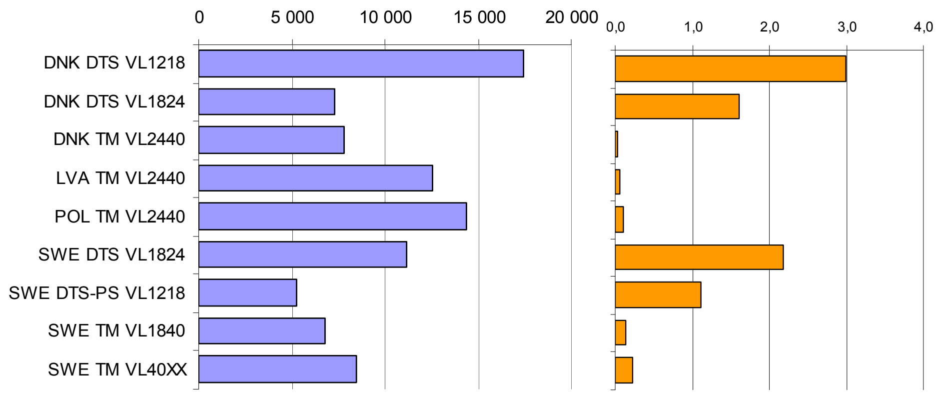


Figure 5.14. *Ecological index for the main fleet segments operating in the Baltic Sea. Left: food web impact index (Primary Production required, 10^6wet tons/year); Right, habitat impact index*

5.4.4 Synthesis and conclusion of the fleet synthesis

All ecological and socio-economic indicators can be calculated for 8 fleet segments, among the 10 selected ones (Figure 5.15). The three Danish fleet segments are characterized by rather high mean wages per FTE. These segments received no or little subsidies and produced large GVA or OCF, but their economic performance is low in term of profits since all exhibit large losses. These Danish fleet segments and especially the demersal trawlers seem to largely impact the Baltic Sea ecosystem, mainly exploiting the heavily-fished and high TL cod stocks with a gear that impact the seafloor. Overall, the Danish demersal trawlers have a larger impact than the corresponding pelagic fleet from both the type of exploited resource and the type of used gear.

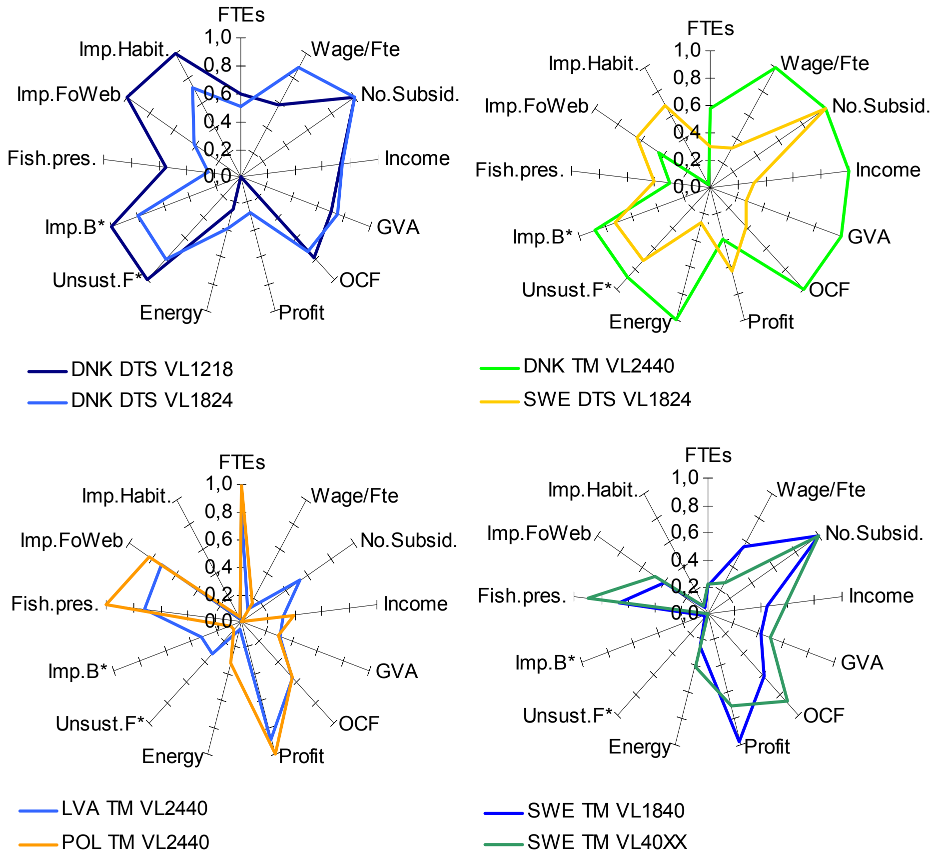


Figure 5.15. *Ecological impact index, and socio-economic performances (from AER 2011) of the main fleet segments operating in the Baltic Sea*

Swedish pelagic trawlers, on the opposite, seem to generate large profits although they are not subsidized. Even if they apply a relative high fishing pressure on the ecosystem, they are exploiting stocks currently in good condition and seem to induce a low global impact on the ecosystem, as shown by the food web and habitat indices. Polish and Latvian pelagic trawlers also appear to be profitable fleets with a quite low impact on the Baltic Sea ecosystem, although it is noticeable that these two fleet segments are the more heavily subsidized. They are also the fleet segments supporting the larger employment but with the smaller mean wages.

5.5 Summary of the Baltic Sea results

Landings Y	Effort E	Mortality F	Biomass SSB	Recruit. R	Sustain. F*	Survey LFI	Survey MMLw	Survey MTL	Landing MMLw	Landing MTL
↘	→	↘	⤴	→	😐	⤴	⤴	⤴	↘	↘

Figure 5.16. *Trends in the main indicators of the Ecosystem health in the Baltic Sea ecosystem*

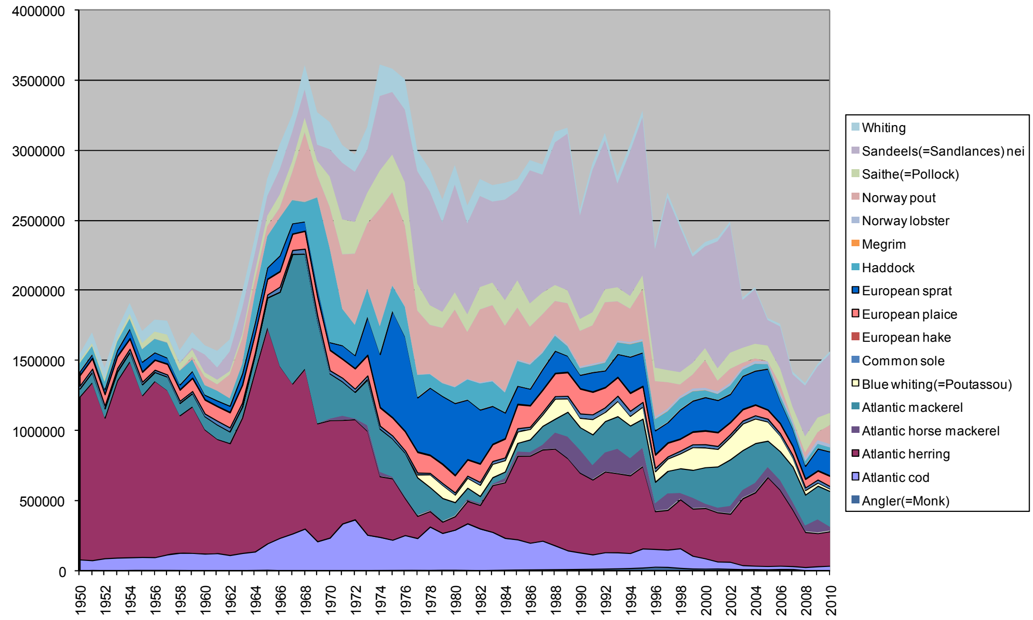
The Baltic Sea is an enclosed ecosystem where stocks are restricted to this area and fishing fleets are highly dependent of the ecosystem. Since 1970,the Baltic Sea state has been fluctuating, experiencing high exploitation rates and environmental changes. Cod and sprat are alternatively dominant in the landings and these two species are thus driving the responses of most indicators. At the end of the 80s, hydrological conditions in the Baltic Sea show a significant change of state which also coincides with important variations of both cod and sprat recruitments and stocks; from this period cod stock has been decreasing whereas sprat stock has been increasing, as shown by landings and ecosystem indicators. Fleets landing cod (demersal beam trawlers) and sprat (pelagic trawlers) have the biggest impact on the ecosystem in term of required primary production due to the high trophic level of cod and the large volume of sprat catches. Their impacts on the assessed stocks remain however moderate. With an ecosystem shifting from cod-dominant to sprat-dominant, the Baltic-dependent fishing fleets have to adapt by avoiding fishing heavily the main 6 species (12 stocks) that are enclosed in the Baltic Sea.

6 NORTH SEA

6.1 Trends in landings and fishing effort

6.1.1 Trends in landings

The North Sea supplies approximately 1.5 to 2 million tonnes of fish each year, for assessed and non-assessed species (Figure 6.1).



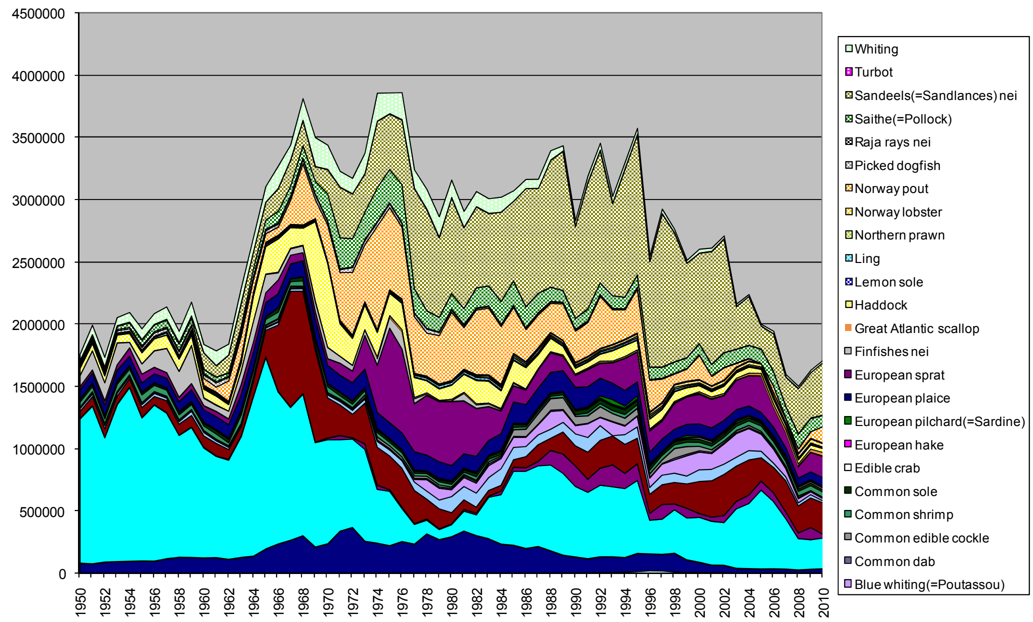


Figure 6.1. *North Sea landings 1950-2010 from ICES Statlant. Top: Assessed species; Bottom: all species also including non-assessed species)*

Demersal fisheries target roundfish species such as cod (*Gadus morhua*), haddock (*Melanogrammusaeglefinus*) and whiting (*Merlangiusmerlangus*) in addition to flatfish species such as plaice (*Pleuronectes platessa*), sole (*Solea solea*) and a fishery for saithe (*Pollachius virens*). Pelagic fisheries target herring (*Clupea harengus*) and mackerel (*Scomber scombrus*) and the industrial fisheries target sandeel (*Ammodytes spp*), Norway pout (*Trisopterus esmarkii*) and sprat (*Spratus sprattus*). There are also important crustacean fisheries for *nephrops* (*Nephrops norvegicus*), pink shrimp (*Pandalus borealis*), brown shrimp (*Crangon crangon*) and brown crab (*Cancer pagurus*).

Industrial and pelagic species combined have accounted for an increasing proportion of the landings, while landings of demersal stocks have declined in line with falling stock sizes and regulated reductions in total allowable catches (Figure 6.1top). Total landings for the assessed species peaked above 3.5 million tonnes in the late 1960's and mid 1970's and have remained higher than 3 million tonnes from 1966 to 1977. Since this period of time, despite increasing landing of some stocks like sandeels, the total catches exhibit a declining trend, with an accelerating decrease since the mid-1990s. Current reported landings stand at around 1.5 million tonnes. The landings of the assessed species in the North Sea accounts for the major part of the total landings including the non-assessed species (see also below).

Total catches of North Sea fish since the turn of the century provide the broader context for the decline seen since the mid-1990s (Figure 6.2). Some stocks, especially herring and secondarily cod, haddock and plaice, were already intensively fished in the late 19th century, providing at that time more than 1 million tonnes of landings per year. Landing of these species and the total landings as well, regularly increased (except during the two world wars) reaching more than 2 million tons in 1956. This changed dramatically in the 1960s. Herring accounted for a large majority of catch before 1960, but when this fishery collapsed a wider range of the ecosystem became exploited. Total landings increased until the mid-1970s, then they decreased significantly in the mid 1990's. It should be noticed that these statistics underestimate total removals because of the prevalence of discarding and also in some periods unreported landings.

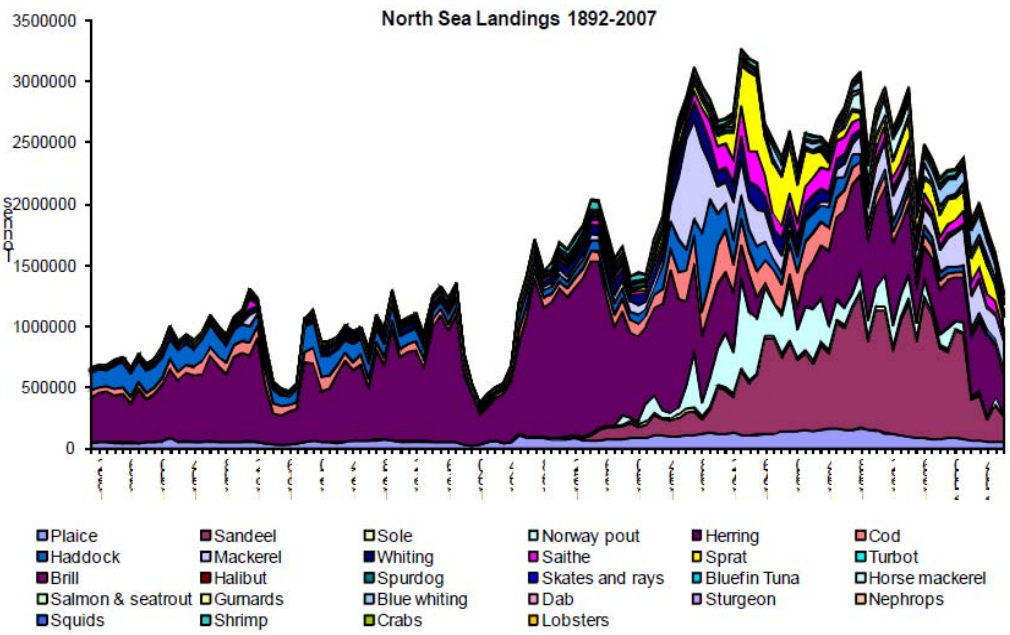


Figure 6.2. *North Sea landings 1892-2007 (Data compiled by Mackinson and Pinnegar, Cefas)*

6.1.2 Trends in the fishing effort

Trends in effort by country and main fishing fleet for the commercial fishery in the North Sea were obtained from the EU DCF Database used in the analyses published in STECF SGRST report 2011. The main fishing effort in the North Sea is conducted by UK, Netherlands and Denmark during the whole period 2002 to 2010 (Figure 6.3). Total fishing effort was highest in the start of the period with between 50 and 75 000 kWdays per year for each of the three major countries. For those countries there has been a significant and continuous reduction in effort until 2010 to a level around 20-35 000 kWdays per year per country. The decrease has been most pronounced for Denmark (DK around 20 000 kWdays), while Netherlands fishing effort remains around 30 000 kWdays, and UK above 35 000 kWdays. The effort for the other countries remained rather constant during the 2002 to 2010period at a significant lower level between 5-15 000 kWdays per year and per countries (Germany, Belgium, Sweden and France).

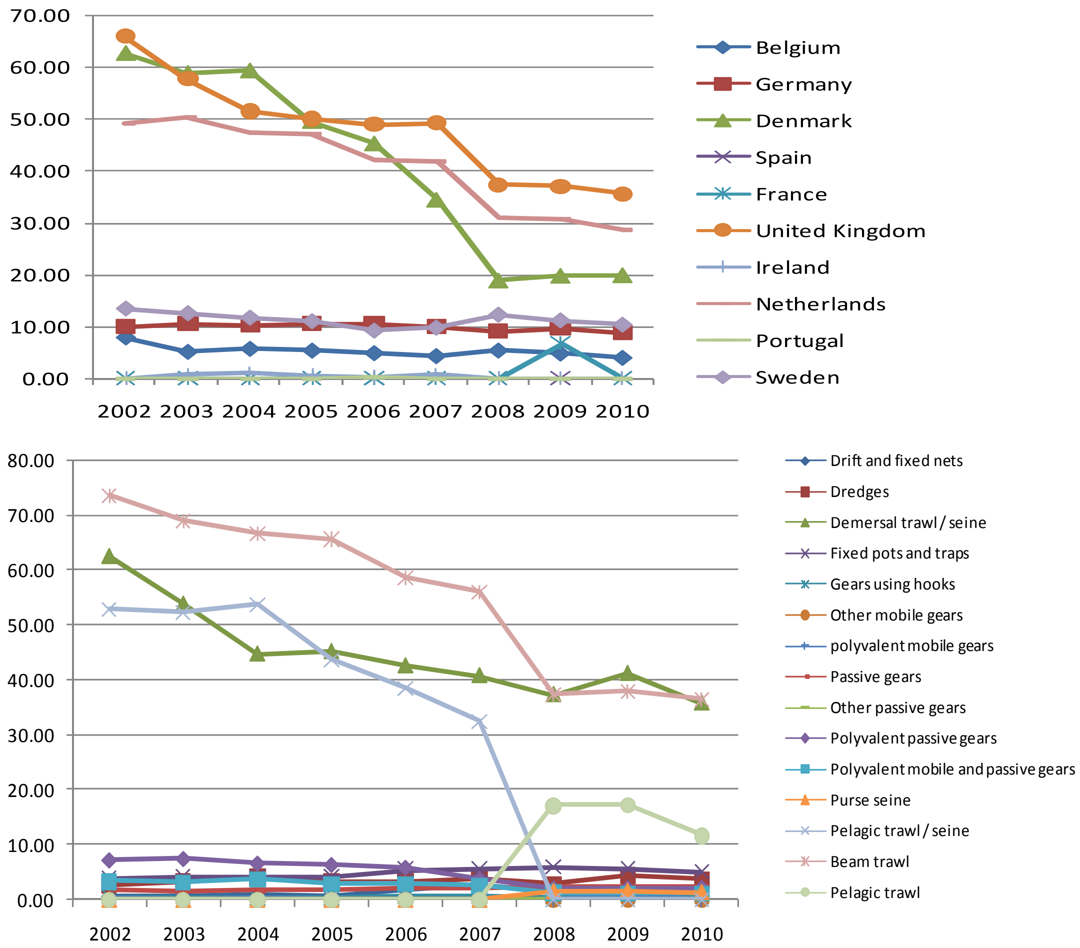


Figure 6.3 Trends in fishing effort in the North Sea ecosystem during the period 2002 to 2010 (in 1000 kWdays): Top - by country ; Bottom - by main fishing gear

Highest effort is associated with active (mobile) fishing gears for the period 2002 to 2010, with a significant decreasing tendency over the same period (Figure 6.3bottom). Effort with beam trawls has decreased from around 70-80 000 kWdays per year to below 40 000 kWdays, while effort of demersal trawl/seine has decreased from around 60 to 40 000 kWdays per year, and also the effort with pelagic trawls/seines has dropped from a level around 50 000 kWdays to 20 000 kWdays per year. Effort for the remaining gears including passive gears have been at a relatively lower level at less than 10 000 kWdays per gear per year, and has remained more constant during the whole period 2002 to 2010. It should be noted that some effort data are not reported for fleets targeting *Nephrops* and Shrimp since 2003 and Scottish Trawls since 2004.

6.2 Stocks synthesis

This section presents indicators on the fishable fraction of the North Sea, based on aggregation of the data available for all stocks assessed by ICES within this ecosystem.

6.2.1 Proportion of landings covered in the assessments and dependency of stocks of the ecosystem

Assessed stocks represent a level fluctuating around 45-65% of the total landings during the period 1964 to 1982 and a rather constant level around 90% during the period from 1983 to now (Figure 6.4). In 1982 the proportion of landings coming from assessed stocks increases from about 50% to 90% and has stayed constant on this level since then; this threshold is mainly due to the beginning of the assessment of sandeels, which represent around 30% of the total landings (cf. Figures 6.1). Sole in the eastern Channel, horse mackerel and Norway pout also started to be evaluated during this period. The slight decrease of the percentage of assessed species in the most recent years (2007 and onwards) is due to the stop of sprat evaluation. The importance of other non-assessed species that are seemingly abundant, but infrequently landed should, however, not be overlooked. Such species include gurnards, and small demersal fish such as weaver fish, bib, dragonets, solenettes, and others.

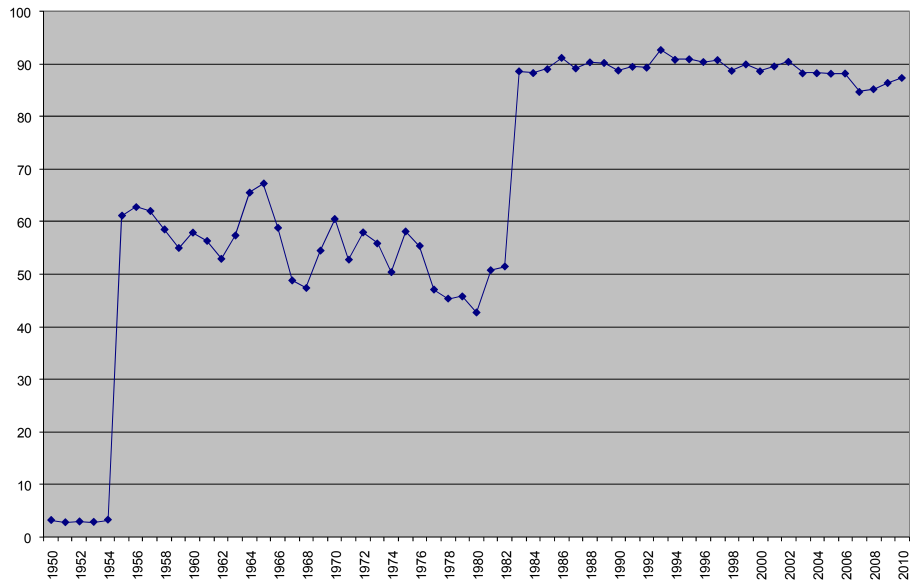


Figure 6.4 *Proportion of the total landings of assessed species over the total landings in the North Sea in percentage. For this figure sprat and blue whiting have been included.*

Stocks are well defined in the North Sea and their spatial distribution is often within the ecosystem boundaries. However, few stocks occur in several ecosystems either due to broad migrations or a poor definition of stocks boundaries for some species. It is particularly the case for the mackerel and blue whiting.Of the 35 stocks which are assessed 29 are uniquely linked to the North Sea, whereas 6 are also associated with other ecosystems to different degree (Figure 6.5). For instance, the saithe stock (Sai-3a46) is mostly associated with the North Sea and only a small fraction is located in the West Scotland/Ireland ecosystem region. On the opposite, the Eastern Channel sprat stock (spr-ech) has only a very small proportion occurring in the North Sea.

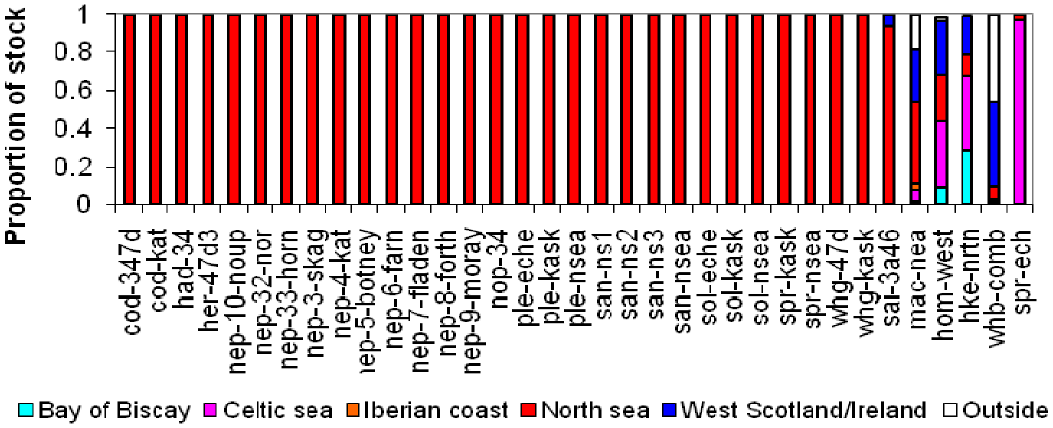


Figure 6.5*The dependencies to different ecosystems of the stocks caught in the North Sea ecosystem*

6.2.2 Trends in total landings, total spawning stock biomass, recruitment index and mean fishing mortality

Trends in total landings (Ytot), total spawning stock biomass (SSBtot), recruitment index (Rindex), and mean fishing mortality (Fmean) were computed for the four stocks assemblages for which sufficient stock data was available (Table 6.1). When considering the ecosystem after 1983, the set of the 15 stocks listed in Table 6.1 is considered as highly representative of the North Sea ecosystem (accounting for around 90% of total landings) and covers the stocks for which the North Sea ecosystem is most dependent on. Starting in 1990, the 20 stocks indicators represent the major part of the most important species in landings in the North Sea (the other species being sprat, blue whiting, blue mussel, common shrimp, common edible cockle, Norway lobster, edible crab and common dab. Among these species, some may be assessed locally but not by ICES).

Table 6.1 *List of stocks used for the computation of total SSB, total catches, mean F and recruitment index according to the period considered.*

Stock assemblage	**Period considered**	**Stocks included**
5-Stocks-Index	1970-2010	Cod in Sub-area IV Divison VIId & Division IIIa (Skagerrak), Haddock in Sub-area IV (North Sea) and Division IIIa, Herring in Sub-area IV, Divisions VIId & IIIa (autumn-spawn.), Plaice Sub-area IV (North Sea), Sole in Sub-area IV (North Sea)
10-Stocks-Index	1982-2010	**Idem +** Mackerel (N.Sea spawn.comp.), Plaice in Division VIId (Eastern Channel) Northern Hake, Saithe in Sub-area IV, Division IIIa (Skagerrak) & Sub-area VI43, Whiting Sub-area IV (North Sea) & Division VIId (E.Channel)
15-Stocks-Index	1983-2010	**Idem +** Western Horse mackerel, Sole in Division VIId (Eastern Channel) North Sea Sandeel area 1, North Sea Sandeel area 2, North Sea Sandeel area 3
20-Stocks-Index	1990-2010	**Idem +** Blue whiting, combined, Cod in Kattegat, Sole in Division IIIa Mackerel (combined Southern, Western & N.Sea spawn.comp.) Norway Pout in Fishing Area IV and IIIa

Total landings from the North Sea had historical high levels between 2.5 to 3.5 million tonnes per year in the late 1980s and decreased since that period to reach around 1.5 million tonnes in the most recent years(which is below the total landings before 1965 ofabout 2 million tonnes). During the 1990s the mean fishing mortality was very high (around 0.6 on average), while the total spawning stock biomass decreased displaying low levels in the 1970's and from 1993 to 2000 (Figure 6.5). Since 2010 themean fishing mortality has decreased by two-fold from about 0.6 to less than 0.3. Note that moreover the fishing mortality includes discard for several stocks in the North Sea for the more recent years. During the same period, the total biomass has increased and fluctuates at a level of about 5 million tonnes in the last years. Nevertheless although largely fluctuating, the overall recruitment shows a clear decreasing trend during the period from1985 to 2010to reach the recent low level of about 0.5.

In other words, the important decrease of the the mean fishing mortality over the last ten years could at least partially explain the decrease in the total landings and the recovery of the spawning biomass to higher levels. But for the moment no effect is observed on mean recruitments which remain at the lowest values over the whole period.

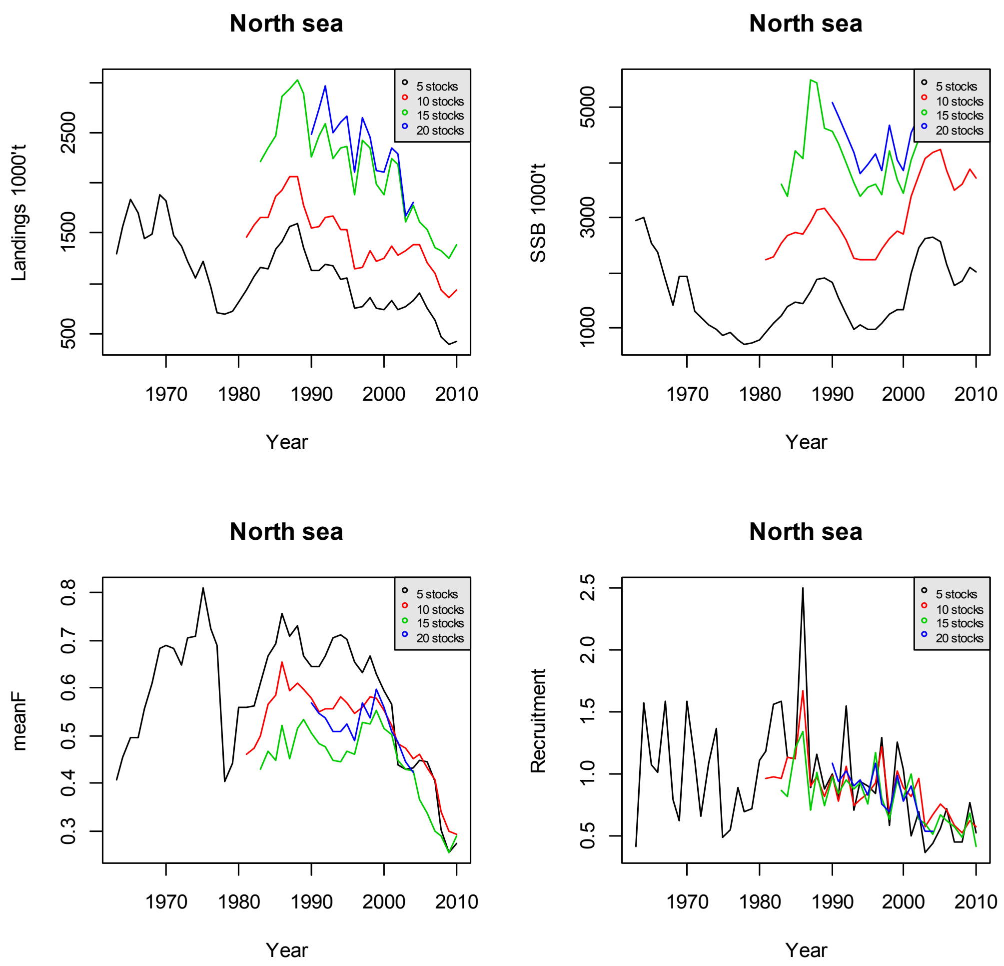


Figure 6.5 *Trends in total landings (Ytot), total spawning stock biomass (SSBtot), recruitment index (Rindex), mean fishing mortality (Fmean)*

6.2.3 Current status of stocks and mean trajectories

The data required to compare the current status of each stock (F*, B*) to the reference points (Fpa and Bpa, and Fmsy) were available for 9 stocks in the North Sea ecosystem (Figure 6.6). Among these stocks, cod (Cod-347d) is currently in an unsustainable position with F and B beyond the precautionary levels. The Fs value for the North Sea mackerel and sole in Division VIId (Eastern Channel) is beyond Fpa, while the sole biomass in Div. IIIa is just below Bpa. The North Sea sole and the saithe are in an intermediate situation with mortalities between Fpa and Fmsy and biomasses above Bpa. The North Sea haddock,plaice and the blue whiting combined are currently in a favourable situation with biomasses above Bpa and Fs around Fmsy. Note however that only a very small fraction of the blue whiting stock is present in the North Sea. According to the MSY approach (i.e. in the green area on the figure), over the 9 assessed stocks only 3 stocks are in the sustainable zoneswhile 4 stocks are considered outside the safe limits of the precautionary approach.

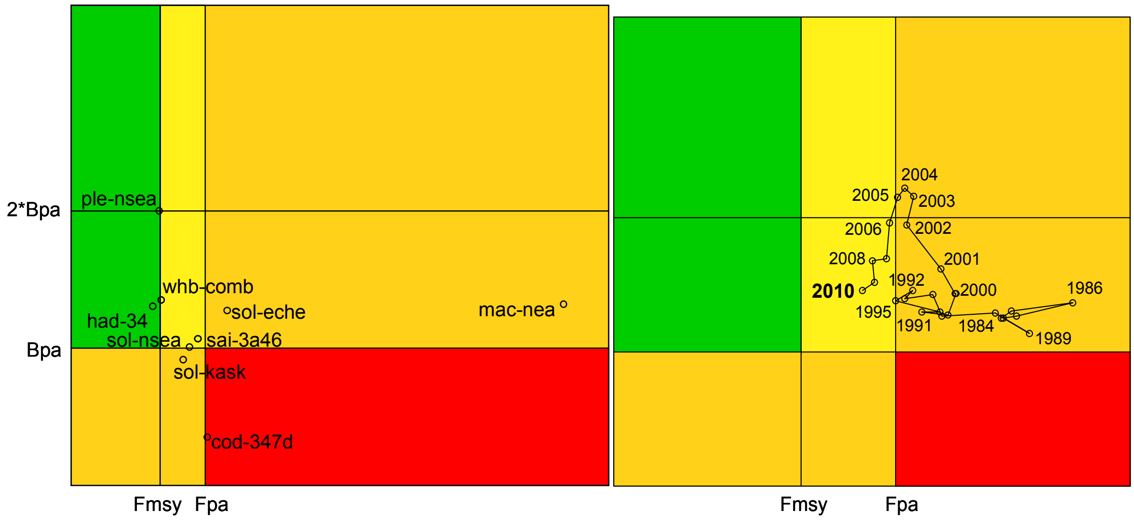


Figure 6.6 *Status of stocks assessed in the North Sea compared to the precautionary approach (pa) and MSY reference points. Left: current state (last assessment for 9 stocks) – Right: mean trajectory from 1983 to 2010 (mackerel excluded, cf. § 4.3)*

The mean trajectory of the average state of the assessed stocks was estimated from 1983 to 2010 (Figure 6.6right). Until 2005 the stocks were on average in the overfished zone with F higher than the precautionary Fpa level and especially in the late 1980s. A clear decrease in the mean F is observed in the 2000-2010 period with current F value between Fmsy and Fpa. The stocks' SSB was on average above Bpa over the whole period (1983-2010).It increased in the period 2000-2004 but came back in 2010 to the 2000's level despite the reduction of fishing pressure.

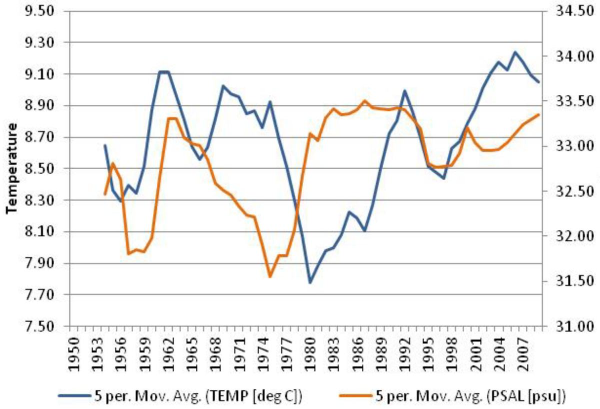
6.2.4 Conclusion of the stock synthesis

The indicators on stock synthesis show a fluctuating state of the North Sea ecosystem from 1965 to 1995 when the ecosystem was experiencing very high exploitation rates (highest landings since 1950). Total landings from the North Sea had historical high levels between 2.5 to 3.5 million tonnes per year from 1965 to 1995. From 1995 to 2010 landings decreased significantly to a level of about 1.5 million tonnes while mean fishing mortality has decreased by two-foldfrom about 0.6 to less than 0.3.The total spawning stock biomass displayed decadal oscillations since 1967 with low levels in the 1970's and 1990's. Since 2000 the total biomass isof about 4 to 5 million tonnes with an increasing trend in the most recent years. Despite the decrease of landings and fishing mortality in the last recent decade, the overall recruitment has shown a clear decreasing trend (although fluctuating)from 1985 to 2010 to reach a recent low index value at about 0.5. The increase in the spawning stock biomass during the last decade, which is likely due to lower landings and fishing mortality levels in the last 15 years, indicate inclinations of the North Sea ecosystem to recover. However, this was not converted in higher recruitment levels in the most recent years. Note that recruitment might also be influenced by trends in temperature (see under environmental indicators below). Although the average fishing mortality was significantly reduced, it just reached levels between Fmsy and Fpa in the most recent yearsand is still higher than the Fmsy target.

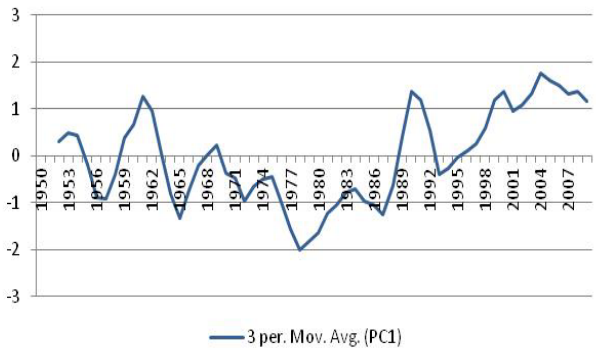
6.3 Environment and Ecosystem Indicators

6.3.1 Environmental indicators

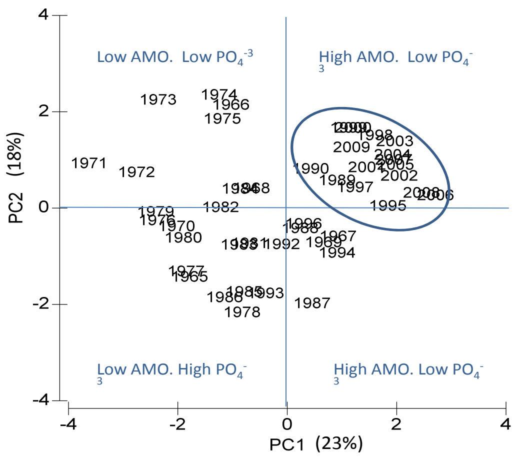
A description of the trends in the environmental conditions of the North Sea (Figures 6.7) was taken from results presented in Annex 17.4 (Kenny, 2012) and is in general agreement with the trends described for the North Sea by Dulvy *et al* (2008) and McQuatters-Gollop *et al* (2007).



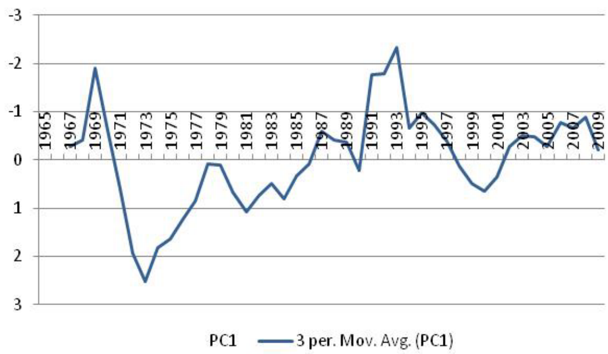
*- **a** - Trends in salinity and temperature in the North Sea using a 5-year moving average fitted to the raw annual averages.*



*- **b** - Hydrological condition: plot of a 3-year moving average of PC1 scores, from PCA of the standardised hydrological factors.*



*- **c** - Plot of PC1 scores as a 3-year moving average derived from a PCA of determinant characteristic of hydrological condition in the Baltic Sea.*



*- **d** - Chemical condition: plot of a 3-year moving average of PC1 scores derived from a PCA of determinant characteristic of chemical condition.*

***Figure 6.7**. Environmental indicators in the North Sea from 1965 to 2009 (see details in Annex 17.4)*

The combined hydrological conditions in the North Sea show a similar pattern to those observed in the Baltic Sea, especially between 1981 and 1990. During this period there is a shift from a ‘negative’ to ‘positive’ hydrological condition mainly driven by a increase trend in temperature and the AMO index. During the last ten years, the North Sea seems to be characterised by particularly high levels of the hydrology index. Both nitrite and nitrate concentrations dominate the trend in chemical conditions with increasing concentrations from the early 1970’s to the early 1990’s emphasizing a significant change of state during that period with a potentially increasing eutrophication. Since 1993 a partial decline of these concentrations is observed.

In the late 1980s a peak of the combined stock biomass is observed in the North Sea which was preceded by a peak in recruitment in 1985-86 (see §6.2.2). At the same time, the hydrological condition index exhibited relatively low values mainly driven by comparatively low temperatures. More precisely, the temperature starts of low in 1983 and has been steadily increasing up to 2005/06 as part of the AMO, so the period of good recruitment was during a relatively cold period. In contrast, during the last decade the hydrological index tends to increase while the recruitment decreases, suggesting that low recruitment observed during the last years, in spite of high SSB, could be linked to unfavourable hydrological conditions

6.3.2 Ecosystem indicators

The ecosystem indicators based on surveys' data are covering the period from 1985 to 2011 (Figure 6.8).The large fish indicator (LFI) and the mean maximum length (MMLw) decreased between 1985 and 1992 while the total SSB increased (for all stocks) between 1982 and 1987 (see stock synthesis section). This observation isin agreement with results presented by Greenstreet *et al* (2012) for the North Sea in which he describes the LFI as being negatively correlated to positive trends in total demersal stock biomass, abundance and production. LFI and MML remained at low level over the last twenty years suggesting the ecosystem is dominated by small species during this period. The mean trophic level decreased in parallel but with a large year-to-year variability, which makes unclear the trend over the last 10 years.

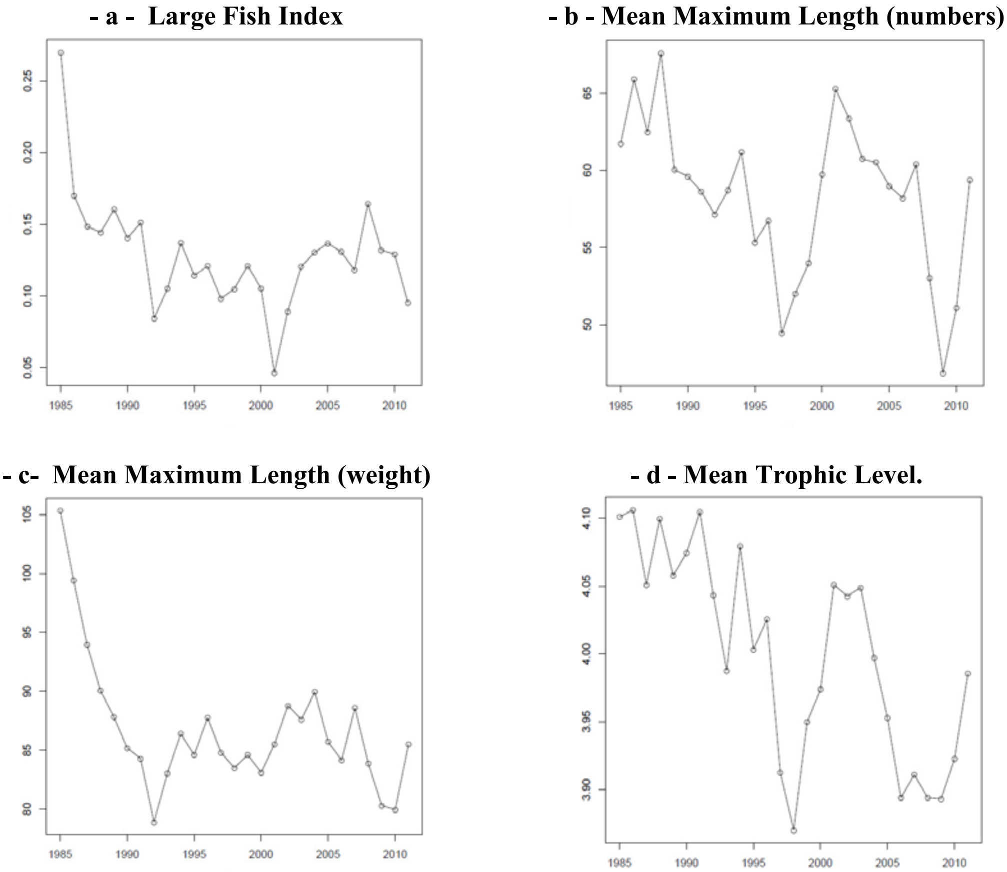


Figure 6.8 *Trends in the ecosystem indicators estimated in the North sea fover the 1985-2011 period from surveys (North Sea Q1 surveys)*

Regarding the ecosystem indicators based on landings (Figure 6.9), the mean trophic level and the mean maximum length slightly decreased during the 1970s and 1980s (from 3.4 to 3.3 and from 50 to 40 cm respectively) at a time where a larger part on the ecosystem started to be exploited (with for instance an increasing catch of sandeel, mackerel and sprat). The marine trophic index (mean TL of the higher part of the food web) fluctuates at about 3.9 from 1950 to the mid-1980swith however lower values at ca. 3.8 for the last twenty years. Such a change can be explained by the decreasing landings of cod, but also of high trophic level species such as whiting and monkfish.

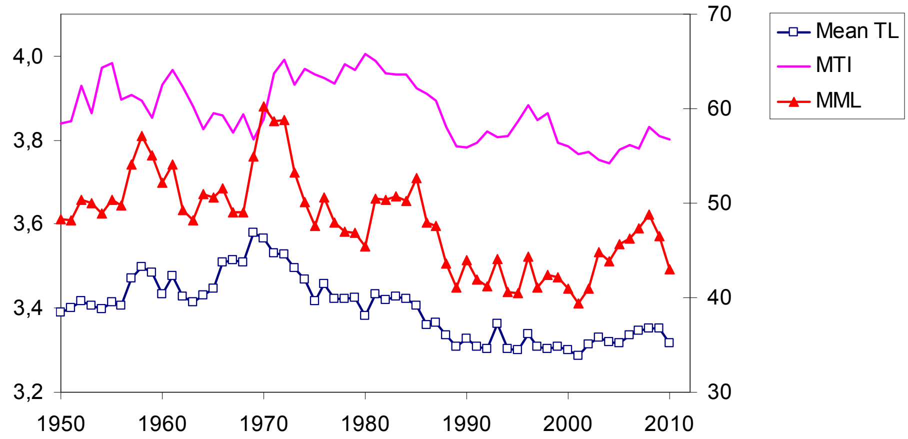


Figure 6.9 *Trends in the North Sea ecosystem indicators based on landings over the 1950 to 2010 period: mean trophic level, marine trophic index and mean maximum length*

6.4 Fleet-based synthesis

6.4.1 General results on fleets operating in the North Sea – Selection of the major fleet segments

The UK fleet represents the most important EU fleet in terms of percentage of total landings value, followed by The Netherland, Denmark and France (Figure 6.10). Note that landings by Norway are not available at DCF level and therefore are not included in the analysis.

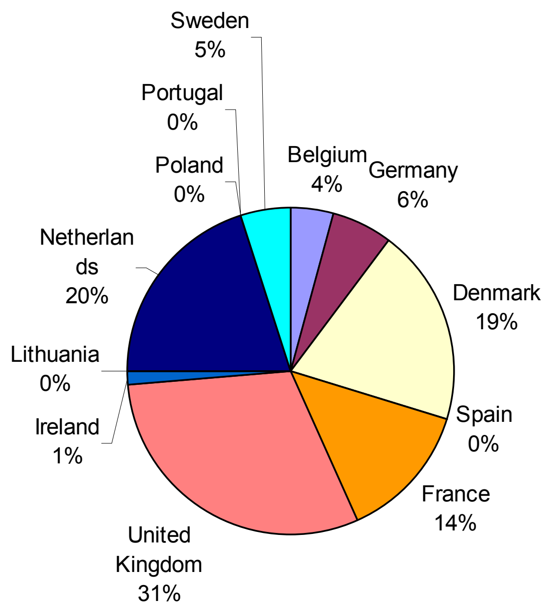


Figure 6.10 *Percentage of total landings value by country in the North Sea (from DCF 2009 values)*

Demersal and beam trawls are the most important gear categories in the North Sea (Table 6.2). They represent together more than 50% of the total landings value. Pelagic trawls are less important in term of value of landings than for demersal and beam trawls but the volume of landings is higher with an excess of 586.000 t.

Table 6.2 Landings volume and value per gear type in the North Sea

Gear type	2006		2007		2008		2009		2010	
	Volume (tons)	Value (€ 1000)	Volume (tons)	Value (€ 1000)	Volume (tons)	Value (€ 1000)	Volume (tons)	Value (€ 1000)	Volume (tons)	Value (€ 1000)
Drift and fixed nets	3,2	17,5	3,5	18,5	4,2	12,8	11,3	48,5	4,6	16,4
Dredges	62,6	27,6	66,1	33,7	49,2	34,7	61,6	72,0	41,3	42,7
Demersal trawl / seine	234,3	397,3	205,6	421,8	200,7	354,8	272,5	373,3	221,8	355,6
Fixed pots and traps	12,4	33,6	13,0	39,9	18,3	48,6	19,5	42,7	17,8	41,1
Gears using hooks	1,4	2,6	1,4	3,5	1,8	4,7	4,3	11,0	2,1	5,9
Other mobile gears	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Polyvalent mobile gears	0,5	1,3	0,5	1,4	0,3	0,7	8,0	18,3	0,8	1,8
Passive gears	1,6	7,5	1,5	8,9	3,1	14,5	2,8	12,0	3,7	16,1
Other passive gears	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Polyvalent passive gears	20,8	58,2	45,0	63,8	13,2	28,2	10,3	25,3	12,9	28,6
Polyvalent mobile & passive gears	18,2	26,4	14,2	27,0	7,9	16,6	8,2	15,0	8,2	15,5
Purse seine	0,0	0,0	0,0	0,0	79,1	67,1	89,2	70,6	86,0	70,5
Pelagic trawl / seine	994,0	355,9	763,1	309,1	0,0	0,0	0,0	0,0	0,0	0,0
Beam trawl	120,2	352,4	121,4	383,3	101,5	345,7	107,1	296,8	116,0	324,9
Pelagic trawl	0,0	0,0	0,0	0,0	575,0	211,6	643,7	199,8	586,6	212,5
Clustered gears	0,5	3,3	0,5	2,7	6,4	25,2	2,6	13,6	35,5	32,8
All gear types	**1469,5**	**1283,7**	**1235,8**	**1313,5**	**1060,8**	**1165,2**	**1241,2**	**1198,9**	**1137,3**	**1164,4**

The Danish segment of large pelagic trawlers is the most important fleet segment with 12% of the total landings' value. The ten most important segments (Table 6.3, mostly mobile but with one passive gear segment - GBR FPO VL 0010) represent more than 50% of the total landings value in the North Sea.

***Table 6.3**The 10 most important fleet segments in the North Sea (based on 2009 landings in value)*

Country	Gear	Vessel length	Total Landings value (1000 €)	%
DNK	TM	VL 40XX	139521	12,0%
NLD	TBB	VL 40XX	121385	10,4%
GBR	DTS	VL 1824	81875	7,0%
GBR	PS	VL 40XX	69627	6,0%
DNK	TM	VL 2440	51826	4,5%
NLD	TBB	VL 1824	46327	4,0%
DNK	DTS	VL 1824	39539	3,4%
DNK	DTS	VL 1218	31294	2,7%
BEL	TBB	VL 2440	28287	2,4%
GBR	FPO	VL 0010	24415	2,1%
Others	segments		530283	45,5%
Total			1164379	100,0%

6.4.2 Economic performance of the selected fleet segments - Dependency to the North Sea

Economic indicators reported in the AER 2011 for the main EU fleet segments operating in the North Sea allow for a comparison among the selected fleet segments (Table 6.4). Among the 10 selected fleet segments, 8 are highly dependent on the North Sea with more than 64% of their landings in value caught in this ecosystem. This is especially the case of the Dutch beam trawlers (NLD TBB) whose landings come exclusively from the North Sea. In contrast, the UK large purse seiners (GBR PS VL40XX) are less dependent on the North Sea (ca. one third of landings) as well as the UK very small vessels using pots and traps (GBR FPO VL0010, ca. half of landings). The former are fishing seasonally in the North Sea while the latter are distributed around the UK coast. In this latter case, related to vessels smaller than 10 m, the fleet segment considered as a whole is not dependent from the North Sea. But among the fleet segments, vessels fishing in the North Sea are mostly located on the East coast of UK and are highly dependent from this ecosystem.

Table 6.4 *Economic indicators of the 10 selected fleet segments with the highest landings value in the North Sea (from the 2011 Annual Economic Report, AER 2011)*

FLEET SEGMENT	Number of vessels	FTEs	Energy consump-tion	North Sea days at sea	North Sea days at Sea as % of total	North Sea volume landed (Tons)	% of total volume landed	North Sea Value landed (€ 1000)	% of total value landed
BEL TBB VL2440	40	210	40 912	5 577	60%	8 849	70%	29 491	64%
DNK DTS VL1218	177	269	10 965	15 467	70%	32 436	61%	25 457	72%
DNK DTS VL1824	77	226	12 588	11 022	89%	48 104	89%	32 240	89%
DNK TM VL2440	46	260	24 469	9 657	91%	117 367	86%	46 354	90%
DNK TM VL40XX	32	209	30 794	4 198	74%	373 731	84%	77 321	81%
GBR DTS VL1824	221	1 143	50 671	26 097	66%	42 468	79%	75 009	78%
GBR FPO VL0010		1 013	16 908	71 482	51%	9 079	48%	23 319	46%
GBR PS VL40XX	31	231	50 100	648	32%	88 398	33%	69 192	34%
NLD TBB VL1824	173	453	23 213	19 360	100%	18 931	100%	43 982	100%
NLD TBB VL40XX	64	392	86 809	12 434	100%	32 378	100%	109 650	100%

FLEET SEGMENT	Direct subsidies (€1000)	Total income (€1000)	Crew wages (€1000)	Gross value added (GVA) (€1000)	Operating cash flow (OCF) (€1000)	Profit / Loss (€1000)	Average wage per FTE
BEL TBB VL2440	728	48 630	14 813	18 509	4 423	-4 296	70 538
DNK DTS VL1218	15	37 663	8 362	19 487	11 141	-7 559	31 081
DNK DTS VL1824	5	38 613	10 573	20 790	10 222	-3 837	46 714
DNK TM VL2440	0	52 628	13 768	27 953	14 185	-2 186	52 874
DNK TM VL40XX	0	98 730	20 863	64 729	43 865	277	99 834
GBR DTS VL1824	6 142	108 373	23 880	38 912	21 174	7 551	20 888
GBR FPO VL0010	2 050	58 294	13 596	36 358	24 811	9 454	13 415
GBR PS VL40XX	5 567	159 268	34 200	92 020	63 387	7 833	148 052
NLD TBB VL1824	0	47 930	12 453	21 668	9 215	-791	27 477
NLD TBB VL40XX	0	112 742	23 459	55 984	32 524	19 977	59 797

If the highest volume of landings inthe North Sea is obtained by large Danish pelagic trawlers (DNK TM VL40XX), other segments can show a higher income such as the large UK purse seiners (UK PS VL40XX), the Dutch beam trawlers over 40 m (NLD TBB VL40XX) and the UK demersal trawlers (GBR DTS VL1824). Five of the ten most important segments reported losses in 2009. The highest profits were obtained by the Dutch beam trawlers above 40 m with nearly 20 Million €.

There are 25 fleet segments with more than 60% of their volume of landings which are from the North Sea. Eight of the ten segments with the highest landings ‘value are also part of this group (Table 6.5).

Table 6.5. *Economic indicators of the fleet segments with more the 60% volume of landings from the North Sea following the 2011 Annual Economic Report (AER 2011)*

FLEET SEGMENT	No. of vessels	FTEs	Volume landed (Tons)	Volume landed as % of total	Value landed (€ 1000)	Value as % of total value	Direct subsidies (€1000)	Total income (€1000)	Crew wages (€1000)	Gross value added (GVA) (€1000)	Operating cash flow (OCF) (€1000)	Profit / Loss (€1000)	Average wage per FTE (€)
DEU TBB VL24XX		34	2138,4	100%	6519,4	100%	20,6	6648,0	1280,3	3927,1	2667,3	1681,9	37657
DNK TBB VL1824	13	48	2389,6	100%	3480,9	100%	25,0	5576,6	2001,3	3140,2	1163,9	-1606,5	42044
NLD DTS VL1824	15	34	2006,2	100%	4677,1	100%	0,0	4898,8	993,4	2764,1	1770,7	1033,4	29175
NLD PG VL0010		110	1061,1	100%	4469,6	100%	0,0	4515,7	801,1	1147,7	346,6	-1441,5	7283
NLD TBB VL1218	10	34	1121,4	100%	2498,5	100%	0,0	2603,2	869,6	578,2	-291,4	-1081,9	25577
NLD TBB VL1824	173	453	18930,8	100%	43982,4	100%	0,0	47930,2	12453,5	21668,3	9214,8	-790,6	27477
NLD TBB VL2440	31	177	8402,7	100%	25880,2	100%	0,0	27231,7	7275,3	7915,0	639,7	-3809,3	41043
NLD TBB VL40XX	64	392	32377,5	100%	109649,9	100%	0,0	112741,6	23459,5	55983,5	32524,0	19976,9	59797
DEU TBB VL1218	140	158	10583,3	100%	21256,2	100%	224,0	21573,7	4660,6	12496,7	8060,2	2382,6	29497
DNK TBB VL1218	14	20	1483,4	100%	3303,8	100%	0,0	1848,5	677,8	910,5	232,7	-825,0	34635
DEU TBB VL1824	63	101	6024,8	99%	13293,2	99%	193,7	13761,7	2909,9	6797,1	4080,9	344,8	28811
BEL TBB VL1824	34	72	3883,1	98%	13678,2	98%	52,9	12638,9	4749,5	4419,5	-277,1	-2828,6	65966
DEU TBB VL0012	20	12	159,2	97%	372,6	97%	0,0	381,0	0,2	283,8	283,6	173,4	17
DNK PMP VL1824	15	54	2547,1	94%	5739,7	97%	0,0	8499,2	2758,9	4249,8	1490,9	-1776,3	51101
NLD DTS VL2440	24	99	5340,4	94%	15496,6	92%	0,0	17933,8	4046,9	8279,0	4232,1	1755,0	40721
GBR TBB VL1218	30	71	1204,0	91%	2669,2	89%	394,6	5532,0	791,3	-3057,9	-3454,6	-4372,2	11071
DNK PGP VL1218		84	4139,2	91%	10398,9	92%	0,0	11103,0	2768,5	6169,7	3401,2	-2377,9	33056
DNK DTS VL1824	77	226	48104,2	89%	32240,4	89%	4,9	38612,8	10573,1	20790,2	10222,0	-3837,1	46714
DNK TM VL2440	46	260	117367,3	86%	46353,9	90%	0,0	52627,7	13767,8	27952,9	14185,1	-2185,7	52874
DNK TM VL40XX	32	209	373730,9	84%	77321,1	81%	0,0	98729,8	20863,4	64728,7	43865,3	276,9	99834
GBR DTS VL1824	221	1143	42468,1	79%	75008,6	78%	6142,4	108372,5	23880,2	38912,3	21174,5	7551,3	20888
GBR DTS VL2440	106	765	45795,8	72%	71765,3	68%	7095,6	116513,6	25688,6	34823,8	16230,8	526,7	33593
BEL TBB VL2440	40	210	8848,6	70%	29491,4	64%	727,5	48630,1	14813,0	18508,8	4423,3	-4295,9	70538
DNK DRB VL1218	34	15	14461,5	67%	2798,6	76%	0,0	2917,2	450,8	1482,2	1031,4	-1103,6	29503
DNK DTS VL1218	177	269	32436,0	61%	25457,2	72%	15,2	37663,4	8362,1	19487,4	11140,5	-7558,8	31081

For a deeper analysis of trends we choose three representative segments with data from 2002 to 2009 in the North Sea. The first segment is the Belgian Beam trawlers VL 2440which shows profits from 2002 to 2004 and in 2007. In all other years losses were reported. The total income and GVA trends are negative over the whole period |(Figure 6.11 top).

The Dutch beam trawlers segment (TBB VL 2440) shows similar trends for the income and GVA with more years with losses. The improvement in 2009 is likely due to the adjustment of fishermen to the fuel crisis, as some changed fishing gear from beam to otter trawls (or even bottom gill nets) or moved to other fisheries (like shrimp fishing) to save fuel.

The British demersal trawlers segment (GBR DTS VL 2440) shows different trends. The income drastically decreased in 2003 but then increased until 2006-2007 and then slightly decreased again until 2009. Only in 2004 the segment reported losses but in 2002, 2005 and 2009 the profit was null.

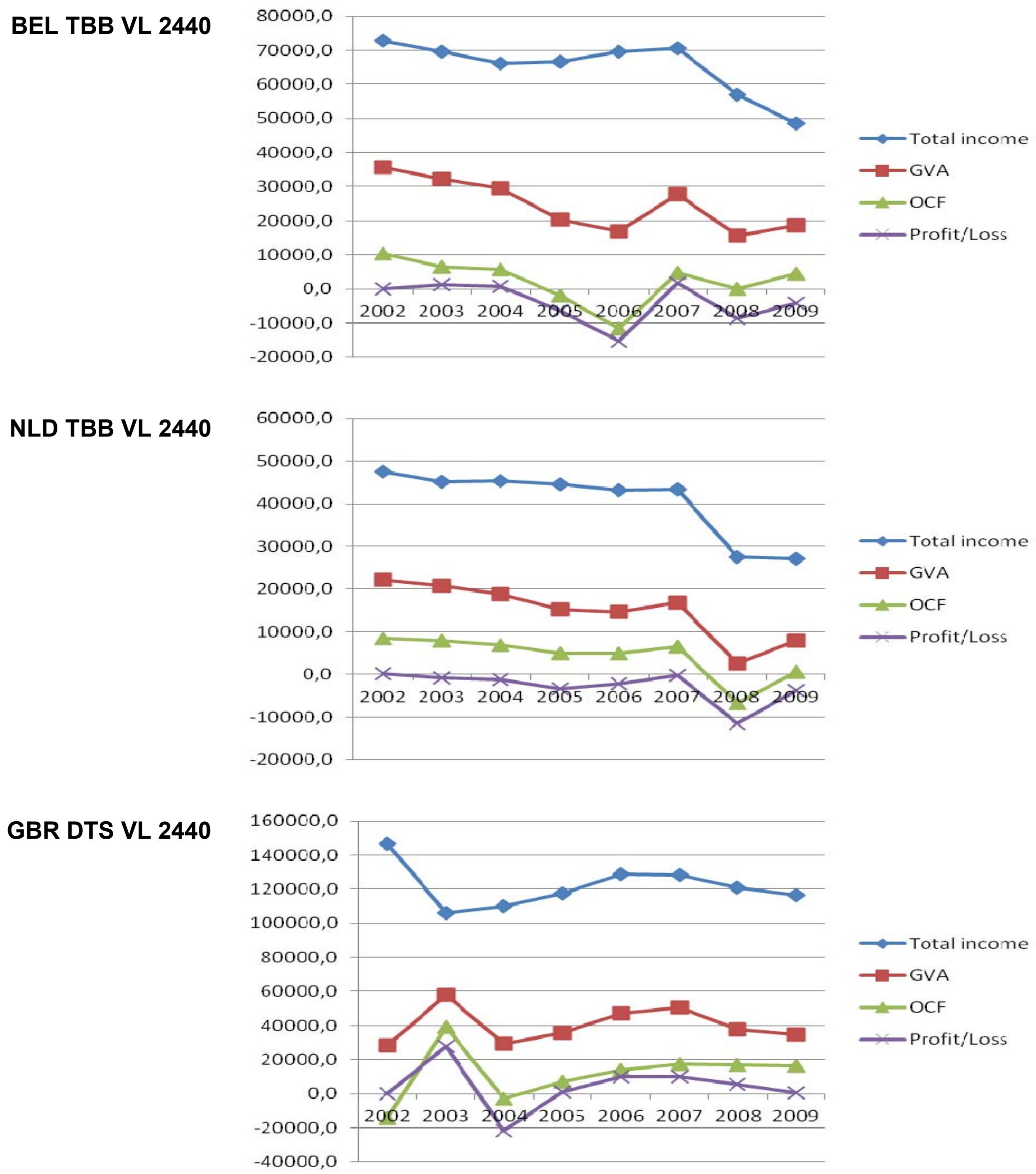


Figure 6.11 *Trends in the main economic indicators for three fleet segments of the North Sea (from AER 2011)*

6.4.3 Ecological indicators of fleet segments

- Partial F: contribution to the fishing mortality of assessed stocks

The partial fishing mortality by fleet segment was estimated for each of the assessed stocks on the basis of the segment landings on the total landings of that stock in the area(Figure 6.12).

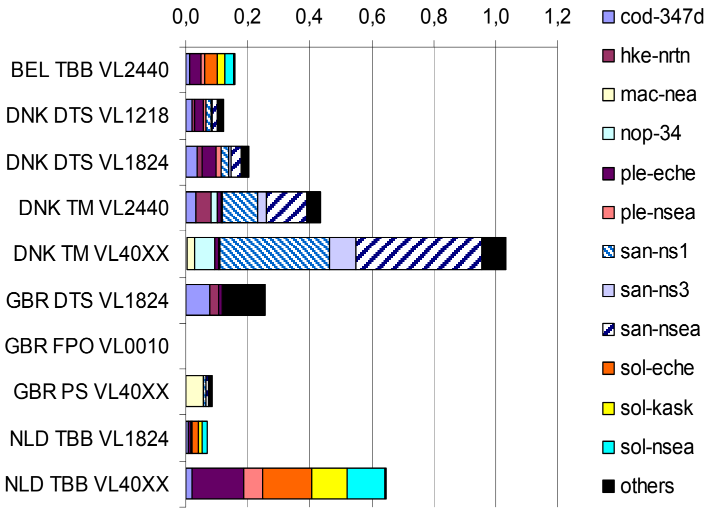


Figure 6.12 *Partial F applied by the selected fleet segments to the stocks assessed by ICES*

The sum of partial F by fleet is a measure of its impact on the assessed stocks. It can be considered as an indicator of the global impact of the fleet on the fishable part of the North Sea ecosystem. From this point of view, two fleet segments have a large impact (F>0.6): the large Danish beam trawlers (DNK TBB VL40XX) due to impact on sole and plaice and the large Danish pelagic trawlers (DNK TM VL40XX)due to their impact on sandeel. The global impact due to the other selected EU fleets remains moderate with total values of induced fishing mortality lower than 0.3.

The analysis also highlighted the fleet segments which mostly affect each stock. In particular, 35% of total F on sole and 25% of total F on plaice are due to the Dutch beam trawlers over 40 m. Regarding sandeel, more than half of total F is due to the Danish pelagic trawlers over 40 m.

- Sustainability index of the selected fleet segments

The sustainability index of fleet segments operating in the North Sea are based on the nine stock assessments for which F and B limits are known and only the eight most highly dependent fleet segments on the North Sea are represented (Figure 6.13). Only the large Danish pelagic trawlers (DNK TM VL40XX) is characterised by both unsustainable index F* and B*. A large part of the landings of this fleet comes from the mackerel for which standardized F* is currently very high (see discussion in §4.3). All other fleet segments are exploiting stocks which status is are on average intermediate with fishing pressures lower than Fpa but higher than Fmsy. The fleet segments exploiting cod (UK and Danish demersal trawlers) are characterized by poor sustainability index in term of B*.

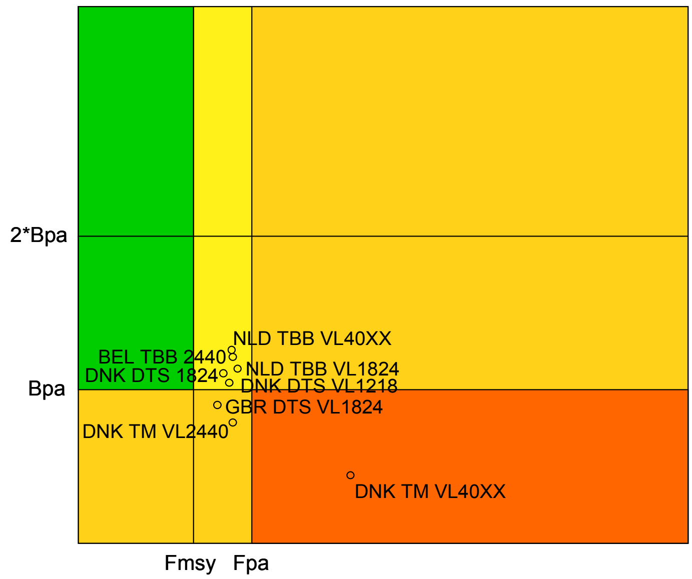


Figure 6.13.*Sustainability index of the selected fleets operating in the North Sea: standardized fishing mortalities F* and biomass B* for the assessed stocks (referred in figure 6.6)*

- Index of the fleet segments impact on the food web and habitat

Among the selected fleet segments, the highest impact on the food web (based on the required primary production) is from the Danish pelagic trawlers because of their very high catches of sandeel (Figure 6.14 left). The UK demersal trawlers also have a large impact on the food web due to the landings of high trophic levels such as cod or whiting.Only bottom trawlers have, as expected, a significant impact on the sea floor (since based on the habitat impact index). The highest impact index on seabed habitat is observed for the Danish beam trawlers and the UK demersal trawlers due to high fishing efforts (in kW.day fishing in the North Sea).

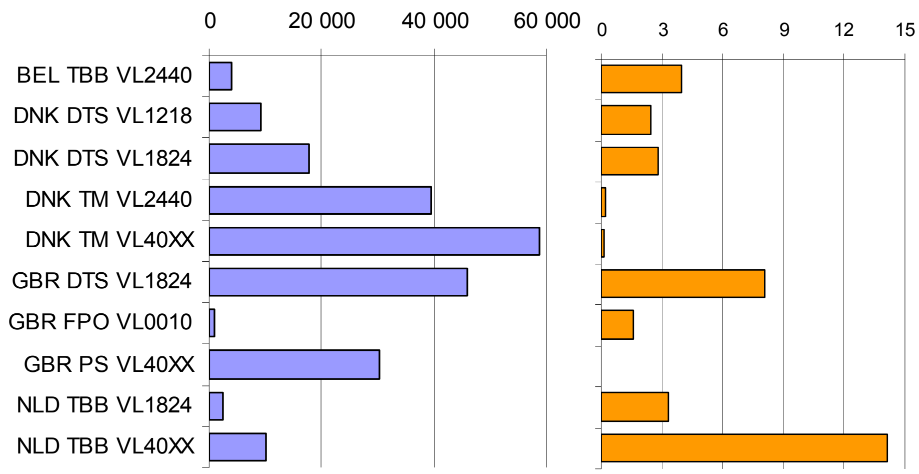


Figure 6.14. *Ecological index for the main fleet segments operating in the North Sea. Left: food web impact index (Primary Production required, 10^6wet tons/year); Right, habitat impact index*

6.4.4 *Synthesis and conclusion of the fleet synthesis*

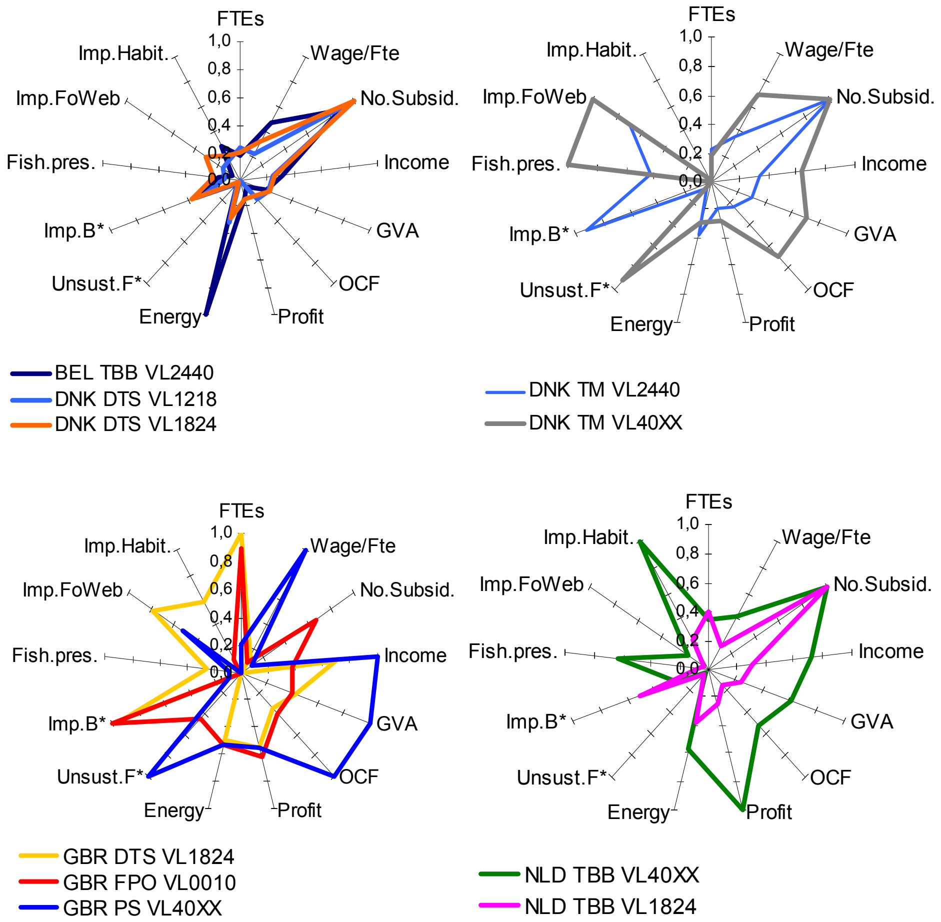


Figure 6.15 *Ecological impact index, and socio-economic performances (from AER 2011) of the main fleet segments operating in the North Sea*

Many fleet segments fishing in the North Sea are depending on the fish stocks of this ecosystem but the catch composition between segments is often highly diverse. Indeed pelagic trawlers are often very specialized on a few species in an ecosystem like the Danish pelagic fleet fishing for sandeel. If the beam trawl fleet segments are totally depending on landings from the North Sea, many of the pelagic and demersal trawl segments have also a significant dependency on other areas (see Baltic Sea fleet synthesis).

Many fleet segments reported losses in 2009 and also in the years before. The three selected fleet segments for the period from 2002 to 2009 (see Fig. 6.11) show a relatively but slightly deteriorating situation over the last years.

6.5 Summary of the North Sea results

The North Sea is an ecosystem which has a long history of exploitation. Some stocks, especially herring and secondarily cod, haddock and plaice, were already intensively fished in the late 19th century. In 1960, the herring fishery collapsed and a wider range of the ecosystem became exploited until the mid-1990s where landings started to decrease significantly. Following this heavy exploitation, fishing effort has been reduced for stock recovery. During the last 10-year period, both fishing mortality levels and landings were lower, probably leading to the increase of the spawning stock biomass and providing recovery signs of the North Sea ecosystem. However, the SSB increasehas not resulted in higher recruitment levels in the most recent period, which can be put in parallel ofhigh levels in the hydrological condition index over the last 10 years.

Landings Y	Effort E	Mortality F	Biomass SSB	Recruit. R	Sustain. F*	Survey LFI	Survey MMLw	Survey MTL	Landing MMLw	Landing MTL
↘	↘	↘	↗	↘	😐	↘	↘	?	low	low

Figure 6.16. *Trends in the main indicators of the Ecosystem health in the North Sea ecosystem*

Both stocks and fleets are highly dependent on the North Sea ecosystem: the 35 assessed stocks (representing 90% of the landings) are well defined and their spatial distribution is often within the ecosystem boundaries (only 6 of them are also associated with other ecosystems). The main fishing effort in the North Sea is conducted by UK, The Netherlands and Denmark with demersal and beam trawls being the most important gear categories in landings value (pelagic trawl for the landings' volume). Even if the average fishing mortality was significantly reduced, it has just reached levels between Fmsy and Fpa in the most recent years and is still higher than the Fmsy target.

7 West Scotland/Ireland

7.1 Long term trends in landings and fishing effort

7.1.1 Trends in landings

The yield by species off the West Coast of Scotland and Ireland was obtained from the Statlant database and shows that the total yield increased substantially since the early 1970s, a trend which continued until 2008 (Figure 7.1). The bulk of this increase was due to blue whiting catches but substantial declines occurred in 2009 and 2010.

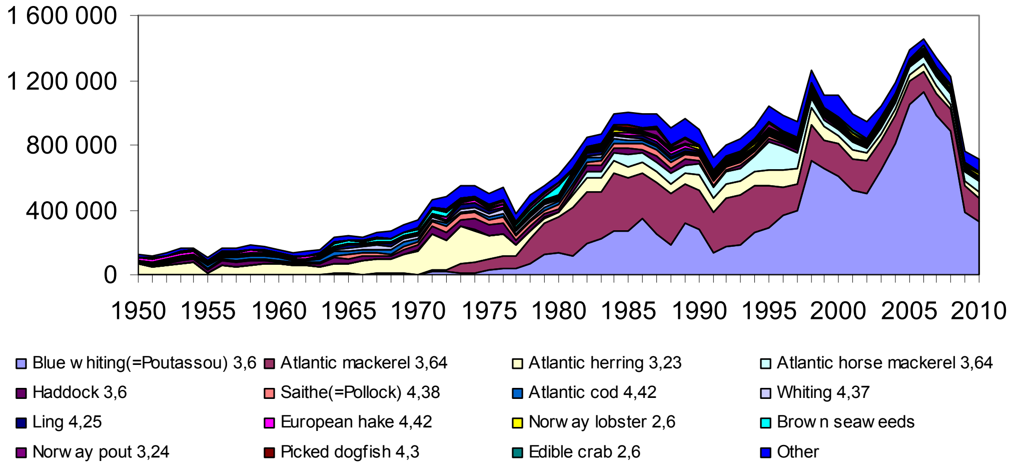


Figure 7.1 *Trend in the landings on the West Coast of Scotland and Ireland between 1950 and 2010 from STATLANT – Note that there is data missing prior to 1977 due to lack of definition in the French catch statistics by ICES Divisions.*

7.1.2 Fishing effort per gear for the last 10 years

Total fishing effort in the West Scotland and West Ireland ecosystem has been declining from nearly 46 kW fish days in 2003 to around 18 kW fish days in 2010, with a more significant decline after 2007 when the gears using hooks and polyvalent mobile and passive gears were removed from the fleet (Figure 7.2). This reduction in effort is also due to a general reduction in the pelagic trawl and seine gears over time from a maximum in 2004 to a minimum in 2009.

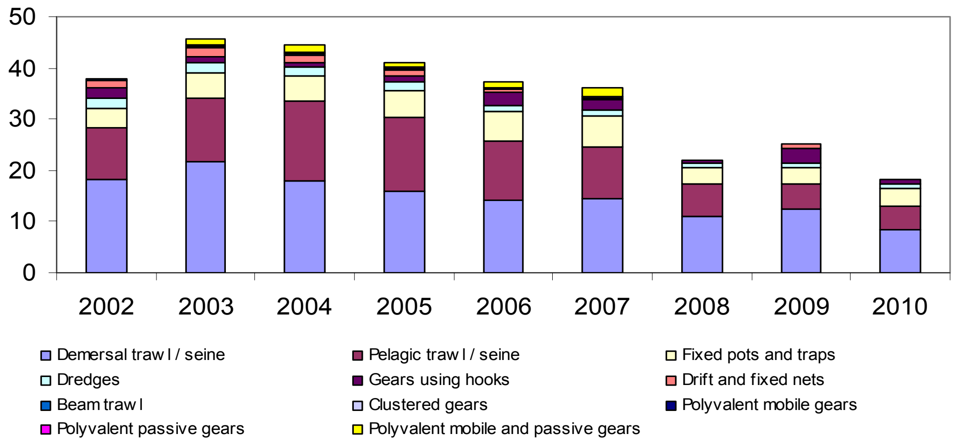


Figure 7.2 *Changes in fishing effort per gear for the West of Scotland and West Ireland ecosystem (Million kW fish.day^{-1}). Note that the 2010 data might be incomplete and that the change between 2007 and 2008 might be due to change from kW days at sea to kW fishing days.*

7.2 Stock synthesis

7.2.1 Proportion of landings covered in the assessments and dependency of stocks of the ecosystem

A high proportion of the total landings in the West of Scotland/West of Ireland areas derived from stocks with analytical stock assessments (Figure 7.3). This proportion has increased over time and now reaches around 90%. This reflects the fact that the bulk of the landings (in biomass) comes from some major assessed pelagic stocks (blue whiting, mackerel and herring).

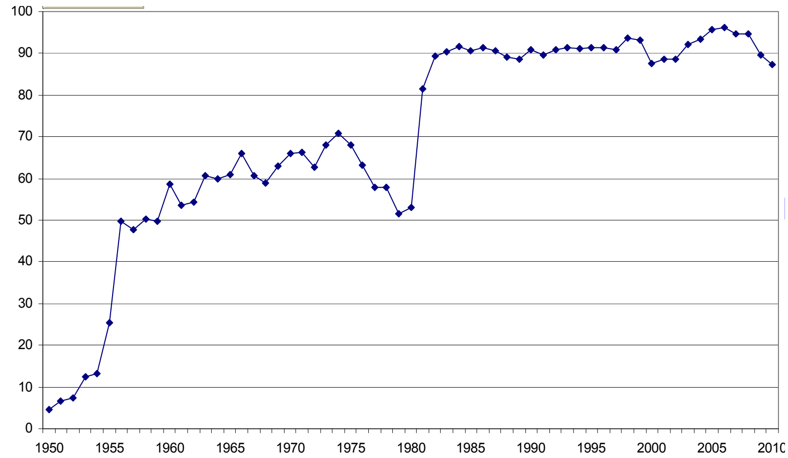


***Figure 7.3** Percentage of total landings by weight coming from stocks with analytical stock assessments.*

Of the 14 assessed stocks on the West Scotland/West Ireland, 5 only occur exclusively in this ecosystem, while the rest of the stocks are shared also with the North Sea, Celtic Sea and Bay of Biscay (Figure 7.3).

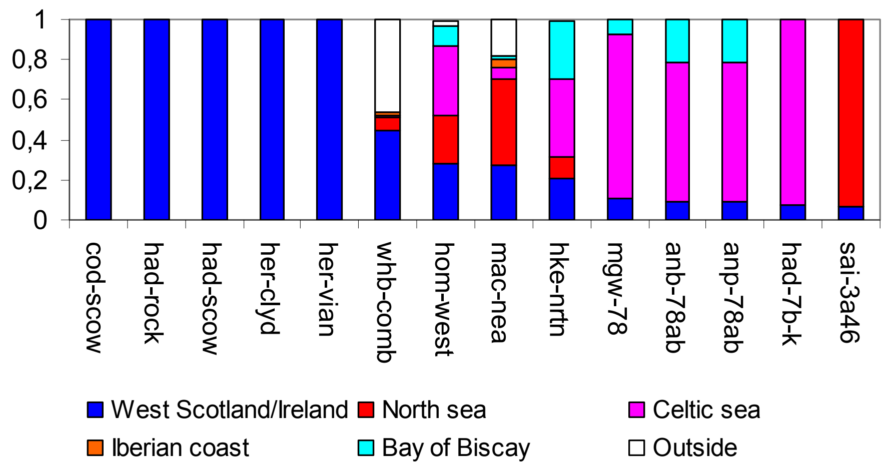


***Figure 7.3** Spatial extent of the stocks in the West Scotland/West Ireland ecosystem*

7.2.2 Stock status meta-analysis

Total landings of the assessed stocks from the West Scotland/West Ireland ecosystem increased significantly from the start of the amalgamated time-series (1990) up to 2005 before declining over the last five years (Figure 7.4). This trend appears to be closely linked to the changes observed in the aggregated index of spawning stock biomass, which also reflect the total abundance of the assessed stocks.

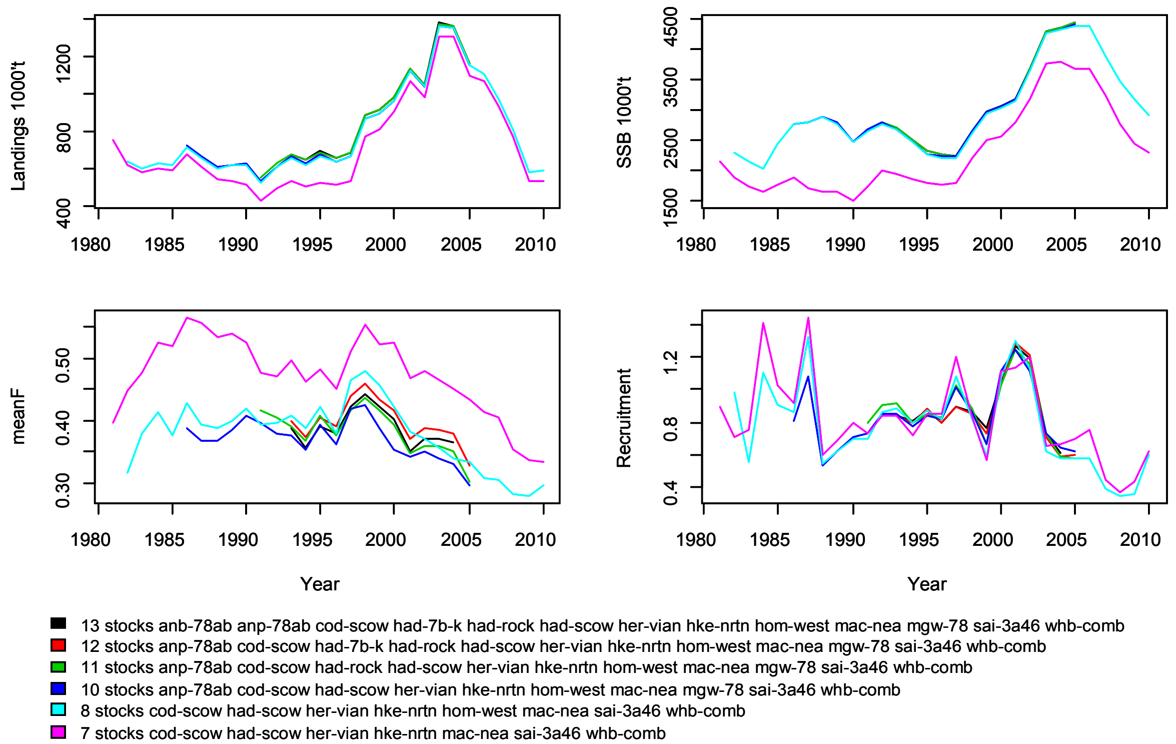


Figure 7.4 *Consolidated trends in landings (top left), SSB (top right), mean F (bottom left) and recruitment (bottom right) from stock assessments in the West of Scotland and West of Ireland ecosystem.*

Indeed the two index landings and SSB are largely driven by blue whiting for which landings increased strongly between 1995 and 2005 before falling to 1980s levels (Figure 7.5).Total SSB of the assessed stocks showed an initial increase (1990-1992) followed by a decline (1992-1995) and an other substantial increase until 2005 and a final decline since 2005. This pattern seems to be largely driven by changes in SSB of blue whiting and, to some extent, of horse mackerel (noted ‘scad’ on Fig. 7.5).

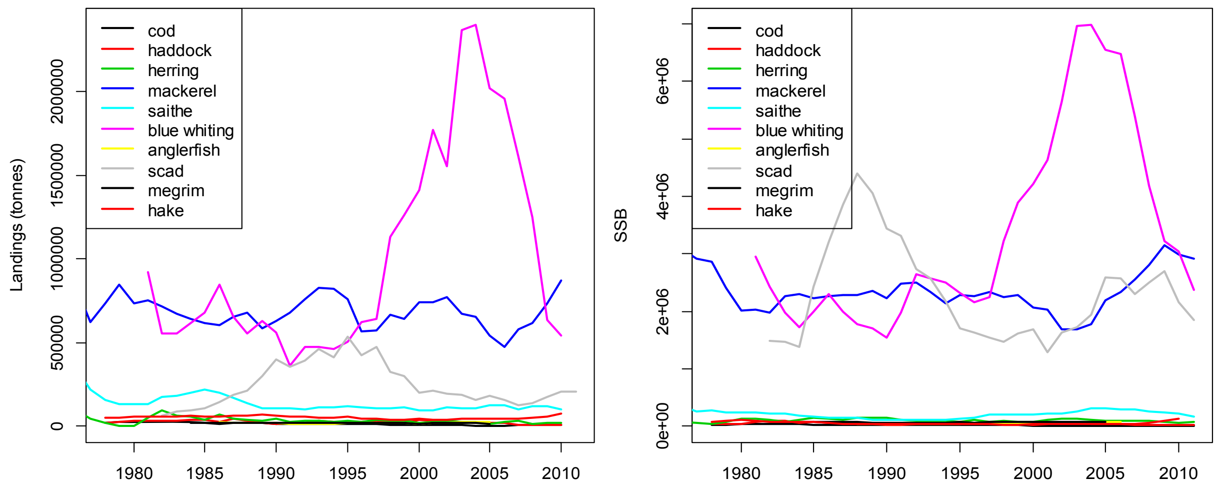


Figure 7.5 *Landings (left) and spawning stock biomass (right) of the 10 stocks used in the meta-analysis*

MeanF generally declined since 1990 in the stock amalgamated index (Figure 7.4) mainly driven by haddock, saithe and herring, but F for mackerel and cod generally shows no trend although fluctuating.

The meta-analysis recruitment index fluctuated until the late 1980s after which the mean level felt but still with rather large fluctuations in some years. In the recent years the index is lower than previously in the time series. The patterns are reasonably similar regardless of how many stocks are included in the amalgamated index.

7.2.3 Overall stock status in relation to reference points

Reference points have been defined for 6 of the assessed stocks (Figure 7.6). The stock status in 2010 indicates that the Rockall haddock and combined blue whiting stocks are in the green area with sufficient biomass and sufficiently low F values. Saithe in Div 3a46 and mackerel still have relatively high levels of biomasson the opposite to haddock and cod, the latter having in addition an unsustainable value for F. Three among the six considered stocks are therefore outside the safe limits. The consolidated stock trajectory shows that generally F declined over time and is between Fmsy and Fpa since 2009. Stock biomasses went through a strong increase in the mid-2000 followed by a decline which can again be explained by the patterns of blue whiting SSB.

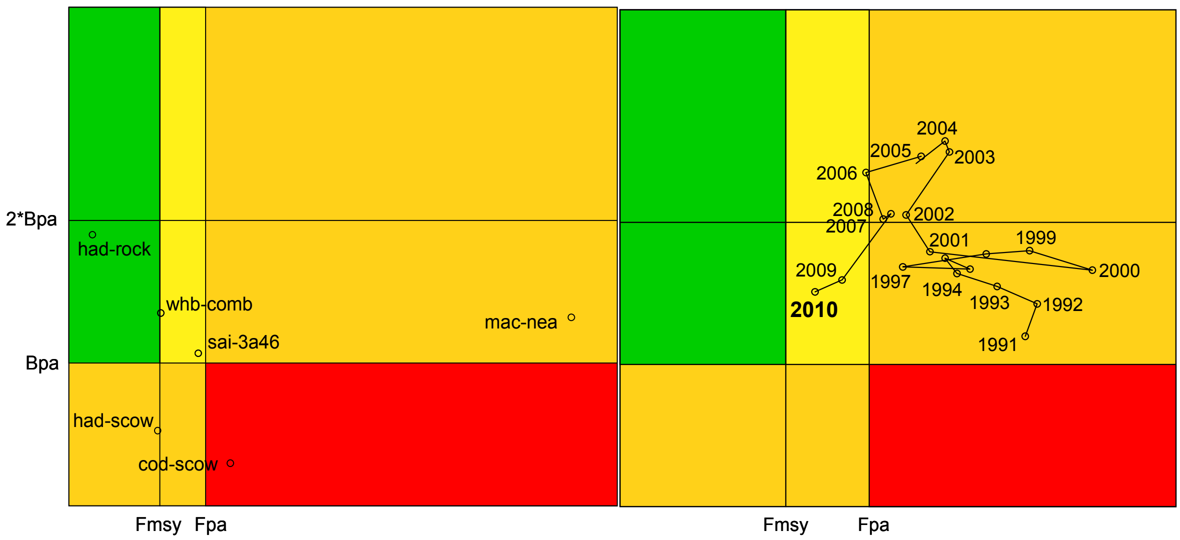


Figure 7.6 *Stock status in 2010 for the assessed stocks for which reference points were defined (left panel) and time-trend for the amalgamated stock status for the same assessed stocks (right panel)*

We note that the species included are nearly all shelf sea species and do not include any deep-water species due to a lack of analytical stock assessments in the metastock database. For some areas such as West of Scotland this represents a serious shortcoming to represent the eco-status of the whole ecosystem.

7.3 Environmental and ecosystem indicators

7.3.1 Environmental indicators

The environmental indicators of hydrological and chemical conditions based on data of the ICES hydrographic database for the West of Scotland and West of Ireland ecosystem are described in detail in Annex17.4. A brief description of the trends in some indices is provided below Figure 7.7).

Surface temperatures in the West of Scotland/West of Ireland ecosystem declined from the start of the time series (1952) until the mid-1960's, followed by a general warming period from the late-1970's until the end of the time series. The overall trend in temperature is consistent with fixed station records from the west of Scotland (Bailey et al., 2012).Surface salinity records are generally constant from the mid-1960's until the end of the time series, apart from two low salinity periods in the early 1970's and late 1980's.

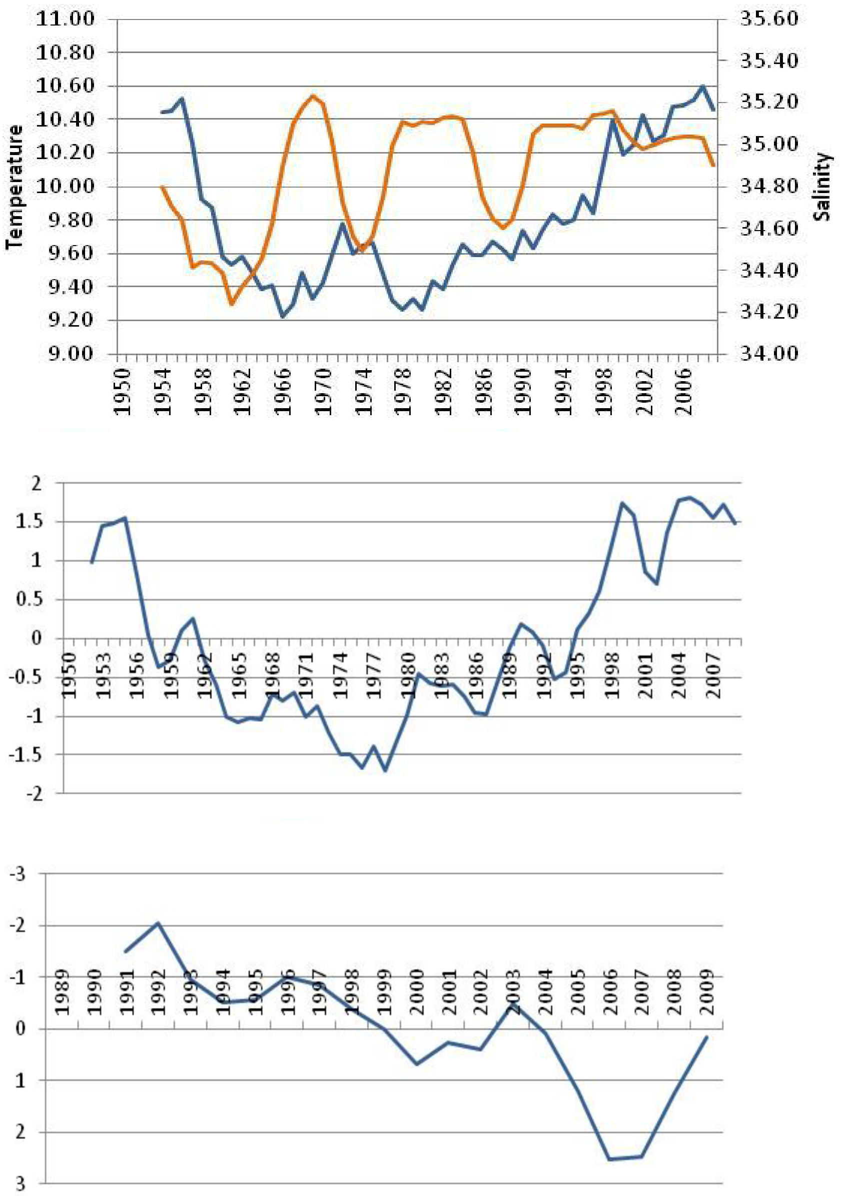


__Figure__ 7.7 Trends in environmental indicators for the West Scotland region. Top: temperature (in C°; blue curve) and salinity (in ‰; red curve) using a 5-year moving average. Middle: hydrological condition using PC1 scores as a 3-year moving average. Bottom: chemical condition using PC1 scores as a 3-year moving average.

Both temperature and the AMO dominate the trend in hydrological conditions which clearly shows a significant change in long-term state (from negative to positive) from 1980 to 2000. The indicator of general hydrological conditions, as described by the variation in PC1 (of the PCA of determinants), undergoes a period of decline from the start of the time series (1952) to the mid-1970's followed by a period of increase from the mid-1970's to 2010. An increase in this index is associated with an increase of water temperatures and the AMO in agreement with known patterns in the large-scale oceanography of the region (Bailey et al., 2012).

Nitrate concentrations dominate the trend in the chemical conditions. The index thus indicates a declining trend in nitrate content since the early 1990’s until 2006 followed by an increase back to the 1999 level in 2009 (Figure 7.3.3).

7.3.2 Ecosystem indicators

The ecosystem indicators based on survey data allow analysing the trends between 1985 and 2010 (Figure 7.8). The LFIs calculated from the Q1 and Q4 (quarters 1 and 4) IBTS surveys follow globally similar trajectories with the Q4 index generally being higher although the trajectories of the two indicators vary differently at the year-to-year scale. The indicator underwent a declining phase from around the late 1980s to a low point in 2000, both LFI indicators then increased, peaking in 2008 and 2005 (Q1 and Q4 respectively) before declining through to the end of the time series.

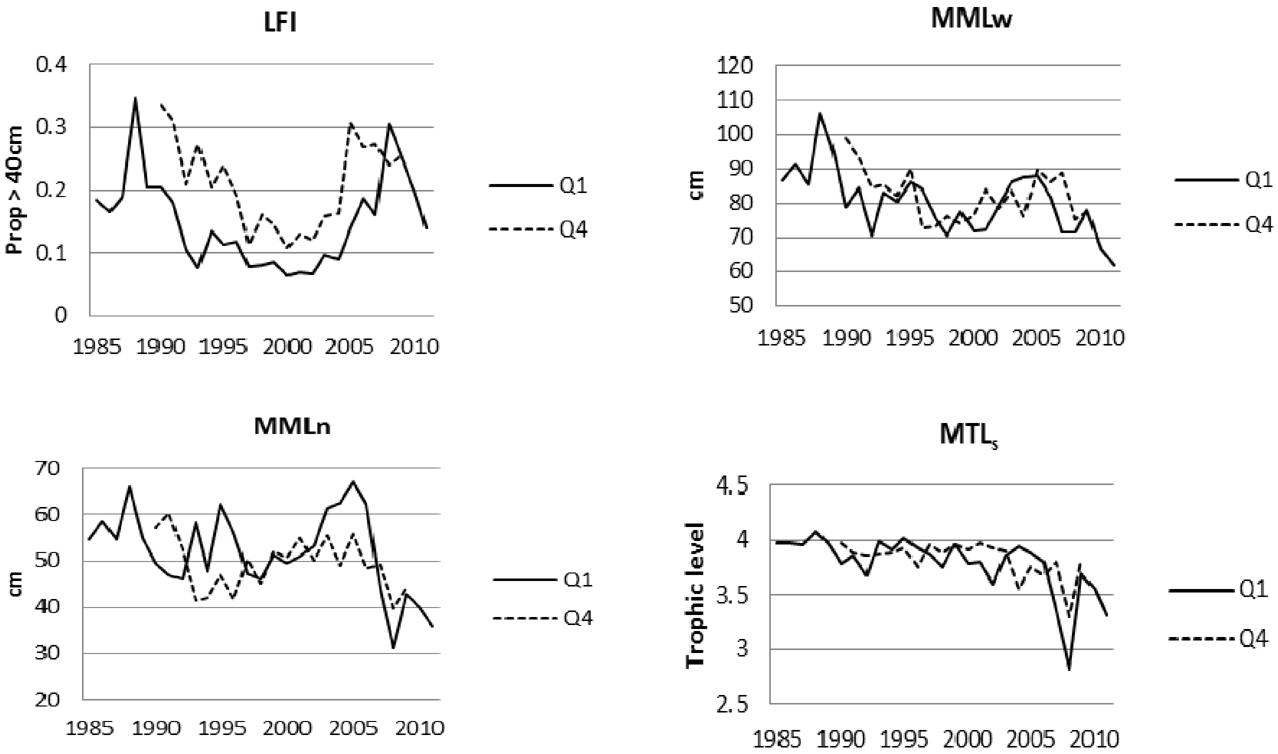


Figure 7.8. *Trends in the ecosystem indicators based on the Scottish West Coast Ground Fish surveys data (QI and Q4 refer to quarters 1 and 4).*

The mean maximum length MMLn indicators show oscillations after a sharp decline in 2007 (for both the Q1 and Q4 indices). The recent decline was more pronounced for the Q1 indicator compared to the Q4 survey based index. The MMLw index from both the Q1 and Q4 surveys oscillates over the time series with a declining trend over time. There is a strong decline in the Q1 survey from 2007.

The mean trophic level MTL for both the Q1 and Q4 surveys shows oscillations with a slight declining trend until about 2005. 2007 is marked by a particularly low value and the 2008-2010 values, although higher, tend to show an intensification of the declining trend (from around 4.0 to 3.5).

The ecosystem indicators based on landings were estimated over the 1950-2010 period. They reveal the long term changes which occurred in the species composition of landings in the West Scottish area (Figure 7.9). The mean TL of the landings shows an overall decreasing trend over the past 60 years, from a fluctuating value of ca. 3.7 in the 1950s and 1960s to a more stable value of 3.6 in the last 20 years. Note that the large increase in the mean TL in 1955 was due to a large reduction in the herring catch that year and that the decline from 1967 to 1971 was due to the increase in herring catches while the catch of higher trophic level species such as cod declined.

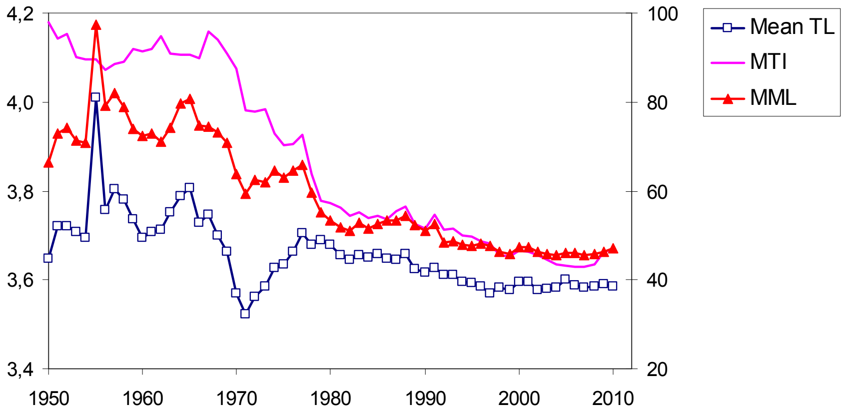
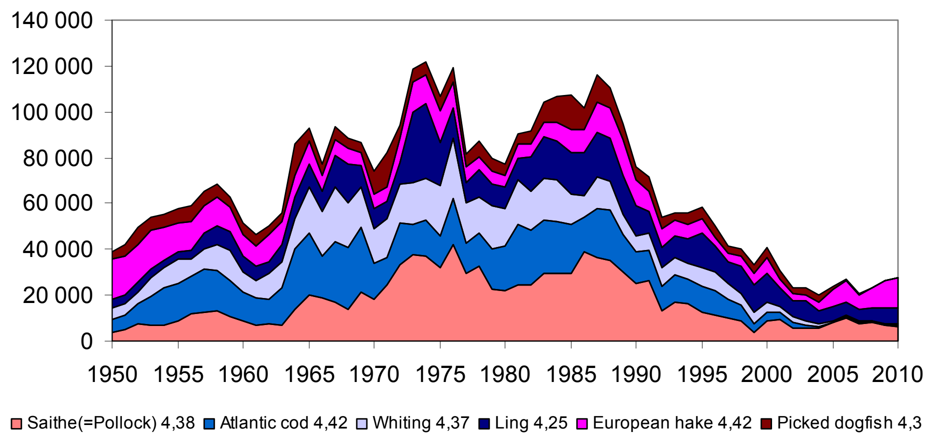


Figure 7.9 *Mean trophic level, MTI and mean maximum length of the landings of the West of Scotland and Ireland from the Statlant data.*

The decrease is much more pronounced for the MTI index which shows a sharp decline between 1970 and 1980 (from 4.3 to 3.8) followed by a lower decline to reach 3.6 in the last years. This overall decline of the MTI index shows that the catch of the higher trophic level species (>3.25) persistently decreased.

The decline in MTI observed between 1967 and 1979 is mainly driven by the increase in the landings of blue whiting and mackerel (Figure 7.10). This increase induces a reduction in the mean maximum length of landings at that time. In contrast, the decreasing trend observed since 1980 for the three indices arises from a strong decline of the landings of the highest trophic level species (saithe, cod, whiting, ling, picked dogfish).



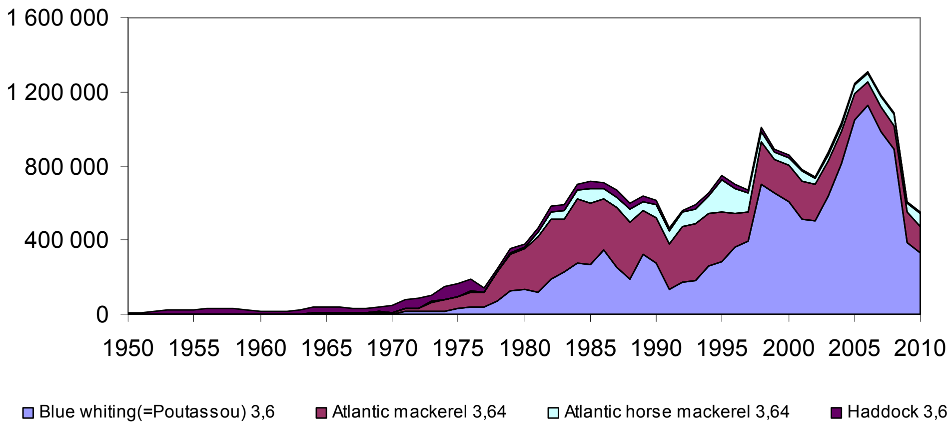


__Figure 7.10__ Landings of high trophic level species (top: TL>4; bottom: 3.25<TL<4).

7.4 Fleet-based meta-analysis

7.4.1 General results – Selection of the main fleet segments

This section contains analysis of data related to the West of Scotland/Ireland ecosystem taken from the EU DCF fleet economic database. In terms of data availability, the Spanish value landed data was missing for all years. Days at Sea for the French fleet were also not available for this ecosystem because to that data was provided at the wrong aggregation level. The substantial drop in days at sea for the Irish fleet in this ecosystem between 2007 and 2008 likely corresponds to a data quality issue rather than a real trend. Although the Norwegian fleet made substantial landings in this ecosystem, economic data is unavailable because Norway is not an EU country and therefore their data is not held in the database.

The available data suggests that the total value of landings generated from this ecosystem by the EU fleet (excluding Spain) in 2009 was 336 million€. The UK fleet generated the highest value (206 million€, 61% of the total) landed from the ecosystem in 2009, followed by the Irish fleet (60 million€, 18% of the total) and then the French fleet (41 million€, 12% of the total). The Dutch and German fleets are also operational in the ecosystem. 78% of days at sea within this ecosystem are from the UK while 13% relates to Spain and 9% to Ireland. The demersal trawl/seine and purse seine gear types generated each 30% of the total value landed from that ecosystem in 2009 while pelagic trawl generated another 20% (Figure 7.11).

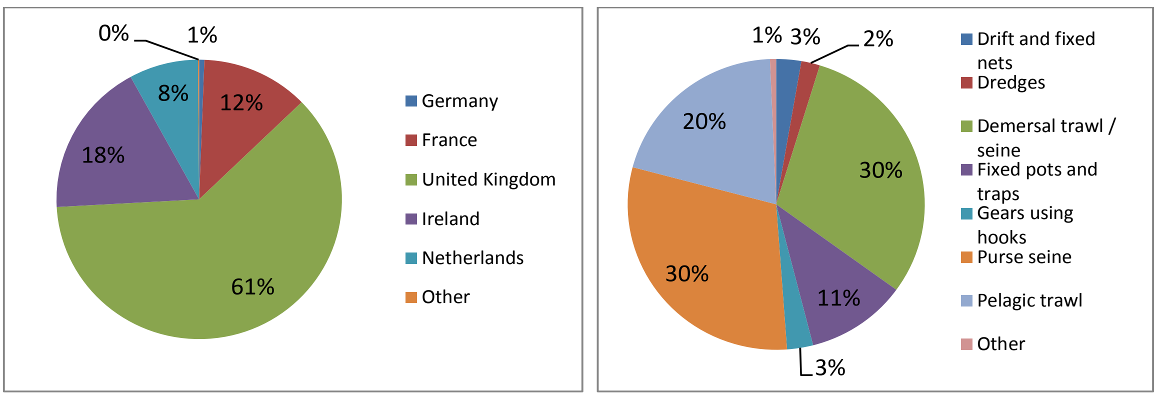


__Figure 7.11__ West of Scotland/Ireland ecosystem value landed by Member State and gear type 2009

Table 7.1 provides a breakdown of available data on weight and value landed by gear type in this ecosystem between 2002 and 2010. Note that before 2008 the pelagic trawl and the purse seine gear types were combined and named pelagic trawl and seine. This changed at the introduction of the DCF. In addition, data for 2010 is incomplete as some Member States were not in the position to provide the necessary data.

Table 7.1 *West of Scotland/Ireland landed weight and value by gear type 2002-2010*

	2002		2003		2004		2005		2006		2007		2008		2009		2010	
Member State	**Volume (1000 tons)**	**Value (€ mln.)**	**Volume (1000 tons)**	**Value (€ mln.)**	**Volume (1000 tons)**	**Value (€ mln.)**	**Volume (1000 tons)**	**Value (€ mln.)**	**Volume (1000 tons)**	**Value (€ mln.)**	**Volume (1000 tons)**	**Value (€ mln.)**	**Volume (1000 tons)**	**Value (€ mln.)**	**Volume (1000 tons)**	**Value (€ mln.)**	**Volume (1000 tons)**	**Value (€ mln.)**
Drift and fixed nets	3,4	6,7	4,0	5,0	3,4	5,8	2,9	6,5	1,9	3,8	1,8	4,7	1,0	2,0	2,9	9,1	0,8	2,4
Dredges	10,3	17,1	6,4	12,6	5,6	11,4	5,2	10,3	3,8	9,4	2,8	8,2	4,8	10,2	4,7	6,8	4,7	6,8
Demersal trawl / seine	61,2	122,7	65,2	117,8	60,3	105,3	55,2	106,5	63,6	123,1	56,4	139,2	47,5	102,5	59,3	101,5	29,4	59,5
Fixed pots and traps	8,3	27,4	12,4	31,7	12,4	32,6	12,4	33,1	13,1	40,3	15,2	47,0	14,0	43,4	13,1	36,9	10,6	35,5
Gears using hooks	4,2	6,5	2,6	3,9	2,9	3,1	5,0	7,5	6,3	6,0	4,1	4,8	6,6	4,8	10,9	9,5	4,4	10,8
Polyvalent mobile gears	0,0	0,0	0,0	0,0	0,1	0,2	0,0	0,0	0,2	0,2	0,0	0,0	0,0	0,0	0,4	0,4	0,0	0,1
Polyvalent passive gears	0,0	0,1	0,0	0,0	0,0	0,0	0,7	0,9	0,0	0,1	1,6	0,9	0,1	0,3	0,0	0,0	0,0	0,0
Polyvalent mobile and passive gears	0,1	0,4	12,1	22,5	12,2	26,5	9,0	21,1	14,5	22,5	4,8	11,0	0,1	0,1	0,1	0,1	0,0	0,1
Purse seine	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	122,5	72,4	118,0	101,6	106,4	84,2
Pelagic trawl / seine	195,4	114,8	295,4	129,9	370,4	126,4	398,0	161,8	364,2	155,3	310,8	160,7	0,0	0,0	0,0	0,0	0,0	0,0
Beam trawl	0,2	0,5	0,2	0,7	0,2	0,7	0,1	0,3	0,0	0,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Pelagic trawl	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	213,4	79,9	165,7	67,8	80,0	30,4
Clutered segments	0,3	0,7	0,6	1,6	0,6	1,8	0,6	2,4	0,4	1,9	0,7	3,4	0,6	2,3	0,5	1,7	0,7	3,1
All Member States	**283,5**	**297,0**	**398,9**	**325,6**	**468,2**	**313,8**	**489,0**	**350,5**	**468,1**	**362,8**	**398,1**	**379,8**	**410,5**	**317,9**	**375,7**	**335,6**	**237,1**	**233,0**

The UK purse seine fleet over 40 m generated over 100 million€ of landed value corresponding to 30% of the total value landed from this ecosystem (Figure 7.12). These vessels target mainly mackerel, herring and blue whiting. The Irish pelagic trawl over 40 m generated 33 million€ in landed value, targeting mackerel, herring, blue whiting and horse mackerel. The Netherlands pelagic trawl over 40 m generated 26 million€, with a similar catch composition to the UK and Irish pelagic segments. The UK, Irish and French demersal trawl segments operating in the ecosystem targeted mainly *Nephrops*, however haddock, saithe and hake also made up the catch composition of these segments. Cod by-catch is a particular problem for these vessels due to low cod quotas. This ecosystem also contains a sizeable hake fishery for vessels using hooks. Finally, there is a significant multi-national small scale fleet/fishery within the ecosystem, with many vessels targeting mainly shellfish species, such as lobsters, crabs and *nephrops* using static gears. Economic performance data on these segments is unfortunately sparse however this sector is extremely important from an employment and regional economic perspective, particularly in remote areas. Data is available for the UK pots and traps under 10 m (FPO 0-10m) which employs a significant number of fishermen, spent over 44 thousand days at sea and generated a landed value of around €18 million from within the ecosystem in 2009.

Fleet segment	2009 Value (€ 1000)	Value landed as % of total value landed within ecosystem
GBR PS VL40XX	101.545	30%
IRL TM VL40XX	32.768	10%
NLD TM VL40XX	26.337	8%
GBR DTS VL1218	18.200	5%
GBR FPO VL0010	18.068	5%
GBR DTS VL2440	17.590	5%
FRA DTS VL40XX	17.544	5%
FRA DTS VL2440	15.251	5%
GBR DTS VL1824	11.288	3%
IRL DTS VL2440	8.050	2%
Other	68.983	21%
All fleet segments	**335.624**	**100%**

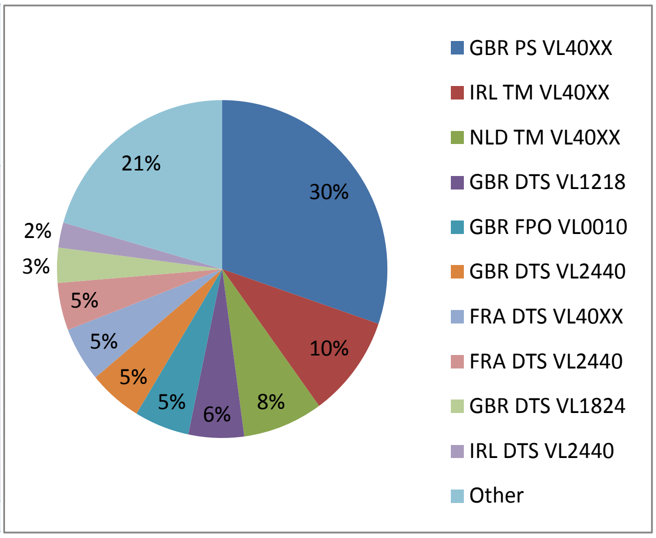


Figure 7.12 *Fleet segments operating in the West of Scotland / Ireland ecosystem with highest landed value in 2009*

7.4.2 Economic performance of the most important fleet segments operating in the ecosystem

The ten main fleet segments in terms of landed value for the West of Scotland / Ireland ecosystem in 2009 account for 66% of the total number of days at sea, 79% of the total weight landed and 73% of the total landed value (Table 7.2). The available data suggests that UK purse seine over 40 m was the most profitable fleet segment operating within the ecosystem region in both relative and absolute terms in 2009, generating over 60% of value added in relation to income and over 30% of profits as a proportion of income (Table 7.2 and Figure 7.13). This segment of just 31 vessels spent 35% of their total days at sea within this ecosystem in 2009 generating 44% of their total landed weight and 50% of their total landed value.

Similarly, the Irish pelagic trawl over 40 m (21 vessels) spent 48% of their total days at sea within this ecosystem in 2009, generating 42% of their total landed weight and 54% of their total landed value. The Netherlands pelagic trawl over 40 m was less dependent on this ecosystem in 2009 with only 29% of their total days at sea within this ecosystem, generating 34% of their total landed weight and 33% of their total landed value. These vessels have a similar catch composition than the UK and Irish pelagic fleets. The Irish pelagic trawl over 40 m generated value added as a proportion of income of over 50% although losses were made overall. The data suggests that The Netherlands pelagic trawl over 40 m segment did not generate enough income to cover the operational costs and made losses overall. The UK pots and traps under 10 m segment was also relatively profitable in 2009 with GVA and profits as a proportion of total income of over 60% and over 15% respectively.

***Table 7.2** Economic indicators for main fleet segments for the West of Scotland/Ireland ecosystem in 2009*

FLEET SEGMENT	Number of vessels	Employ-ment (FTE)	West Scotland /Ireland (ICES VIa-b, VIIb-c) days at sea (1000)	West Scotland / Ireland (ICES VIa-b, VIIb-c) days at sea as % of total days in area 27	West Scotland / Ireland (ICES VIa-b, VIIb-c) volume landed (1000 tons)	West Scotland / Ireland (ICES VIa-b, VIIb-c) volume landed as % of total volume in area 27	West Scotland/Ireland (ICES VIa-b, VIIb-c) Value landed (€ million)	West Scotland/Ireland (ICES VIa-b, VIIb-c) value as % of total value in area 27	Direct subsidies (€ million)	Total income (€ million)	Gross value added (GVA) (€ million)	Operating cash flow (OCF) (€ million)	Profit / Loss (€ million)	Crew wage per FTE (€ 1000)
IRL TM VL40XX	21	224	1,0	48%	72,4	42%	32,8	54%	0,9	80,2	43,1	27,5	-4,1	73,7
GBR PS VL40XX	31	252	0,7	35%	118,0	44%	101,5	50%	5,0	213,3	131,7	90,3	62,0	184,6
IRL DTS VL2440	27	203	2,3	38%	5,2	48%	8,1	41%	11,2	37,0	12,2	18,8	7,9	22,8
GBR DTS VL1218	270	894	17,3	42%	8,3	35%	18,2	39%	3,0	53,8	20,7	11,9	7,2	13,1
GBR FPO VL1012			10,9	38%	1,5	19%	7,0	38%	0,5	19,6	10,5	5,9	4,1	
GBR FPO VL0010		1013	44,0	32%	3,9	20%	18,1	35%	2,0	58,3	36,4	24,8	9,5	13,4
NLD TM VL40XX	13	502	0,6	29%	66,7	34%	26,3	33%	0,0	108,0	28,6	-2,0	-18,7	61,0
IRL DTS VL1824	59	294	2,0	15%	2,7	16%	5,2	17%	0,0	26,9	10,2	2,5	-30,1	26,0
GBR DTS VL2440	106	765	3,4	15%	10,9	17%	17,6	17%	7,1	116,5	34,8	16,2	0,5	33,6
GBR DTS VL1824	221	1143	5,7	14%	5,3	10%	11,3	12%	6,1	108,4	38,9	21,2	7,6	20,9
Other segments			45,9		80,1		89,0							
Total			134,0		375,0		335,0							

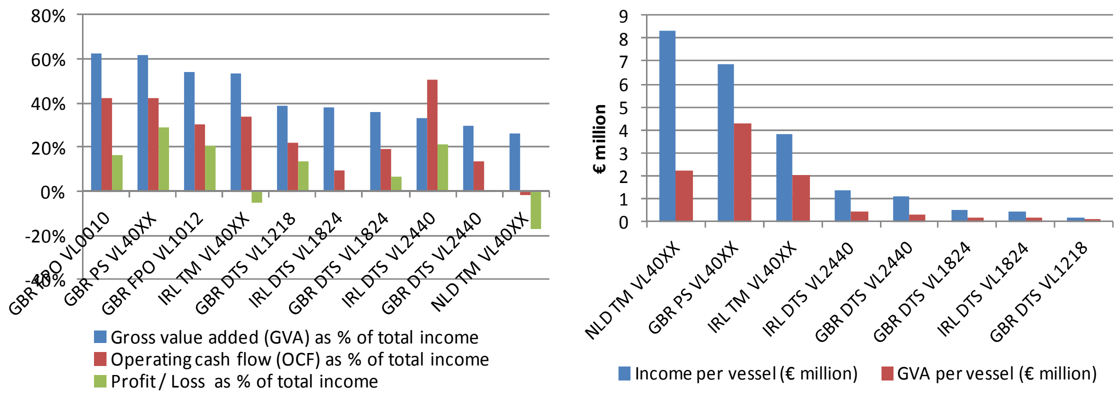


***Figure 7.13** Economic performance of main West of Scotland/Ireland ecosystem segments in 2009*

Figure 7.13 provides the economic performance trends and the trends in effort and landings for some of the major fleet segments operating in this ecosystem on the extent of data availability. Note that, in the frame of the existing segmentation, none of the presented segments spent more than 50% of their days at sea within the ecosystem. Similarly, no segment generated more than 50% of either weight or value landed from this ecosystem. There are evidently vessels, especially the smaller units, that are solely or highly dependent on the ecosystem, however the economic data is not disaggregated enough to highlight the activity of those vessels or fleets.

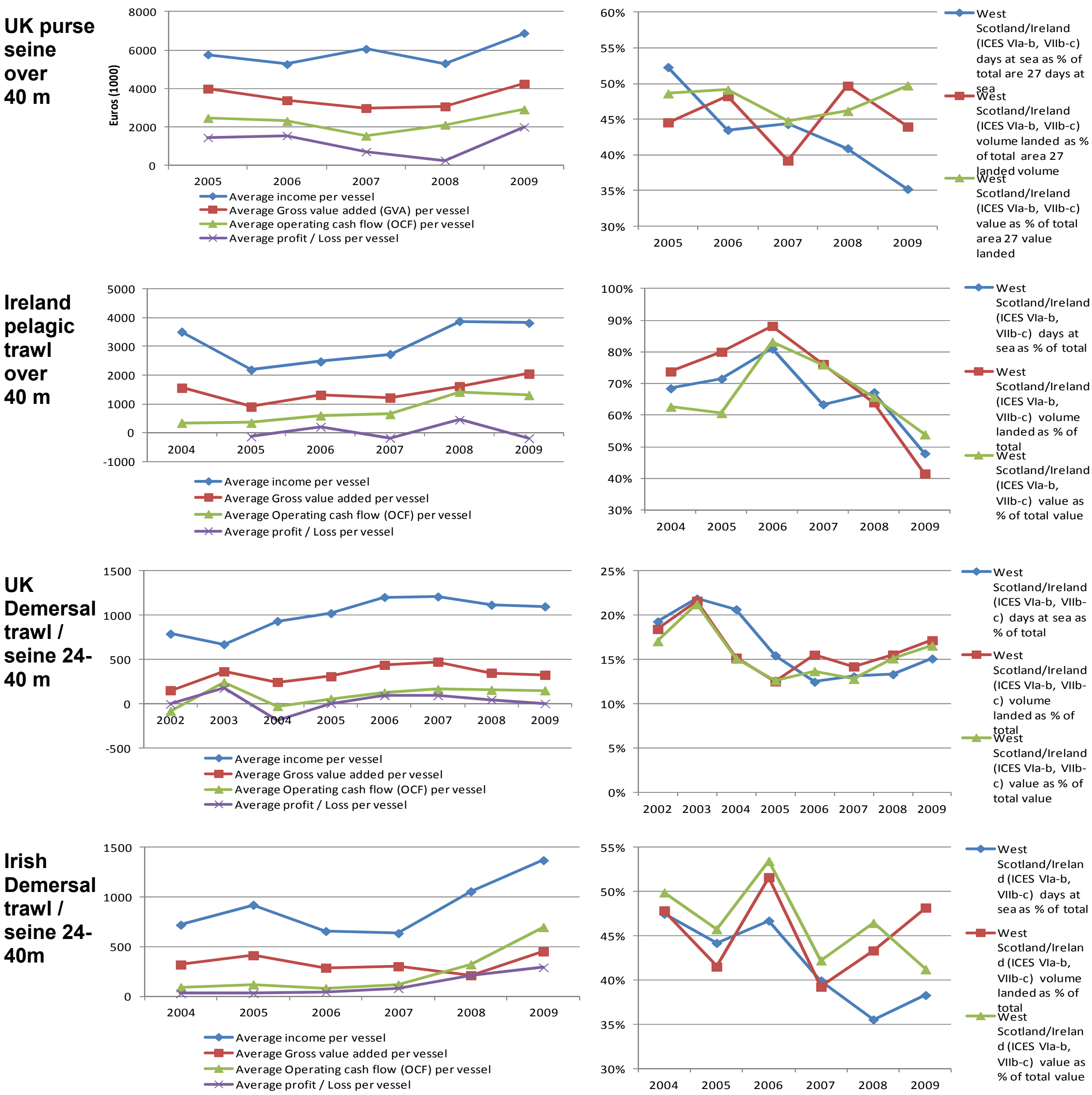


Figure 7.14 *Trends in economic performance and ecosystem dependency of four major fleet segments operating in the West Scotland/Ireland ecosystem*

Of the main fleets fishing in the West Coast of Scotland/Ireland ecosystem the Irish pelagic and demersal fleets had the highest proportion of days at sea, catches and landed value in this area (Table 7.2 and Fig 7.14). Note that these dependencies decreased over time with the highest values for the Irish pelagic fleet over 40 m in 2006. Generally the average income per vessel was relatively stable if not increasing for most fleets and the average profit increased at least for the Irish demersal trawl/seine (24-40 m) fleet.

7.4.3 Ecological indicators of fleet segments

- Partial F: Impact of the selected fleet segments on the fishable fraction of the ecosystem

The UK demersal trawl 22-24 m segment is the only fleet that seems to have a large impact on the fishable fraction of the West Scotland/Ireland ecosystem with a cumulative partial F higher than 1.0 (Figure 7.15). The relative fishing mortality on assessed stocks remains lower than 0.3 for all other segments. Nevertheless, note that the two fleets with null partial F values had an economic impact but their exploited stocks were not assessed –FPO vessels use pots or trap.

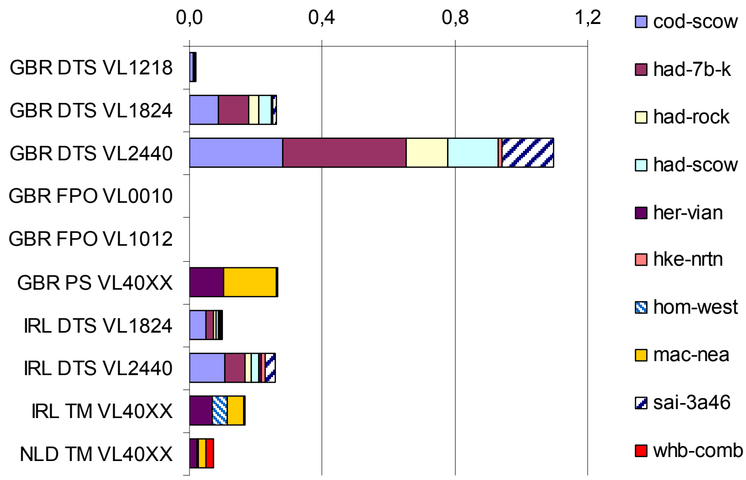


Figure 7.15 *Partial fishing mortality by gear for the West Coast of Scotland and Ireland most important gears.*

- Sustainability index of the selected fleet segments

The sustainability index of fleet segments operating in the West Scotland/Ireland ecosystem are based on the 6 stock assessments for which F and B limits are known (see Figure 7.6). The UK demersal trawls exploit sustainably the stocks on average, with a low fishing pressure (F*<Fmsy) and a relatively high abundance (B>Bpa). This applies to the landings by these fleets of haddock, saithe and blue whiting.
The UK pots and traps were not reported on the graph since most of the targeted stocks are not assessed by ICES. All other fleet segments exhibit a poor sustainability index in term of F*, exploiting stocks that are under current heavy fishing pressure. This partially applies to mackerel for which very high F*estimate is considered an artefact of the methodology (see §4.3).

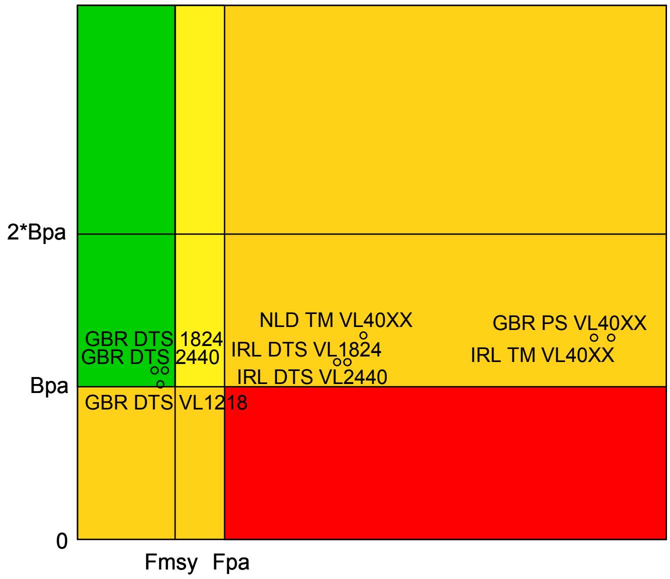


Figure 7.16.*Sustainability index of the selected fleets operating in the West Scotland/Ireland ecosystem: standardized fishing mortalities F* and biomass B* for the assessed stocks (referred in figure 7.6)*

- Index of the fleet segments' impact on the food web and habitat

Among the selected fleet segments, the highest impact on the food web (based on the required primary production) was from the large UK purse seiners (Figure 7.17)in relation to the large amount of total catches. The food web impact is also substantial for the large Irish and British pelagic trawlers. The demersal trawlers had on the opposite a lower impact on the food web due to limited catches since they target higher trophic level species. However these fleet segments are unsurprisingly mostly impacting the sea floor with a particularly high habitat impact index for the small demersal trawlers due to an important fishing effort.

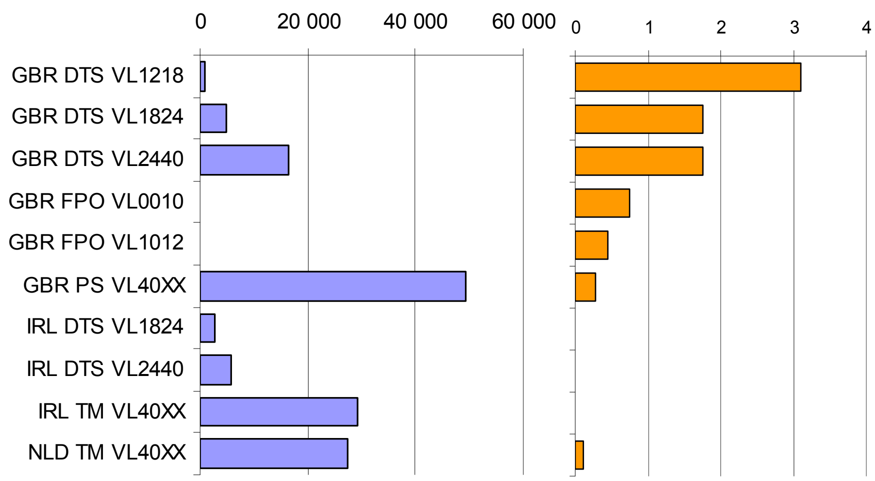


Figure 7.17. *Ecological index for the main fleet segments operating in the West Scotland/Ireland ecosystem. Left: food web impact index (required primary production, 10^6wet tons/year); Right, habitat impact index (values for Irish fleets missing)*

7.4.4 Synthesis and conclusion of the fleet synthesis

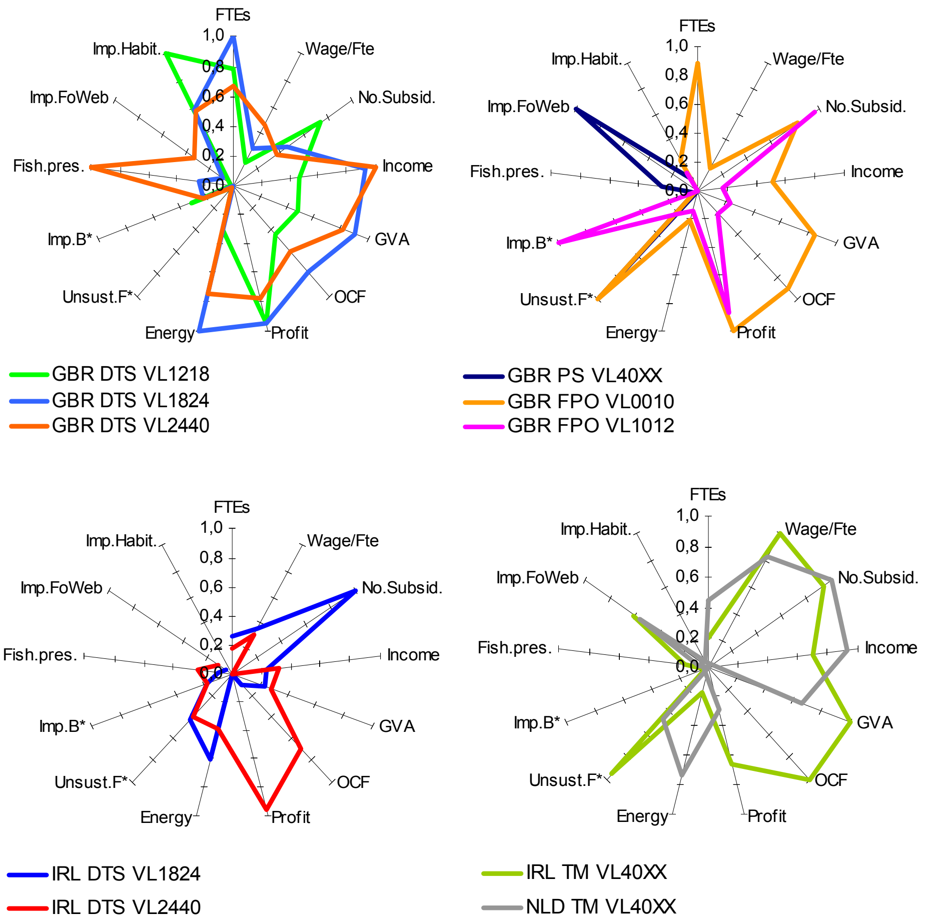


Figure 7.18 *Ecological impact index and socio-economic performances of the main fleet segments operating in theWest Scotland/Ireland ecosystem (note that the impact on habitat and food web were not computed for IRL DTS due to insufficient data)*

The overall ecological impact of the different fleets show that the UK demersal trawl fleets were mostly doing well on income, gross value added (GVA), operating cash flow (OCF) and profit as well as generally on employment opportunities. These fleets also show the best sustainability index (Fig.7.16) and the lowest impact on primary production (Fig 7.17). The impact on seabed habitat is however the highest (Fig 7.17) especially for the smaller vessels (12-18 m). The partial F is high but for the larger vessels (18-24 m and 24-40 m) and these segments show a general energy inefficient. Similarly the Irish and Dutch mid-water trawlers had good results on the economic indicators of wages, subsidies, income, GVA, OCF and profit while not performing that well on the impact on the foodweb, on fishing mortality and energy consumption. Conversely the Irish demersal trawlers did not performed so well on the economic side with only profitability for the 24-40 m segment although the operating cash flow was positive and the 18-24 m fleet was low-subsidized. These fleets had a low fishing pressure and impact on biomass but note that the impact on habitat and food web were not computed due to insufficient data.

Finally, the small UK pot and trap fleet is the least ecologically impacting and the most profitable segment with good indices for GVA, OCF and employment and generally very little ecological impact. The only ecological impact were on sustainable biomass index which was high for the <10 m fleet and the unsustainable fishing mortality for the 10-12 m fleet.

7.5 Summary of the West Scotland/Ireland results

This ecosystem is notable for the role played by blue whiting with an increasing importance between the mid-1990s and 2005 followed by a recent decline. This pattern was mainly driven by a reduction in the recruitment success as this decrease occurred before a substantial drop in SSB. The position and strength of the North Atlantic sub-polar gyre (SPG) is thought to influence the spawning distribution of blue whiting. This gyre may influence recruitment success through food availability and predation levels but these mechanisms are not fully understood. Environmental influences are also believed to be important for recruitment success of other pelagic species such as mackerel and herring which are important in this ecosystem. However, the recruitment time-series of these three pelagic species do not show similar trends suggesting that competition between them or different mechanisms may be driving their recruitment success. Pelagic species tend to dominate the landings although significant quantities of demersal species and shellfish were also landed from this ecosystem. Because pelagic species are dominant, a high proportion of the landings were from stocks with analytical stock assessments. For the other species, the failure of the West of Scotland cod stock to recover presents a major challenge and the side-effects of the cod recovery plan are a significant issue for some of the fisheries (due to constraints on gears, discards, …).

Trends in the estimated ecosystem indicators (Figure 7.19) allow drawing a global diagnosis on the West Scotland/Ireland ecosystem health. Although the fishing effort and the overall fishing mortality significantly decreased recently, the biomass index did not increase and most indicators are still highlighted in red. The decrease of the fishing pressure was likely not important or long enough to allow for a substantial recovery of this ecosystem.

Landings Y	Effort E	Mortality F	Biomass SSB	Recruit. R	Sustain. F*	Survey LFI	Survey MMLw	Survey MTL	Landing MMLw	Landing MTL
↘	↘	↘	?	↘	😐	?	↘	↘	↘	↘

Figure 7.19. *Trends in the main indicators of the Ecosystem health in the West Scotland/Ireland ecosystem*

It should be noted that this diagnosis on the status of the ecosystem does not take into account some significant components of the ecosystem such as sea mammals and birds. In the west of Scotland, seals are known to have a major role in the marine ecosystem (and in the state of some exploited species such as cod).

Generally the fishing fleets off the West Coast of Scotland and Ireland are not fully dependent on this ecosystem with only the Irish fleets fishing more than 50% in value in the area. The fleets in general show good economic performances with profitability for most of them but substantially impacting the ecology of the ecosystem. Even the segment that shows the best economic and social (employment) performances with the least ecological impact (the UK pot and trap)does not present the full characteristics of sustainable fishing (substantial impact on biomass). The UK demersal trawl fleets show good economic performance and targeted the healthier stocks (haddock, saithe, blue whiting) but generates substantial impact on the seabed habitat.

8 IRISH SEA

8.1 Long term trends in landings and fishing effort

8.1.1 Trends in landings

The yield by species for the Irish Sea was obtained from the Statlant database. Overall landings increased from 1950 up to a peak over 150 000 tonnes in 1974, but have generally strongly declined thereafter (Figure 8.1). Total landings in 2010 were just over 60,000 tonnes. The main species landed are herring, *Nephrops* and scallops.

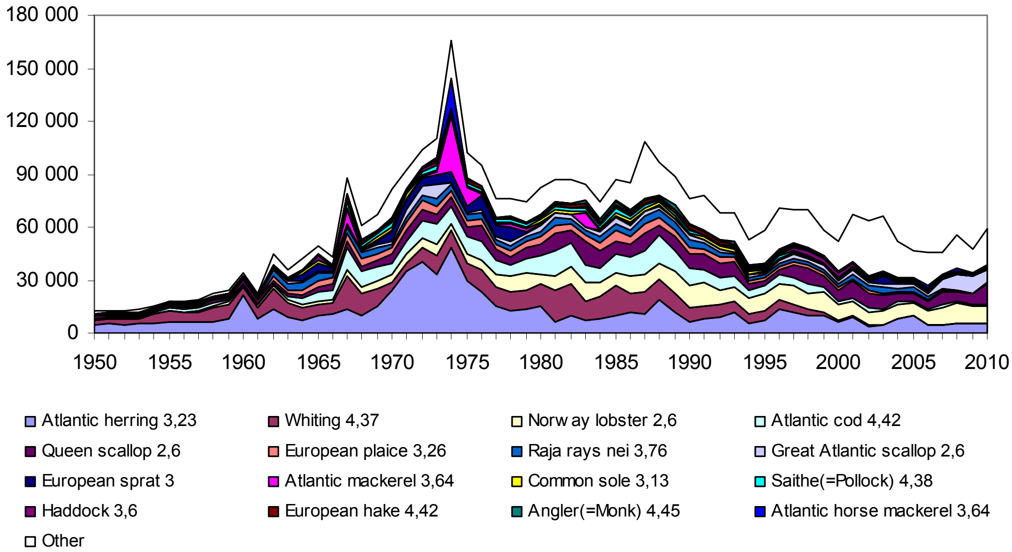


Figure 8.1. *Trend in landings from the Irish Sea from 1950 to 2010 from STATLANT.*

8.1.2 Fishing effort per gear for the last 10 years

Total fishing effort in the Irish Sea slightly declined over time from a peak at about 13 kW days in 2003to about 10 kW days in 2010 (Figure 8.2). The main gears used are dredges (targeting scallops) and demersal trawl/seines (targeting *Nephrops* and whitefish). Fixed pots (targeting mainly *Nephrops*) are also used. There is a small amount of beam trawling targeting flatfish and particularly plaice and sole.

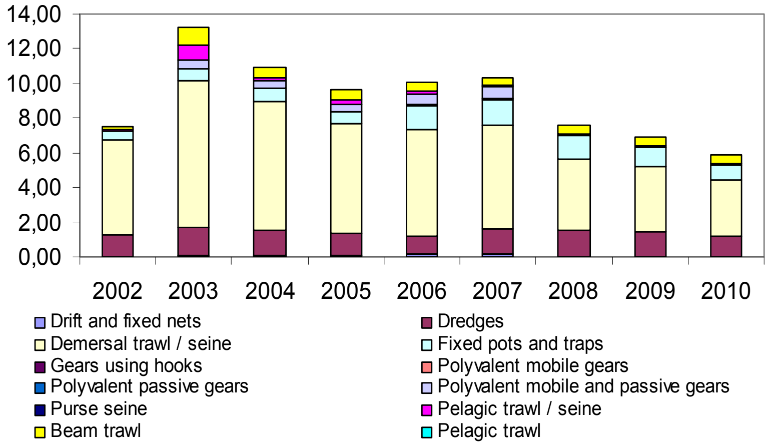


Figure 8.2 *Changes in fishing effort per gear for the Irish Sea (in kW day).*

8.2 Stock synthesis

8.2.1 Proportion of assessed stocks in the ecosystem and dependency to the ecosystem

The percentage of landings from the fully assessed stocks in the Irish Sea peaked at around 60-65% in the 1980s but has since declined to only 30%. The quality of several stock assessments is known to have deteriorated in the recent years (e.g. for cod). The important *Nephrops* and scallop fisheries are based on stocks which assessment is mostly derived from catch trends (and TV burrow surveys for *Nephrops*). These stock assessments do not provide comparable time-series than other fish stocks (e.g. plaice and sole assessments).

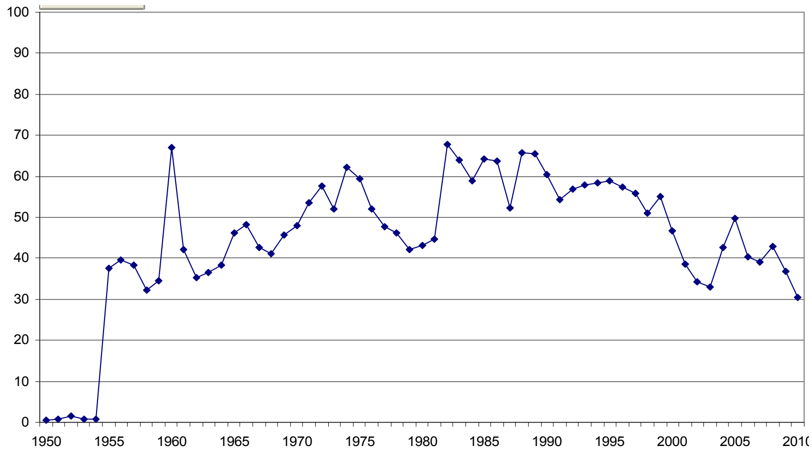


Figure 8.3 *Percentage of total landings by weight coming from stocks with analytical stock assessments.*

For management purposes, four of the assessed stocks in the Irish Sea (cod, plaice, sole and herring) are considered to be resident of this area. Nevertheless, biological studies have shown some mixing of juvenile herring from the Celtic Sea into the Irish Sea and southward movements of tagged plaice into the Celtic Sea.

8.2.2 Stock status meta-analysis

Total landings of the assessed stocks from the Irish Sea ecosystem show a general decline across the time-series apart from a period between the mid-1980s and early 1990s (Figure 8.4). This pattern is observed for all aggregated indices. Landings of herring started to decline in the 1980s, while landings of the three other stocks (cod, plaice and sole) were relatively stable until around 1990 when they also started to decrease.

Aggregated SSB also exhibits a clear and strong declining trend over the last 40 years whatever the time series we consider. Herring SSB peaked at ca. 1970 before declining strongly in the late 1970s. Cod and sole SSBs declined over the time-series and at a substantial rate for cod. Plaice also showed a decline in SSB until the mid-1990s but has since increased.

Mean F shows somehow different patterns between aggregating indices implying that trends in F for cod are different from those for plaice, sole and herring. Although the fishing mortality for cod increased, the amalgamated index (2, 3 or 4 stocks grouping) fluctuated around a relatively constant level until 1990 and declined since then. This general decreasing trend observed in the overall fishing pressure applied on the assessed stocks of the Irish Sea arises from a slight decrease in F on herring and sole while F on plaice declined more intensively.

The recruitment indices of the different groups of stocks are in relative agreement. Up to the mid-1980s the indices showed relatively large oscillations but with no clear trend. In contrast, since 1990 the consolidated recruitment indices showed a decline down to a minimum in 2007. The consistency between the time-series using different groups of species suggests that the recruitment levels of species in the groups were at lower levels during the last two decades compared to earlier decades.

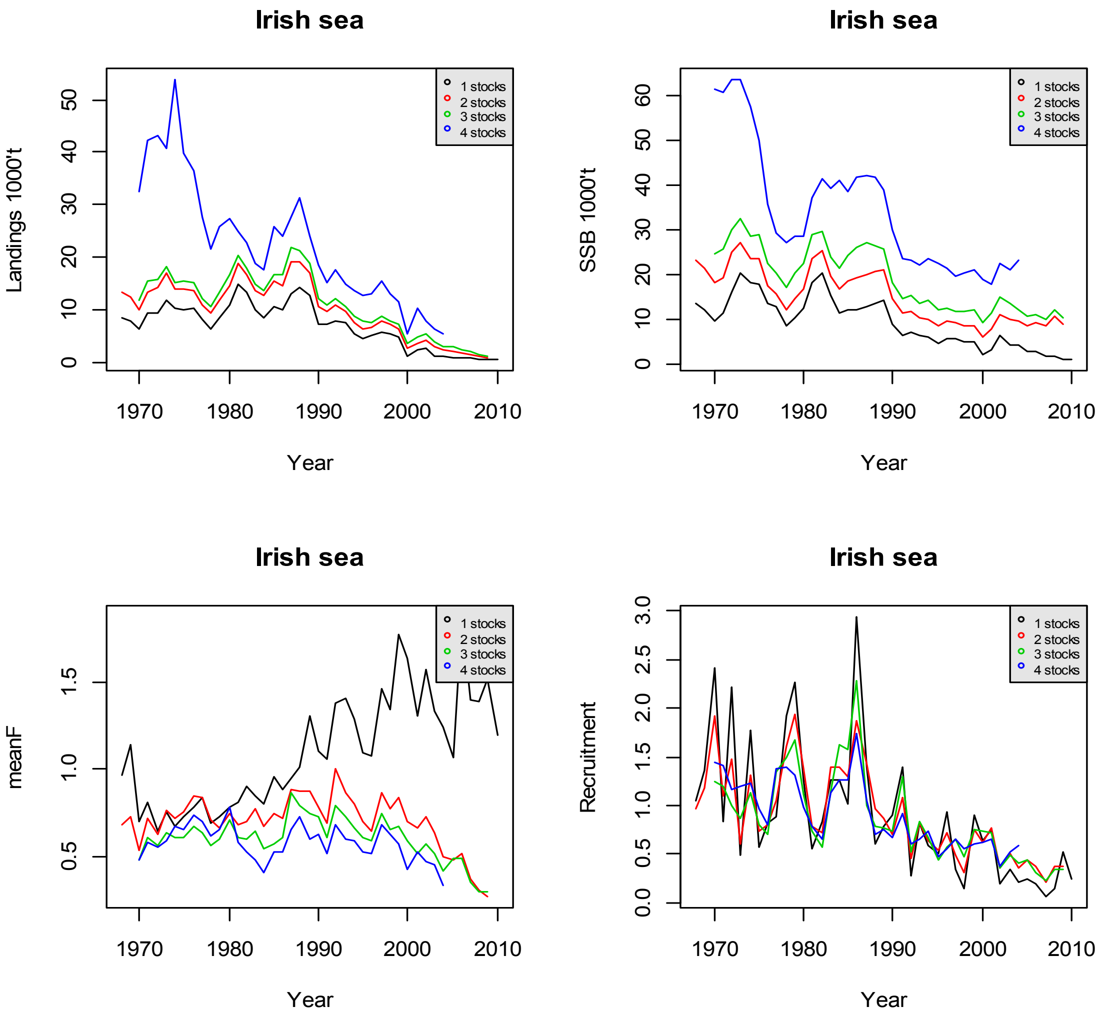


Figure 8.4 *Consolidated trends in landings (top left), SSB (top right), mean F (bottom left) and recruitment (bottom right) from stock assessments in the Irish Sea ecosystem.(From 1 to 4-stocks aggregated indices, stocks are included in the following order: cod-irish, plaice-irish, sol-irish, herring-nirs)*

8.2.3 Overall stock status in relation to reference points

The biomass and F stock traffic light plots show that limits are known for three stocks (Figure 8.5).Only plaice appears in the green zone, with low and sustainable F together with a high biomass. But the uncertainty in the assessment is large due to discarding. Sole and Cod are not exploited sustainably with a biomass below the precautionary level and a high fishing pressure especially for cod. Concerning the time-trend, the index suggests that the fishable fraction of the Irish Sea experienced unsustainable fishing pressures over the last 40 years with F* on average higher than Fpa. The mean biomass was lower than Bpa from the mid-1990s to the mid-2000s and is still very low near the precautionary limit. Nevertheless, it should be keep in mind that stock assessments from the Irish Sea are available only for about one-third of landings by weight.

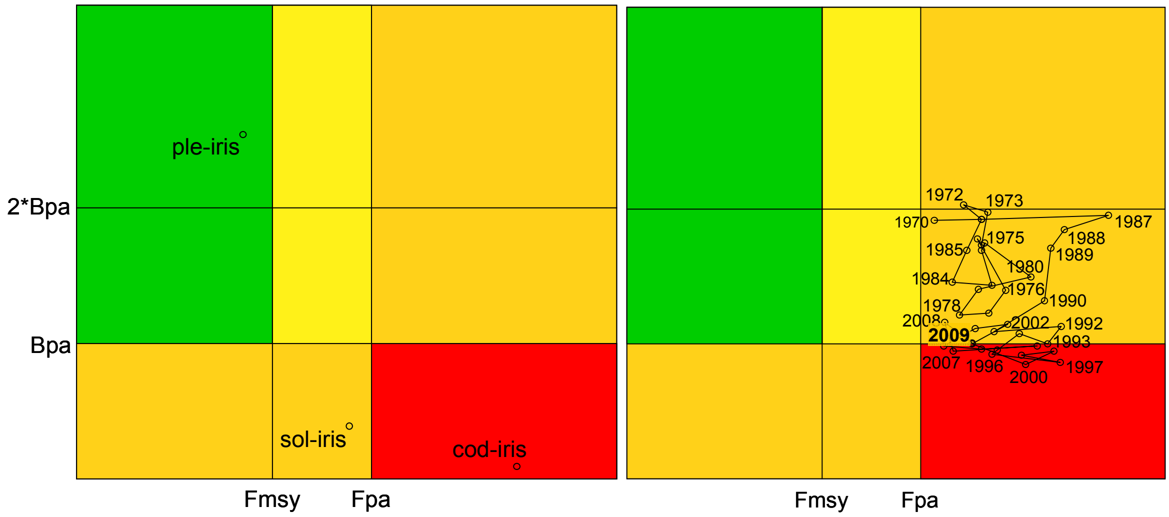


Figure 8.5 *Stock status in 2010 for the assessed stocks used in the meta-analysis for which reference points have been defined (left panel) and time-trend for the amalgamated stock status for the assessed stocks used in the meta-analysis for which reference points have been defined (right panel).*

8.3 Trends in environmental and ecosystem indicators

8.3.1 Environmental indicators

The environmental indicators of hydrological and chemical conditions based on data in the ICES hydrographic database for the Irish Sea are described in detail in Annex 17.4.

There is no apparent trend in the surface temperature records in the Irish Sea from the 1950 to 2009 (Figure 8.6 top). There is also no long term trend in salinity although a period of reduced salinity was observed during the 1980's. Further analysis is required on these datasets since other published reports suggest that winter-spring and annual average SSTs in the Irish Sea have increased since the mid-1990s (Plangue and Fox, 1998; Heather et al. 2009). Differences between these sources may reflect temporal and spatial biases in sampling in the ICES database.

Salinity dominates the long term trend in PC1 of the hydrological conditions of the Irish Sea (Figure 8.6 middle). In parallel of the salinity trend, the hydrological conditions show a 'negative' trend during the 1980's followed by a 'positive' trend in the 1990's.

Nitrate concentrations dominate the trend in PC1 of the chemical conditions for the Irish Sea (Figure 8.6 bottom). A general 'positive' trend in PC1 is observed over the course of the time series with a sharp increase in the mid-1980's, a decrease in the late 1990'sand a progressive return to the long term trend in the late 2000's. The trend in nitrate concentrations calculated for the whole Irish Sea is in agreement with results from consistent sampling at long term monitoring stations in the Isle of Man and Menai Straight (Evans et al. 2003; Gowen et al. 2008).

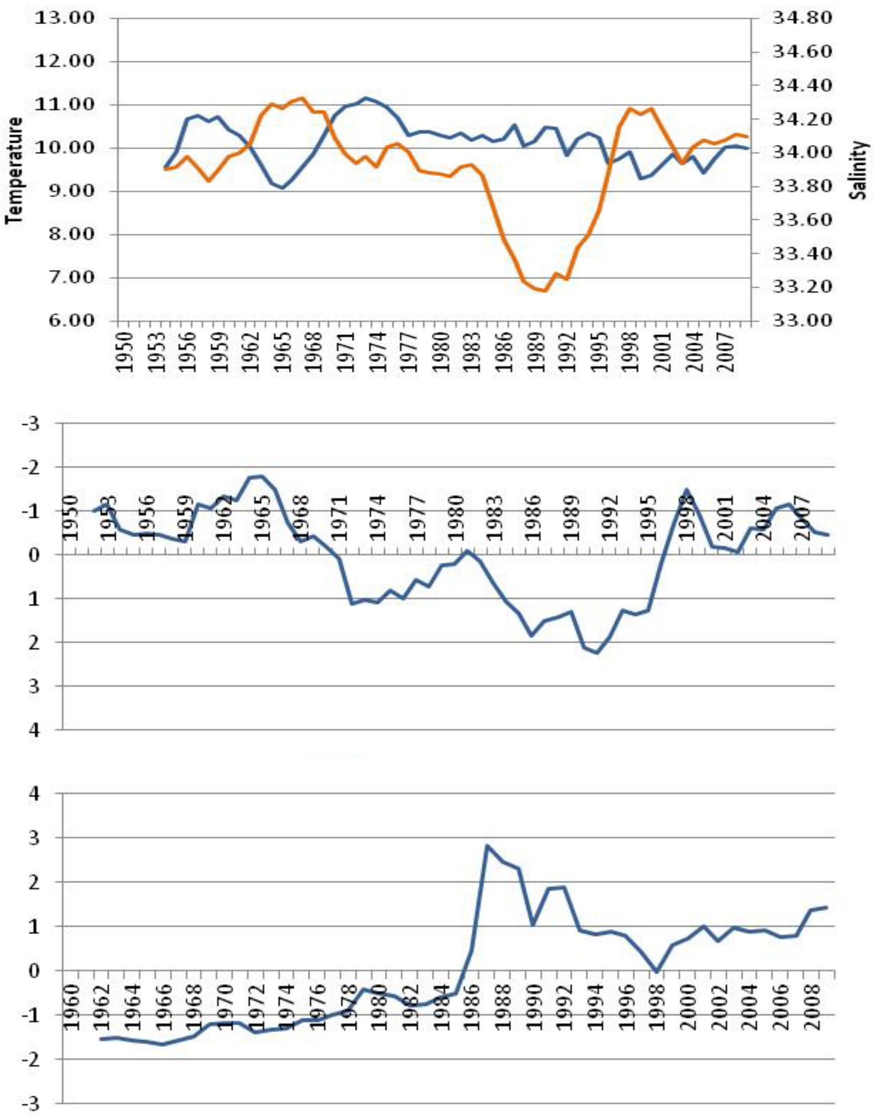
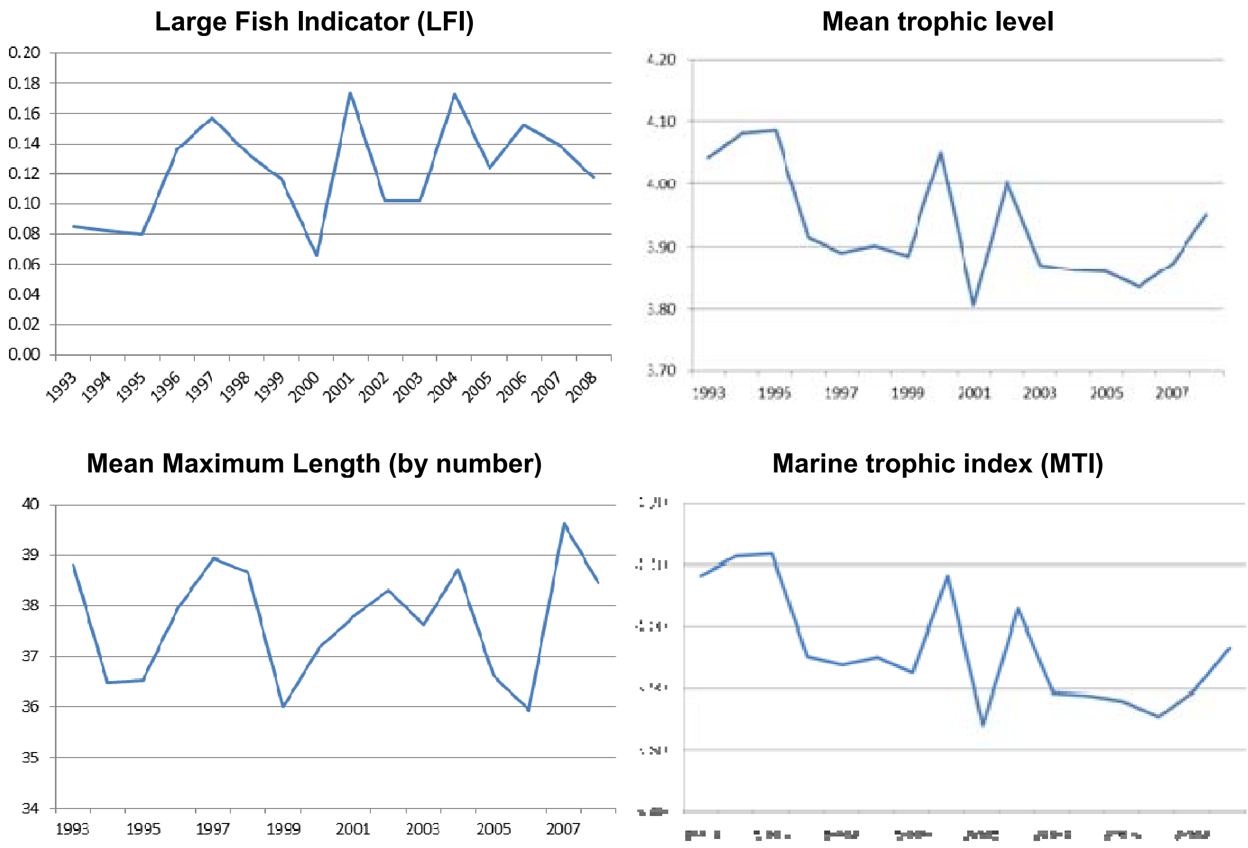


Figure 8.6 *Trends in environmental indicators for the Irish Sea region. Top: salinity (in red) and temperature (in blue) (5-year moving average). Middle: hydrological conditions (PC1 scores as a c3-year moving average). Bottom: chemical conditions (PC1 scores as a 3-year moving average).*

8.3.2 Ecosystem indicators

The ecosystem indicators based on the Irish Sea surveys fluctuated throughout the time series. Two of the five indicators (the large fish indicator LFI and the mean maximum length of fish in weight MMLw) show a slight increase over the course of the time series although the increasing trend is substantially lower than the high frequency variation. In contrast the mean trophic level MTL and the marine trophic index MTI show a general declining trend.

It should be noticed that these indicators have very low absolute values with a proportion of large fish (LFI) below 12%onaverage, and a mean maximum length of about 46 cm



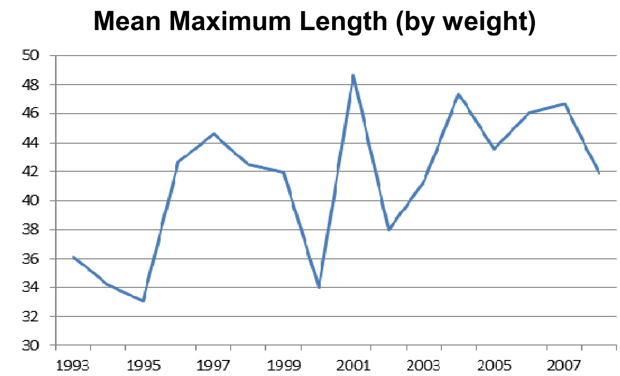


Figure 8.7 *Ecosystem indicators for the Irish Sea, based on the English Irish Sea survey*

The ecosystem indicators based on landings exhibit different trends (Figure 8.8). The MTL and MTI were generally stable between 1950 and the mid-1980's followed by a period of decline until the end of the time series, with a higher decrease for MTL compared to MTI. Over the same period the MML index generally increased between the 1950's and the early 1980's to reach a plateau and declined then after the mid-1990's.

The decline in the MTL is probably due to the increase in low TL landings in the 1990s, while the increase in the MML is due to the change of main landings from mackerel to horse mackerel.

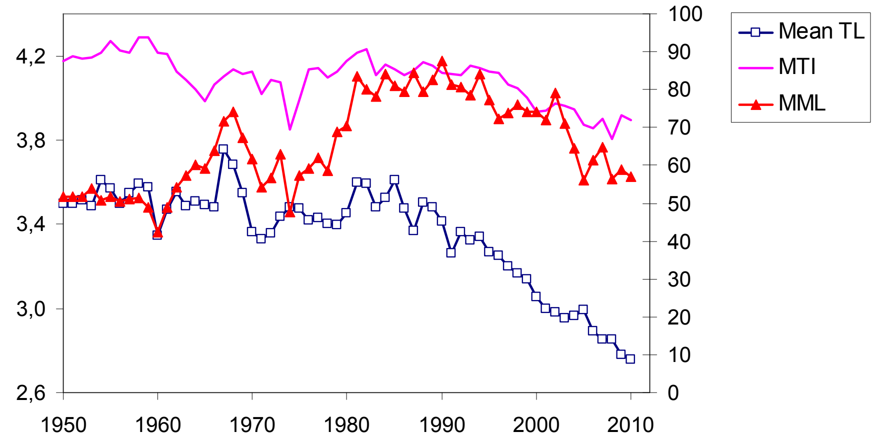


Figure 8.8 *Landings based indicators of system status in the Irish Sea: mean trophic level of all landings, marine trophic index (average trophic level of landings with TL > 3.25) and mean maximum length by weight.*

8.4 Fleet-based synthesis

8.4.1 General results

The Irish Sea ecosystem as defined in this section comprises ICES sub-area VIIa. In economic terms, it should be noted that the southern boundary of the Celtic Sea area at latitude 52°00' N includes the important Irish harbour of Kilmore East in which large vessels fishing in the Celtic Sea are landing.

The fishery is populated by vessels from the UK (England, Scotland, Wales, Northern Ireland, and Isle of Man), Belgium, The Netherlands and France. The contribution to total supplies of raw fish products is low in general so that the impact of landings on quayside prices can safely be assumed to be nil (AER, 2011). Exceptions to this are Norway lobster (*Nephrops*) and scallops (*Pecten maximus*)for which the Irish Sea is an important source both in terms of quantity and quality (Figure 8.9).

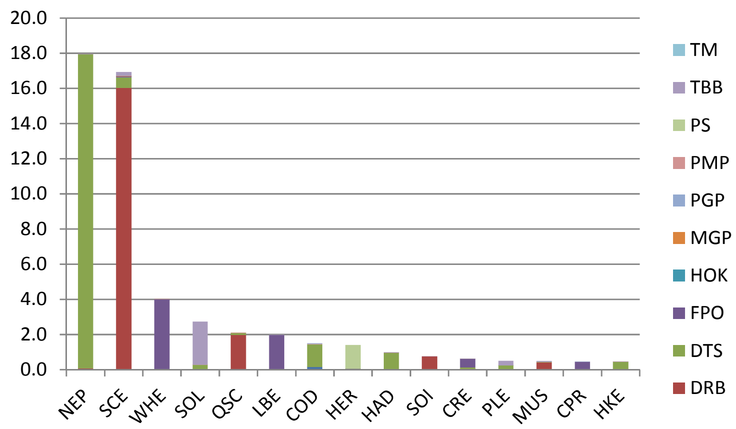


Figure 8.9 *Contribution of Individual Stocks to Vessel Earnings in the Irish Sea, 2009*

The weight and value of total landings in the Irish Sea show no specific trend but marked increases occurred in 2007 and 2008mostly due to changes in the DCF reporting arrangements (Figure 8.10). The figure from the Irish and UK fleets highlight a general but uncertain decline of the fishery in the recent years but there is little corroborating evidence for this from the other fleets. The UK and Irish fleets are the most important with gross values of 38m€ and 17m€ in 2009 respectively. French demersal trawlers and Belgian and Dutch beam trawlers represent a minor contribution and there is anecdotal evidence that they are fishing less intensively in the Irish Sea in recent years due to the costs of fuel.

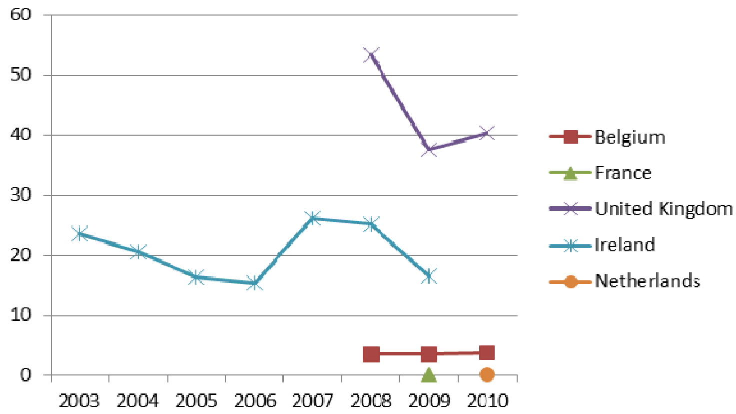


Figure 8.10 *Trends in the total value of landings by country in the Irish Sea*

These fleets seemed to show a slightly declining capacity to increase their landings value (Table 8.1). The apparent rise of the importance of fixed gears and purse seining is more likely to result from the improvement in data collection although, from 2008, the slow downward trend continues.

Table 8.1 *Relevant fleet segments in the Irish Sea in terms of landings weight and value*

Gear Type	2003 Volume (000t)	2003 Value (€m)	2004 Volume (000t)	2004 Value (€m)	2005 Volume (000t)	2005 Value (€m)	2006 Volume (000t)	2006 Value (€m)	2007 Volume (000t)	2007 Value (€m)	2008 Volume (000t)	2008 Value (€m)	2009 Volume (000t)	2009 Value (€m)	2010 Volume (000t)	2010 Value (€m)
Drift and fixed nets	0.8	0.3	1.9	0.5	1.0	0.3	0.8	0.4	0.4	0.9	0.7	1.2	0.4	0.5	0.2	0.1
Dredges	0.6	0.8	0.6	1.1	0.5	0.7	0.7	1.1	0.8	2.7	16.9	23.6	13.0	19.5	17.1	16.8
Demersal trawl / seine	6.8	8.7	7.7	7.8	6.7	6.7	4.5	6.1	5.1	12.3	16.1	37.9	14.1	24.0	9.4	16.3
Fixed pots and traps	0.2	0.1	0.2	0.1	0.3	0.2	0.7	0.4	0.5	0.2	8.0	12.2	6.8	7.4	4.3	5.7
Gears using hooks	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Polyvalent mobile gears	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Polyvalent passive gears	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Polyvalent mobile and passive gears	13.3	11.3	11.0	9.6	6.2	6.4	4.0	5.5	5.7	8.1	0.0	0.0	0.1	0.0	0.0	0.0
Purse seine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7	1.4	4.4	1.3	4.9	1.6
Pelagic trawl / seine	0.4	0.1	1.0	0.2	2.1	0.5	0.6	0.1	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Beam trawl	1.0	2.3	0.6	1.4	0.7	1.6	0.5	1.6	0.7	1.9	1.5	5.4	1.6	4.6	0.9	3.5
Pelagic trawl	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.3	0.0	0.0	0.2	0.1
All Gear Types	**23.1**	**23.6**	**23.0**	**20.6**	**17.4**	**16.4**	**11.9**	**15.3**	**13.6**	**26.2**	**48.2**	**82.1**	**40.4**	**57.6**	**36.8**	**44.1**

8.4.2 Economic performance of the most important fleet segments operating in the ecosystem

The economic indicators reported in the AER 2011 for the main EU fleet segments operating in the Irish Sea allow for a comparison of the dependency of the fishery on the Irish Sea ecosystem (Table 8.2).

Table 8.2 *Economic indicators of the 10 main fleet segments selected in the Irish Sea following the 2011 Annual Economic Report (AER 2011)*

FLEET SEGMENT	Number of vessels	FTEs	Energy consump-tion	Irish sea days at sea	Irish sea days at sea as % of total	Irish sea volume landed (Tons)	Irish sea volume landed as % of total	Irish sea Value landed (€ 1000)	Irish sea value as % of total value
BEL TBB VL2440	40	210	40 912	590	6%	814	6%	3226,5	7%
GBR DRB VL1218	62	153	5 363	1 816	22%	2 629	28%	3354,2	18%
GBR DRB VL1824	20	79	4 039	1 295	35%	5 340	53%	5233,4	42%
GBR DRB VL2440	24	132	6 890	1 073	20%	1 745	14%	3326,1	16%
GBR DTS VL1218	270	894	24 600	6 750	16%	3 677	15%	5546,8	12%
GBR DTS VL1824	221	1 143	50 671	6 742	17%	4 776	9%	7964,8	8%
GBR FPO VL0010		1 013	16 908	11 286	8%	1 064	6%	2627,4	5%
IRL DRB VL2440	30		4 882	206	46%	1 569	81%	3189,2	50%
IRL DTS VL1824	59	294	14 102	2 135	17%	2 394	15%	4768,1	16%
IRL DTS VL2440	27	203	13 848	670	11%	662	6%	1573,0	8%

FLEET SEGMENT	Direct subsidies (€1000)	Total income (€1000)	Crew wages (€1000)	Gross value added (GVA) (€1000)	Operating cash flow (OCF) (€1000)	Profit / Loss (€1000)	Average wage per FTE
BEL TBB VL2440	728	48 630	14 813	18 509	4 423	-4 296	70 538
GBR DRB VL1218	650	20 420	5 152	10 518	6 016	4 677	33 775
GBR DRB VL1824	490	13 166	3 140	6 600	3 949	2 919	39 820
GBR DRB VL2440	835	21 727	5 356	10 531	6 010	3 239	40 534
GBR DTS VL1218	2 982	53 801	11 725	20 689	11 946	7 214	13 114
GBR DTS VL1824	6 142	108 373	23 880	38 912	21 174	7 551	20 888
GBR FPO VL0010	2 050	58 294	13 596	36 358	24 811	9 454	13 415
IRL DRB VL2440	22 694	42 759	11 373	14 151	25 473	19 120	
IRL DTS VL1824	0	26 948	7 639	10 162	2 523	-30 067	25 957
IRL DTS VL2440	11 236	36 990	4 633	12 217	18 820	7 874	22 839

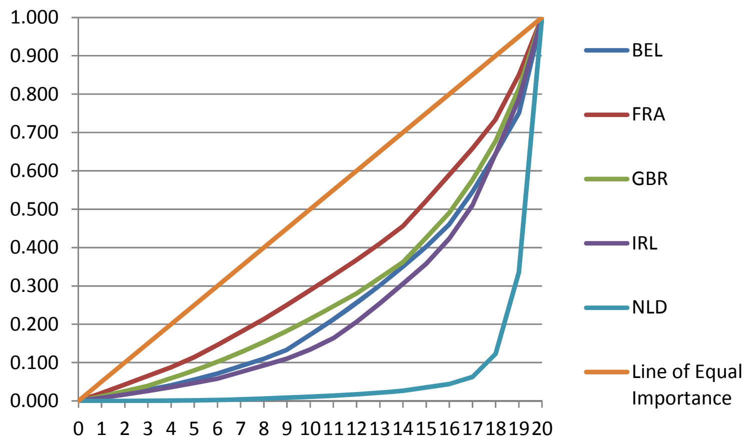
Unsurprisingly six of the top ten fleets fishing in the Irish Sea are from the UK and the vessels that have the highest gross value added are generally the largest in terms of vessel length.UK vessels<10 m and demersal trawlers/seiners are among the top earners. The profitability of the fleets is extremely variable and frequently reflects the level of direct subsidies. Three of these top-earning fleets would show losses without subsidies.

The dependency by flag of the fleets fishing in the Irish Sea may be illustrated by the Lorenz Curves adjusted[2] to 20 species and is shown in Figure 8.11.The Rodgers-Bertram Coefficients[3] for fleet dependency are reported on the figure.

The closer RB20 coefficients from 0.5, the higher spread of species providing income to the fleets. The spread is thus reasonable for the fleets involved except for the Dutch fleet which depends on only five key species for their income and will therefore be vulnerable to negative changes in stock sizes and TACs in those stocks.

[2] The method is set out in Rodgers P and Bertram P (1999) Dispersion of Revenue in Mixed Fisheries, *Marine Policy*, 23, 1, 37-46.

[3] Rodgers P and Bertram P (1999) *op cit*. The value of the coefficient lies between 0 which indicates equal dependency on all species and 1 which indicates complete dependency on a single species.



	BEL	FRA	GBR	IRL	NLD
RB20	0.776	0.747	0.709	0.674	0.932

***Figure 8.11** Lorenz Curves adjusted to 20 species for the Irish Sea.*

8.4.3 Ecological indicators of fleet segments

- Partial F: Impact of the selected fleet segments on the fishable fraction of the ecosystem

The UK medium size bottom trawlers have the largest impact on the fishable fraction of the Irish Sea ecosystem with a cumulative partial F higher than 0.7 mainly in relation to the cod exploitation (Figure 8.12). Irish and other UK demersal trawlers also impact the cod stock with partial fishing mortalities comprised between 0.1 and 0.22 while the Belgium beam trawlers 24-40 m mostly impact sole. The fishing mortality on assessed stocks is null for the other segments. Nevertheless, note that the three fleets with no values do have an impact but is not shown since the stocks they target are not assessed – DRB are dredgers and FPO vessels using pots or trap.

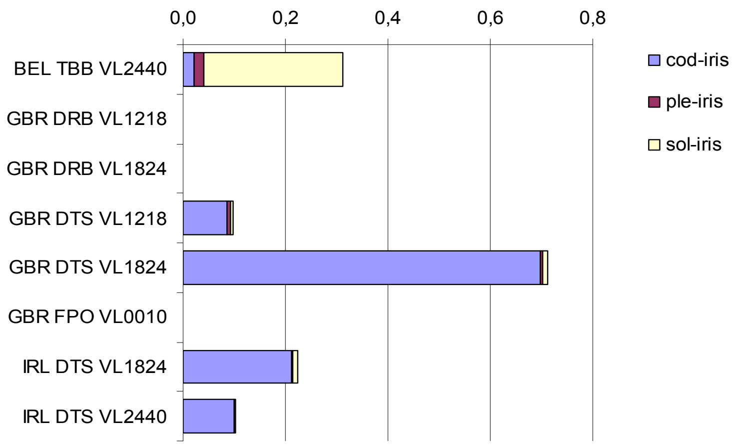


***Figure 8.12** Partial fishing mortality by gear for the Irish Sea most important gears (note the three null values correspond to non-assessed stocks, thus no F* can be computed).*

- Sustainability index of the selected fleet segments

The sustainability index of fleet segments operating in the Irish Sea ecosystem are only based on the 3 stock assessments for which F and B limits are known (see Figure 8.5). Note that most of the major fleet segments are mostly not dependent on the Irish Sea. Thus only 3 fleet segments for which more than 10% of their 2009 landings in value come from the assessed stocks are presented on the graph (Figure 8.13). The Irish bottom trawlers are characterised by a poor sustainability index in relation to their landings of the highly overexploited cod stock. Belgium beam trawlers show an intermediate sustainability index due to their exploitation of sole.

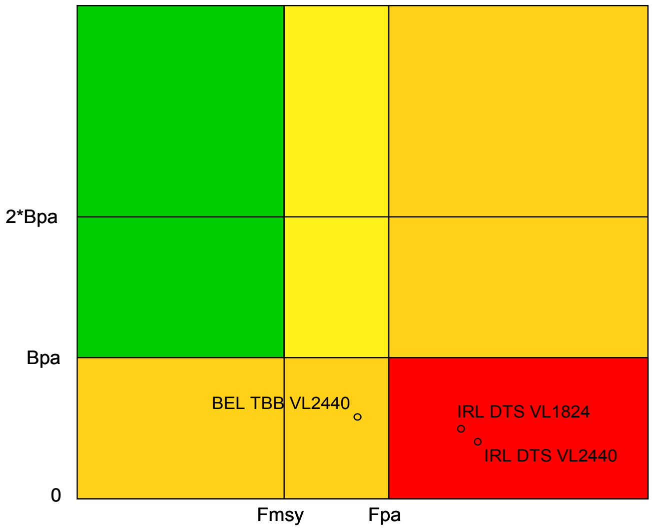


Figure 8.13.*Sustainability index of the selected fleets operating in the Irish Sea: standardized fishing mortalities F* and biomass B* for assessed stocks (cf. figure 8.5)*

- Index of the fleet segments impact on the food web and habitat

Among the selected fleet segments, the highest impact on the food web (based on the required primary production) arises from the medium size UK bottom trawlers (Figure 8.14) due to their large catch of a high trophic level species (cod). This fleet segment is logically the most impacting the sea floor. The habitat impact index is also high for the small demersal trawlers due to a high large fishing effort.

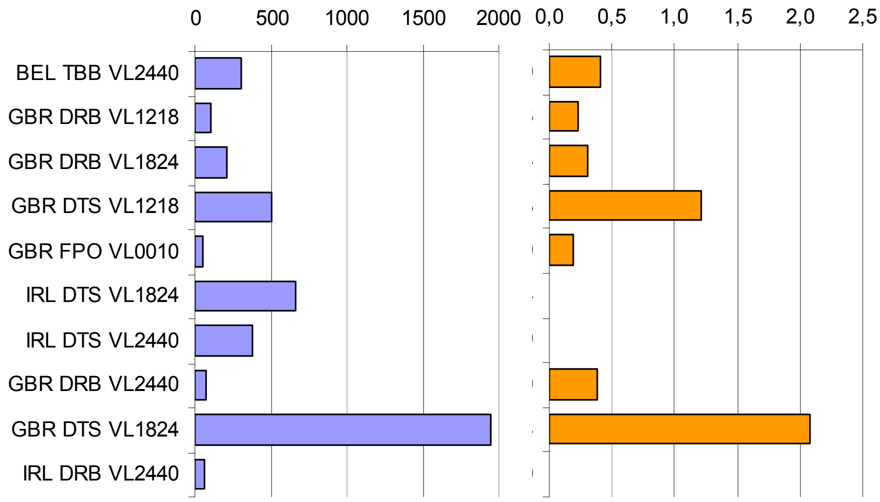


__Figure 8.14.__ Ecological index for the main fleet segments operating in the Irish Sea ecosystem. Left: food web impact index (required primary production, 10^6 wet tons/year); Right, habitat impact index (values for Irish fleets are missing)

8.4.4 Synthesis and conclusion of the fleet synthesis

The UK dredgers segment is rather small, is relatively profitable with low subsidies and has low ecological impacts. Similarly the Belgian and Irish dredgers also show a high profit and low subsidies with little ecological impact. The highest ecological impact in terms of on seabed habitat, food web and fishing pressure occurs for the 18-24 m UK demersal trawlers. The segment with the highest ecological impact in terms of biomass and fishing mortality is the Irish demersal trawlers.

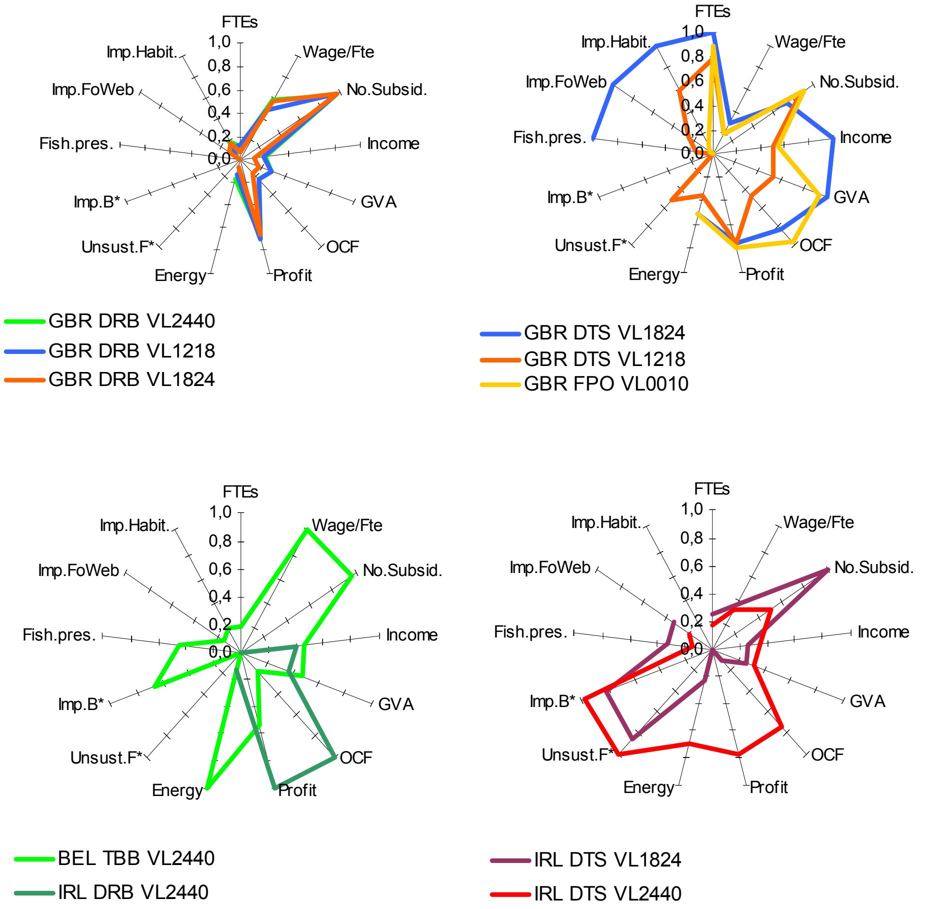


***Figure 8.15** Ecological impact index, and socio-economic performances of the main fleet segments operating in the Irish Sea*

8.5 Summary of the Irish Sea results

The Irish Sea is semi-enclosed so that there is relatively more impact from coastal run-off compared with the other considered ecosystems in this report (excepting the Baltic Sea). This is reflected in nutrient enrichment in some areas of the Irish Sea although it has been argued that this has not led to undesirable disturbance of water quality (eutrophication). As elsewhere, the sea temperature in the

Irish Sea increased over the last decades and was suggested to influence the recruitment success of cod and plaice. This hypothesis however remains speculative and underlying mechanisms were not clarified. The evaluation of the ecosystem relations to the fish stocks is hampered for this ecosystem by the low number of species for which the analytical stock assessment was derived. For some of the species, e.g. plaice, uncertainties in the assessments are large due to the high and variable levels of discarding (although study programs make attempts to remedy to this data deficiency), whilst for other stocks of importance in this ecosystem (e.g. *Nephrops* and scallops), the full analytical assessment methods are either not available or not applied. The failure of the cod stock to show signs of recovery is of particular concern in this ecosystem.

As a result, the ecosystem indicators exhibit controversial signals (Figure 8.16). While the fishing pressure is globally decreasing, the spawning biomass and the recruitment index are strongly deteriorating. The index related to the structure of demersal communities or landings does not exhibit any clear trend which suggests that the ecosystem show signs of recovery from a heavily exploited state.

Landings Y	Effort E	Mortality F	Biomass SSB	Recruit. R	Sustain. F*	Survey LFI	Survey MMLw	Survey MTL	Landing MMLw	Landing MTL
↘	↘	↘	↘	↘	?	→	↗	↘	→	↘

Figure 8.16. *Trends in the main indicators of the Irish Sea ecosystem health*

Even if the fleets fishing on this system show some profitability focusing on stocks that are below the target limits for fishing mortality and biomass, their impact on the seabed habitat, primary production and food web are substantial.

9 Celtic Sea (ICES Divisions VIIe-k)

9.1 Long term trends in landings and fishing effort

Total landings in the Celtic Sea from the ICES Statlant database are estimated to be about 50,000 tonnes in 1950 and remained below 200,000 tonnes until the late 1960s (Figure 9.1). Nevertheless, it should be noted that there is missing data prior to 1977 due to the lack of aggregation of the French catch data by ICES Division. In addition Russian vessels targeting mackerel were operating in the area prior to the 1970s and it remains unclear if these landings were included in the statistics.

During the early 1970s, the reported landings sharply increased mostly in relation to the arrival of the Soviet Union fleet and their catches of mackerel and horse mackerel. The maximum reported total catches were of 760,000 t in 1976 just before the establishment of the European common waters in 1977 and the departure of the Soviet and Spanish fleets from the Celtic Sea. Total catches showed important variations since the mid-1970sfrom 250,000 t (1985) to 570,000 t (1995). Over the last three decades, countries involved in the exploitation of small pelagic species (Denmark, The Netherlands and Norway) increased their catches. Total landings showed lower levels to about 400,000 t 1999-2008 followed by a recent increase to reach nearly 500,000 t in 2010.

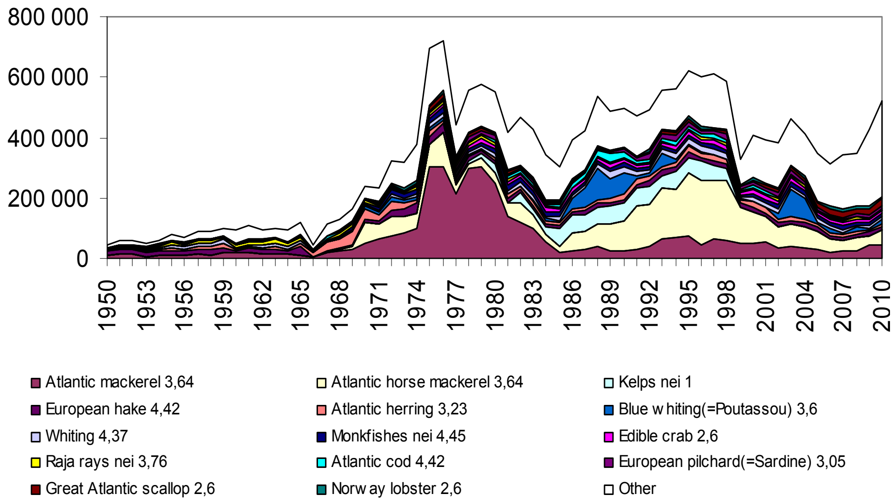


Figure 9.1. *Trend in the landings on the Celtic Sea between 1950 and 2010 from STATLANT (Note that data prior to 1977 might be incomplete)*

Total fishing effort in the Celtic Sea ecosystem remained fairly constant from 2003 and 2007 (Figure 9.2). Since then the effort apparently declined (except for 2009) but this may be due to a change in data reporting since 2008, from kW days at sea to kW fishing days. The main historical effort arisen from the demersal trawl and seine gears but it declined in 2010 to better balance between gear types with dredges, fixed pots and traps and long-lines.

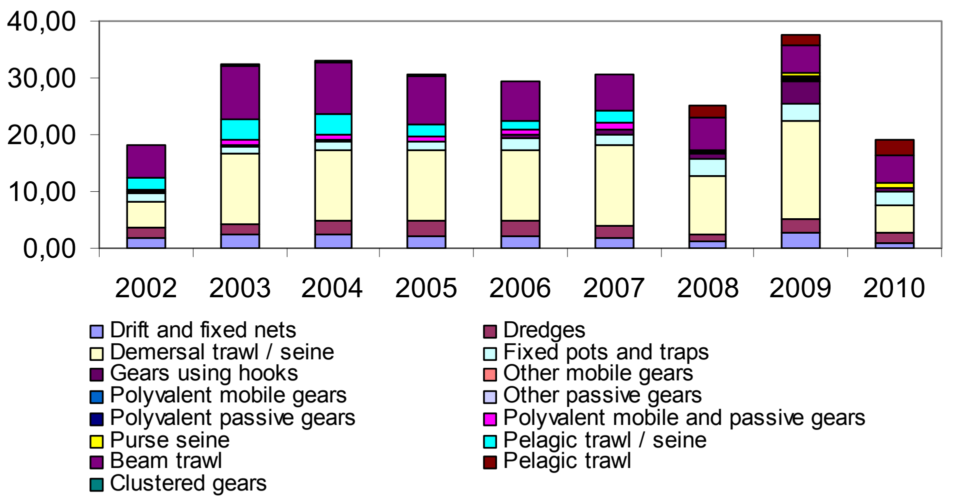


Figure 9.2 *Changes in fishing effort per gear from 2002 to 2010 for the Celtic Sea(kW days at sea in millions).*

9.2 Stock synthesis

9.2.1 Proportion of assessed stocks in the landings

The proportion of the reported landings coming from stocks with analytical stock assessments in the Celtic Sea ecosystem generally increased from 1950 up to 2000 at about 70% (Figure 9.3). Since then that proportion decreased to reach about 35% in 2010. The reasons for this are unclear but it may reflect a higher diversity of species being caught in this ecosystem and the challenges to perform stock assessments for certain species (e.g. anglerfish, megrim).

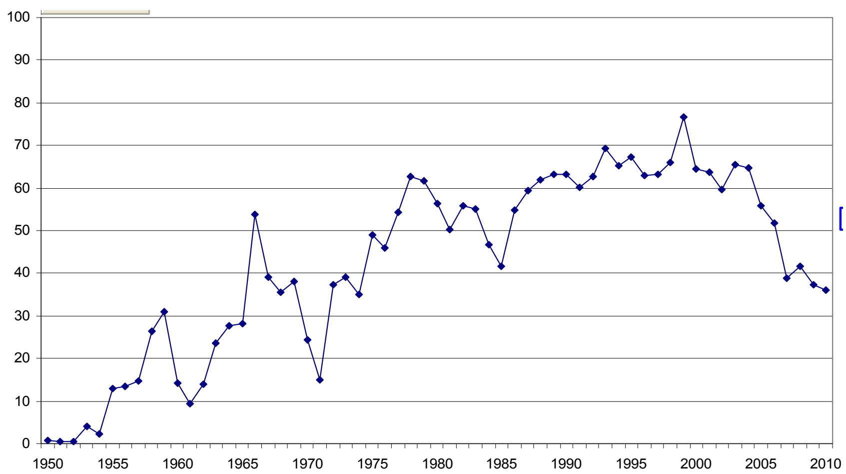


Figure 9.3. *Percentage of total landings by weight coming from stocks with analytical stock assessments.*

Sixty stocks which are assessed by ICES are caught in the Celtic Sea (Figure 9.4). Seven of them are entirely from the Celtic Sea and for five other stocks a large proportion of catches is originating from it. On the opposite, stocks such as blue whiting, mackerel, horse mackerel and northern hake largely spread across other ecosystems.

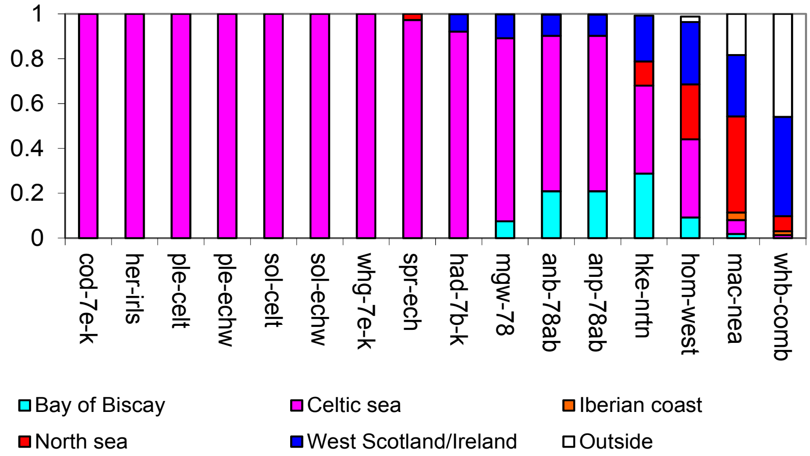


Figure 9.4. *Spatial extent of the stocks in the Celtic Sea (in % of volume landed within each ecosystem for the 2000-2010 period)*

9.2.2 Stock status meta-analysis

The trends in landings and SSB indices substantially differ when calculated using 8 or 11 stocks (Figure 9.5) while the addition of more stocks has relatively minor effect on these patterns. The trend in the aggregated landings of the Celtic Sea increased up to the mid-1990s followed by a steady decline until 2005 reflecting the changes in catches of horse-mackerel (hom-west, see also Table 9.1).

The 11-stock SSB aggregated index shows an initial increase until 1990 followed by a decline to 2000 and another increase since then but only at a level to about half the earlier peak (Figure 9.5). Here too this pattern reflects changes in horse-mackerel SSB.

The patterns for the mean F and recruitment indices seem to be relatively consistent whatever the number of stocks taken into account is. The aggregated F index shows a slight increase from 1980 to 2000 but substantially declined since then from more than 0.50 to the minimum at about 0.25 in 2009.

The aggregated recruitment index prior to 1980 is likely not to be reliable since only based on 4 species. After 1980, although showing large fluctuations the aggregated index for recruitment slightly increased until 1987, and show a declining trend since then.

Table 9.1 *Groupings of stocks in the 4, 8, 11 and 15 stock combinations shown in Figure 9.4*

Celtic Sea Grouping	**Stock**
4 stocks	"cod-7e-k" "her-irls" "sol-celt" "sol-echw"
8 stocks	Idem + "hke-nrtn" "mac-nea" "ple-echw" "whb-comb"
11 stocks	Idem + "hom-west" "ple-celt" "whg-7e-k"
15 stocks	Idem + "anb-78ab" "anp-78ab" "had-7b-k" "mgw-78"

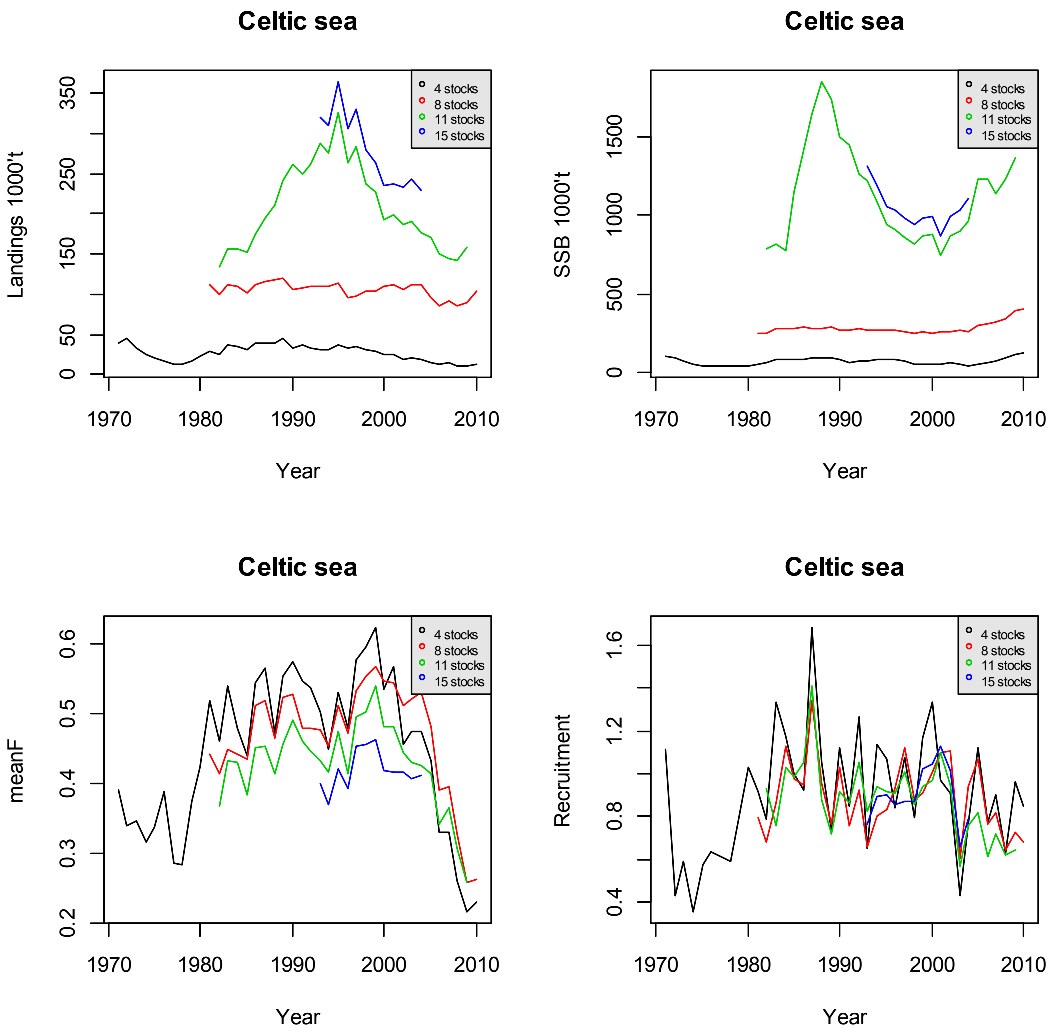


Figure 9.5. *Trends in the aggregated index on stock status in the Celtic Sea ecosystem: total landings (top left), total SSB (top right), mean F (bottom left) and recruitment index (bottom right). See table 9.1 for the list of stocks included in each group.*

9.2.3 Overall stock status in relation to reference points

None of the five stocks for which reference points were defined is located in the critical zone (in red) but F* remains high on mackerel and above the precautionary level for plaice-echw (Figure 9.6 left). The time-trend (Figure 9.6 right) indicates a decrease in the combined F since 2003 suggesting a trend towards sustainability. The combined index however hides the poorer performance of some components such as cod-7ek where SSB remains lower than desirable.

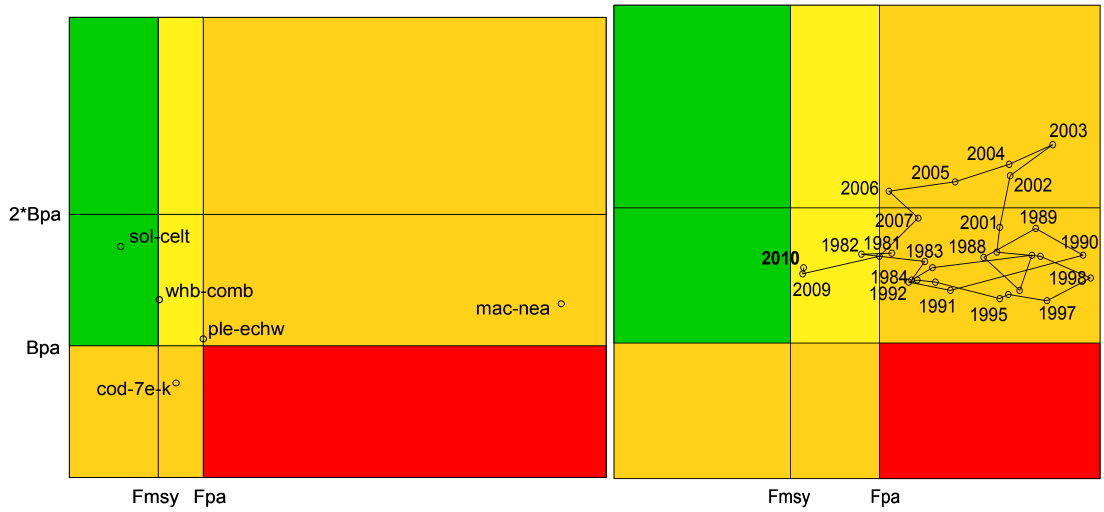


Figure 9.6. *Stock status in 2010 for the assessed stocks used in the meta-analysis for which reference points were defined and time series were available for the combined stock status.*

9.3 Environmental and ecosystem indicators

9.3.1 Environmental indicators

The environmental indicators of hydrological and chemical conditions based on data in the ICES hydrographic database for the Celtic Sea are detailed in Annex 17.4.

The surface water temperature in the Celtic Sea shows a sudden decline at the start of the 1980's followed by a sharp increase in the early 1990's and a general positive trend since then (Figure 9.7). Surface salinity fluctuated around an increasing trend until 2000 followed by a decline to the 1950s levels in the recent years.

The hydrological condition index shows a negative anomaly in the 1950s, a large positive anomaly during the period 1971-2001 and back to a negative state since then. Salinity and the AMO (which are negatively correlated) dominate the trend in the hydrological conditions.

Winter surface levels of nitrate, phosphate and silicate all showed a general increasing trend until 1997. Concentration levels for the three chemical components substantially decreased in the period 1997-2002 (by 20 to 50%) to become fairly stable since then at the early 1990s levels. Nitrate showed in particular an approximate 400% increase over this period and this may simply reflect some bias in the sample numbers and data. However the general trend of increasing concentration during the 70's, 80 and early 90's followed by a decreasing trend from the late 90's is likely to correspond to reality as this trend has been seen in other regions, but the absolute values as presented here are probably inaccurate.

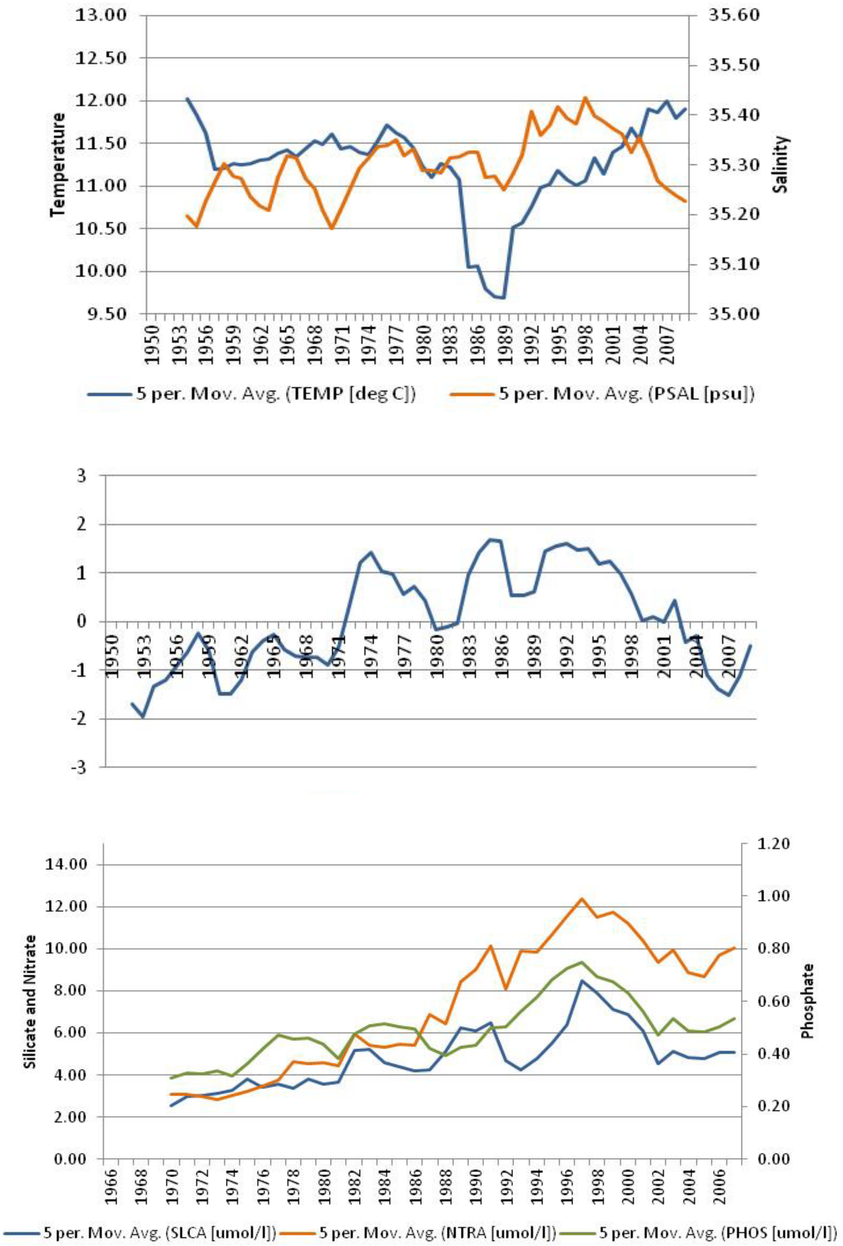


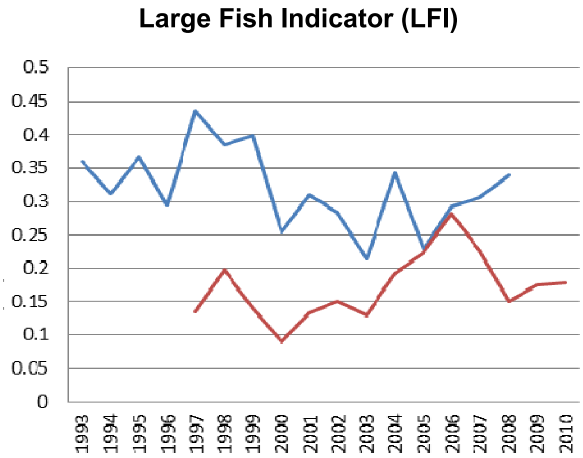
Figure 9.7. *Trends in environmental indices in the Celtic Sea. Top: salinity and temperature (5-year moving average); middle: hydrological conditions (PC1 scores as a 3-year moving average); bottom: Nitrate and phosphate average concentrations.*

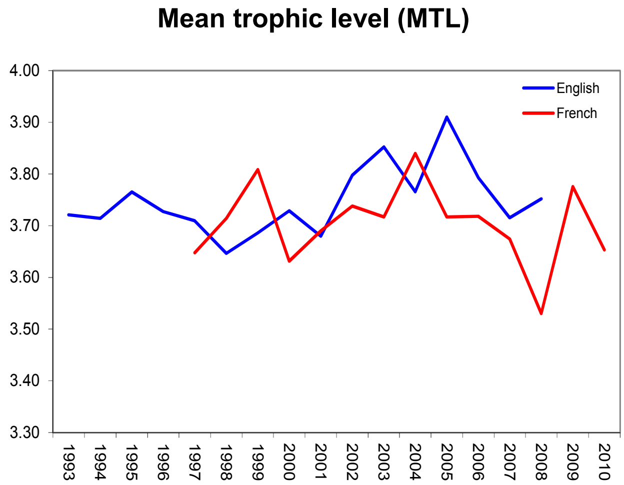
9.3.2 Ecosystem indicators

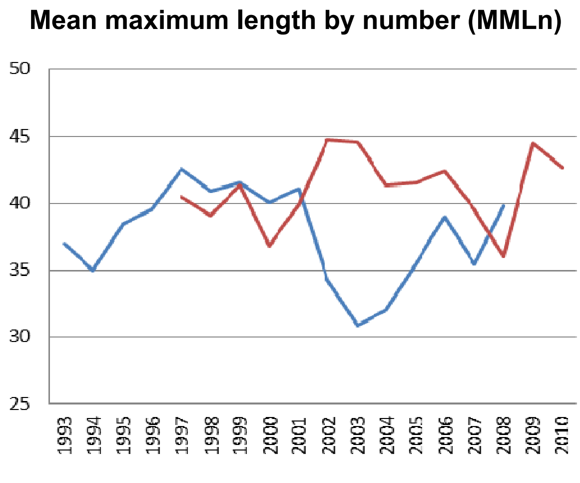
The large fish indicator (LFI) differs somewhat when calculated from the English and the French surveys (Figure 9.8). However, the LFI in both survey datasets shows a high variability with no significant trend over time. Previous comparisons of the French and English surveys in the Celtic Sea found that whilst both surveys can provide different pictures of a single population, they show similar trends for the whole community metrics (Trenkel et al 2004).

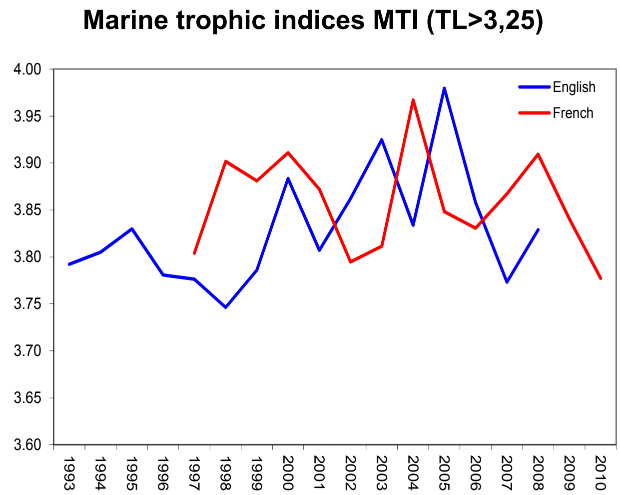
No general trend is showed in either the mean maximum length estimated by number (MML_n) or by weight (MML_w) for both the English or French Celtic Sea surveys over the time period. Both the

MMLn and MMLw in the English survey declined during the early 2000’s followed by an increase to previous levels, but the French survey shows an opposite signal of an increase in the early 2000’s.









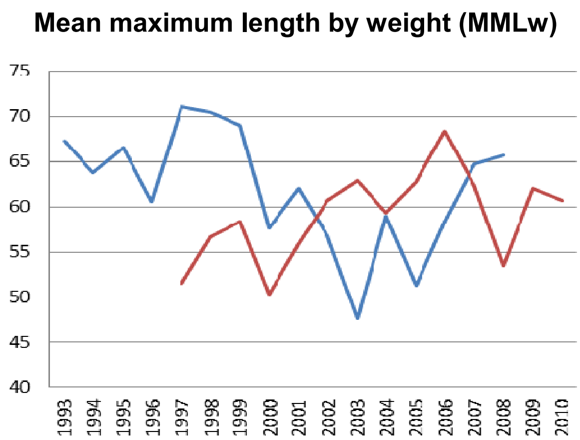


Figure 9.8. *Ecosystem indicators in the Celtic Sea from the English Celtic Sea survey (blue) and French EVHOE survey (red).*

As with the MML indicators, no consistent trend is observed in the mean trophic level MTL nor the marine trophic index MTI for both the English or French surveys over the time period. These indices appear to be dominated by the inter-annual variability which somehow may reflects variance in survey estimates.

The index of mean trophic level (mean TL), the marine trophic index (MTI) and the index of mean maximum length of landings (MML)all show a consistent decline between the 1950s and late 1970s (Figure 9.9). After an increase in the early 1980s, MML and MTI show a fairly stable trend since the early1980s in agreement with the community pattern observed by the survey indices (see above). However, the mean TL of the landings shows a steady decline since 1990. Since this is not reflected in either landings or survey metrics, this decrease of mean TL is likely driven by an increase in the same proportion of landings of low trophic level pelagic species.

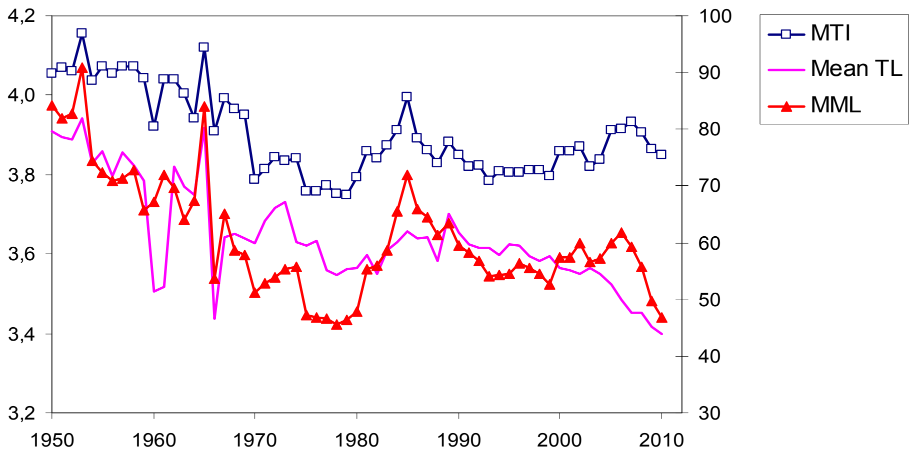


Figure 9.9.*Landings based indicators of the Celtic sea system status: mean trophic level of all landings (MTL), marine trophic index of landings (MTI trophic level of fish with TL > 3.25), mean maximum length MML by weight.*

9.4 Fleet-based synthesis

9.4.1 General results

The Celtic Sea fishery is largely international with vessels from the United Kingdom, France, Spain, Ireland, Belgium, The Netherlands and Denmark (Figure 9.10).The contribution of the Celtic Sea to the total supplies of raw wild fish products is generally low so that the impact of landings on quayside prices can safely be assumed to be negligible. The spread of species landed is broad, creating low dependency on individual species, but monkfish, scallops (*Pecten maximus*), mackerel and Norway lobster are dominant.

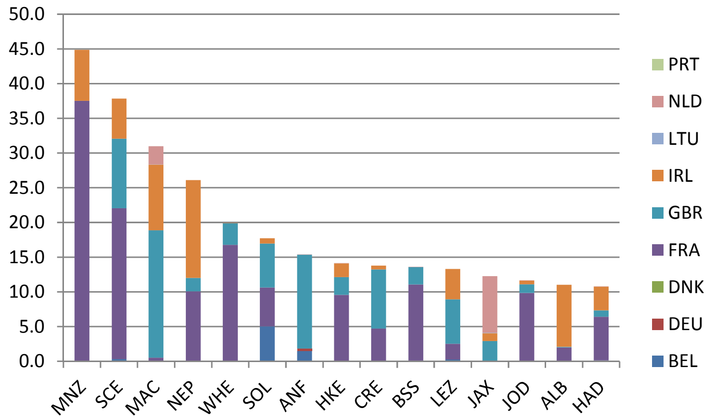


Figure 9.10. Contributions of Individual Stocks to Vessel Earnings in the Celtic Sea, 2009

The trend in total landings by weight and value from the national fleets in the Celtic Sea shows a slight general increase. However this pattern is mostly affected by a sharp increase in the reported weights and values for 2008 and 2009 in relation to changes in the DCF requirements rather than from a genuine trend (Figure 9.11).The presence of Lithuania in the list appears as anomalous but its contribution is nevertheless low compared to landings from France at 237m€, the UK at 111m€, and Ireland at 77m€.

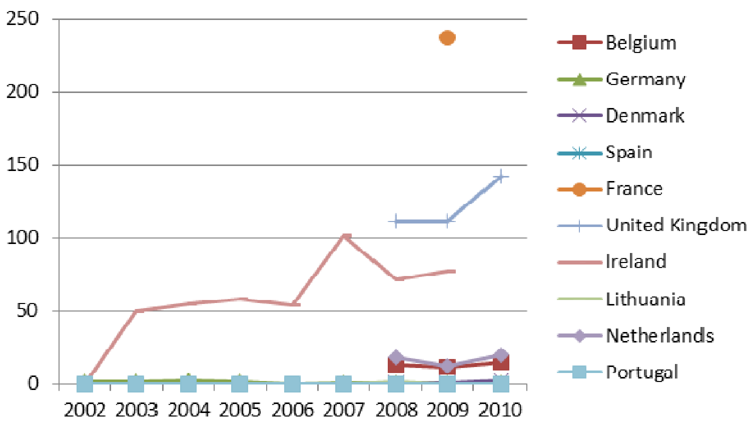


Figure 9.11.*Trend in the total value of landings by country in the Celtic Sea*

The variety of fishing methods used reflects the diverse nature of these fisheries (Table 9.2). The data for 2010 appears to be incomplete and must be disregarded. Demersal trawling/seining and pelagic trawling are the most important gears although most methods show a sharp positive trend in values and weight between 2008 and 2009. Note that this trend is at least partially caused by improvements in data reporting of the fleets using gears associated with smaller vessels. Note also the Spanish fleet is missing due to the data unavailability.

Table 9.2. *Relevant fleet segments in the Celtic Sea in terms of landings weight and value*

	2002		2003		2004		2005		2006		2007		2008		2009		2010	
Gear Type	**Volume (000t)**	**Value (€m)**	**Volume (000t)**	**Value (€m)**	**Volume (000t)**	**Value (€m)**	**Volume (000t)**	**Value (€m)**	**Volume (000t)**	**Value (€m)**	**Volume (000t)**	**Value (€m)**	**Volume (000t)**	**Value (€m)**	**Volume (000t)**	**Value (€m)**	**Volume (000t)**	**Value (€m)**
Drift and fixed nets	0.0	0.0	4.3	3.0	2.1	2.7	2.1	2.8	1.4	1.6	1.1	2.3	7.2	15.7	20.4	51.4	5.8	12.5
Dredges	0.0	0.0	1.0	1.5	1.2	1.8	0.9	1.6	0.4	1.1	0.4	2.0	6.2	13.6	26.0	33.4	8.4	13.7
Demersal trawl / seine	0.0	0.0	18.7	24.0	16.8	25.7	21.2	34.0	17.5	31.4	21.4	51.1	48.2	75.4	97.1	181.9	13.3	39.5
Fixed pots and traps	0.0	0.0	0.2	0.2	0.2	0.3	0.4	0.5	0.1	0.2	0.2	0.4	12.8	23.8	25.0	45.6	12.9	20.9
Gears using hooks	0.0	0.0	0.3	0.7	0.0	0.0	0.1	0.1	0.0	0.0	0.1	0.1	12.0	3.5	12.8	9.9	1.6	3.9
Other mobile gears	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
polyvalent mobile gears	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	3.7	5.2	0.9	0.3
Passive gears	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other passive gears	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0
Polyvalent passive gears	0.0	0.0	0.1	0.2	0.1	0.1	0.1	0.2	0.1	0.2	0.0	0.0	0.2	0.6	0.6	1.8	0.2	0.4
Polyvalent mobile and passive gears	0.0	0.0	5.4	9.5	6.8	13.2	2.4	5.6	5.0	10.1	5.7	20.4	0.2	0.3	12.8	12.4	0.0	0.0
Purse seine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.1	11.0	42.4	28.7	47.2	29.0
Pelagic trawl / seine	0.0	0.0	28.0	5.2	21.8	4.4	15.9	6.8	9.2	3.5	36.2	17.3	0.0	0.0	0.0	0.0	0.0	0.0
Beam trawl	0.0	0.0	2.6	5.5	2.9	6.4	2.7	6.7	2.2	6.3	2.1	8.1	12.7	43.6	11.4	35.1	11.3	38.4
Pelagic trawl	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	75.6	28.9	123.3	44.4	46.7	20.2
Clustered gears	0.7	1.5	0.9	1.4	1.0	2.0	0.5	1.1	0.0	0.1	0.1	0.6	0.1	0.4	0.1	0.5	0.1	0.3
All Gear Types	**0.7**	**1.5**	**61.6**	**51.2**	**52.9**	**56.7**	**46.3**	**59.3**	**35.9**	**54.5**	**67.1**	**102.2**	**193.4**	**216.8**	**375.6**	**450.7**	**148.34**	**179.1**

9.4.2 Economic performance of the most important fleet segments operating in the ecosystem

The economic indicators reported in the AER 2011 for the main EU fleet segments operating in the Celtic Sea allow for a comparison among the selected fleet segments (Table 9.3).

Table 9.3. *Economic indicators (2009) of the selected fleet segments in the Celtic Sea following the 2011 Annual Economic Report (AER 2011)*

FLEET SEGMENT	Number of vessels	FTEs	Energy consump-tion	Celtic sea days at sea	Celtic sea days at sea as % of total	Celtic sea volume landed (Tons)	Celtic sea volume landed as % of total	Celtic sea Value landed (€ 1000)	Celtic sea value as % of total value
BEL TBB VL2440	40	210	40 912	2 165	23%	2 399	19%	9 153	20%
GBR DTS VL2440	106	765	58 535	3 231	15%	4 596	7%	13 242	12%
GBR FPO VL0010		1 013	16 908	12 747	9%	5 033	26%	7 172	14%
GBR PS VL40XX	31			419	21%	27 947	10%	20 657	10%
GBR TBB VL2440	27	145	11 199	5 021	86%	5 063	80%	14 243	83%
IRL DTS VL1824	59	294	14 102	8 705	68%	11 256	69%	20 463	67%
IRL DTS VL2440	27	203	13 848	3 085	51%	4 973	46%	9 902	51%
IRL TM VL2440	14	98	5 464	697	50%	9 644	35%	9 090	53%
IRL TM VL40XX	21	224	25 002	908	42%	81 423	47%	15 633	26%
NLD TM VL40XX	13	502	86 809	397	18%	24 777	12%	11 006	14%

FLEET SEGMENT	Direct subsidies (€1000)	Total income (€1000)	Crew wages (€1000)	Gross value added (GVA) (€1000)	Operating cash flow (OCF) (€1000)	Profit / Loss (€1000)	Average wage per FTE
BEL TBB VL2440	728	48 630	14 813	18 509	4 423	-4 296	70 538
GBR DTS VL2440	7 096	116 514	25 689	34 824	16 231	527	33 593
GBR FPO VL0010	2 050	58 294	13 596	36 358	24 811	9 454	13 415
GBR PS VL40XX							
GBR TBB VL2440	1 358	26 866	3 961	-11 488	-14 092	-17 461	27 353
IRL DTS VL1824	0	26 948	7 639	10 162	2 523	-30 067	25 957
IRL DTS VL2440	11 236	36 990	4 633	12 217	18 820	7 874	22 839
IRL TM VL2440	7 292	29 422	6 627	12 799	13 464	7 812	67 627
IRL TM VL40XX	869	80 226	16 511	43 092	27 450	-4 122	73 708
NLD TM VL40XX	0	108 036	30 626	28 644	-1 983	-18 734	61 009

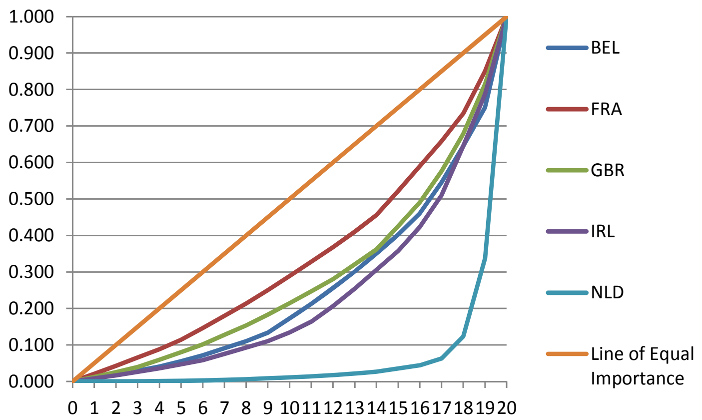
In the Celtic Sea fishery, the United Kingdom and Ireland each has 4 fleets in the list of the top ten earning segments. Note that French fleet segments did not provide economic results at the right disaggregated level and are thus not considered in this analysis. Generally the vessel size is large except for the UK below 10 m fixed pots and traps and 12-18 m demersal trawl/seine fleets. The profitability is generally poor and losses are not compensated for by direct subsidies. Only four fleets among the top ten earners returned to profit in 2009 while one bankrupted. Only two of the top ten would be profitable without subsidies (Table 9.3).

Fleets operating in the Celtic Sea exhibit on average a 20% dependency of the fishery for their sales revenue but the target species (mainly Norway lobster, scallops and crabs) and the location of the home ports of the smaller vessels make them highly dependent on that ecosystem. None of the reported segments is fully dependent but the top seven most dependent rely on the Celtic Sea fishery for two-thirds or more of their sales revenue. Sixteen fleet segments rely on the fishery for 50% or more of their earnings.

The dependency to the Celtic Sea of the fleets by flag can be illustrated using the Lorenz Curves adjusted[4] to 20 species (Figure 9.12).The Rodgers-Bertram Coefficients[5]used in that formulation show the extreme dependency of the Dutch fleet and particularly on few species (high level of the RB20 coefficient). This indicates that the Dutch fleet is very dependent on only a few key species for its income and will therefore be vulnerable to negative changes in stock sizes and TACs in those stocks. Otherwise lower coefficients indicate broader based landings and substantially less vulnerability.

[4] The method is set out in Rodgers P and Bertram P (1999) Dispersion of Revenue in Mixed Fisheries, *Marine Policy*, 23, 1, 37-46.

[5] Rodgers P and Bertram P (1999) *op cit*. The value of the coefficient lies between 0 which indicates equal dependency on all species and 1 which indicates complete dependency on a single species.



	BEL	FRA	GBR	IRL	NLD
RB20	0.484	0.317	0.431	0.524	0.878

Figure 9.12. *Lorenz Curves adjusted to 20 species for the Celtic Sea*

9.4.3 Ecological indicators of fleet segments

- Partial F: impact of fleet segments on the fishable fraction of the ecosystem

The main pressure exerted on the fishable fraction of the Celtic Sea ecosystem is due to the French middle size demersal trawlers (FRA DTS VL1824) with cumulative partial F higher than 0.7 (Figure 9.13). Impact is also significant for the larger French and Irish demersal trawlers (FRA DTS VL2440 and IRL DTS VL1824) and for some UK and Belgium beam trawlers (GRB TBB VL2440 and BEL TBB VL2440), with partial F higher than 0.2. Note that due to data unavaibility, only two of the important fleet segments for fishing impact are included in the list of the selected fleet segments based on landed values.

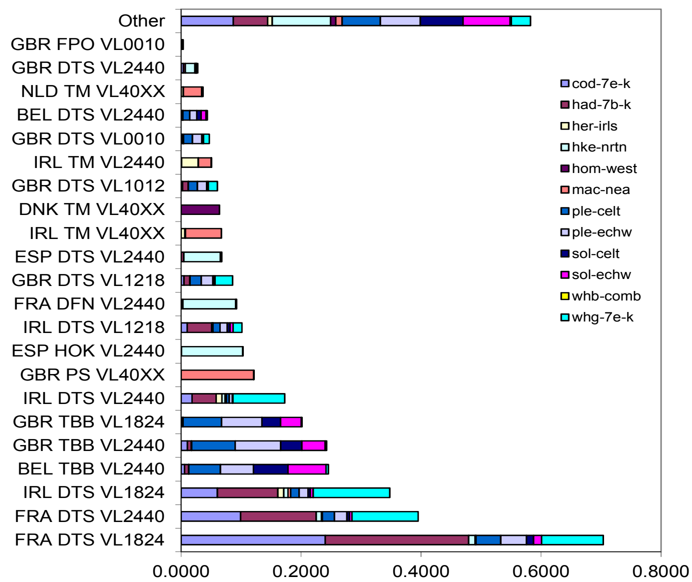


Figure 9.13. *Partial fishing mortality by gear for the Celtic Sea for the most important gears (>1% of total mortality applied across stocks).*

- Sustainability index of the selected fleet segments

Seven of the nine fleet segments considered in term of sustainability index are exploiting stocks which are not on average within the precautionary limits with either fishing mortalities F* higher than Fpa or biomass B* smaller than Bpa (Figure 9.14). Due to their high valuable landings of sole, UK and Irish beam trawlers exhibit a better sustainability index (green area).

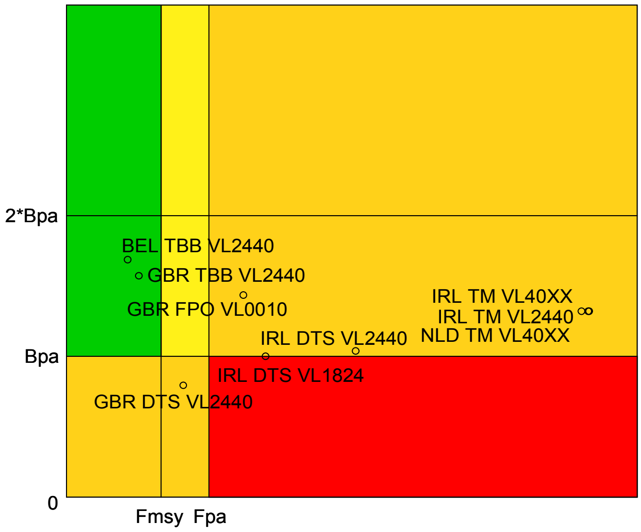


Figure 9.14. *Sustainability index of the selected fleets operating in the Celtic Sea: standardized fishing mortalities F* and biomass B* for assessed stocks (cf. figure 9.5)*

- Index of the fleet segments impact on the food web and seabed habitat

The index of the impact on food web (PPR) was calculated for the selected fleet segments and for the two French fleets which have the highest impact in term of partial fishing mortalities (see Figure 9.13). These two French fleets also appear to have the larger impact on the food web (Figure 9.15). Among the few segments considered for the seabed habitat index, the large UK beam trawlers are the only fleets with an index higher than 2.

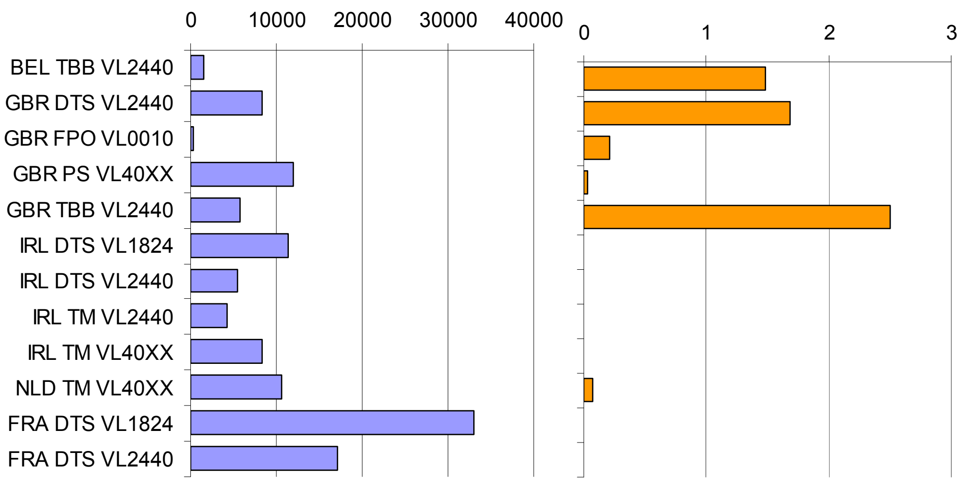


Figure 9.15. *Ecological index for the main fleet segments operating in the Celtic Sea ecosystem. Left: food web impact index (required primary production,* $*10^6$*wet*

tons/year); Right: index of seabed habitat impact (note that values for the Irish and French fleets are missing)

9.4.4 Synthesis and conclusion of the fleet synthesis

Several indicators were missing for the fleet segments which are important in terms of landed values or ecological impact. Consequently, radar plots were not drawn for the Celtic Sea. Some general results nevertheless emerge from the available indicators. Most considered fleets depend for a large part on the Celtic Sea, either for a large variety of species (France) or only a several (The Netherlands). French fleets reported the landings with the highest value, although it was not possible to calculate their profitability. The French demersal trawlers and seiners exerted the highest cumulative fishing mortality and required the highest primary production probably in relations to the large number of species and high trophic level of their landings. Most fleets show low profitability and target too heavily exploited stocks to meet management targets.

9.5 Summary of the Celtic Sea results

The Celtic Sea includes the area of the Atlantic that spans the French, British and Irish coasts. The reported landings in this area strongly increased during the early 1970s mainly due to the new activity of the Soviet Union fleet and the maximum reported total catch was of 760,000 t in 1976, just before the establishment of the European common waters in 1977 and the departure of the Soviet and Spanish fleets.

The main biomass trends show the changes in the biomass of horse-mackerel (labelled scad) with a peak in the late 1980s in parallel of low levels of sea surface temperature during that time. Another dominant feature of the landings is the massive increase in blue whiting landings from the late 1990's until the early 2000's followed by a decline in 2010. Note that this pattern is not clearly related to changes in any of the environmental or ecosystem indicators. Since many of the exploited stocks are within the ecosystem, the evaluation of the impact of fisheries on the ecosystem is highly relevant.

The stock synthesis indicates that the average SSB for the assessed stocks was above B_{pa} throughout the time series. The highest average F occurred in 2003 with a substantially higher value than Fpa and largely declined since to just above F_{MSY} value in 2009 and 2010. As a result, the average SSB increased and the assessed stock are now in relatively satisfactory health.

Landings Y	Effort E	Mortality F	Biomass SSB	Recruit. R	Sustain. F*	Survey LFI	Survey MMLw	Survey MTL	Landing MMLw	Landing MTL
↘	↘	↘	↗	↘	☺	?	?	?	low	↘

***Figure 9.16.** Trends in the main indicators of the Celtic Sea ecosystem health*

The average trophic level of landings declined from the 1950's throughout to the 1970's. Since the start of the survey indicators in the early 1990's there was no observed changes in any of the ecosystem metrics apart from the average trophic level of landings which was likely driven by a corresponding increase in landings of low trophic level pelagic species. Therefore, comparatively to the other studied ecosystems, the Celtic Sea appears to be more sustainably exploited over the very last years.

10 Bay of Biscay(ICES Divisions VIIIabd)

10.1 Long term trends in landings

Total landings in the Bay of Biscay from the ICES Statlant database increased steadily from the early 1983 until a peak at 142,000 tonnes in 1998. An unrealistic sudden drop of landings occurred in 1999 from the ICES Statlant database (Figure 10.1) in relation to French missing data. Total landings subsequently became more variable in the last decade, peaking at 238,000 tonnes in 2006 before sharply declining to 134,000 tonnes in 2008. The total recorded landings were 187,000 tonnes in 2010.

The main caught species in the Bay of Biscay are European hake, Atlantic horse mackerel, European pilchard (sardine), European anchovy and Atlantic mackerel. In 2000-2010 these species contributed to an average of 35% to total catches.

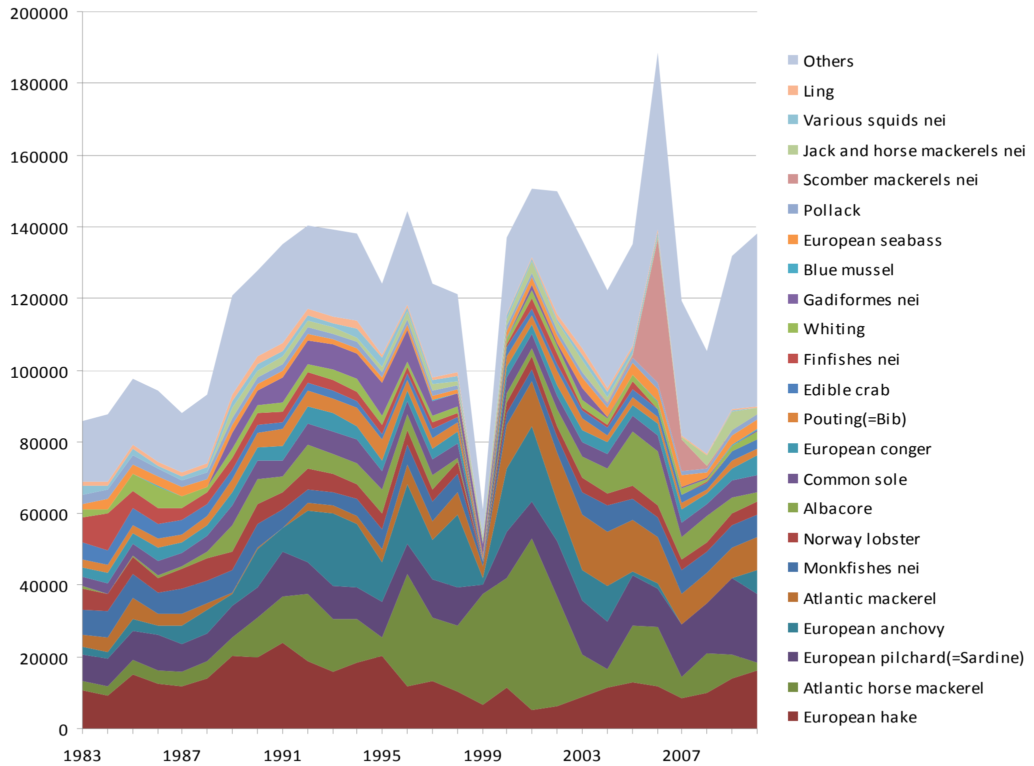


Figure 10.1. *Annual landings (in tons) in the Bay of Biscay (from ICES databases)*

10.2 Stock synthesis

The stocks synthesis aims at providing an overview on what is known from the single stock assessments performed by ICES regarding stocks caught in the Bay of Biscay. In other words, the stocks assessment results are considered to be part of the EAFM providing knowledge on the exploited part of the ecosystem.

10.2.1 Proportion of landings covered in the assessments and dependency of stocks of the ecosystem

Between 1986 and 2005, the percentage of assessed stocks in the Bay of Biscay fluctuated at about 60%. In the following years, the proportion of assessed stocks declined to reach about 50% of stocks assessed in the Bay of Biscay in 2010.

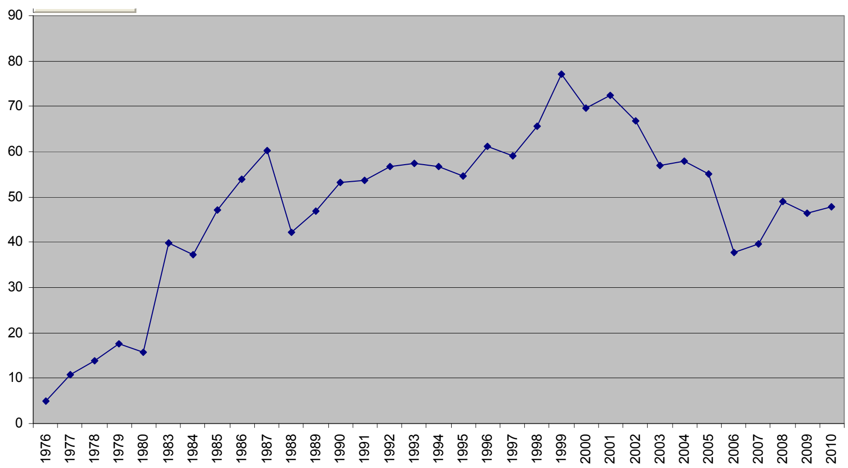


Figure 10.2. *Percentage of assessed catches in 1976-2010 for the Bay of Biscay.*

The relative proportions of landings of the assessed stocks which have been taken in the Bay of Biscay (in 2000-2010 period) show that the sole and *Nephrops* stocks are fully part of that ecosystem (100%, Figure 10.3). Anchovy landings are from the Bay of Biscay and the Iberian coast while, for the other stocks, the contribution of the Bay of Biscay is minor.

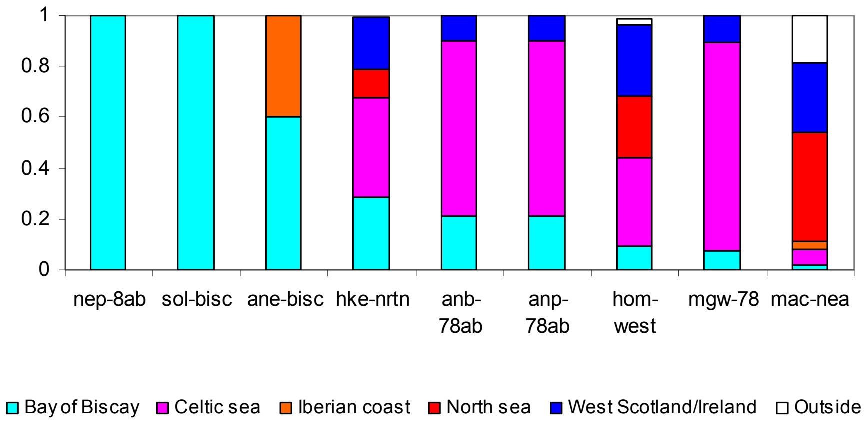


Figure 10.3. *Relative importance of assessed stocks to Bay of Biscay landings.*

10.2.2 Trends in total landings, total spawning stock biomass, recruitment index and mean fishing mortality

The four-aggregated stocks index of the Bay of Biscay covers the whole period until 2010but it does not include the highly dependent stocks. Conversely, the addition of more stocks in the aggregated index provides more significant index, but it reduces the covered period with the loss of the last 5 years during which analytical assessments for either anglerfish or megrim were not available.

Table 10.1*List of stocks used for the computation of total SSB, total catches, mean F and recruitment index according to the period considered (Figure 10.4).*

Number of Stocks	stocks
3 stocks	horse mackerel [hom-west], mackerel [mac-nea], hake [hke-nrtn]
4 stocks	Idem + sole [sol-bisc]
8 stocks	Idem + *nephrops* [nep-8ab], anchovy [ane-bisc], anglerfish [anp-

	78ab], megrim [mgw-78]
9 stocks	Idem + anglerfish [anb-78ab]

Landings of the assessed stocks in the Bay of Biscay increased in 1985-1995 period before steadily declining from 1995 to 2005 reflecting changes in the most abundant species (see below). The most recent available landings data, although incomplete (four-stocks), shows a slight increase in 2007-2010. The spawning stock biomass (SSB) shows a steep decline from a peak at about 500,000 tonnes in 1988 to 200,000 to 300,000 tonnes in 1995 followed by a fluctuating period. Most recent estimates indicate an SSB at about 300,000 tonnes. The mean fishing mortality (mean F) shows an increasing level in the 1985-1995 period followed by a sharp decline from 1997 to 2005 (from about 0.4 to 0.2). Then from 2007 to 2010, a small but noticeable rise in mean F occurred for hake, mackerel and horse mackerel. The estimated recruitment pattern is dominated by horse mackerel with high values in 1982 and 2001 (see Figure 10.5). The general trend of recruitment for the group of the four selected stocks (horse mackerel, mackerel, hake and sole) shows a decrease since the mid-1990s.

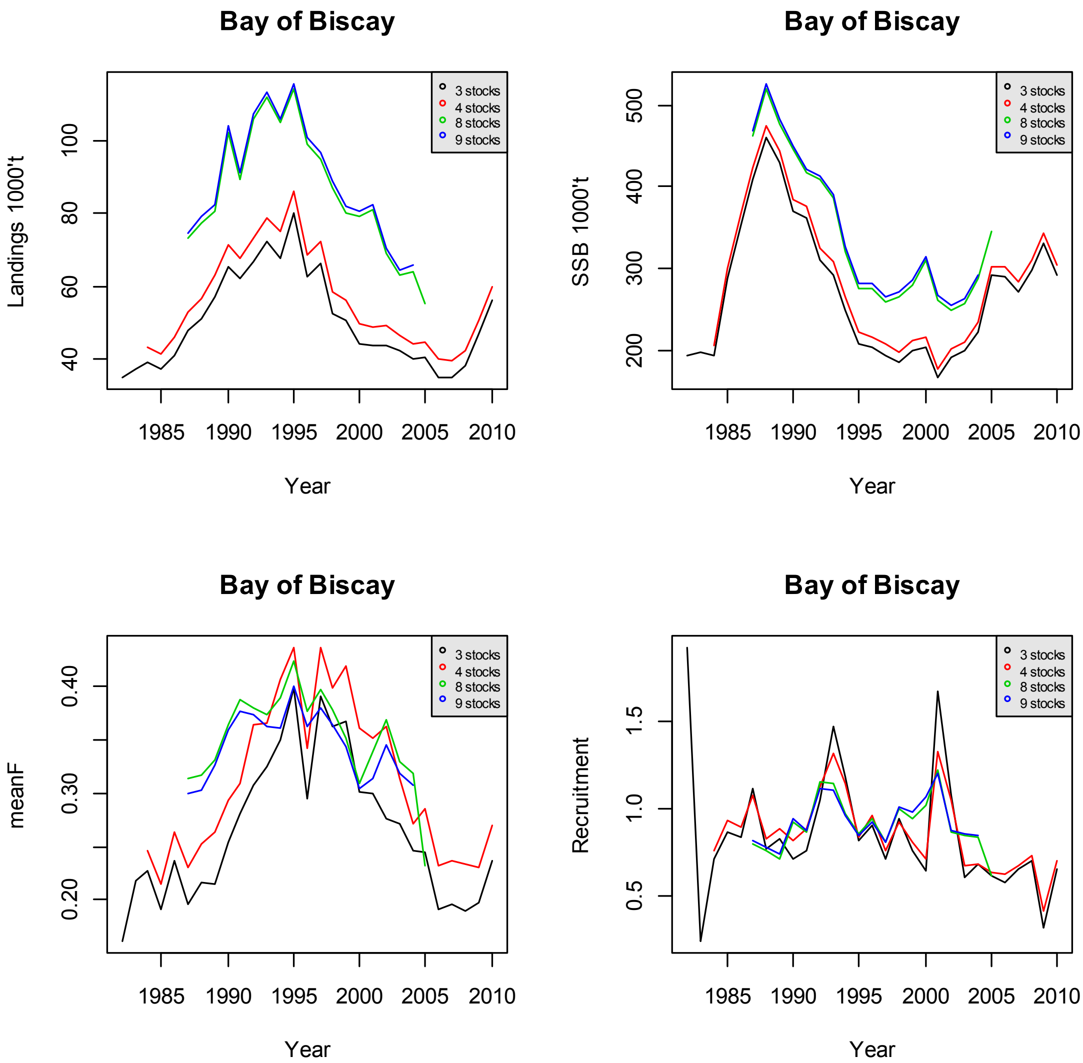


Figure 10.4. *Landings, spawning stock biomass, mean fishing mortality and recruitment index for the Bay of Biscay. Lines refer to time series available for 3 (black line); 4 (red line); 8 (green line); 9 (blue line) stocks respectively as listed in Table 10.1 above.*

In order to interpret the figures above, the trends in the main indicators for each of the assessed stocks are showed in Figure10.5. The values of each stock were standardized to the average over the full assessed period, thus only the trends could be considered and no information on the relative contribution of each stock to the average trends can be deduced. It should also be noticed that these graphs relate to the whole stock and not to the specific part of the concerned ecosystem.

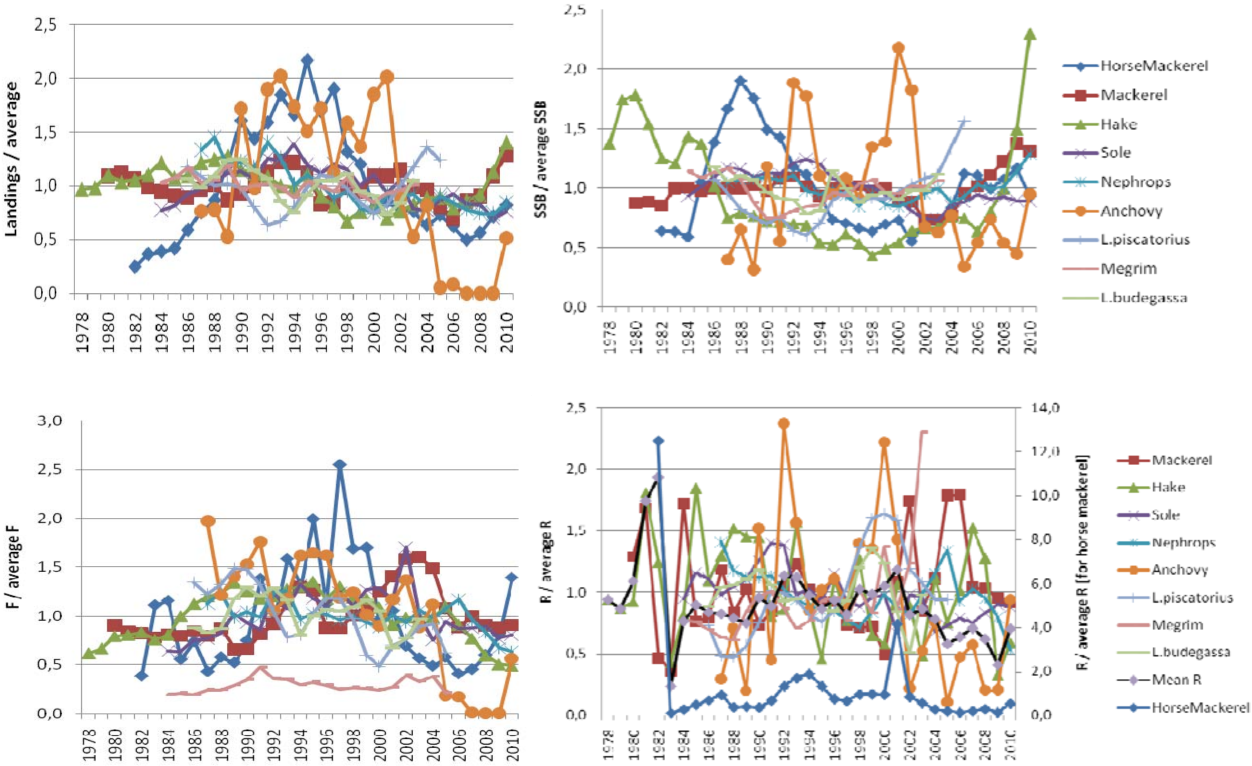


Figure 10.5. *Trends in standardized indicators for each assessed stock exploited in the Bay of Biscay*

Horse mackerel and anchovy are shown to be the most variable stocks in terms of landings over the period. The peak observed in the average graph is mostly due to horse mackerel which is one of the main contributors of the overall landings in the Bay of Biscay. It should also be noticed from this figure that nearly all the assessed stocks show an increase in landings in the very recent years (besides anchovy for which the fishery was closed).

Spawning stock biomasses are relatively variable for horse mackerel, northern hake and anchovy. Similarly than for landings, the horse mackerel biomass drives the average which explains the peak of combined stocks SSB in 1988. Mostly all the assessed stocks show an increasing trend since 2000, especially for northern hake, which explains the pattern observed for the aggregated SSB.

The overall picture for fishing mortality is relatively similar for all stocks with an increasing F in the earlier part of the period and a decreasing trend since the late 1990s. The increase estimated of the aggregated trends in F for 2010 seems to be mostly due to horse mackerel and anchovy while fishing mortality for hake is still decreasing. Note that the fishery for anchovy was mostly closed during 2005-2009.

The estimated recruitment appears to be highly variable. The two observed peaks in 1982 and 2001 on Figure 10.4 (aggregated trends) are due to the high recruitment levels of horse mackerel. Part of the lower value of average recruitment since 2002 is likely due to the low observed recruitment of anchovy.

10.2.3 Overall stock status in relation to reference points

Precautionary and MSY limits were estimated only for two stocks within the Bay of Biscay. Based on the relative biomass and fishing mortality, common sole is characterised by a slightly lower biomass than the precautionary level B_{pa}, with F above F_{MSY} but below F_{pa}. Atlantic mackerel exhibits a biomass level between B_{pa} and twice B_{pa}, whilst F exceeds F_{pa}. Overall both stocks thus fail to reach the F_{MSY} target (Figure 10.6).

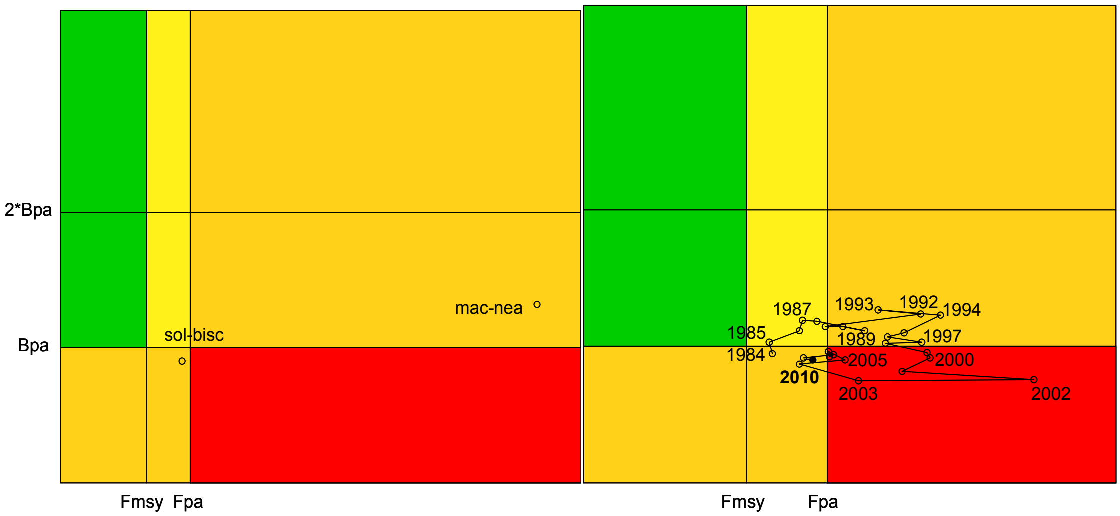


Figure 10.6. *Relative biomass B* and fishing mortality F*, as compared with reference point: current status of the assessed stocks and trajectory for common sole*

The mean trajectory of these indices for sole shows that this stock has been overfished since the beginning of the time series in 1984 as the mean fishing mortality F* never was below F_{MSY} and the mean relative biomass B* never reached B_{MSY}. In the 1989-1990 period, the mean fishing mortality was below F_{MSY} and the biomass was near B_{pa}. From the 1990s, the mean F increased beyond F_{pa} and in the 1999-2003 period and in 2005 the biomass fell below B_{pa}. In 2009 and 2010, the mean fishing mortality decreased below F_{pa} but remained higher than F_{MSY}. However the stock is currently very close to this target value.

- Conclusion

Provided that only two stocks were able to be evaluated against the reference points in the Bay of Biscay(mackerel and sole), it is impossible to conclude on the state of the ecosystem regarding the impact of fisheries based on the MSY target. However, it should be noted that the overall fishing pressure decreased since the mid-1990s and the spawning stock biomass increased since 2000. These trends are encouraging signals of stock recovery.

10.3 Environmental and ecosystem indicators

10.3.1 Environmental indicators

A total of 148,161 sample records were analysed for the Bay of Biscay region (ICES VIIIabd). It appears that sampling effort, although having increase in the late 1980's, has subsequently declined during the most recent period.

When selecting temperature, salinity, the AMO and NAO as determinants of hydrological conditions (for the period 1950–2009) and subjecting this data to an integrated analysis using PCA, it appears clearly that temperature dominates the variation associated with PC1 (36%), whereas the NAO dominates the variation associated with PC2 (28%). The trend in hydrological conditions can be visualised by plotting the scores of PC1 as a time series (Figure 10.7).

There was insufficient data to make an assessment of chemical conditions in the Bay of Biscay.

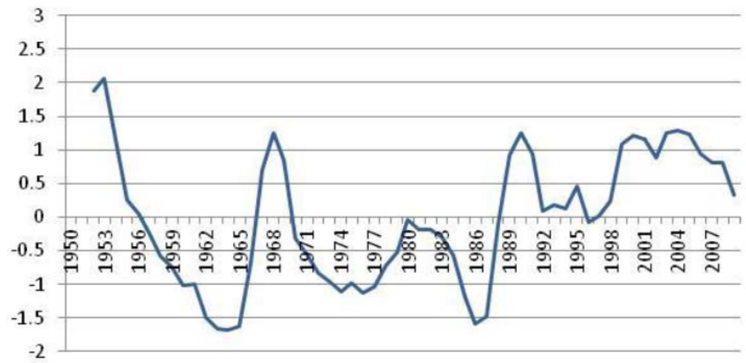


Figure 10.7.*Hydrological conditions for the Bay of Biscay (PC1 scores as a 3-year moving average derived from the PCA).*

10.3.2Ecosystem indicators

This section contains the results of two of the ecosystem indicators suggested by the EC Regulation(EC 2008):the proportion of large fish and themean maximum length of fishes. Mean trophic levels were also calculated..

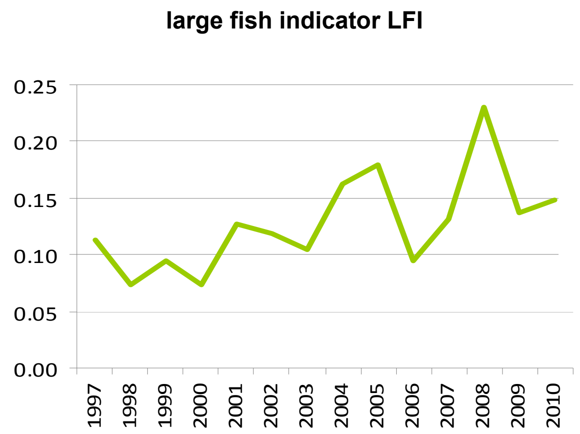
- Ecosystem indicators based on survey data

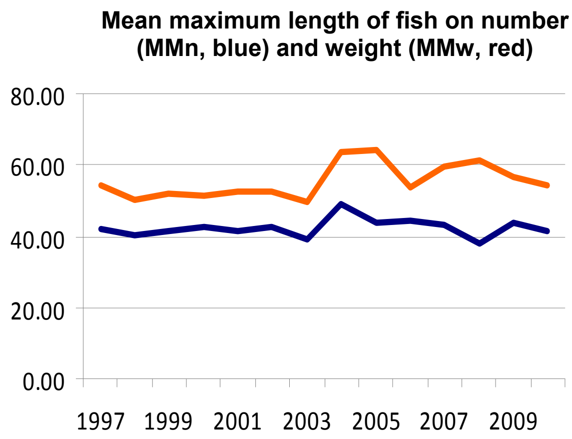
The proportion of large fish in the assemblage was calculated to reflect the size structure and thus the life history composition of the fish community. The large fish indicator (LFI) for 1997-2010 based on EVHOE survey data taken from the DATRAS database indicates an overall increasing trend(Figure 10.8 top). The indicator reached its lowest point in 1998 and 2000 with a value of 0.07 and peaked at 0.23 in 2008. An indicator value of 0.15 was recorded in 2010.

The proportion of large fish indicator based on the 1997-2007 EVHOE survey data as calculated in the MEFEPO project revealed that the exclusion of pelagic species had a large impact on the results obtained for this indicator (Figure 10.9). The effect depends on both the species excluded and the catching capacity of the gear for these species. When all species are considered the indicator shows limited variation in the 1997-2007 period with the lowest point in the time series in 2003. The inclusion of small pelagic species considerably increase the variations with the lowest point of the time series in 2000 and the highest in 2005. Overall the proportion of large fish calculated in 1997 was at similar levels than the proportion calculated for the last year of analysed data within this project, i.e. 2007.

The mean trophic level of the community was calculated from 1997 onwards using EVHOE survey data from the DATRAS database. The mean trophic level for predators (MTI, conventionally defined as species with a tropic level higher than 3.25) was also estimated (Figure10.8 middle). The results in the assessed time period show that the mean trophic level of the community remained constant both when predators were included (average MTL of 3.71) and when predators were excluded (average MTI of 3.81).

Two indices were calculated for the mean maximum length of fish, one based on the total number of individuals of each species caught during the survey (MMn) and the other based on the weight of the respective fish species in the sample (MMw). Both indices showed a similar pattern with a stable period from 1997 to 2010 (average MMn of 42; average MMw of 55).





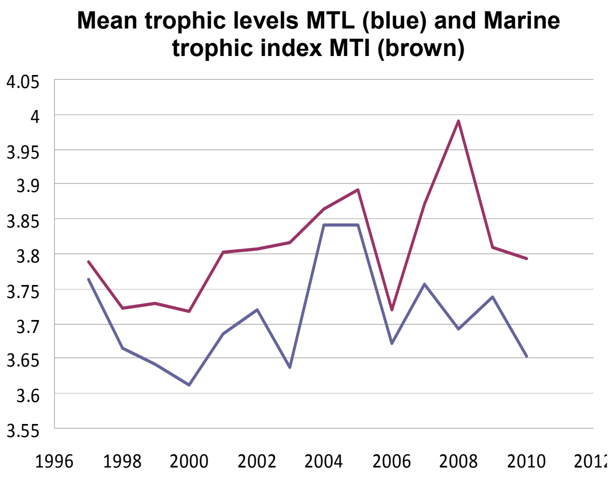


Figure 10.8. *Variations in the ecosystem indicators of the Bay of Biscay based on EVHOE survey data from DATRAS.*

Figure 10.9. *Proportion of large fish including and excluding pelagic fish, in the Bay of Biscay (From the MEFEPO project, Borges et al. 2010).*

- Indicators based on landings

The mean trophic level of landings was calculated from 1983 onwards using data from the ICES Statlant database (Figure 10.10) and including all landed species. The mean trophic level indicator reflects both changes of the fishing strategy and of the ecosystem itself. Nevertheless, because almost all available resources are targeted nowadays, the indicators derived from landings often provide useful information on the changes occurring in the ecosystem itself. The mean trophic level was calculated for all landings and for the proportion by weight of predators in landings (conventionally defined as the species with a tropic level higher than 3.25). The latter indicator is referred to as MTI.

In the assessed time period, the mean trophic level of all species landed in the Bay of Biscay is relatively stable fluctuating at about a value of 3.6. The mean trophic level peaked at 3.72 in 2006 whilst the minimum recorded was 3.53 in 2001. The recorded trophic level was 3.56 in 2010, which is slightly lower than the average over the last decade. The mean trophic level calculated for predators was more variable. Values fluctuated around a trophic level of 4 in the 1983-1993 period (average of 4.02) before decreasing to lower levels between 1996 and 2001 (average of 3.86). In the 2001-2010 period, MTI increased again to a value of 4.03 in 2010. This corresponds to the period where small pelagic fish declined substantially due to a moratorium in their catch, especially of anchovy.

The mean maximum length of fish indicator follows the same pattern with a decreasing trend in the 1990s (from 76 cm in 1983-88 to 50 cm in 2001)followed by an increase in the 2000s reaching 69 cm in 2010.

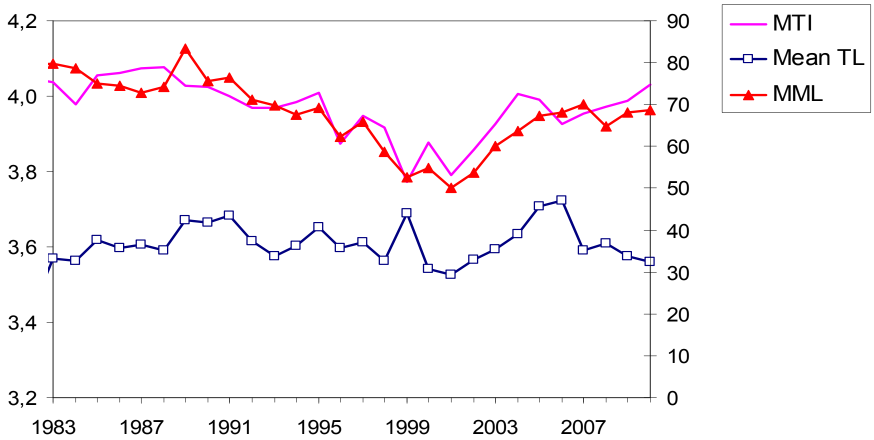


Figure 10.10. *Trends of ecosystemindicators based on landings, in the Bay of Biscay: Mean trophic levels, marine trophic index (MTI) and mean maximum length (MML).*

10.4 Fleet-based synthesis

10.4.1 General results of fleets operating in the Bay of Biscay

The Bay of Biscay (ICES subdivisions VIIIabd) is mostly fished by the French and Spanish. UK, Danish and Dutch fleets also contribute to the fishery, while landings by fleet segments from Belgium, Portugal, Ireland and Germany amount to less than 1% of the total volume landed in the area and therefore were not analyzed. Nevertheless, all landings are considered in order to calculate the percentages of landings from the ecosystem by the selected segments.

The French fleet is the most important EU fleet in the ecosystem in terms of total volume with almost three quarters of the volume landed in 2009. It is followed by the Spanish fleets with almost 20% and the UK, Denmark and The Netherlands with shares from 4 to 1% each. Other countries with minor stakes in this ecosystem in 2009 or recent years are also shown for completeness (Fig. 10.11).

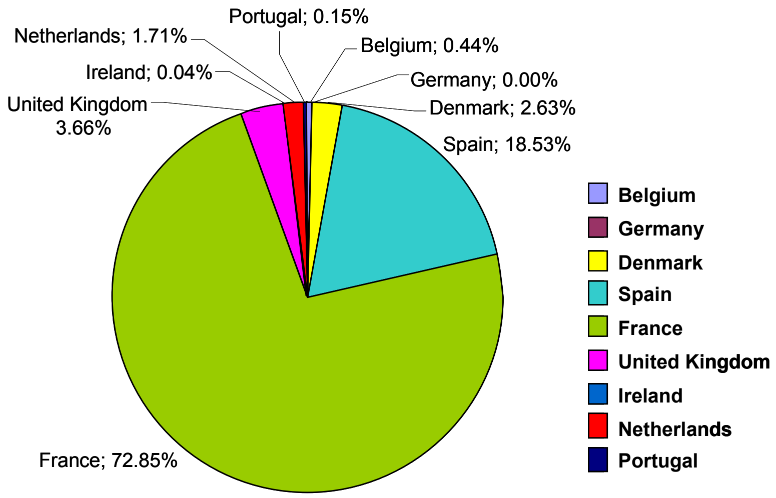


Figure 10.11*Landing volume (2009) by Countries from the Bay of Biscay.*

The comparison among countries refers to 2009 which is the most complete data set. Volume is used instead of value because no value of landings data was available for the second most important country, i.e. Spain, and therefore value of landings data would not be a clear measure of the fleet dependency on the ecosystem. Nevertheless the distribution of the landings by species and countries shows interesting patterns on the dependency on specific species for the main actors in this ecosystem (Figure 10.12).

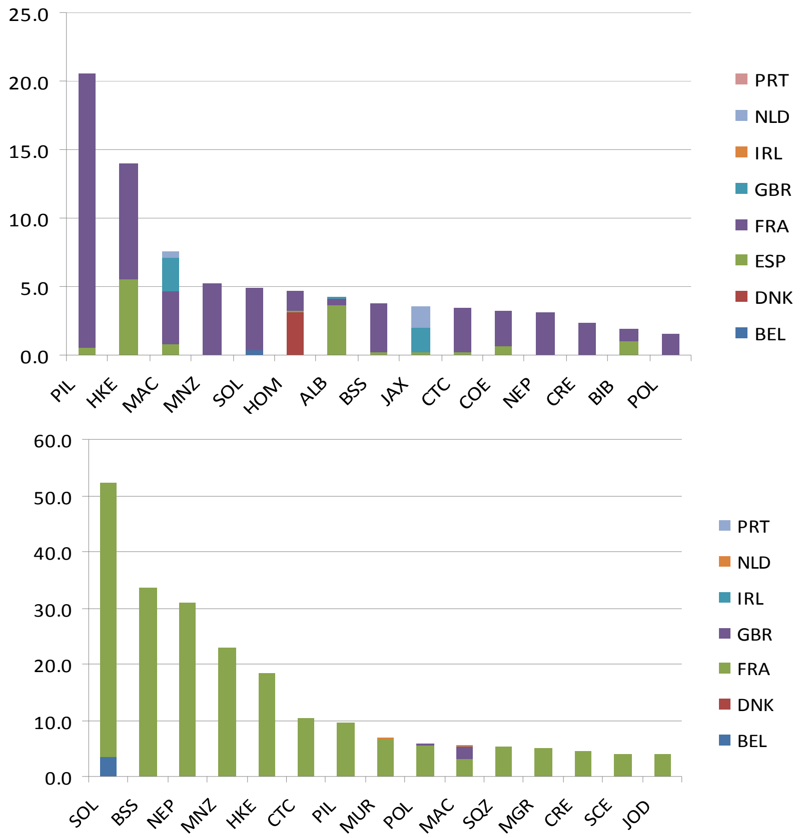


Figure 10.12: *Total volume (top) and value (bottom) of landings by country in the Bay of Biscay ecosystem.*

While targeting many different species, some species (e.g. sardine, sole or *nephrops*) are mainly if not exclusively targeted by France. Spanish fleets target mainly hake and albacore, while data shows that Denmark focuses only on horse mackerel. Other countries as The Netherlands or the United Kingdom also target only two species. Therefore, despite having a wide variety of species in the ecosystem and different countries involved, their economic dependency shows a high degree of species specialization for most countries.

The value of landings, and therefore the direct economic magnitude of the fishing activity in the ecosystem cannot however be correctly determined due to the lack of data from Spain. The Spanish fleet segments have considerable shares of the total landings' volume of relatively high valuable species such as hake (more than 40%) and albacore (over 60%). Assuming for example that the value of the Spanish share of the hake landings is similar to that of France, hake would be the second species by value instead of the fifth. Additionally, there is no available data on the value of the albacore landings which have a similar volume than other economically important species in the ecosystem such as sole, monkfish or horse mackerel. Therefore the figure 10.12 bottom must be taken with caution.

The importance of considering value instead of volume in this ecosystem is highlighted for instance in the case of sardine and sole. These two stocks are exploited almost exclusively by the French fleets and therefore data is available on the value of landings for these species (or nearly all for the case of sardine) for 2009. Sole yields the highest value of landings overall despite its small volume (only less than 25% of the volume of sardines). Sardines, in return, are only seventh by value (or slightly higher with the small contribution of the Spanish segments) despite being the main landed species overall by volume.

Table 10.2 *Relevant gears in the Bay of Biscay in terms of landings volume and value*

	2008		2009		2010	
Gear type	**Volume (1000 tons)**	**Value (€ mln.)**	**Volume (1000 tons)**	**Value (€ mln.)**	**Volume (1000 tons)**	**Value (€ mln.)**
Drift and fixed nets	2.712	0.770	19.779	81.264	0.212	0.856
Dredges	0	0	0.905	1.768	0	0
Demersal trawl / seine	10.498	0.012	37.274	112.526	0.020	0.069
Fixed pots and traps	0	0	2.908	8.570	0.001	0
Gears using hooks	8.707	0.305	11.472	21.833	0.278	0.688
Other mobile gears	0.252	0	1.081	2.388	0	0
polyvalent mobile gears	0	0	1.472	4.068	0	0
Other passive gears	0	0	0.916	2.233	0	0
Polyvalent passive gears	0	0	1.113	5.814	0	0
Polyvalent mobile and passive gears	0.863	0	1.528	5.521	0	0
Purse seine	12.050	2.153	24.589	12.522	0.682	0.474
Pelagic trawl / seine	0	0	0	0	0	0
Beam trawl	0.458	4.021	0.528	4.402	0.593	5.861
Pelagic trawl	10.915	4.607	15.346	24.782	1.981	0.838

Since data for the French fleet segments in 2008 was not available (neither in volume nor value) the picture for this specific year is partial. The greatest volume of landings for 2008 was for the Spanish fleet segments (the 24-40 m length categories of demersal trawlers, hooks and purse seiners) for which no corresponding values was available. Data of landings' value for the purse seiner fleet segments was only available for the UK fleets with 2.56 million euros. Concerning the drift and fixed nets, most of the landings' volume was for the Spanish fleets (2,429 tons) while available data only refers to the UK fleet segments with only 0.275 tons of volume of landings. The largest amount of landings' value in the table corresponds therefore to the Dutch and Danish pelagic trawlers and to the Belgian beam trawlers.

For 2009 the volume data shows the rather complete picture of the ecosystem although the Spanish data for the value of landings was missing. A coarse estimate of that missing value is approximately 20% of the ecosystem value. Note that this estimate has to be taken with caution since differences in prices across member states can be high as well as differences in landings composition. The proportion of volume for which the value is missing can be as little as 10% for the purse seiners segments but as large as 59% for the hooks segment.

This data therefore is mostly used to illustrate the distribution of values among segments in 2009 (with the exception of the Spanish fleets) since less data was available for 2008 and data for 2010 was mostly not available. Overall the main fleet segments together (demersal trawlers and fixed nets, purse seiners, netters, beam trawlers and vessels using hooks)account for more than 90% of the volume of landings from the Bay of Biscay(see fig. 10.23 below). Note that the available data mostly corresponds to medium or large size vessels (18-24 m length class for France, 24-40 m length category for Spain).

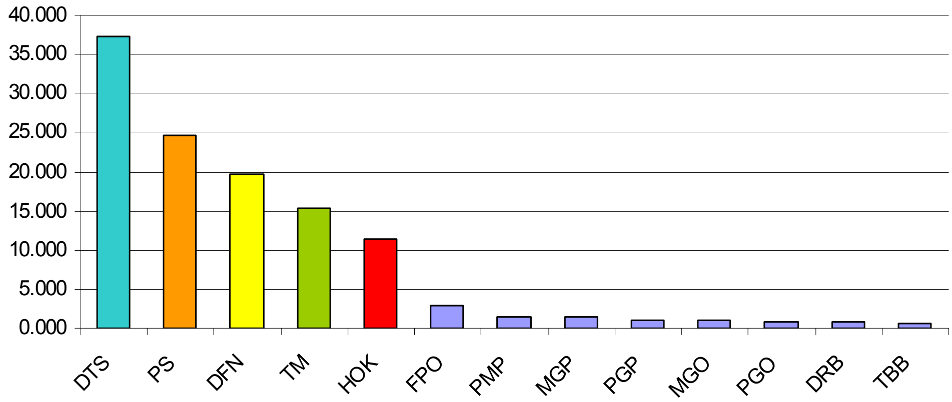


Figure 10.13 *Relative importance of fleet segments by volume of landings*

10.4.2 Economic performance of the selected fleet segments – dependency to the Bay of Biscay

A criteria for selecting the fleet segments was a fraction of landings' value from the Bay of Biscay ecosystem above 50%. Another criterion for a fleet segment was a minimum landing of 1,000 tons in total. Data availability for the indicators was as well selecting criteria for segments as a limited set had data for both 2008 and 2009 and some key data were missing from the database for other segments such as the number of vessels.

In addition, France did not provide data for days at sea and thus more processing was required for these segments in order to be allocated to a distinct ecosystem. Only three fleet segments have therefore comparable data (Table 10.4). The economic indicators reported in the AER 2011 for the main EU fleet segments operating in the Bay of Biscay are presented below (Table 10.3 and 10.4).

Table 10.4 represents only segments for which number of vessels was available with, in general, positive and increasing profits per vessel in the selected segments with high volumes of landings for the medium-sized vessel fleet segments (12-18 m).

Table 10.3*Economic indicators of selected Bay of Biscay fleet segments (2009, in 1,000 €).*

FLEET SEGMENT	2009 Total income	2008 Total income	2009 Gross value added (GVA)	2008 Gross value added (GVA)	2009 Operating cash flow (OCF)	2008 Operating cash flow (OCF)	2009 Profit / Loss	2008 Profit / Loss
FRA DFN VL0010	26 783	29 622	16 192	16 490	3 800	5 152	3 800	3 627
FRA DFN VL1218	37 194	43 346	21 603	25 634	5 271	8 566	5 271	4 567
FRA DFN VL1824	28 367	30 831	15 239	18 177	3 151	6 019	3 151	3 348
FRA DTS VL1012	32 111	39 965	17 411	20 755	5 245	7 367	5 245	5 076
FRA DTS VL1218	70 255	87 280	37 006	39 754	11 191	13 636	11 191	5 766

Table 3 *Relative economic indicators of selected fleet segments of the Bay of Biscay ecosystem.*

FLEET SEGMENT	YEAR	number of vessels	Total income per vessel (€1000)	Gross value added (GVA) per vessel (€1000)	Operating cash flow (OCF) per vessel (€1000)	Profit / Loss per vessel (€1000)
FRA DFN VL1218	2008	91	5234	54	1749	29
FRA DFN VL1824	2008	41	18341	24	6074	13
FRA DTS VL1218	2008	200	2182	91	748	39
FRA DFN VL1218	2009	91	4492	53	1096	53
FRA DFN VL1824	2009	42	16081	23	3326	23
FRA DTS VL1218	2009	166	2550	87	771	87

10.4.3 Ecological indicators of the fleet segments

- Partial F

We computed two indices with the purpose of assessing different fleets' activity and their impact on the Bay of Biscay ecosystem under an EAMF approach. These indices are the partial fishing mortalities applied on the ICES assessed stocks of the Bay of Biscay and the sustainability index per fleet segment allowing to compare the current state of the exploited stocks with the targets F_{pa}, F_{MSY}, B_{pa} and MSY-$B_{trigger}$.

The partial fishing mortality by fleet segment was estimated for each of the assessed stocks on the basis of the weight of landings by segment over the total landings of that stock (Figure 10.14). The partial F by fleet is a measure of its impact on the assessed stocks. The sum of the partial F values over the relevant stocks can be considered as an indicator of the global impact of each fleet on the Bay of Biscay ecosystem.

We identified 74 fleets operating over six assessed stocks: anchovy (ane-bisc), northern hake (hke-nrtn), western horse mackerel (hom-west), northeast Atlantic mackerel (mac-nea), *Nephrops* (nep-8ab) and sole (sol-bisc). We chose the fleets producing at least 2% of the sum of the partial fishing mortalities of all fleets in Figure 10.14.

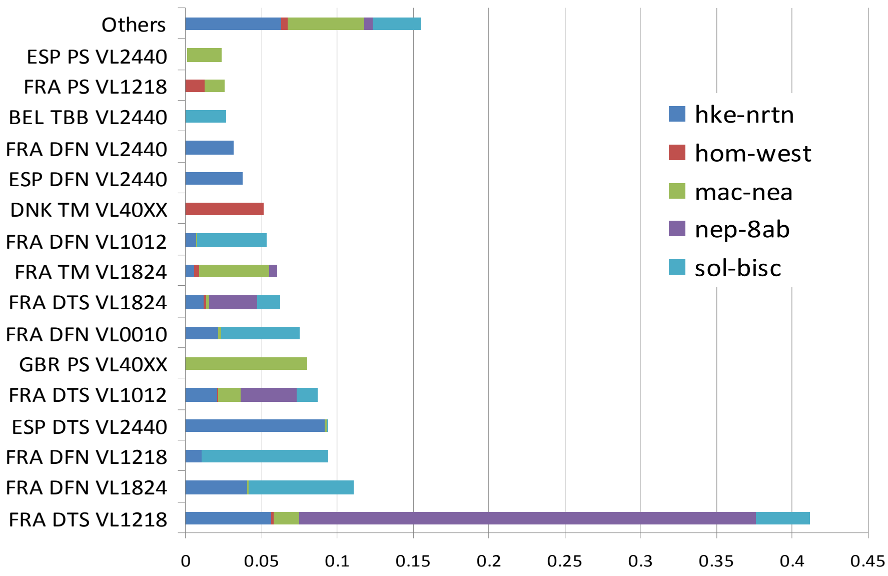


Figure 10.14.*Partial fishing mortality by fleet segment contribution to the fishing mortality of assessed stocks.*

French 12-18 m demersal trawlers produce the highest mortality over *Nephrops*, while also exploiting hake, sole and mackerel. This segment appears to have the highest cumulated fishing mortalities, mostly because it is the major contributor to the *Nephrops* fishery. However it must be kept in mind that this picture is limited to five assessed stocks representing around 50% of the total Bay of Biscay landings and it may not reflect the overall picture of the fleets on the whole ecosystem.

- Sustainability index of the selected fleet segments

Precautionary and MSY limits were estimated for only two exploited stocks in the Bay of Biscay (see Figure 10.6). The sustainability index by fleet segment therefore only represents the proportion of the two stocks, sole and mackerel, in the landed value (Figure 10.15).

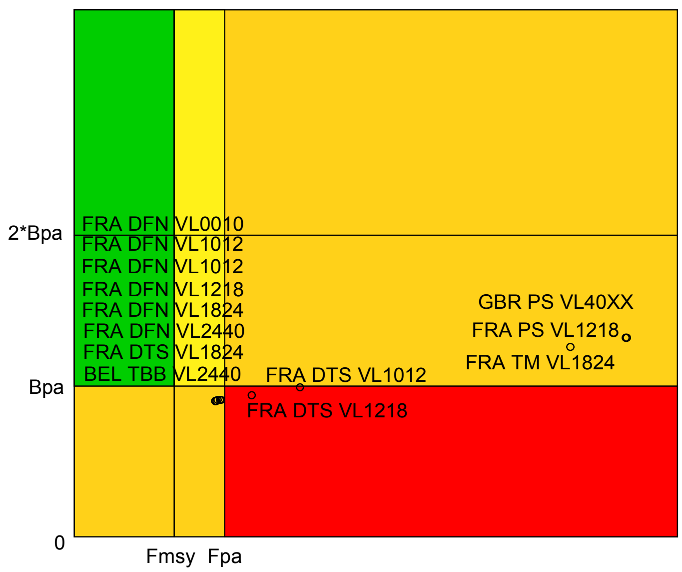


Figure 10.15.*Sustainability index of the selected fleets operating in the Bay of Biscay: standardized fishing mortalities F* and biomass B* for the assessed stocks (cf. figure 10.6).*

- Index of the fleet segment impact on the food web and seabed habitat

The French middle size demersal trawlers (FRA DTS VL1218 and FRA DTS 1824) appear to have the highest impact on the food web (based on required primary production) although the impact from netters (code DFN) is also substantial. Unfortunately due to data unavailability, we were able to calculate the habitat impact index only for half of the selected fleet segments (six over twelve). Given the high values of effort, this index unsurprisingly confirmed the overall large impact of demersal trawlers on the sea floor.

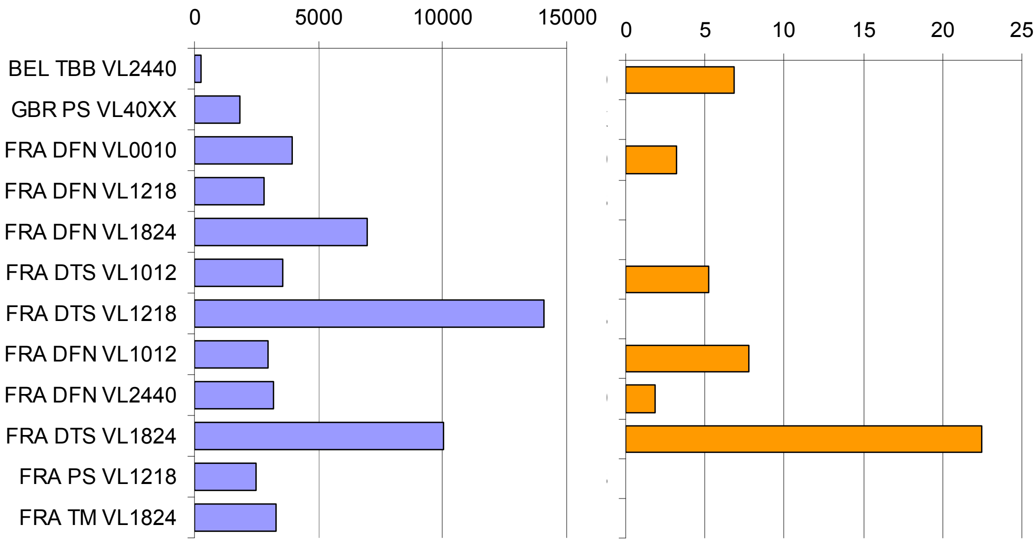


Figure 10.16.*Ecological index for the main fleet segments operating in the Bay of Biscay ecosystem. Left: food web impact index (required primary production, 10^6wet tons/year); Right, seabed habitat impact index. Note that values for six fleet segments are missing.*

10.4.4 Synthesis and conclusion of the fleet synthesis

Several economic and ecological indicators were not estimated consistently for the main fleet segments operating in the Bay of Biscay due to the lack of data. Therefore radar plots were not drawn for this ecosystem. The available information shows nevertheless that France is by far the most important fishing country in the Bay of Biscay, relying on a wide variety of species and the most important fishing gear in term of partial fishing mortality and required primary production is the demersal trawl/seiners, particularly on *nephrops* and sole. Available partial information on the economic aspects show that some segments using those gears have positive and increasing profits per vessels.Other countries target a reduced set of preferred species.

10.5 Summary of the Bay of Biscay results

Landings Y	Effort E	Mortality F	Biomass SSB	Recruit. R	Sustain. F*	Survey LFI	Survey MMLw	Survey MTL	Landing MMLw	Landing MTL
→	?	↘	↗	↘	?	↗	→	→	↗	→

Figure 10.17. *Trends in the main indicators of the Bay of Biscay ecosystem health.*

Given the low number of stocks for which full assessments (including reference points) are available, it is not possible to conclude on the state of the ecosystem regarding the impact of fisheries based on the MSY target. However, it should be noted that the overall fishing pressure decreased since the mid-1990s and the spawning stock biomass increased since 2000. Furthermore, the ecosystem indicators are found to be stable or increasing. These are encouraging signals of ecosystem recovery.

11 IBERIAN COAST

11.1 Long term trends in landings

The total landings in the Iberian Coast from the ICES Statlant database were estimated to vary at about 350,000 tons (Figure 11.1). Landings sharply increased since 1950 to peak at 470,000 tons in 1965. In the 1970s the fisheries production substantially declined and increased again in the 1980s with reduced volumes in 1986 and 2002. Since 2000 landings remained below 400,000 tons, except in 2007 and 2008. The main species caught in the Iberian Coast is the European pilchard (sardine) which accounts for 30% of the historic landings. It is important to note however that this fishery is highly multi-specific and the contribution of new species and "others" has increased with time.

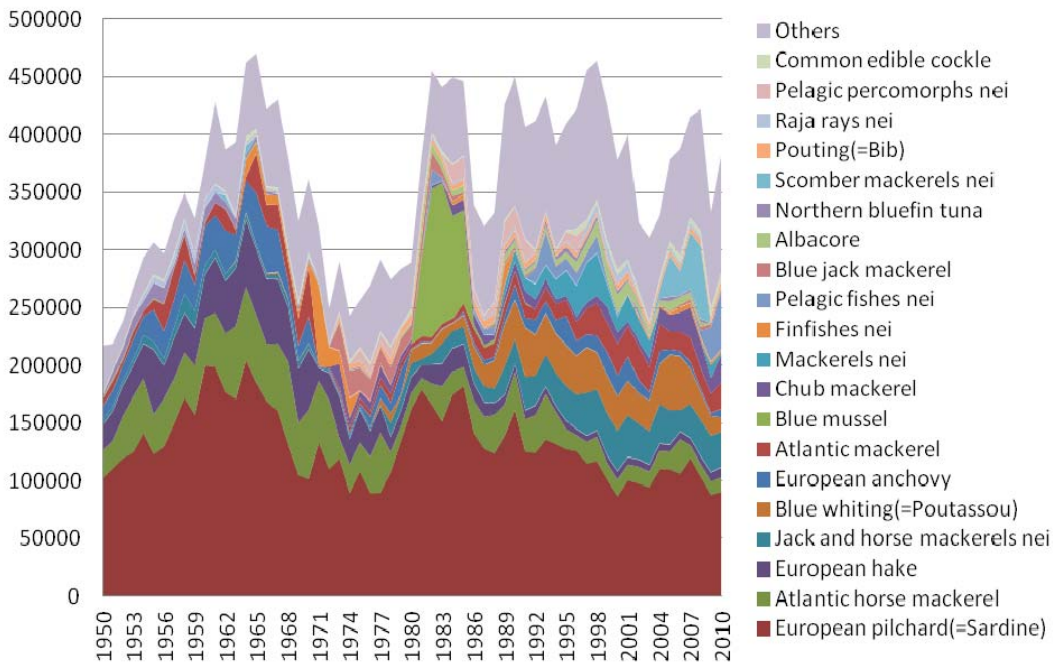


Figure 11.1. *Annual landings (in tons) in the Iberian Coast per species group (from ICES Statlant database).*

In order to overcome the unavailability of landings per fleet in the ICES Statlant database, we used the Sea Around Us project global database by LME (www.searooundus.org), which includes data for the Iberian Coast (http://www.seaaroundus.org/lme/25.aspx). The overall catch volume from this database was slightly different than the Statlant database showing values above 600,000 tons in the 1960s and a continuous decline since the mid-1960s. The most important countries fishing in the Iberian Coast are Spain and Portugal with a minor contribution of France (Figure 11.2).

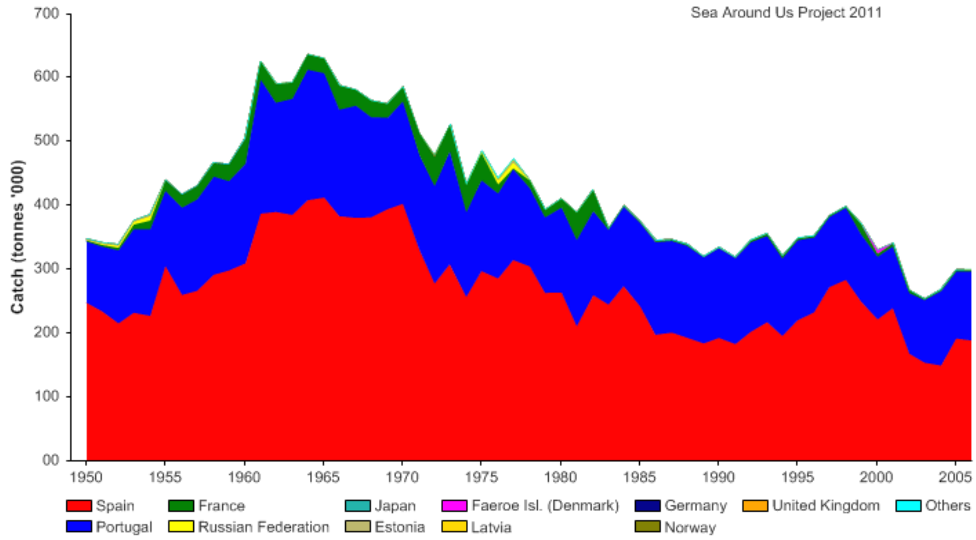


Figure 11.2. *Annual landings (in tons x 1000) in the Iberian Coast per country (from Sea Around Us project global database by LME, www.searooundus.org).*

The results of landings divided by the main fleet segments highlighted that most catches in the Iberian Coast ecosystem are from purse seiners, bottom trawlers, mid-water trawlers and gillnets (Figure 11.3). However, significant contributions are also made by the other fleets due to the multi-specificity of the fishery. Unfortunately, more detailed data on fleet segments was not available in the Iberian Coast.

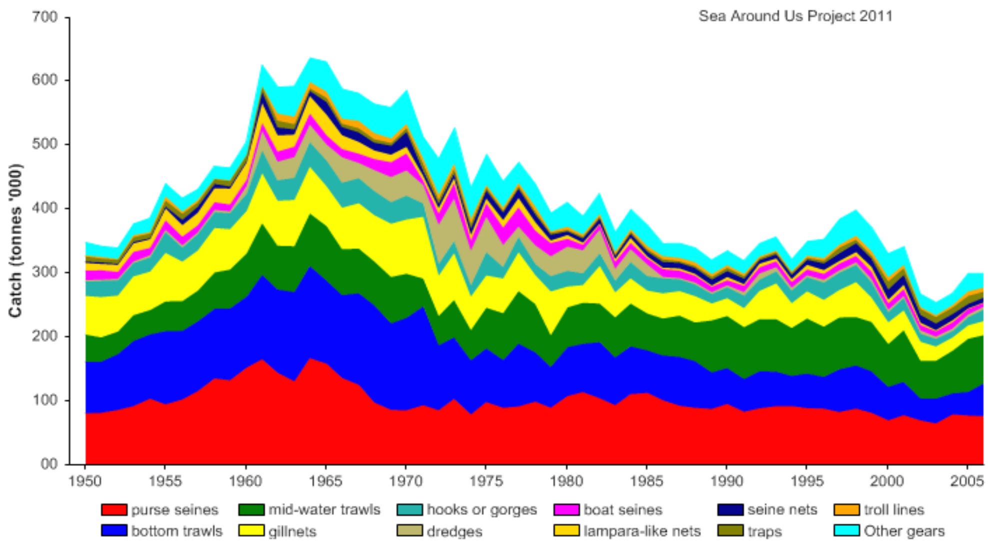


Figure 11.3. *Annual landings (in tons x 1000) in the Iberian Coast per main fleet (from Sea Around Us project global database by LME, www.searooundus.org).*

The analysis of long term trends in the Iberian Coast landings shows that the area was intensively exploited at least since the 1950s. Total landings peaked in the mid-1960s and then have either constantly declined since (Sea Around Us database) or varied in the 1970s and slightly decreased since 1980 (ICES dataset). Substantial fluctuations in time are also emphasized by both datasets, mainly in relation to the pelagic stocks. Spain and Portugal contributions represent almost 100% of total landings in the Iberian Coast. Purse seiners, bottom trawls and mid-water trawls are the most important gears operating in the area.

11.2 Stock synthesis

This section aims at providing an overview on what is known of the single stock assessments performed by ICES in the Iberian Coast. The stock assessments results were then included in the EAFM approach to increase knowledge on the exploited part of the ecosystem.

A total of eight stocks were assessed by ICES in the Iberian Coast (Table 11.1).

Table 11.1. *Stocks assessed by ICES, caught on the Iberian coast.*

Stock name	***Stock Id.***
Anchovy in Sub-area VIII	"ane-bisc"
Hake, southern stock (Divisions VIIIc, IXa)	"hke-soth"
Southern horse mackerel (Divisions VIIIc, IXa)	"hom-soth"
Mackerel (combined Southern, Western & North Sea spawn. comp.)	"mac-nea"
Megrim (Boscii) (Divisions VIIIc, IXa)	"mgb-8c9a"
Megrim (Whiffiagonis) (Divisions VIIIc, IXa)	"mgw-8c9a"
Sardine (Divisions VIIIc, IXa)	"sar-soth"
Blue whiting combined stock (Sub-areas I-IX, XII & XIV)	"whb-comb"

- **Proportion of landings submitted to the ICES assessments**

The proportion of total landings from the eight assessed stocks by ICES (Table 11.1) sharply increased in 1978. That proportion reached a maximum in 1986 (65% of total landings) and slightly declined since. These eight assessed species currently contribute to approximately 40% of the total landings from the Iberian Coast (Figure 11.4).

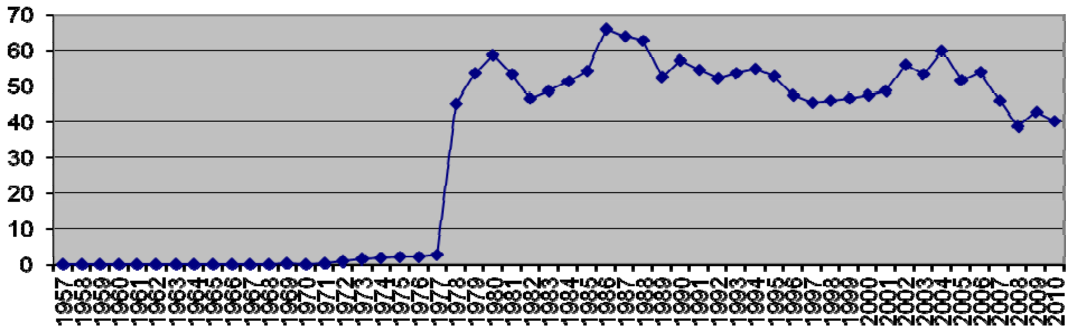


Figure 11.4. *Percentage (%) of landings submitted to ICES assessments in the Iberian Coast (1957-2010).*

- **Dependency of the stocks in the Iberian Coast ecosystem**

Five of the eight stocks assessed by ICES in the area are exclusively from the Iberian Coast area (Figure 11.4). The anchovy stock is similarly shared between the Iberian Coast and the Bay of Biscay waters while mackerel (mac-nea) and blue whiting (whb-comb) in the Iberian Coast represent a small fraction of the stocks.

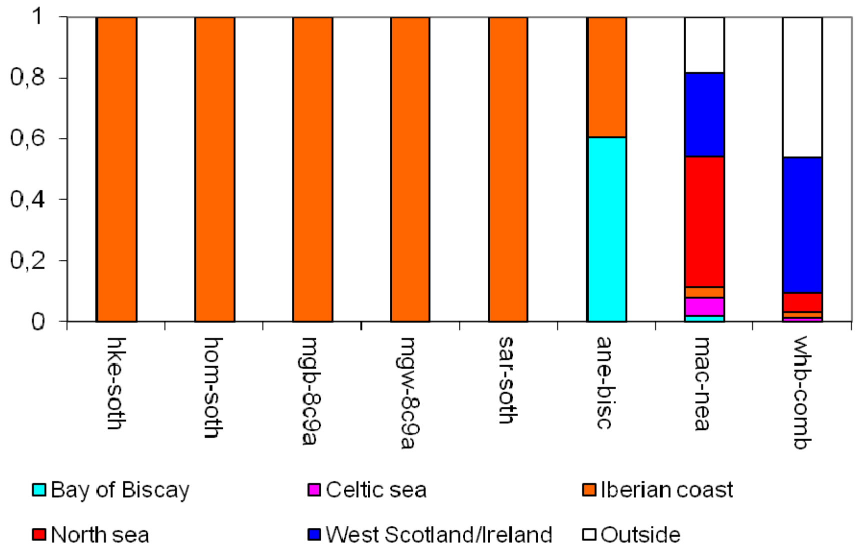


Figure 11.5. *Fish stocks dependency on the Iberian coast (proportion of the landings from the Iberian coast and adjacent ecosystems).*

- **Mean indicators of stock status**

Landings, spawning stock biomass (SSB), mean fishing mortality (mean F) and the recruitment index are plotted for four different species aggregations (Figure 11.6) considering 8, 6, 4 and 2 stocks of among the assessed stocks (Table 11.1). The aggregations are based on assessments availability and are summarized in Table 11.2.

Table 11.2. Stocks aggregation for the Iberian Coast.

Aggregation	*Stocks*
2 stocks	“mack-nea”, “sar-soth”
4 stocks	Idem + “hke-soth” and “whb-comb”
6 stocks	Idem + “mgb-8c9a” and “mgw-8c9a”
8 stocks	Idem + “ane-bisc” and “hom-soth”

Landings of the assessed stocks show an overall decline since 1980 (Figure 11.6). During the same period, a consistent decline of the corresponding average biomass is shown although more variations. The biomass sharply declined especially since 2004 to the lowest levels. Fishing mortality slightly increased until 1997 and decreased since except for sardine and mackerel stocks which increased again since 2004. The status of these stocks slowly degraded following a steadily increase of fishing mortality. Indeed, a reduction of F since 2000 was followed by a slight increase in stock biomass however, in the last six or seven years, the sharp increase in F was immediately followed by a strong biomass decline. Recruitment patterns show a consistent decline similar to the biomass trends. Recruitment improved in the early 2000s but the sharp decline in biomass also substantially reduced the recruitment levels since 2006.

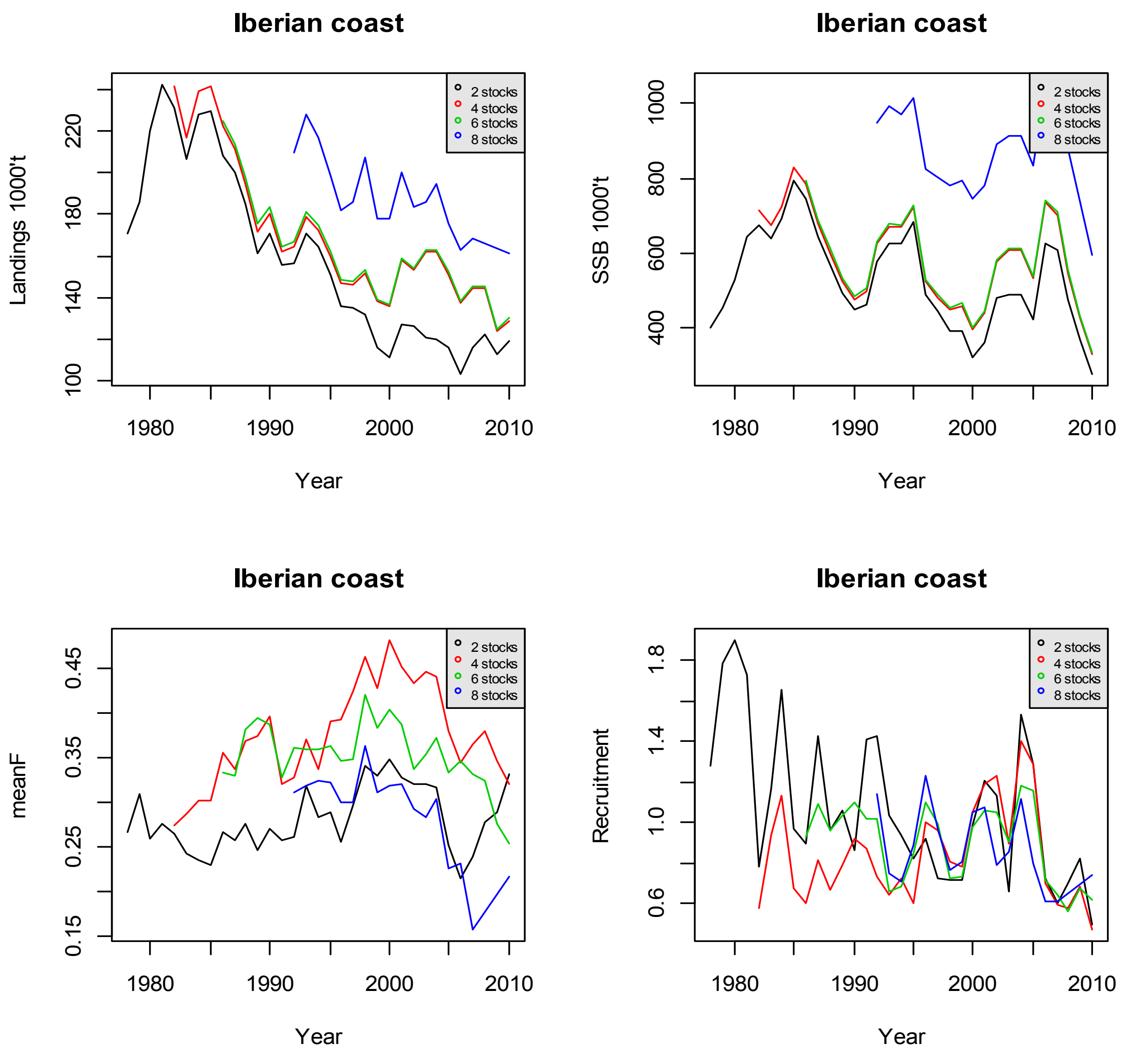


Figure 11.6. *Landings, spawning stock biomass, mean F and Recruitment index for the period 1980-2010.*

- **Global stocks diagnosis**

Due to limited data availability on the precautionary and MSY limits (F*, F_{MSY} or F_{pa} and their respective biomass levels), the stock diagnosis was only estimated for two of the eight assessed stocks in the Iberian Coast (Figure 11.7). These two stocks are mackerel (combined Southern, Western & North Sea spawn. comp.) and combined blue whiting (Sub-areas I-IX, XII & XIV) (Table 11.1). Results in 2010 show that the spawning stock biomass of mackerel is above B_{pa} but the fishing mortality is higher than F_{pa}. Indicators for blue whiting show that the stock and its exploitation are currently in accordance with the MSY approach. It should be kept in mind that these two stocks are widely distributed and the above presented diagnostic refers to the whole stock distribution areas. The trajectory diagram only refers to blue whiting and shows that, although the fishing mortality increased in the 1990s, the biomass also increased thanks to good recruitment levels in those years (Figure 11.7).

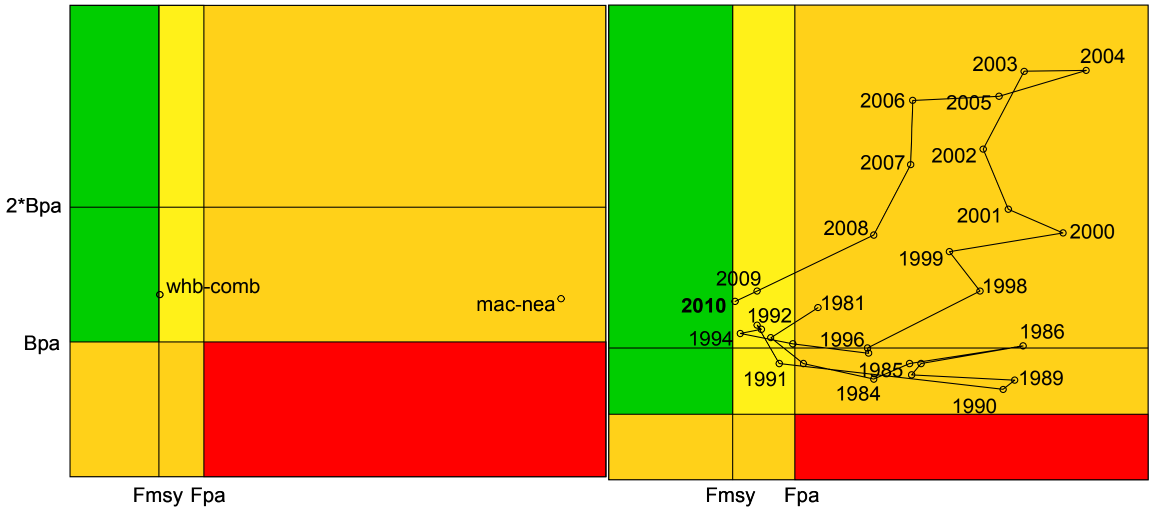


Figure 11.7. *Relative biomass (B*) and fishing mortality (F*) compared with Fmsy and Fpa reference points in the Iberian Coast. Left : current status for whb-comb and mac-nea stocks. trajectory for blue whiting stock (whb-comb).*

- **Conclusion**

The stock synthesis of the Iberian Coast reflects the important need to collect for most exploited species of this ecosystem information on the stock assessments to estimate the relative biomass and fishing mortality. Data available for the mac-nea stock highlights that fishing causes a noticeable impact on this stock while the whb-comb stock is less impacted.

11.3 Environmental and ecosystem indicators

11.3.1 Environmental indicators

A total of 183,449 sample records were analysed to calculate the environmental indicators in the Iberian Coastal region (ICES VIIIc, IXa). The record of collected samples in the Iberian coastal region (in the ICES database) only extends to 2001 and the number of samples before 1986 was limited. Of the twelve extracted determinants, only those associated with the hydrological conditions were available as continuous time series between 1951 and 2001 (temperature, salinity, and the AMO and NAO indices).

Data was insufficient to perform a PCA ordination on the combined chemical and hydrological determinant datasets, however the records for the determinants for the hydrological conditions are complete for the period from 1951 to 2001 and therefore a PCA was conducted on this restricted part of the data (Table 11.3).

Since temperature, salinity, the AMO and NAO were the determinants of hydrological conditions (for the period 1951 – 2001),the applied PCA emphasizes a dominance of salinity in the variation associated with PC1 (33%) whereas the NAO dominates the variation associated with PC2 (29%) (Table 11.3).

Eigenvalues			
PC	Eigenvalues	%Variation	Cum.%Variation
1	1.32	33.0	33.0
2	1.17	29.3	62.3
3	0.813	20.3	82.6
4	0.697	17.4	100.0

Eigenvectors

(Coefficients in the linear combinations of variables making up PC's)

Variable	PC1	PC2	PC3	PC4
TEMP [deg C]	0.593	0.376	0.389	0.596
PSAL [psu]	-0.669	-0.214	0.166	0.692
AMO	-0.405	0.576	0.612	-0.360
NAO	0.192	-0.693	0.668	-0.190

Table 11.3. *PCA results for determinants related specifically to the Iberian Coast Hydrological Conditions.*

Figure 11.8. *Hydrologival condition for the Iberian Coast ecosystem (PC1 scores as a 3-year moving average derived from a PCA).*

The trend in hydrological conditions can therefore be visualised by plotting the scores of PC1 as a time series (Figure 11.8). Hydrological conditions on the Iberian Coast show some variability around a rather stable level over the last 30 years except for a short period in the mid-1980s. Nevertheless, note that the index ends in 2001 due to data unavailability. Data on the chemical conditions was insufficient data to make an assessment in the Iberian Coastal region. However, due to the quasi-absence of shelf in this ecosystem, chemical conditions are expected to be rather constant over time except in the immediate vicinity of the main rivers.

11.3.2 Ecosystem indicators

Because of limited data to compute several ecological indicators in the entire Iberian Coast, we used the available data combined with the results from Borges et al. 2010 (Developing and testing the process across selected RAC regions: The South Western Waters Region).They reported data for several indicators distributed between different regions of the South Western Waters region which includes the Iberian Coast area. We extracted that data in the Northern Spanish Shelf and the Portuguese area. Additional indicators for the Iberian Coast LME can be found from the project Sea Around Us (www.seaaroundus.org)at http://www.seaaroundus.org/lme/25.aspx.

Borges et al. 2010 noted at the beginning of their report that this work was intended to develop a set of environmental objectives that could operationally be implemented in the short term and that this constraint would undoubtedly lead to limitations in the coverage of the indicators. Indeed limitations of coverage were manifest during this work. Nonetheless, following the reasoning developed above, we started with a limited set of indicators mostly based on the fish community when a rational starting point is provided to monitor the effects of fishing on the status of the marine environment.

Indicators included in this section are 1) Proportion of Large Fish, 2) Spatial Distribution of Fishing Activities, 3) Mean Maximum Length of fishes, 4) Mean Trophic Level of the surveys, and 5) Mean Trophic Level and Marine Trophic Index of landings. No data was available to calculate the size at maturation of exploited fish species in the Iberian Coast ecosystem.

- **Proportion of large fish**

Since data was not available to calculate the ecological indicators for the entire Iberian Coastal area, we used results from Borges et al. (2010)derived from available demersal scientific surveys on the Northern Spanish Shelf and the Portuguese area.

The proportion of large fish indicator (LFI) describes the weight of fish ≥ 40 cm over the total weight. Calculation of the LFI was based upon fishery independent trawl survey data that reports

CPUE of species by length. The LFI should be based on species that are regularly and consistently sampled by the survey gear. Thus the indicator is survey specific and the method requires that surveys are annually conducted in the same area and with a standard gear.

Values of the LFI from the Northern Spanish shelf varied from 1992 to 2007 at about 0.10 and seem to increase in the last available years (Figure 11.9 top).Values from the Portuguese area from 1991 to 2008 did not indicate any significant trend (Figure 11.9 middle) and values varied in the approximate range of 0.05 to 0.10 and even when pelagic species were excluded from the analysis.

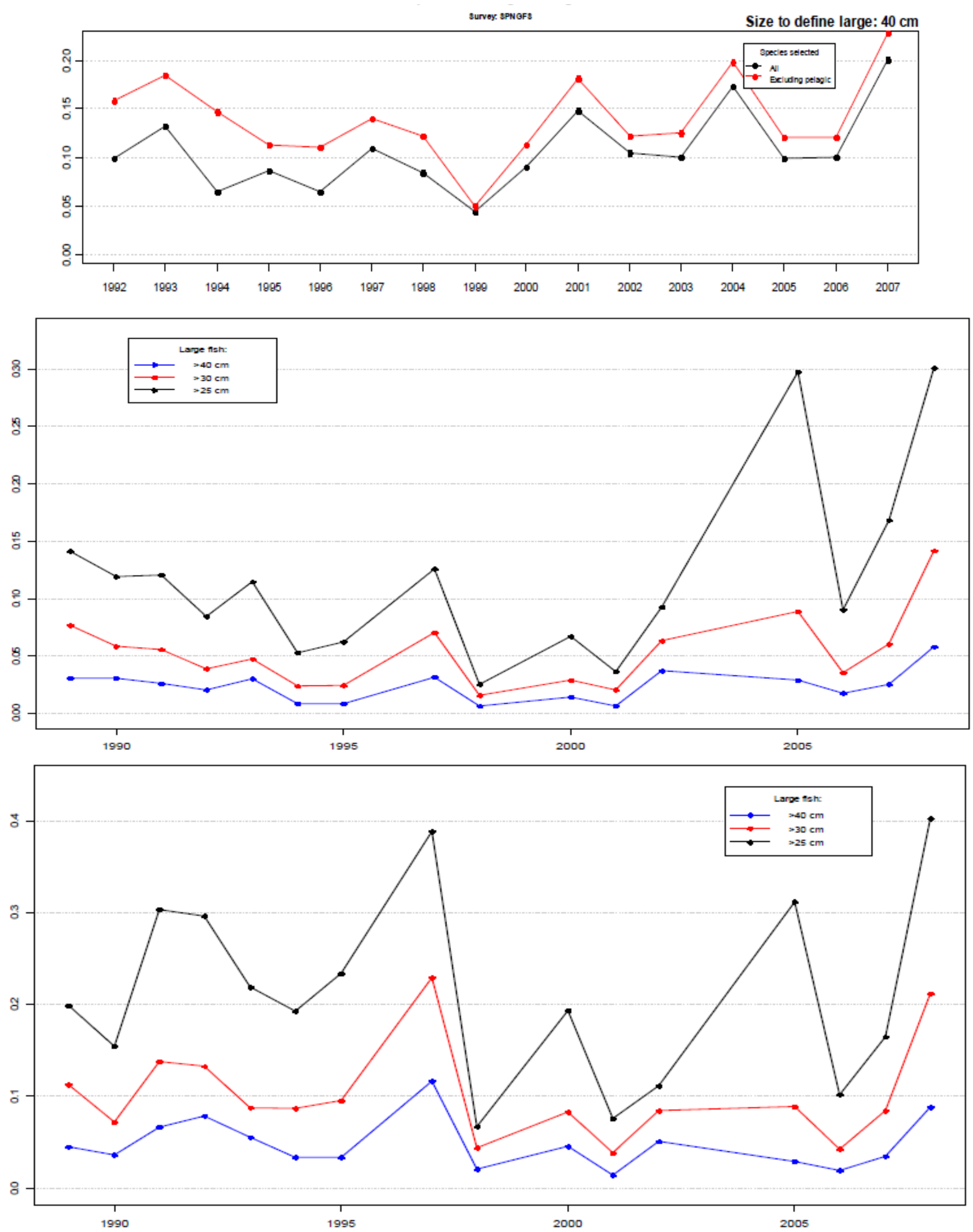


Figure 11.9.*Evolution of the LFI indicator (proportion of large fish calculated in weight larger than L/total catch weight) using different data sets. Top: northern Spanish shelf bottom trawl survey from 1992 to 2007; middle: Portuguese Survey from 1991 to 2008; bottom: LFI taking out the pelagic species on the Portuguese bottom trawl survey from 1991 to 2008.*

Data to calculate the proportion of large fish > 40 cm from the demersal assembly of the whole area was only available from the EVHOE survey from years 2002 to 2008 (Figure 11.10). This indicator shows a decline from 2003 to 2006 and an increase in 2008.However, since data from this survey in the Iberian Coast is very scarce no clear trend can be deduced.

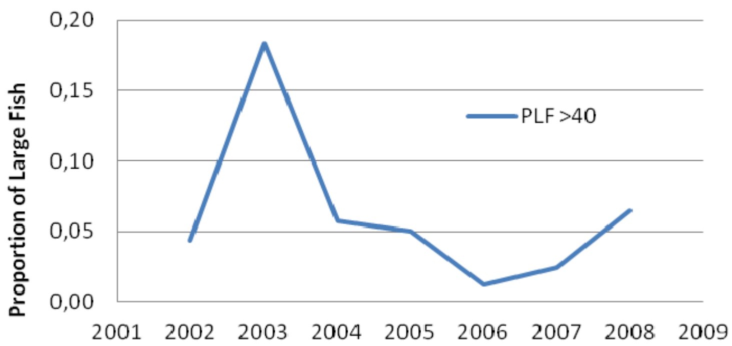


Figure 11.10.*Proportion of Large Fish > 40 cm from demersal surveys EVHOE for the Iberian Coast from 2002 to 2008.*

The analysis of the PLF indicator for the different ecosystems highlighted that the choice of a 40 cm threshold represents less than 20% of the number of fish in the Spanish surveys and less than 10% for the Portuguese area (Borges et al. 2010). As no reference limit was defined for this indicator in the SWW RAC region, no assessment of the fishing impact on the Good Environmental Status (GES) is currently possible.

The southern Iberian shelf ecosystem is part of the Canary upwelling system where small pelagic species are dominant. The larger demersal species are thus expected to naturally have a small proportion in the overall upwelling ecosystem. The exclusion of pelagic species in the LFI indicator is thus important if one wants LFI to be indicative of the demersal group. A limit of reference is also needed to generate the LFI indicator. This limit can be determined by further research to find other observations on the historical size structure of the demersal species, in each of the biogeographic provinces (Dinter 2001) of the study area (Borges et al. 2010).

- **Spatial distribution of fishing activities: proportion of area not trawled**

Since data was not available to calculate the ecological indicators for the entire Iberian Coastal area, we here again used the results from Borges et al. 2010 of the Northern Spanish Shelf and the Portuguese area which are derived from the available demersal scientific surveys.

The ecological indicator would ideally be calculated as the proportion of habitat type which is not trawled. No seabed habitat maps were available for the whole areas; therefore the indicator was calculated within the MEFEPO project according to the depth strata.

The proportion by depth of area which is not trawled was computed from the map of effort from the mobile bottom gears compiled within the MEFEPO project (Figure 11.11). The corresponding indicator of the proportion of not trawled area was calculated for 2005 by depth ranges (see Table 11.4).

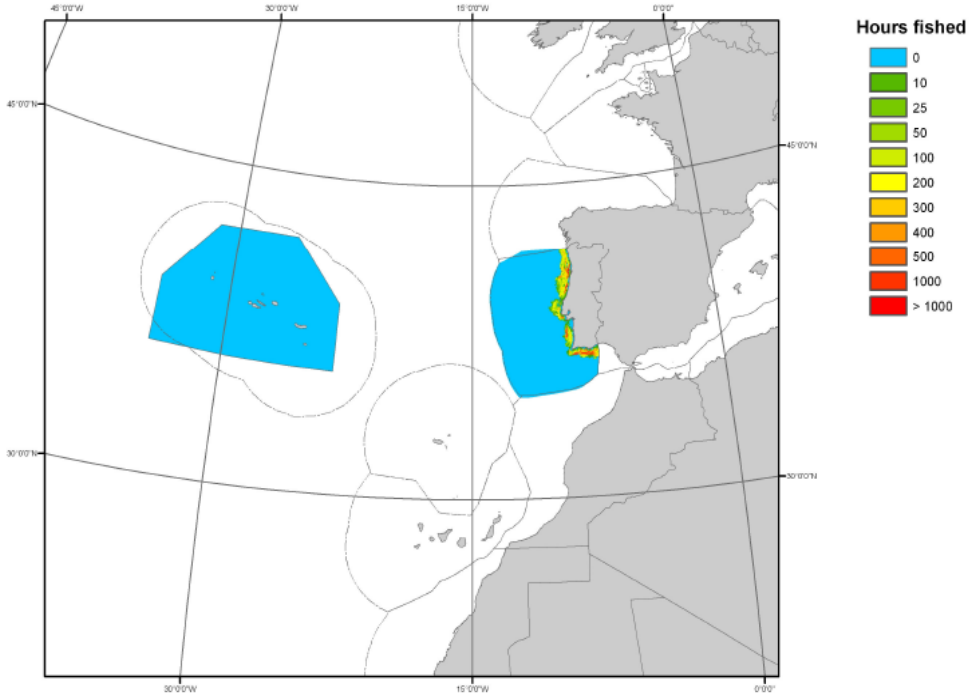


Figure 11.11 Distribution of fishing effort of mobile bottom gears in 2005 (3’x3’ grid) based on Vessel Monitoring System (VMS) records from submitting nations. The VMS data was processed using the point estimation method described above.

Table 11.4. Percentage of area not impacted by mobile bottom gears by depth band for the South Western Waters RAC region for 2005. See text for details.

Depth Band (m)	% area not trawled
0 – 20	98
20 – 50	65
50 – 80	51
80 – 130	36
130 – 200	36
>200	99

A primary concern with an indicator based on VMS records is that vessels <15 m are not taken into account. This is likely to be of particular importance for inshore and shallow areas of the Iberian Coast and, consequently, a high proportion of waters<20 m reported as not trawled could be biased (Table 11.4). Further work needs to be developed to assess the distribution of fishing effort by the fleet <15 m and to integrate this information together with the VMS records of the >15 m fleet (Borges et al. 2010).

It is essential to consider the issue of the involved spatial scale when interpreting these results and their implication on the sea floor integrity. A smaller spatial scale of analysis produces an increasingly perceived patchiness of trawls and thus lowers the proportion of area which is not impacted. In this analysis it should be noted that if 100% of an area is impacted by bottom trawls, it does not imply that 100% of the area was actually impacted. An improved understanding of the spatial distribution of sea floor habitat and of the scale of the impact (surface effectively trawled) is essential to fully determine the impact of mobile bottom gears on seafloor integrity.

The temporal scale of analysis similarly affects the level of perceived impact (Piet & Quirijns, 2009). The indicator in this study was calculated over one year periods but, ideally, the temporal scale of analysis should be tied to recovery time following the impact. No reference limits was set or proposed for the indicator of proportion of not trawled area when used as a pressure indicator to report on the MSFD GES descriptor 6 (sea-floor integrity). Only few limits were suggested for the coverage of rare and threatened habitats in protected areas. The distinction between concern for rare and threatened benthic habitats, such as OSPAR listed habitats, and the GES descriptor 6 is presently important to raise. On the opposite to the rare and threatened benthic habitats, the focus of GES descriptor 6 is on the functioning of benthic ecosystems as a whole leading to the investigation of the status of the dominant benthic habitats.

Concerns for rare and threatened habitats falls under GES descriptor 1. So far this report has only discussed the use of VMS data to report against GES descriptor 6, but VMS data could also be used as a pressure indicator to examine the impact of fishing on rare and threatened habitats for GES descriptor 1. However, rare and threatened habitats tend to occupy limited areas that require an appropriate spatial resolution when integrating VMS data in order to examine the impact of mobile bottom gears.

Furthermore, the extent and frequency of impact that different benthic habitats can withstand before becoming functionally degraded vary between habitat types and the type of bottom gear used. Management decisions that aim at sustaining the benthic habitat functioning will need in the coming years to be made in full awareness of these uncertainties. If these limitations are overcome, VMS data can play an important role in the monitoring and understanding of the effort distribution by vessels deploying mobile bottom gears (Borges et al. 2010).

In addition to fishing effort, the understanding of the fishing impact on benthic ecosystems requires knowledge on the distribution and composition of benthic habitats and improved mapping of European seafloor habitats is an essential activity to allow GES to be defined and monitored. Although currently incomplete, the EUSeaMap research effort in the frame of the EC DG MARE EMODNET project should be mentioned as it aims at predicting benthic habitat layers across the Celtic, North and Baltic Seas under the EUNIS classification, as well as undertaking broad-scale mapping of the western Mediterranean for the first time (http://jncc.defra.gov.uk/page-5020).On the other hand, extending the VMS requirement to the smaller vessels and increasing the VMS reporting frequency would both contribute to improve the impact assessment of mobile bottom gears on benthic ecosystems. The data policy for sharing VMS data outputs across nations and scientific bodies need to be developed to allow computing this indicator on a regular basis (Borges et al. 2010) and a fine scale fishing effort in general.

- **Mean maximum length of fishes**

Data to compute the Mean Maximum Length of fishes (MML) of a demersal assemblagefor the 2002-2009 period were derived from the EVHOE survey. The available time series were too short to be informative (Figure 11.12). In general, MMLw (in weight) varied at about 40 cm and MMLn (in number) slightly increased from 2002 to 2008.

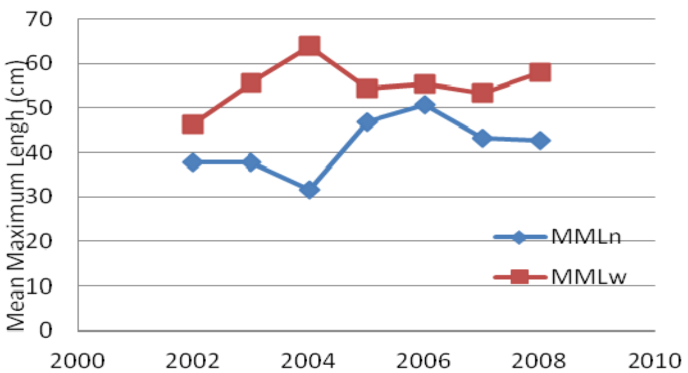


Figure 11.12. Mean Maximum Length of fishes (MMLwand MMLn) from demersal surveys EVHOE for the Iberian Coast from 2002 to 2008.

- **Mean trophic level of surveys**

Data to calculate both the mean trophic level of the demersal surveyed community (MTLs) and the corresponding indicator excluding organisms with trophic level lower than 3.25 (MTIs) were derived from the EVHOE survey from 2002 to 2008. Both MTLs and MTIs value slightly increased overall during the seven years together with data availability, but overall the time series is too short to have an informative trend (Figure 11.13).

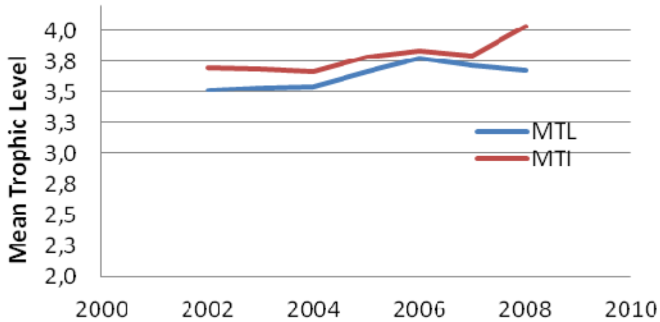


Figure 11.13.*MTLs and MTIs of the demersal community of the Iberian Coast from 2002 to 2008.*

11.3.3 Ecosystem indicators based on landings

The indicator of Mean Maximum Length of all fish (MML) in weight derived from the landings shows a clearer pattern (Figure 11.14). Data was available to calculate the indicator in the Iberian Coast from 1950 to 2010. This indicator peaked in 1955 (54 cm) and 1968 (53 cm) and declined significantly from 1975 to 1980. Since then, it fluctuated at about 40 cm. The mean trophic level of the landings (Mean TL) for the Iberian Coast showed overall no trend with a low period from 1981 to 1985 (Figure 11.14). Since 1986 the Mean TL varied at about 3.40.The Marine Trophic Index (MTI) shows on the opposite a clear decreasing trend from 1950 to 2010 (from 4.0 to 3.7), highlighting that the organisms with trophic level equal or higher than 3.25 had declined with time in total landings.

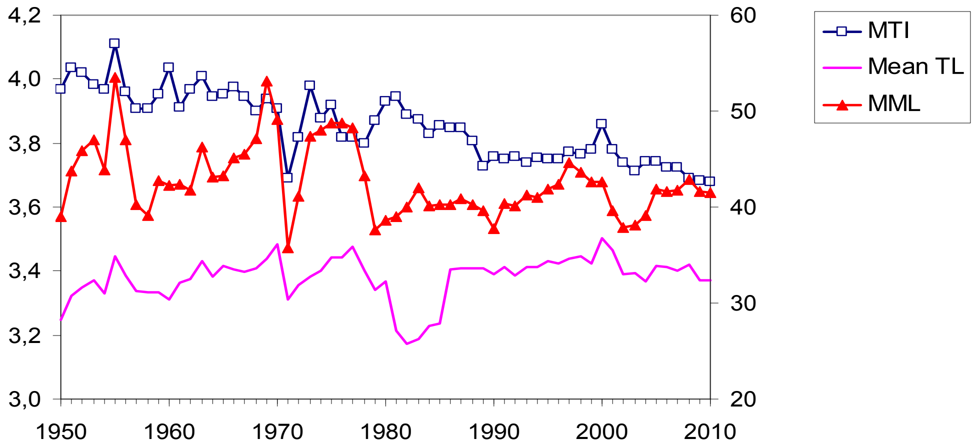


Figure 11.14*.The mean trophic level of the landings (MTL) and the Marine Trophic Index (MTI) for the Iberian Coast from 1950 to 2010.*

11.4 Fleet-based synthesis

11.4.1 General overview

The Iberian Coast area considered in this section includes the ICES areas VIIIc and IXa. The analysis of landing values by country shows however that the data is not always available at the subdivision level. This area is mainly fished by Portuguese and Spanish fleets. Effort by fleet segments from Germany, United Kingdom, France and Ireland amount to less than 1% of the effort in the area and therefore were not analysed.

The Spanish fleet represents the most important EU fleet in the Iberian Coast area in terms of total volume landed in 2009 (Fig. 11.15)although in 2008 the landings of Portugal and Spain were similar. The economic magnitude of the landings for these two years could not however be evaluated due to the lack of data on the value of the Spanish landings. Note that data from Spain for 2010 is also missing.

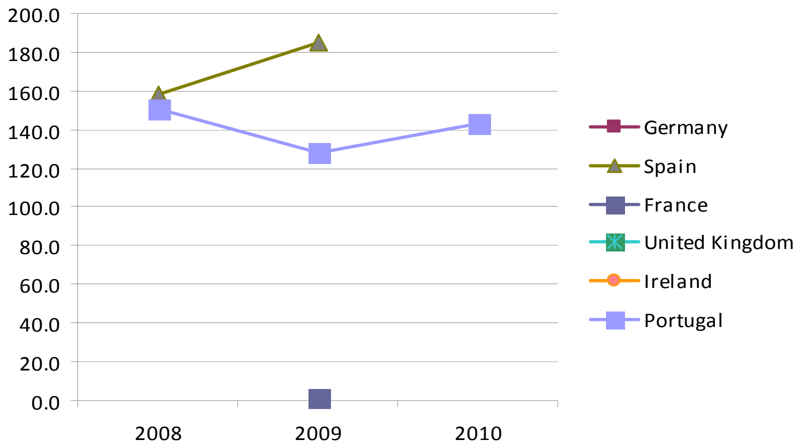


Figure 11.15. *Total landing volume by country in the Iberian Coast ecosystem.*

The purse seine is the main fleet segment operating in the ecosystem in terms of volume of landings, accounting for half both in 2008 and 2009 and twice the volume of the demersal trawlers (Table 11.5). Drift and fixed nets together with hooks amount for more than 10% of the landings. The difference in the volume of landings for 2010 in the table is due to the absence of data for the landings of the Spanish fleet in that year. Note that the total value of landings excludes the value of landings for the Spanish segments since the data was unavailable.

Table 11.5. *Relevant gears operating in the Iberian Coast, in terms of landings volume and value*

	2008		2009		2010	
Gear Type	**Volume (1000 tons)**	**Value (€ mln.)**	**Volume (1000 tons)**	**Value (€ mln.)**	**Volume (1000 tons)**	**Value (€ mln.)**
Drift and fixed nets	22.1	21.3	23.5	24.9	7.1	24.4
Dredges	3.7	2.6	3.9	2.3	1.4	2.5
Demersal trawl / seine	77.1	55.0	83.3	48.9	18.3	48.1
Fixed pots and traps	11.4	38.2	7.5	21.0	6.9	24.6
Gears using hooks	21.7	28.6	23.2	28.2	9.7	28.3
Other mobile gears	0	0	0	0	0	0
polyvalent mobile gears	0	0	0.1	0.1	0	0
Polyvalent passive gears	10.1	40.6	7.7	31.6	9.6	38.6
Poly. mobile & passive gears	6.4	5.2	7.4	5.0	3.4	5.8
Purse seine	156.4	55.5	156.9	51.4	87.0	52.5
Pelagic trawl / seine	0	0	0	0	0	0
Beam trawl	0.1	0	0.1	0	0	0
Pelagic trawl	0	0	0.4	0.7	0	0
Clustered gears	0	0.1	0	0	0	0.1
All Member States	**309**	**247.1**	**314.1**	**214.1**	**143.4**	**224.9**

Table 11.6. *Relevant Portuguese fleet segments in the Iberian coast in terms of value of landings.*

Country	**Gear**	**Vessel length**	**Total value (1000€)**	**%**
PRT	DTS	VL2440	40361.5	10.69%
PRT	PGP	VL0010	26048.6	6.90%
PRT	PS	VL1824	23224.3	6.15%
PRT	PS	VL2440	12172.0	3.22%
PRT	DFN	VL1218	12113.3	3.21%
PRT	FPO	VL0010	9770.3	2.59%
PRT	PS	VL1218	8521.4	2.26%
PRT	PS	VL1012	4934.2	1.31%
PRT	FPO	VL1012	4167.9	1.10%
PRT	PS	VL0010	2 432.8	0.64%
Other	segments		233777.6	61.92%
Total			**377524**	**100.00%**

11.4.2 Economic performance of the selected fleet segments – dependency to the Iberian Coast

The economic indicators reported in the AER 2011 for the main EU fleet segments operating in the Iberian Coast allow comparing the selected fleet segments (Table 11.7 and Figure 11.17).

Table 11.7. *Economic indicators of the selected fleet segments in the Iberian Coast following the 2011 Annual Economic Report (AER 2011).*

FLEET SEGMENT	Number of vessels	FTEs	Energy consump-tion	Iberian coast days at sea	Days at sea as % of total	Iberian coast volume landed (Tons)	Volume landed as % of total	Iberian coast value landed (€ 1000)	Value as % of total value
ESP DFN VL0010		19		4 378	100%	10 925	100%		
ESP DFN VL1824	62	242		7 166	83%	955	55%		
ESP DTS VL2440	229	3 306		33 023	41%	56 735	62%		
ESP HOK VL1824	97	553		7 817	41%	4 334	60%		
ESP PS VL1218	166	896		22 990	100%	19 482	100%		
PRT DFN VL1218	86	670	2 472	13 532	100%	3 699	100%	12 113	100%
PRT DTS VL2440	74	538	27 051	14 245	100%	17 738	100%	40 362	100%
PRT FPO VL0010		407	511	31 031	100%	2 707	100%	9 770	100%
PRT FPO VL1012			512	6 575	100%	1 180	100%	4 168	100%
PRT PGP VL0010		3 084	8 087	97 665	100%	6 093	100%	26 049	100%
PRT PS VL0010		292	296	3 669	100%	2 263	100%	2 433	100%
PRT PS VL1012			612	3 694	100%	4 787	100%	4 934	100%
PRT PS VL1218	37	352	896	4 282	100%	10 466	100%	8 521	100%
PRT PS VL1824	52	867	5 024	6 836	100%	38 105	100%	23 224	100%
PRT PS VL2440	17	357	2 233	2 512	100%	18 389	100%	12 172	100%

FLEET SEGMENT	Direct subsidies (€1000)	Total income (€1000)	Crew wages (€1000)	Gross value added (GVA) (€1000)	Operating cash flow (OCF) (€1000)	Profit / Loss (€1000)	Average wage per FTE
ESP DFN VL0010	68	607	308	299	59	-454	16 585
ESP DFN VL1824	318	10 102	4 132	6 736	2 923	22	17 060
ESP DTS VL2440	15 829	274 625	91 410	98 498	22 916	-34 290	27 649
ESP HOK VL1824	1 118	28 013	11 437	15 887	5 569	-94	20 687
ESP PS VL1218	753	37 127	19 228	28 109	9 633	5 859	21 453
PRT DFN VL1218		11 834	4 424	8 461	4 037	-673	6 606
PRT DTS VL2440		43 254	12 190	21 732	9 542	-6 064	22 651
PRT FPO VL0010		5 609	964	4 381	3 417	1 391	2 370
PRT FPO VL1012		3 934	1 266	2 838	1 572	420	
PRT PGP VL0010		28 314	6 783	19 468	12 686	5 048	2 199
PRT PS VL0010		2 349	2 558	1 848	-710	-1 191	8 769
PRT PS VL1012		5 288	1 913	4 112	2 199	1 501	
PRT PS VL1218		8 359	3 973	6 336	2 363	1 057	11 278
PRT PS VL1824		24 382	14 521	18 184	3 663	-1 477	16 749
PRT PS VL2440		14 198	6 841	10 668	3 827	174	19 142

Fleet segments were selected on the basis of their dependency on the ecosystem (% of their landings and days at sea). As most of segment fulfilled that criteria, those with significant landings' volume (over 1,000 t) and relatively high value were selected. This shows a very high overall dependency of fleets on this particular ecosystem, with a minimum percentage of landings of 55%.

The data on subsidies for the selected segments was not available. Some inconsistencies also were noticed with available data such as for example total income lower than the value of total landings for several segments. Finally, the number of vessels in the segment is only available for half of the selected segments.

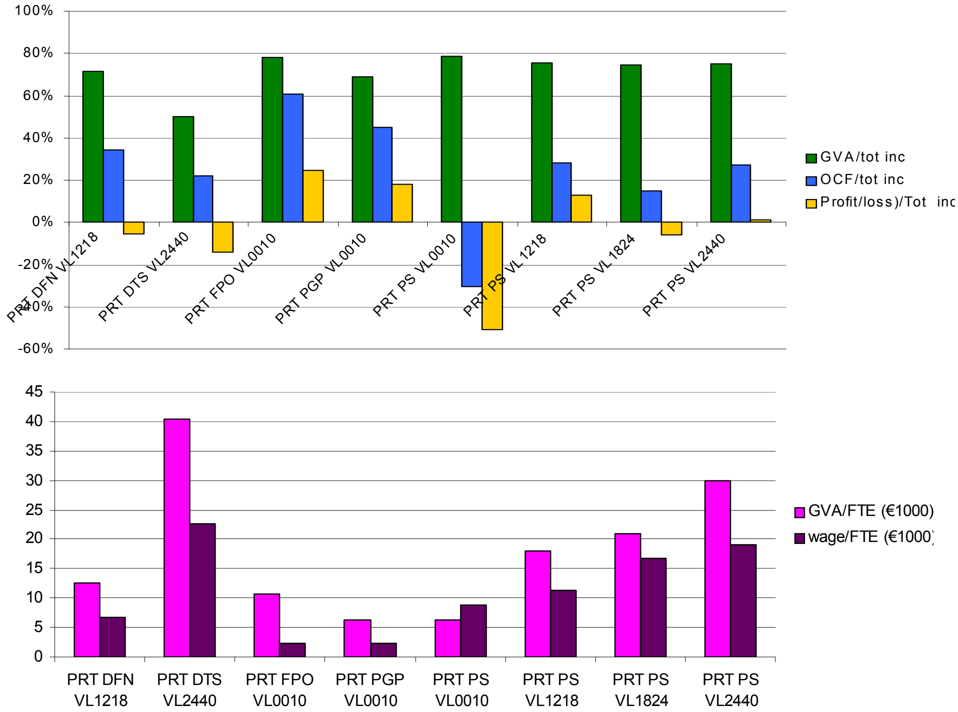


__Figure 11.16.__ Economic and social indicators of the Portuguese fleet segments operating in the Iberian Coast (2009).

Two segments which had similar values for most economic indicators in 2008 can be used for comparison (Table 11.18). The Portuguese netters (PRT DFN VL1218) and purse seines of length class 18-24 m (PRT PS VL1218) had both around €10M of total income and a gross value added of around €7M. The netters had higher operating cash flow and profits. In terms of impact in the ecosystems, the volume landed by the purse seiners was more than four times larger.

The situation from 2008 to 2009 shows an increase in both landings and number of vessels for the netters. However this segment shows a downfall in all the economic indicators, moving from profits to losses with an increasing fleet. The seiners segment instead shows an improvement in the operating cash flow per vessel and sustained profits in 2009. The parameters per vessel (GVA and OCF) also show a negative trend for the seiners, although the profit per vessel was similar for both years.

It should be noticed that, despite the worsening of the economic indicators of the seiners, the social indicators show substantially higher performances than for the netters.

Table 11.8. *Main economic indicators for individual vessels in segments PRT DFN VL1218 and PRT PS VL1218 (From AER 2010).*

FLEET SEGMENT	YEAR	number of vessels	Total income per vessel (€1000)	GVA per vessel (€1000)	OCF per vessel (€1000)	Profit / Loss per vessel (€1000)
PRT DFN VL1218	2008	66	162	116	55	26
PRT DFN VL1218	2009	86	138	98	47	-8
PRT PS VL1218	2008	37	280	199	54	30
PRT PS VL1218	2009	37	226	171	64	29

11.4.3 Ecological indicators of fleet segments impact on the Iberian coast ecosystem

With the aim of assessing different fleet activities and their interaction with the Iberian Coast ecosystem under an EAF approach context, three ecological indices were computed: 1) the partial fishing mortality applied on the ICES assessed stocks from the Iberian Coast, 2) the sustainability index per fleet segment through a comparison between the current state of the exploited stocks and the targets limits F_{pa}, $F_{0.1}$, B_{pa} and $B_{0.1}$, and 3) the required primary production to sustain the catches of each fleet.

- **Partial F - contribution to the fishing mortality of the assessed stocks**

The partial fishing mortality by fleet segment was estimated for each assessed stocks on the basis of the weight of the fleet segment landings over the total landings of that stock in the area. The partial F by fleet is a measure of their impact on the assessed stocks. Their sum can be considered as an indicator of the global impact of the fleet on the Iberian Coast ecosystem.

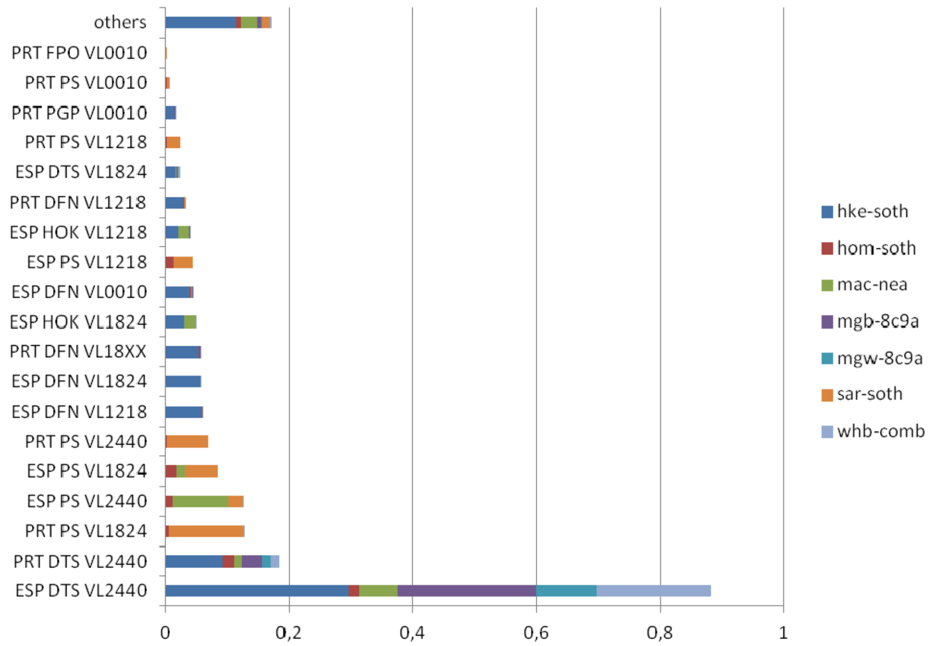


Figure 11.17. *Partial fishing mortality by fleet segment contributing to the fishing mortality of the assessed stocks.*

We identified 74 fleets operating over six assessed stocks: southern hake (hke-soth), southern horse mackerel (hom-soth), northeast Atlantic mackerel (mac-nea), *nephrops* (nep-8ab), two stocks of megrim (mgb-8c9a and mgw-8c9a), southern sardine (sar-soth) and blue whiting (whb-comb). We chose the fleets producing more than 1.5% of the sum of the partial F of all fleets (Figure 11.17). The Spanish demersal trawlers of 24-40 m produced the highest mortality with a cumulative F higher than 0.8 and a high impact on hake, megrim and blue whiting.

- **Sustainability index**

Due to data limitations, the sustainability index could only be estimated for a limited set of four fleet segments and took into account largest distributed assessed stocks, i.e. blue whiting and mackerel (Figure 11.17). The seiners and pelagic netters thus exhibit a poor sustainability index because their exploitation of mackerel among other not considered stocks, while the demersal trawlers of 24 to 40 m exhibit a higher sustainability index since they preferably exploit blue whiting. In such a case where only a low fraction of landings is considered due to data unavailability, we conclude that index estimates provide unreliable information. However, these results are shown in Figure 11.18 as an example.

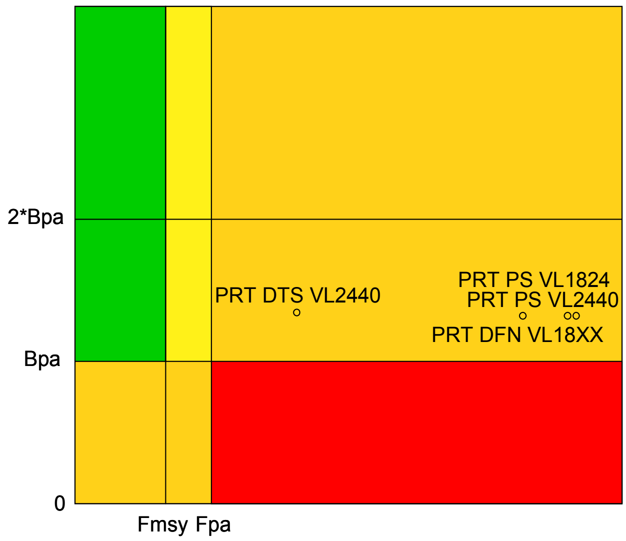


Figure 11.18. *Sustainability index as (B*, F*) for Portuguese fleet segments (only fleets exploiting mackerel or blue whiting are considered; note that this graph is provided as an example of unreliable result due to data unavailability; see text for details).*

- **Index of food web impact**

The food web impact index (required primary production to sustain the activity of a fleet segment) shows that the Spanish demersal trawlers of 24-40 m extract by far the highest fraction of total PPR in the Iberian Coast with a value of 27% (Figure 11.19).

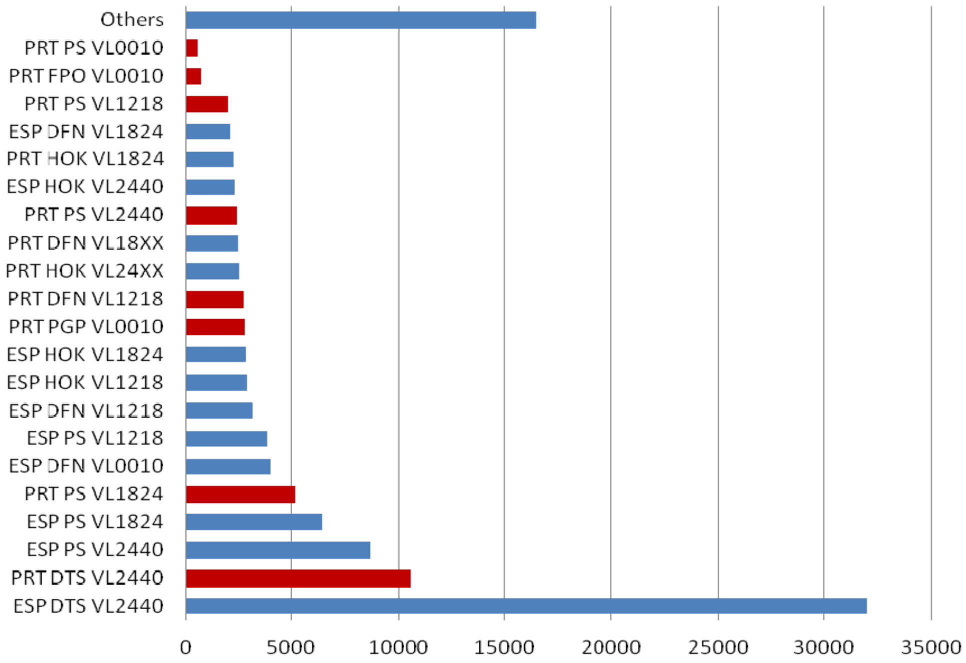


Figure 11.19.*Required primary production to sustain the catch of each fishing fleet segment with PPR >2% of total PPR, or segments with economic data available (in red).*

The seabed habitat impact of the selected fleets is shown in Figure 11.20. We selected the fleets which contributed at least to 2% of the total habitat impact in that area. We also included the fleets for which the economic data was available for the economic analysis. The Spanish demersal trawlers of 24-40 m produced the highest impact on the Iberian Coast ecosystem.

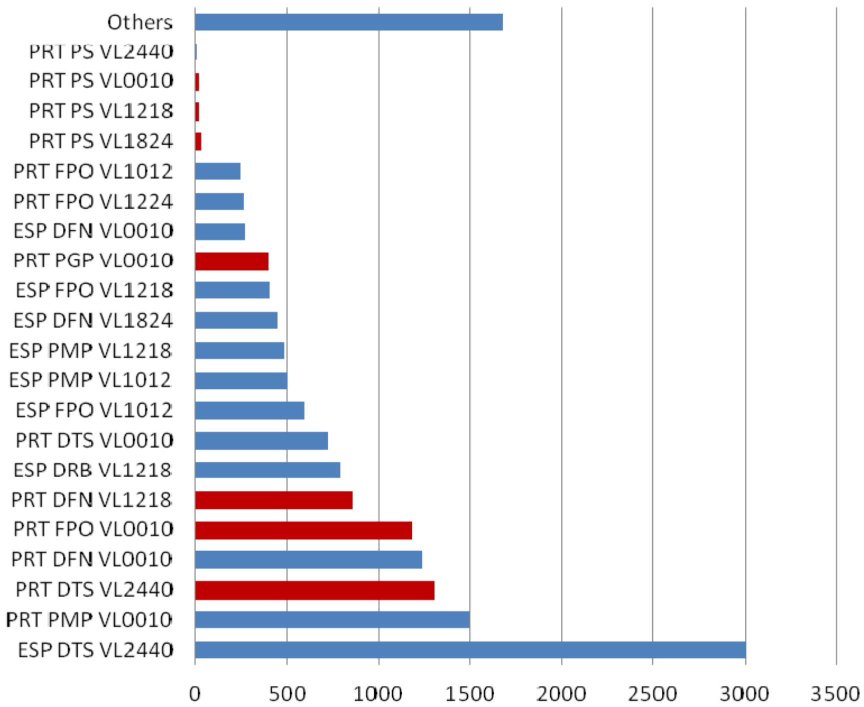


Figure 11.20. *Index of habitat impact estimated for the fleet segment operating in the Iberian Coast ecosystem (based on fishing effort in 1000 day at sea * score index from Chuenpagdee et al., 2003).*

11.4.4 Synthesis and conclusion of the fleet synthesis

Some indicators are missing for some fleet segments (especially index of energy and subsidies). Indicators exhibit large contrasts between Spanish fleets. Large trawlers are characterised by large GVA, income and OCF but also by large ecological impact and economic losses. In contrast, Spanish netters and seiners show large profit and ecological impact, but receive large subsidies. Portuguese fleets also appear profitable and exhibit low ecological impact, but data related to subsidies are unavailable. Therefore, more data is needed to assess the economic and ecologic impact of fleet segments for the Iberian Coast area.

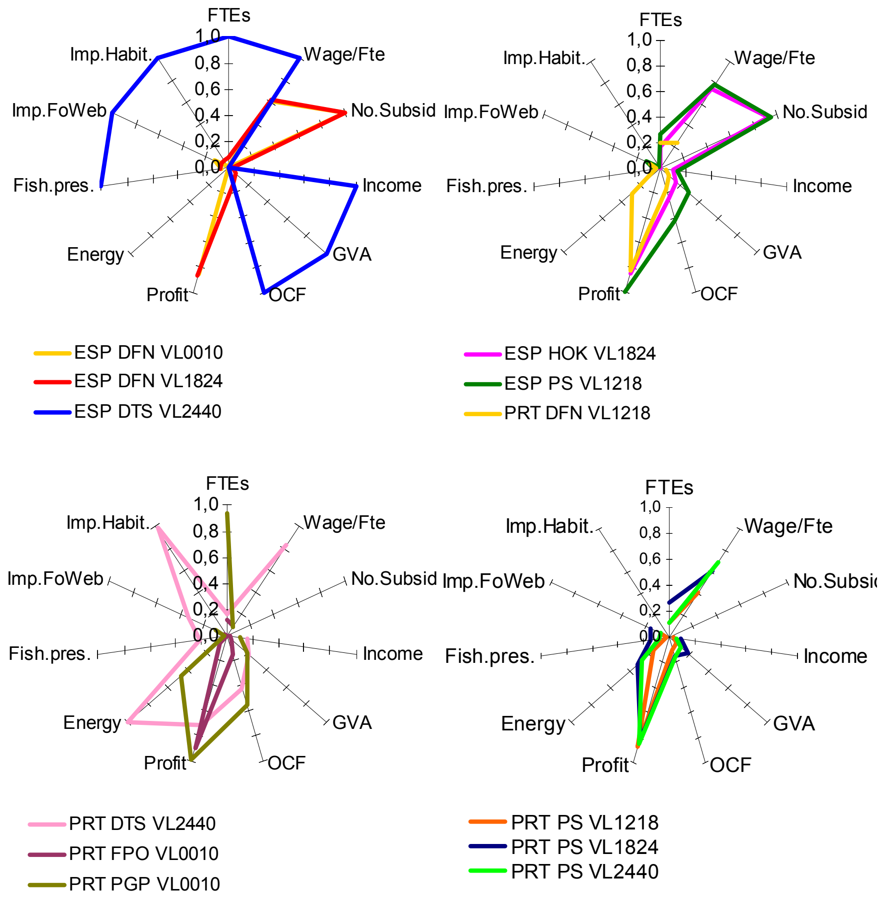


***Figure 11.21**. Standardized economic and ecological indicators for the main fleet segments operating in the Iberian Coast ecosystem (due to a lack of data the sustainability index was not considered; only fleet for which indicators can be calculated are reported on the graph).*

11.5 Summary of the Iberian coast results

Three salient aspects of this ecosystem emerged from the current analysis.

1. Further economic and ecological information is necessary to move towards an integral Ecosystem Approach to Fisheries Management in the Iberian Coast. The analyses shown in this Chapter are based on commercial fisheries databases, eight ICES-evaluated stocks (but reference points were available only for two stocks), hydrographical information from ICES, results on ecosystem indicators from published studies (Borges et al., 2010), EVHOE survey and the Annual Economic Report on the EU

fishing fleets (JRC, 2010). Nevertheless, most of the value of landings and other important variables (subsidies, employment etc.) are not available. Thus, the methodology was only partially applied due to the lack of data. Therefore, we strongly encourage further data collection programs, including those intended to quantify fleet's dependency on the multiple stocks exploited in the area, their subsidies and economic performance; and those aiming to investigate the direct and indirect impacts of the fishing activity in the Iberian Coast ecosystem through ecosystem indicators.

2. Available data indicates a rapid development and exhaustion of fisheries from 1950s to 1970s, with a consistent declining pattern since 1970s (appreciable in data from Sea Around Us database).Although Statland database shows significant fluctuations, a declining trend on total landings can be appreciated, especially when using data from Sea Around Us. Since 1980's a consistent decline is appreciated in the assessed stocks landings too. However, fishing intensity grew until the end of the 1990s where fishing mortality was significantly reduced in the assessed fisheries. This reduction was accompanied by a slight growth in biomass that ended in 2005-2006, just when fishing mortality grew again. Further reductions in fishing effort need to be enforced following our results.

3. Iberian Coast fisheries are dominated by 24-40m demersal trawlers (mainly Spanish but also Portuguese). Demersal trawls seem to be responsible of most of the impact, both on direct stocks and habitats in the Iberian Coast. Although some other Portuguese fleets exploit at levels above precautionary limits, managing demersal trawlers appears to be a must when deciding Iberian Coast fisheries management plans. However, Spanish demersal trawls obtain high scores on economic performance. Conversely, some of the smaller segments with a lighter pressure on the stock show negative economic results.

Landings Y	Effort E	Mortality F	Biomass SSB	Recruit. R	Sustain. F*	Survey LFI	Survey MMLw	Survey MTL	Landing MMLw	Landing MTL
↘	?	↘	↘	↘	?	→	→	↗	→	↘

Figure 11.22. *Trends in the main indicators of the Iberian Coast ecosystem health*

12 COMPARATIVE ANALYSIS BETWEEN STECF-DEFINED ECOSYSTEMS

The STECF experts working group was asked in the term of reference 4 to undertake a comparative analysis of the results obtained in the various marine ecosystems belonging to the same ICES eco-regions (i.e. 3a/3b/3c on one hand, and 4a/4b on the other hand) in order to assess the pertinence of such sub-divisions. The working group had very restricted time for this analysis but briefly compared the list of stocks and fleet segments present within each ecosystem and the trends in the main ecosystem indicators.

Regarding the large North Western waters ICES eco-region, about50% of the exploited stock in the West of Scotland/Ireland ecosystem expands to the Celtic Sea, while more assessed stocks are specifically bounded in the Celtic sea (Figure 12.1). All currently assessed Irish Sea stocks are included within the boundaries of this ecosystem. Therefore many exploited resources appear to be largely independent from one ecosystem to the other.

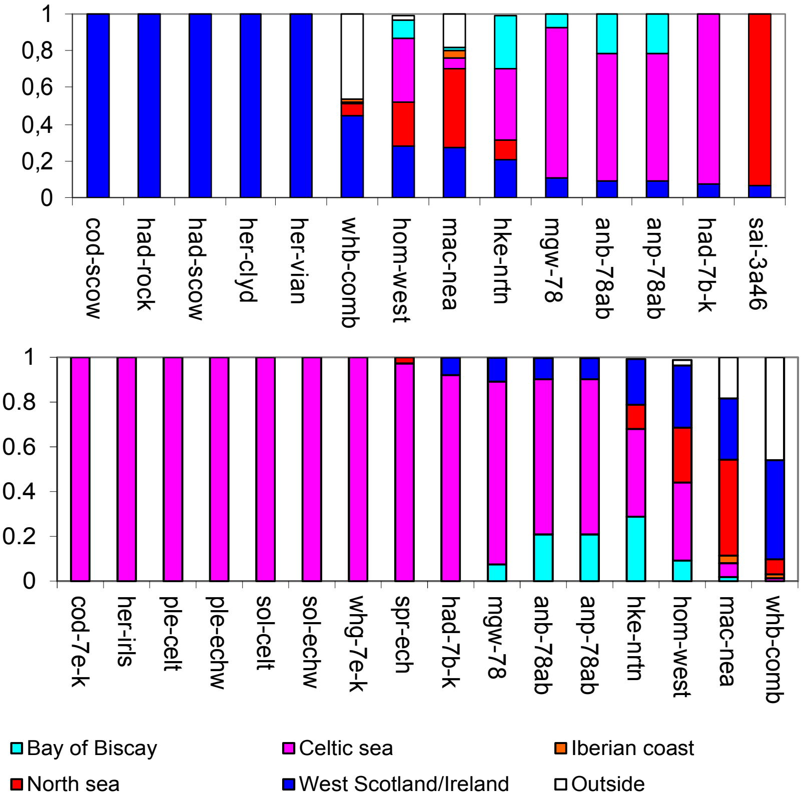


Figure 12.1. *Spatial extent of the stocks in the West Scotland/West Ireland ecosystem(top) and in the Celtic Sea (bottom) (in % of volume landed within each ecosystem for the 2000-2010 period).*

It is even clearer in the case of the two southern ecosystems which appeared largely independent one to each other (Bay of Biscay and Iberian Coast, Figure 12.2). Among the 16 assessed stocks, some are shared between the Bay of Biscay and the Celtic Sea (especially hake, anglerfish, megrim), but only the anchovy from the Bay of Biscay (including the Northern Spanish coast) is significantly shared with the Iberian Coast area. More generally a clear ecological separation does exist between the Bay of Biscay and the Iberian Coast in relation to the different morphology of the continental shelf separated by the Cap Ferret trench.

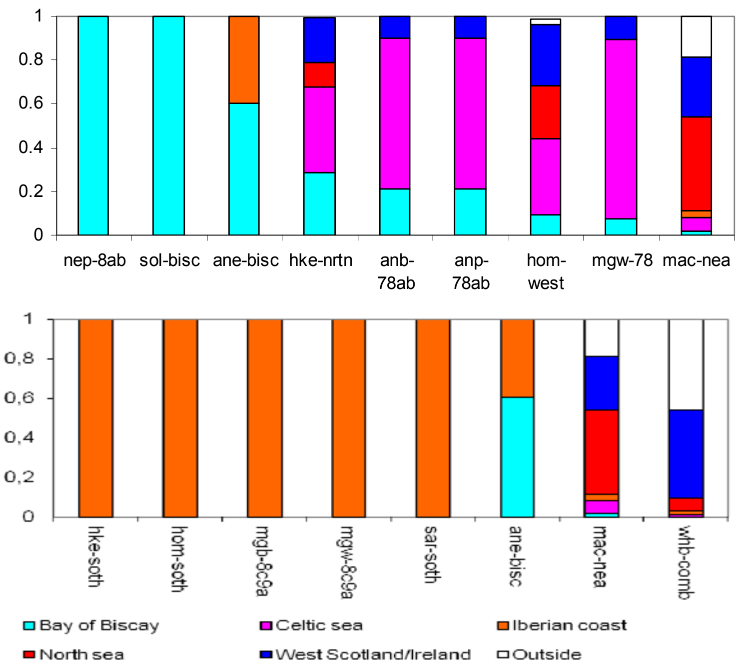


Figure 12.2*Spatial extent of the stocks in the Bay of Biscay ecosystem (top) and in the Iberian coast (bottom) (in % of volume landed within each ecosystem for the 2000-2010 period)*

The ecosystem indicators do not exhibit the same trends between the ecosystems included in the same ICES eco-region (Figure 12.3). Thus the diagnosis can be different. The STECF expert working group also notes that fleet segments and flags operating within each ecosystem largely differ. It is especially true between the Bay of Biscay where French fleets are predominant and the Iberian Coast where the Spanish and Portuguese vessels are numerous.

From figure 12.3, we can summarize main results by highlighting that the Western Scotland/Ireland ecosystem showed the largest number of indicators with negative trends (arrows in red), followed by the Irish Sea and the Iberian coast. On the contrary, the Bay of Biscay is the ecosystem showing the largest number of indicators with positive trends (arrows in green). Another interesting result it the fact that all ecosystems showed negative trends on recruitment indicators, highlighting a general problem in recruitment in all ecosystems analysed (see general results in Chapter 2).

		Land. Y	Effort E	Mortal. F	Biom. SSB	Recr. R	Sust. F*	Survey LFI	Survey MMLw	Survey MTL	Land. MMLw	Land. MTL
North western Atlantic waters	West Scot./Irl.	↘	↘	↘	?	↘	😐	?	↘	↘	↘	↘
	Irish Sea	↘	↘	↘	↘	↘	?	→	↗	↘	→	↘
	Celtic Sea	↘	↘	↘	↗	↘	☺	?	?	?	low	↘
South western Atlantic waters	Bay of Biscay	→	?	↘	↗	↘	?	↗	→	→	↗	→
	Iberian Coast	↘	?	↘	↘	↘	?	→	→	↗	→	↘

Figure 12.3. *Trends in the main indicators of the ecosystems health.*

The STECF expert working group on EAFM concluded in relation to ToR 4 that considering such ecosystem subdivision appears pertinent. Ecosystems used in the present report, based on the list defined by STECF in line with the previous EAFM working group, represent a good compromise in term of size. Indeed, these ecosystems are compatible with stocks-based and fleet-based analyses and with modelling approaches as well. Smaller ecosystems can also be considered in more detailed research programs and for local (mostly coastal) management but the scale used in the current report seems to be more appropriate for providing scientific advice to European political bodies. Larger areas than the seven considered ecosystems, and especially the two larger ICES eco-regions, would be characterized by a high heterogeneity in terms of both ecological processes and fleet dynamics.

The feasibility analysis conducted during this working group confirms that ecosystems defined by STECF represent the appropriate level:

- To draw syntheses on stock status and analyse trends in the ecosystem indicators,
- To study ecological impacts and economic performances of fleet segments,
- To analyse trade-offs between economy and ecology in order to develop a fleet-based management of fisheries.

Such ecosystems also appear to be the right entities to develop models devoted to scientific advices in both ecological and economical frames and to defined long term management plan at such scale. They could and should be a “territory” to improve the dialogue and to involve stakeholders in the participative management of fisheries.

13 LINKS BETWEEN INDICATOR-BASED APPROACH OF EAFM AND MSFD

According to the Term of Reference number 5, the relevance of the indicator-based approach to "develop an ecosystem approach to fisheries management in European seas" for the MSFD is discussed below.

13.1 The MSFD indicators and the fisheries impacts on ecosystems

The MSFD forms the environmental pillar of the Integrated Maritime Policy[6] (IMP), and is the thematic strategy for the protection and conservation of the marine environment '*with the overall aim of promoting sustainable use of the seas and conserving marine ecosystems*'[6] with the goal of achieving good environmental status (GES) across all European waters by 2020. The role of the MSFD in defining environmental objectives for fisheries policy is clearly stated in the MSFD. For example the MSFD states that it:

> *"...should contribute to coherence between different policies and foster the integration of environmental concerns into other polices, such as the Common Fisheries Policy."*

Whilst in relation to the prioritisation of environmental objectives the MSFD states:

> *"...while enabling a sustainable use of marine good and services, priority should be given to achieving or maintaining good environmental status in the Community's marine environment..."*

This role for the MSFD in developing environmental objectives for all aspects of maritime management including fisheries is acknowledged in the Green Paper on the reform of the CFP which notes that:

> *"... the fisheries sector interacts closely with other maritime sectors. The Integrated Maritime Policy (IMP) addresses interactions between EU policies and maritime affairs."*

Furthermore the need for the reformed CFP to manage fisheries such that the objectives of the MSFD are not compromised is clearly stated in the CFP Green Paper which adds that:

> *"... an ecosystem approach to marine management, covering all sectors, is being implemented through the Marine Strategy Framework Directive, which is the environmental pillar of the IMP and sets the obligation for Member States to achieve Good Environmental Status in 2020. The future CFP must be set up to provide the right instruments to support this ecosystem approach."*

This illustrates the commitment of the reformed CFP to manage fisheries and to operate within the constraint of achieving GES across European waters. In order to establish what this means for fisheries managers and what the operational environmental objectives for fisheries management should actually be, a closer examination of the MSFD definition of, and requirements for, GES is required.

The MSFD is the European thematic strategy for the protection and conservation of the marine environment with the goal of achieving GES across all European waters. Thus ecological objectives defined in the MSFD were established with regard to the impact of all pressures on the system and not just fisheries. Within the MSFD GES is broadly defined as:

> *"... the environmental status of marine waters where these provide ecologically diverse and dynamic oceans and seas which are clean, healthy and productive within their intrinsic*

[6] An Integrated Maritime Policy for the European Union. COM(2007)575.

conditions, and the use of the marine environment is at a level that is sustainable, thus safeguarding the potential for uses and activities by current and future generations."

In addition to the general definition of GES, the MSFD lists eleven qualitative descriptors of good environmental status (hereinafter referred to as the 'GES descriptors') that provide more specific statements of desired environmental status (Table 13.1). These eleven more specific qualitative descriptors of GES provide an appropriately detailed starting point for the development of operational environmental objectives on the basis of policy aspirations.

In order to decide on the relevance of the indicator-based approach developed as part of EAFM it is necessary to identify which of the eleven qualitative descriptors of GES covers aspects of marine environmental status impacted by fishing so that only the descriptors notably affected by fishing are explicitly considered.

Table 13.1. *The eleven qualitative descriptors of GES. Ticks indicate the descriptors of environmental status that were deemed to be impacted by fishing (see text for discussion of selection).*

Marine Strategy Framework Directive ANNEX I **Qualitative descriptors for determining good environmental status** (referred to in Articles 3(5), 9(1), 9(3) and 24)	
(1) Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.	✓
(2) Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems.	x
(3) Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock.	✓
(4) All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity.	✓
(5) Human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters.	x
(6) Sea-floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.	✓
(7) Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems.	x
(8) Concentrations of contaminants are at levels not giving rise to pollution effects.	x
(9) Contaminants in fish and other seafood for human consumption do not exceed levels established by Community legislation or other relevant standards.	x
(10) Properties and quantities of marine litter do not cause harm to the coastal and marine environment.	x
(11) Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.	x

The selection of GES descriptors that cover aspects of the marine environment impacted by fishing were made at the same time by various bodies in European countries. They have especially be selected during two MEFEPO project workshops involving MEFEPO project partners and policy makers, NGO representatives and marine scientists external to the project (see LeQuesne 2010). There was unanimous agreement amongst all participants over the selection of the four descriptors that were chosen for inclusion; namely descriptors 1, 3, 4 and 6 relating to biodiversity, commercial species, food webs and benthic processes respectively.

Descriptors 2, 9, 10 and 11, relating to invasive species, contaminants in seafood, litter and underwater noise, were highlighted during the workshops as possibly requiring inclusion. The reasons for not including these descriptors are briefly outlined below.

(2) *Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems*: The potential impact of non-indigenous species (NIS) on ecosystems and fisheries is of concern. For example introduction of the comb-jelly *Mnemiopsis leidyi* to the Black Sea is believed to have contributed to the poor recovery of Black Sea fish stocks following reduction in fish pressure (Shinganova & Bulgakova 2000). However fishing activities are not seen as the direct cause of species introductions; rather fishing may create conditions that facilitate establishment of introductions. Theory suggests that ecosystems that are species rich with many ecological links are more resilient to invasion (May & McLean, 2007). Therefore if fishing simplifies the system by, for example, selective removal of top predators or larger size classes there may be an increased likelihood that introduced species can become established. However as this effect is linked to fisheries impacts on biodiversity and food web structure it is considered that the effect of fisheries on system simplification will be addressed by GES descriptors 1 and 4 respectively.

(9) *Contaminants in fish and other seafood for human consumption do not exceed levels established by Community legislation or other relevant standards*: In relation to contaminants in seafood it was noted that whilst fisheries managers may have to respond to contamination in seafood, such as the monitoring and closure of shellfish areas, fisheries are not a significant cause of contamination. As fishery managers cannot take measures to control the levels of contamination in the marine environment it was not considered appropriate for this descriptor to be included as an environmental objective for fisheries management.

(10) *Properties and quantities of marine litter do not cause harm to the coastal and marine environment*: Two separate aspects of fishing and litter were considered separately; these were 'general' litter from fishing vessels, and 'ghost fishing'. Litter is widespread in the marine environment, and the incident of plastic litter is particularly prevalent due to its long lifetime in the marine environment. Monitoring of the incident of plastics in beach washed dead fulmars (*Fulmarus glacialis*) in the Netherlands between 1999-2003 found that 98% of the birds examined contained plastics (Van Franeker et al. 2004), and it was assumed that many of the litter items observed were discarded from ships (but not exclusively fishing vessels). However it was considered that general marine litter was under the remit of MARPOL and did not require specific consideration by fishery managers. Under MARPOL Annex V the North Sea is designated a special area and disposal of plastics at sea is entirely prohibited.

In relation to ghost fishing it is inherently difficult to quantify both the extent of gear loss and the effect of this gear loss on mortality rates. Despite the limited information available a review of ghost fishing in European waters concluded that ghost fishing accounted for less than 1% of the total mortality caused by fishing operations (not including discard mortality) (Brown & Macfadyen 2007). As ghost fishing is only responsible for a minor portion of the total mortality caused by fishing operations it was decided not to include impacts of ghost fishing as a specific separate objective for fisheries managers.

(11) *Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment*: During the expert workshops it was considered whether noise relating to fishing operations should be explicitly considered by fishery managers. It was concluded that

whilst fishing operations did cause underwater noise, the levels were low compared to the noise produce by other parts of the shipping sector, other offshore developments (such as the renewable and hydrocarbon industries) and natural background levels, and that fishing operations were not a significant area of concern.

This process justifies the selection of four MSFD GES descriptors that need to be considered in the context of the SGMOS indicator-based approach. The criteria and potential indicators applicable to these descriptors defined in COM(2010)477 are given in the table 13.2.

Table 13.2. *Proposed MSFD descriptors, attributes and indicators which were identified as potentially affected by fishing.*

Descriptor		Criteria		Indicator	
1	Biological diversity	1.1	Species distribution	1.1.1	Distributional range
1	Biological diversity	1.1	Species distribution	1.1.2	Distribution within the latter, where appropriate
1	Biological diversity	1.1	Species distribution	1.1.3	Area covered by the species (for sessile/benthic species)
1	Biological diversity	1.2	Population size	1.2.1	Population abundance and or biomass, as appropriate
1	Biological diversity	1.3	Population condition	1.3.1	Population demographic characteristics (e.g. body size or age class structure, sex ratio, fecundity rates, survival/mortality rates)
1	Biological diversity	1.3	Population condition	1.3.2	Population genetic structure, where appropriate
1	Biological diversity	1.4	Habitat distribution	1.4.1	Distributional range
1	Biological diversity	1.4	Habitat distribution	1.4.2	Distributional pattern
1	Biological diversity	1.5	Habitat extent	1.5.1	Habitat area
1	Biological diversity	1.5	Habitat extent	1.5.2	Habitat volume, where relevant
1	Biological diversity	1.6	Habitat condition	1.6.1	Condition of the typical species and communities
1	Biological diversity	1.6	Habitat condition	1.6.2	Relative abundance and/or biomass, as appropriate
1	Biological diversity	1.6	Habitat condition	1.6.3	Physical, hydrological and chemical conditions
1	Biological diversity	1.7	Ecosystem structure	1.7.1	Composition and relative proportions of ecosystem components (habitats and species)
3	Commercial Fish and Shellfish	3.1	Level of pressure of the fishing activity	3.1.1	Primary indicator: Fishing mortality (F)
3	Commercial Fish and Shellfish	3.1	Level of pressure of the fishing activity	3.1.2	Secondary indicator: Ratio between catch and biomass index (hereinafter catch/biomass ratio)
3	Commercial Fish and	3.2	Reproductive capacity of the stock	3.2.1	Primary indicator: Spawning Stock Biomass (SSB)

	Shellfish				
3	Commercial Fish and Shellfish	3.2	Reproductive capacity of the stock	3.2.2	Secondary indicator: Biomass indices
3	Commercial Fish and Shellfish	3.3	Population age and size distribution. Primary indicators. Healthy stocks are characterised by high proportion of old, large individuals. Indicators based on the relative abundance of large fish include	3.3.1	Proportion of fish larger than the mean size of first sexual maturation
3	Commercial Fish and Shellfish	3.3	Population age and size distribution. Primary indicators. Healthy stocks are characterised by high proportion of old, large individuals. Indicators based on the relative abundance of large fish include	3.3.2	Mean maximum length across all species found in research vessel surveys
3	Commercial Fish and Shellfish	3.3	Population age and size distribution. Primary indicators. Healthy stocks are characterised by high proportion of old, large individuals. Indicators based on the relative abundance of large fish include	3.3.3	95% percentile of the fish length distribution observed in research vessel surveys
3	Commercial Fish and Shellfish	3.3	Population age and size distribution. Primary indicators. Healthy stocks are characterised by high proportion of old, large individuals. Indicators based on the relative abundance of large fish include	3.3.4	Size at first sexual maturation, which may reflect the extent of undesirable genetic effects of exploitation (secondary indicator)
4	Food webs	4.1	Productivity (production per unit biomass) of key species or trophic group	4.1.1	Performance of key predator species using their production per unit biomass (productivity)
4	Food webs	4.2	Proportion of selected species at the top of food webs	4.2.1	Large fish (by weight)
4	Food webs	4.3	Abundance/distribution of key trophic groups/species	4.3.1	Abundance trends of functionally important selected groups/species. [groups with fast turnover rates (e.g. phytoplankton, zooplankton, jellyfish, bivalve molluscs, short-living pelagic fish) that will respond quickly to ecosystem change and are useful as early warning indicators; groups/species that are targeted by human activities or that are indirectly affected by them (in particular, by-catch and discards); habitat-defining groups/species; groups/species at the top of the food web; long-distance anadromous and catadromous migrating species; groups/species that are tightly linked to specific groups/species at another trophic level].
6	Seafloor Integrity	6.1	Physical damage, having regard to substrate characteristics	6.1.1	Type, abundance, biomass and areal extent of relevant biogenic substrate (6.1.1)
6	Seafloor Integrity	6.1	Physical damage, having regard to substrate characteristics	6.1.2	Extent of the seabed significantly affected by human activities for the different substrate types (6.1.2).

6	Seafloor Integrity	6.2	Condition of benthic community	6.2.1	Presence of particularly sensitive and/or tolerant species (6.2.1)
6	Seafloor Integrity	6.2	Condition of benthic community	6.2.2	Multi-metric indexes assessing benthic community condition and functionality, such as species diversity and richness, proportion of opportunistic to sensitive species (6.2.2)
6	Seafloor Integrity	6.2	Condition of benthic community	6.2.3	Proportion of biomass or number of individuals in the macrobenthos above some specified length/size (6.2.3)
6	Seafloor Integrity	6.2	Condition of benthic community	6.2.4	Parameters describing the characteristics (shape, slope and intercept) of the size spectrum of the benthic community (6.2.4).

13.2 Using ecosystem indicators in the context of MSFD and EAFM: what next?

The Commission Decision for the assessment of GES(COM(2010)477) specifies that the status of the marine environment should be assess in relation to the criteria and indicators defined in the Commission Decision. However the use of indicators should be selected and prioritised on the basis of analysis of the predominant impacts and pressures in the assessment region. Where a Member State does not apply a criteria or indicator the reason must be justified. Similarly COM(2010)477 notes that in areas there is the need for further development and refinement of indicators for application to the MSFD.

This indicates that assessments of GES, and the impact of fishing on GES do not need to utilise the full range of indicators specified. A further consideration relates to the need to establish management responses if a system is considered to be failing to achieve GES. Against this background when considering the application of indicators to support the integration of MSFD requirements into EAFM some key points to note are;

i) at least in the first instance, indicators are not required to monitor every impact of fishing on the marine environment, and **a focused set of indicators that capture the predominant impacts of fishing on the marine environment may be applied**,

ii) so that appropriate management interventions can be defined **it is preferable to apply indicators that are specifically responsive to fishing pressure**, rather than all anthropogenic activities, so that it is clear when fisheries management actions need to be taken rather than applying management measures to other sectors.

iii) where possible it is preferable to use indicators that can be calculated with currently available data.

Due to commitments to reduce the impacts of fishing on the marine environment under the current CFP, 10 indicators of the effects of fishing on the marine environment were specified in Appendix XIII of the DCF. These indicators are convenient for application to the MSFD as they can be calculated with data that are currently collected and in many instances there is a theoretical underpinning and history of testing the indicators.

The potential role of the DCF indicators for reporting on the impacts of fishing on GES was discussed in ICES (2012), the potential mapping of DCF indicators to MSFD criteria is presented in table 13.3. Previous works (e.g. Le Quesne et al 2010) have identified limitations and challenges associated with the use of the current set of DCF indicators for widespread reporting of the impacts of fishing on the marine environment with respect to GES.

It is advised by the current working group that a workshop or working group is established by STECF or ICES before the revision of the DCF in 2013 to provide advice on options to revise the indicators (and their calculation methods) of the impacts of fishing on the marine environment in relation to the requirements of the MSFD. This should be conducted in the light of Members States initial statements on the determination of GES due to be communicated to the Commission by 15th October 2012.

Table 13.3. *The relationship between the DCF 'ecosystem' indicators and the MSFD (from ICES 2012).The fixed calculation method refers to whether modifications to the original indicators have been proposed to allow widespread application to the MSFD, and reference levels refers to whether specific reference levels appropriate for the MSFD have been proposed for each indicator.*

	Indicator	**AttributesIndicators**	**Fixed calculation method**	**Reference level**
1	Conservation status of fish species	1.2.1	Modifications proposed	Proposed
2	Proportion of large fish	1.7.1, 4.2.1	Regionally specified	Proposed in regions
3	Mean maximum length of fish	1.7.1		No
4	Size at maturation of exploited fish species	3.3.4	Modifications proposed	No
5	Distribution of fishing activities			
6	Aggregation of fishing activities			
7	Areas not impacted by mobile bottom gears	6.1.2, 1.6	Options proposed	No
8	Discarding rates of commercially exploited species			
9	Discarding rates in relation to landed value			
10	Fuel efficiency of fish capture			

The majority of GES assessment criteria and indicators defined in COM(2010)477 are state metrics of biodiversity, food webs and integrity of sea-floor communities. However managing on the basis of state indicators can be challenging, especially where long lag periods are expected between a change in pressures and a response in 'state'. To further application of the indicator based approach to EAFM it would be desirable to specify, and where necessary develop, a set of pressure indicators that are linked to the state indicators. Simple indicators used by the working group for the fleet-based analyses (especially habitat impact index and the food web impact index) can be seen as a first preliminary test in that direction.

The application of indicators to support of the integration of fisheries management within measures to achieve GES is currently in a state of flux; member states are required to define the indicators and targets they will use to assess GES and to report this to the Commission by 15th October 2012. Once MS have declared their determination of GES and the selection of indicators is known the requirements for integrating measures to support achievement of GES into EAFM can be more clearly assessed.

Once the initial set of indicators being applied by MS in relation to biodiversity, food webs and seafloor integrity have been specified it should be considered how these indicators can be incorporated into the development of EAFM to support achievement of GES. In particular it could be considered whether the indicators applied are sufficient to monitor the predominant impacts of fishing on marine ecosystems and gaps identified. Further it could be assessed, on the basis of available knowledge, whether the state indicators are specifically responsive to fishing impacts, and in the case of pressure indicators the fractional contribution of different fleet segments calculated where possible.

13.3 The ecosystem indicators of the IndiSeas international WG

In addition, the working group discussed the existence of other ecosystem-based indicators initiative, such as that of IndiSeas international working group (www.indiseas.org, Shin et al. 2010). IndiSeas international WGwas established in 2005 as a collaborative program under the auspices of EUROCEANS and endorsed by IOC/UNESCO. This group aims at performing comparative analyses of ecosystem indicators to quantify the impact of fishing on marine ecosystems and to provide decision support tools for fisheries management. Therefore, since 2005 the group was been gathering indicator expertise to evaluate the exploitation status of marine ecosystems with respect to fishing activity using a set of ecological indicators, a comparative approach across marine ecosystems and a common set of interpretation and visualization methods. To date, IndiSeas includes more than 30 ecosystems, several of them located in European Seas. State and trend indicators included in IndiSeas1 (2005-2009) are listed in table 13.4. As an example, Figures 13.1 and13.2 show results of IndiSeas state and trend indicators available from European Seas, which are also covered by STECF working group on EAFM.

Table 13.4.*IndiSeas 1 Indicators to capture the ecosystem effects of fishing (Shin et al. 2010).*

Indicators	Headline label	Used for State or Trend	Management objective[a]
Mean length	Fish size	S, T	EF
TL of landings	TL	S, T	EF
Proportion of under- and moderately exploited stocks	% healthy stocks	S	CB
Proportion of predatory fish	% predators	S, T	CB
Mean lifespan	Lifespan	S, T	SR
1/CV of total biomass	Biomass stability	S	SR
Total biomass of surveyed species	Biomass	T	RP
1/(landings/biomass)	Inverse fishing pressure	T	RP

[a]CB, conservation of biodiversity; SR, maintaining ecosystem stability and resistance to perturbation; EF, maintaining ecosystem structure and functioning; RP, maintaining resource potential.

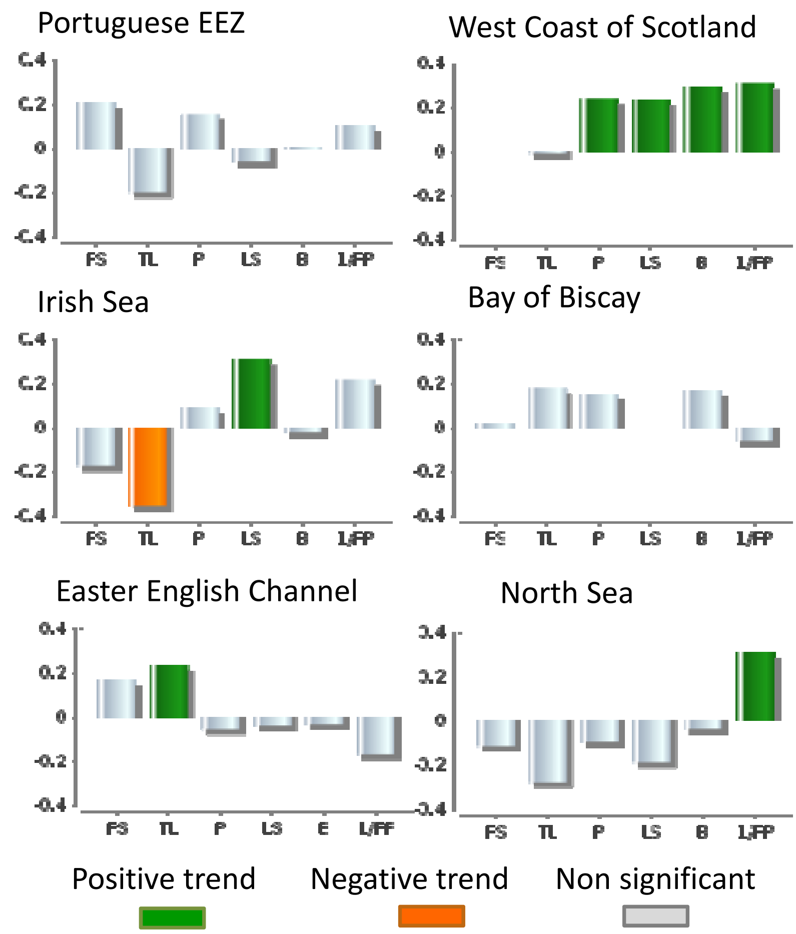


Figure 13.1. Trend indicators (1996-2005) from IndiSeas working group for selected European Seas included in STECF working group on EAFM (data available at www.indiseas.org). FS: Fish size, TL: Trophic level, P%: P% predators, LS: Life span, B: Biomass, 1/FP: Inverse fishing pressure.

Interestingly, by just looking at Figure 12.3 and 13.1 some similarities in results appear. For example, the Irish Sea shows a declining (negative) trend in IndiSeas results and state indicators are low for 4/6 indicators, suggesting a high fishing impact in the system, and in line with results from STECF WG (Figure 12.3). However, the West Coast of Scotland in IndiSeas is showing some increasing trends in indicators (positive response) while this ecosystem was negatively rated in 5 indicators by STECF. The fact that IndiSeas indicators are available for many European Seas (including Mediterranean ecosystems) and more will be available in the near future, could be an incentive to perform a formal comparison of STECF indicators based on DCF with results from IndiSeas. This comparison could aim at finding commonalities and differences in current results, but also to consider the inclusion of IndiSeas indicators in future STECF work, or in DCF requirements.

14 FUTURE STRUCTURE OF EAFM AND FORMAT OF ANNUAL REPORT (TOR 7)

The working group was requested to suggest a general format that could be used for the publication by STECF of an annual EAFM report and an organizational structure that would be responsible for addressing future ecosystem analyses.

The working group had limited time during the meeting to discuss in details the format of an annual EAFM report. However the group took into account the recommendations of the 2010 STECF working group on EAFM and considers that such a report would be very valuable. Nevertheless, the group considers that such a report does not necessarily need to be published on an annual basis. Because trends in ecosystem indicators are difficult to interpret in the short term and data update are often not immediately available, a report published every two or three years would be sufficient, at least as a first step.

Such a report on the EAFM in European Seas could be based on the format used in the present report that includes a general chapter for methods, a chapter for each ecosystem and a chapter for synthesis and general comments. Consequently, the analysis presented for each ecosystem should ideally include the following aspects: trends in catch and fishing efforts, stock-based synthesis, analysis of environmental and ecosystem indicators, fleet-based diagnosis on ecological and economic performances per fleet segment, results of ecosystem and bio-economic models notably for assessing the effect of management options.

The group also discussed the fact that current analysis did not cover all European marine ecosystems, so efforts in the future should be directed to include all European marine ecosystems extending the analysis to Mediterranean ecosystems and peripheral archipelagos of the Azores and Canary Islands missing in current analysis (see Figure 4.1 to identify ecosystems missing: areas 5a, 5b, 6, 7a, 7b, 8 and 9, and see also Table 15.1).

Note that, even if not included in the present report, results from models should be an important part of such a report. This point is discussed below in Chapter 15.

A single STECF working group could clearly not be in charge of managing all the analysis required for EAFM. According to previous comments, the working group suggests to start discussions with the other STECF groups and with ICES (and potentially with GFCM) in order not only to share the work, but to mobilize a large panel of experts and to promote an advice-oriented ecosystem approach in many existing STECF and ICES committees. The working group especially suggests to:

- Perform fleet-based analyses including, for the main fleet segments (and selection criteria have to be analysed), the environmental assessments of their ecological impact and evaluation of their economic performances. This should be the task of a specific STECF working group, with the participation of biologists and economists;
- A working group (possibly split per RACs in the future) could be in charge of regularly updating and running the reference ecosystem and bio-economic models to assess changes in each of the European marine ecosystems and to test various management options (see Chapter 15); this working group should also take into account specific results from other groups (e.g. ICES WGMIXFISH, …);
- Another yearly meeting could be in charge of aggregating results, building synthesis and formalizing scientific advice under the authority of STECF. The EAFM report would be the final product of this group based on an integrative approach of results obtained by several bodies. Because aggregating and interpreting results within each ecosystem is an heavy task and according to the fact that a report does not need to be published every year for each ecosystem, it can be foreseen to publish such an annual EAFM report alternatively for one or another subset of the 14 European ecosystems defined by STECF (for instance one year dealing with Mediterranean ecosystems, the next with the Atlantic-related ones; or possibly divided in three parts, …).

JRC should be strongly involved in the process, especially in the management of data call and required database and should actively participate in the annual EAFM reporting.

15 HOW TO IMPROVE EAFM IMPLEMENTATION IN EUROPEAN WATERS (TOR 8)

This chapter of the report is dedicated to more general comments, based on discussions between the experts during the meeting. In the first paragraph some general comments are presented on the tested method during the working group in reference to ToRs 1 to 3 and 6. In the following paragraphs, terms of reference 7 and 8 are more specifically addressed.

15.1 Comment on the methods used by the study group (ToRs 1 to 3 and 6)

Based on the seven case studies, one of the main objectives of the working group was to improve the preliminary approach developed by the 2010 STECF working group on EAFM, and to analyse the feasibility of building useful ecosystem advices. General comments can be made regarding what was learned from this test.

- **ToR1 Catch reconstruction.** Reconstructing long time-series of catch by species (or group) appears to be a necessary step within the ecosystem approach to fisheries management. It obviously provides a long term perspective on the exploitation history that has to be kept in mind when looking at the ecosystem health in the recent period.

Realistic time series of landings can be easily built in each European ecosystem since 1950, on the basis of ICES Statlant data (and using for 1950-72 simple hypotheses for the distribution of landings by subdivision). These time series constitute a first important approach for an overview of catch trends although not precise. Nevertheless, ICES Statlant statistics underestimate the real catch due to misreporting and discards. Thus, the use of time series estimated in the frame of a research program, such as the ones shown for the North Sea, provides certainly a more accurate and longer perception of the exploitation history. Statistics provided by the Sea around program may be useful information for a comparative analysis.

The working group was not able to provide during the meeting any estimate of the fishing effort trends over a long period. Such time series is likely to exist in the scientific literature or could be rebuilt within specific research programs. This means that more work is required before establishing such time series for all ecosystems. This effort should be considered as an important need for the EAFM.

- **ToR2 Stocks synthesis.** The “stocks synthesis” appears to be a key part of the EAFM. Using results based on single species assessments to build an ecosystem approach may not be perceived as an intuitive method. However, such synthesis at the ecosystem level provides an important overview on the best estimates we currently have regarding the status of all the assessed stocks exploited within the ecosystem.

This synthesis was built using F_{pa}, B_{pa} and F_{MSY}so that the status of each stock is defined with reference to both the “old” precautionary reference values and to the new MSY reference values. The new MSY-based objectives should be reached (for F) in 2015 (where possible) and it will be especially interesting to monitor the stocks’ trajectories (for each individual assessed stock or as a whole) in the coming years.

One current constraint of the method is that reference points were not available for all stocks assessed by ICES, because they have not yet been estimated. Accordingly to STECF advice, $F_{0.1}$ could be used as a proxy of F_{MSY}, where no direct estimate of F_{MSY} is available. Nevertheless, this proxy is not often used by ICES working group and the STECF EWG on EAFM had no time to estimate it from yield per recruit analyses.

The stock synthesis is also based on mean indicators and trajectories calculated for the combined assessed stocks. According to the report of the previous working group, the method has been improved by using geometric means for F and R indicators and by exploring more systematically various sets of stocks included in the aggregated indicators. This allows drawing an overview using both long time series of few assessed stocks versus short time series representing more species. Furthermore, only stocks assessed by ICES were presently considered, while other stocks locally assessed by national bodies should be included in future analysis.

To be powerful in an EAFM perspective, such a stock synthesis implies that a large part of the exploited stocks, if not all of them, would be assessed. From this point of view, we observed not only differences between ecosystems but also changes over time. In the last years the proportion of landings coming from stocks that are assessed by ICES is very high in some ecosystems (especially in the Baltic Sea, the North Sea, the West Scotland/Ireland ecosystem, with values close to or higher than 90 %), but has globally decreased, especially in the Celtic Sea (from 70 to 35 % of the total landings), in the Irish Sea (from 65 to 30 %) and in the Bay of Biscay (from 75 to 50 %). This is due to a decrease in the number of stocks that ICES working groups are able to assess (mainly caused by the lack of data delivery from Member States) and to an increase of landings of stocks which are not assessed (or stocks assessed by national bodies).

In contrast, the 2010 STECF working group underlined that assessing all resources exploited as target should be considered as a requirement of the EAFM. It should be admitted as a general ethical rule that exploiting natural resources implies a scientific survey (no assessment, no fishing). Thus, the current 2012 working group suggests STECF should recommend that an increasing proportion of the stocks targeted by European fisheries should be assessed by ICES, European programs or national bodies (Note that this is partly happening (e.g. see ICES WKLIFE report) following a large incentive from the Commission to improve stock coverage – the proposal to cut TAC by 25% year on year for all un-assessed stocks). Such assessments should not necessarily be provided on an annual basis and using the same full set of age-based methods. They could clearly consider various approaches, based on surveys and/or models according to species and fishery characteristics. As for non-targeted species complete coverage is probably not realistic, a risk based approach should be defined in order to assess a sufficient number of the key vulnerable species to provide a representative overall assessment of vulnerable species exploited in each ecosystem. Thus, defining this strategy in all ecosystems, building a database on assessments and gathering the necessary data for the scientific survey of all exploited stocks has to be considered as a high medium-term priority.

- **ToR3 Environmental and ecosystem indicators**. During the previous 2010 STECF working group on EAFM it was concluded that environmental and ecological indicators are not routinely estimated for the European ecosystems in any working group or scientific program. A large research effort has been done regarding methods used to estimate or interpret ecosystem indicators, especially under the auspice of the ICES WGECO and within EU-funded research programs (e.g. IMAGE, MEFEPO). From this work and from the test performed during the current working group, it can be concluded that, even if agreed by ICES and STECF, the reference list of ecosystem indicators based on DCF cannot be considered a comprehensive and fully developed set of operational indicators.

Regarding the environmental indicators, further work needs to be done to ensure that indices are calculated correctly e.g. STEFC WG felt that some of the patterns in some of the computed environmental indices might have been affected by changes in sample coverage in time and space in the ICES hydrographic database (e.g. SST patterns for the Irish Sea do not appear to accord with published data). For some parameters e.g. SST there are products available where in-situ observations have been blended with satellite data to address this issue. For SST, it is suggested that these accepted and available products are used. Patterns in SST and salinity should also be compared with available fixed-station data to ensure trends are consistent. Comparison of trends with satellite-derived SST is also highly desirable. Furthermore, calculated hydrographic indices should be reviewed by relevant experts with oceanographic knowledge of the ecosystems concerned before being used further.

The calculation of the ecosystem indicators used in this report can give valuable insights into changes in the ecosystem in relation to the impacts of fisheries, environmental parameters, and the state of fish stocks. The interpretation of ecosystem indicators, and their response to fishing activities was challenging and requires further work (beyond the scope of this WG) to develop the theoretical understanding of the relationship between fishing activities, management measures and the responses of the indicators.

Interpretation of the DCF indicators of the conservation status of vulnerable fish species was confounded due to the lack of consistent results between the indicators values calculated in previous works and by the ad hoc contract prior to the EWG. It is considered that the inconsistency in indicator calculations is due to the limited specification of the steps in indicator calculation described in **(**SEC2008**)** that meant that workers had to make decisions on exact details of the calculations at some stages during processing. Due to confounding issue of inconsistent indicator calculations the DCF conservation status of fish species indicator was not used in the current analysis. It is noted that it is frequently difficult for independent workers to calculate consistent values when attempting to calculate the same indicator. The group notes that it is important for all indicator calculation steps to be clearly defined, including data cleaning steps applied to public databases, when indicators are being applied for formal analyses.

On the other hand, results obtained in the seven ecosystems seem to confirm that the mean trophic level could also be of interest as an ecosystem indicator. Nevertheless, more work is still required, especially in close coordination with approaches issued from the MSFD (see Chapter 13), before adopting a single consistent protocol on the calculation of indicators, as well as appropriate reference values for each of them.

The STECF working group considers that this work on the ecosystem indicators should be the task of a specific (and probably permanent) working group, whose terms of reference would be to provide the best possible estimates of ecosystem indicators on a regular basis for all European ecosystems (as defined in the STECF reference list, Figure 4.1) and to discuss potential drawbacks mostly in relation to data coverage. Discussion with the Commission and with ICES should determine which appropriate group could be in charge of such a task in the context of the MSFD.

- **ToR 6 Fleet-based synthesis.** Fleet-based synthesis using indicators of both the ecological impact and the economic performances of fleets operating in the ecosystem also appears to be a key step of EAFM. Several aspects were discussed by the working group.

. *Methodological considerations on ecological indicators per fleet segment*

We present here a test using stock assessment results to derive indicators of the impact of each fleet segment on the exploited resources of an ecosystem. For that purpose we used the best knowledge issued from ICES assessments to characterize the fleet impact on the fishable fraction of the ecosystem. In that sense, this approach has to be considered as part of the EAFM.

Due to the still poor quality of the data available from the 2011 AER data call (with for instance no data at the right disaggregation level for some member states), the results we obtained should be considered preliminary and thus interpreted with care. Nevertheless, from a methodological point of view the test was successful. Partial mortalities and sustainability indices allow to highlight significant contrasts between the various fleet segments operating in the ecosystem, in term of their global (and direct) impact on the fishable fraction of the ecosystem. Assessment diagrams based on standardized F* and B* show whether each fleet segment, on average, sustainably exploits the stocks compared to the Fmsy and Fpa (or Bpa) targets. Naturally, this approach is more powerful when the fraction of the total fleet landings included in the analysis is near 100 %. Note this endorses again the fact that all exploited resources should be taken into account in the assessment process (see recommendation above, in § on ToR2).

Compared to the work performed during the 2010 working group, this analysis has been improved taking into account not only the direct impact of each fleet segment on the exploited resources, but also the impacts on seabed habitat (e.g. due to trawling and dredging)and the impact on the food web. These new indices still need improvements and the working group recommends that a meeting should be organised as soon as possible in order to discuss the method. Furthermore, other more integrated approaches, such as LCA (Life Cycle Analyses), should also be investigated in order to analyse the environmental impact of various fishing practices.

The working group highlights that the work done during the meeting has to be considered as a first step. This step is incomplete but is important in the frame of EAFM as it links the stocks with the fleets (i.e. also State and Pressure in the PSR paradigm). Consequently the STECF group concludes that this work should contribute to allow moving from a stock-based management to an integrated fleet-based management of fisheries. In such an approach, stock-by-stock assessments will remain essential (and stock–by-stock regulation will certainly remain required), but additional fleet-based tools and regulation will have to be developed.

. *Methodological considerations on the economic indicators*

As underlined by the previous 2010 working group, description of the economic performances by fleet are available in the framework of the DCF by country but no methodology of disaggregation of these economic performances between different ecosystems is available. Therefore, the methodological question of using economic performances by fleet and country as a proxy to describe the performance of fleets operating in a specific ecosystem was addressed in the working group.

The proportion of the total value of landings caught in the studied ecosystem by fleet segment gives an indicator of the dependency of the fleet to the ecosystem and a proxy of the time spent in the ecosystem. When this indicator is high, i.e. when the fleet spent most of its time in the studied ecosystem, it can be considered as a satisfactory proxy to describe the economic performances of the fleet in this ecosystem using economic indicators available in the DCF even if they are not disaggregated by region or ecosystem. When dependency of the fleet to the ecosystem is low, fixed costs by fleet can be used to describe the economic performance of the fleet studied as they are not related to the activity.

The working group concludes that data availability at regional level is the key element. Implementing EAFM in European seas should lead to an in-depth revision of the DCF. Trade-offs between ecological impact and economic performances should be provided on an ecosystem basis. Therefore economic analysis at the ecosystem level are clearly required while economic data are currently collected within the DCF only with reference to the three very large marine areas: the Baltic Sea, the Atlantic waters and the Mediterranean Sea. The group recommends that the revised DCF should consider the ecosystem spatial reference for collecting the data using the reference STECF list of ecosystems.

. Building trade-offs between ecology and economy - Towards a fleet-based management

The STECF working group considers that defining a general homogeneous and agreed framework for the fleet-based environmental assessment and applying this framework progressively to all the European marine ecosystems should be the task of a specific and probably permanent working group, gathering both ecologists and economists.

The environmental assessments will likely highlight differences in the fleet ecological impact and economic performance. Some fleet segments will likely exhibit simultaneously strong ecological impacts and poor economic performances, while others will probably appear more virtuous from both points of view. Such contrasts were already identified in our analyses. For some other fleet segments the analysis will be more complex and a global assessment will have to integrate a compromise between ecological and economic indicators. Note that such a compromise generally occurs in the environmental assessment of all industrial activities. Fishing practices are no exceptions. Marine ecosystems, such as the ones taken into account by the working group, appear to be the correct level to build and analyse this type of compromises.

As stated by the 2010 working group (see also Gascuel et al, 2012), the ecosystem assessments could clearly be part of a framework used to determine which fleet segments would need to be reduced and which ones could be developed and to what extent. Environmental assessments should be used to guide the definition of long term management plans, including some regulations of the fishing efforts and fleet-based access right. It could also be used to introduce positive or negative economic incentives in order to encourage fleets to improve their fishing practices. The payments for ecological services are indeed quite common in agriculture to preserve certain ecosystems and reduce pressure on them.

The STECF working group on EAFM concludes that the challenge is not to replace the stock-by-stocks regulation which noticeably remains a necessity, but to develop an additional fleet-based management. The environmental assessment must be part of that additional management of fleets (another important part being the ecosystem and fleet-based modelling; see below).

15.2 Improving EAFM in European Seas

15.2.1 Implementing the EAFM in all European Seas

As a feasibility test, the current working group took into consideration seven ecosystems. The approach has obviously to be expended to all the 14 ecosystems included in the STECF reference list (Table 15.1). As stated above, this will certainly require organising the work in more than one working group, either sharing the work in several sub-groups (for instance according to RACs), or working alternatively each year on a sub-set of ecosystems.

Table 15.1. STECF reference list of the 14 European marine ecosystems

	Ecosystem	FAO subdivisions	Depending on the RAC:	MSFD Marine region close
1	Baltic sea	ICES IIIb, 22-32	Baltic sea	Baltic sea
2	North sea	ICES IVa-c, IIIa, VIId	North sea (except VIId)	North sea
3a	West Scotland/Ireland	ICES VIa-b, VIIb-c	North western waters	North sea / Celtic sea
3b	Irish sea	ICES VIIa	North western waters	Celtic sea
3c	Celtic sea	ICES VIIe-k	North western waters	Celtic sea
4a	Bay of Biscay	ICES VIIIabd	South western waters	Bay of Biscay and Iberian coast
4b	Iberian coast	ICES VIIIc, IXa	South western waters	Bay of Biscay and Iberian coast
5a	Acores	ICES X	South western waters	Atlantic ocean
5b	Canarias, Madeira	CECAF 1.2	South western waters	Atlantic ocean
6	Western Mediterranean Sea	GFCM 1.1, 1.2 & 1.3 (GSA 1-12)	Mediterranean Sea	Western Mediterranean Sea
7a	Adriatic Sea	GFCM 2.1 (GSA 17-18)	Mediterranean Sea	Adriatic Sea
7b	Central Mediterranean Sea	GFCM 2.2 (GSA 13-16, 19-21)	Mediterranean Sea	Ionian sea
8	Eastern Mediterranean Sea	GFCM 3.1, 3.2 & 4.1 (GSA 22-28)	Mediterranean Sea	Aegean-Levantin sea
9	Black sea	GFCM 4.2 (GSA 29)	- none -	

15.2.2 Building advice-oriented ecosystem models in all European Seas

The improvement of methods for modelling marine ecosystems and fisheries is currently the aim of many research programs. This field of research is clearly moving fast and many aspects are still under construction. Therefore there is no doubt that working groups and research projects devoted to model improvement will remain required in the coming years and may directly impact the use of models in fisheries management.

At the same time, operational models do already exist and many projects have provided knowledge, simulations or diagnoses to fisheries management. Experience especially showed that trophodynamic models can contribute to assess the global impact of fishing on the food web including environmental changes and to monitor changes in the ecosystem health over the years or to analyse the potential ecological impacts of various management scenarios. Such food-web models mainly focus on the long-run effect of alternative fishing pressures. On the other hand, bio-economic models allow assessing whether the short-term impact of regulation on fishermen revenue is acceptable, i.e. if they would still meet the costs in a fluctuating environment. They provide a valuable framework to assess the effect and test scientific recommendations of management measures, such as TACs, closures, gear modifications and monitoring schemes (etc.).

However these research efforts on models are not directly included in the institutional process leading to scientific advice used by decision makers. There is no working group currently in place, under the auspice of ICES or STECF, to use agreed ecosystem and/or bio-economic models, to test various options for fisheries management and to provide on a regular basis scientific advice after the request of political bodies. In other words, useful tools do exist but they are not really used or poorly used for the management of European fisheries.

Therefore, how should operational models be implemented in order to provide scientific advice that can be effectively used in the frame of EAFM? The working group considers this has to be done similarly to the assessment working groups of ICES which are now currently using single species models (more or less homogeneously) in order to provide diagnoses and scientific basis for fish stocks management. The development of an equivalent although different system for AEFM could be undertaken in the two following steps:

1. First, a reference model or more plausibly a set of a limited number of reference models (for instance, one ecosystem model such as EwE (Ecosim with Ecopath) and one bio-economic model such as Fcube or using a MSE approach) should be developed or adapted based on the best available knowledge for each one of the 14 European marine ecosystems. The working group suggests this could be done through a specific call for projects possibly managed and sponsored by DG MARE. The terms of reference for such a call should be to implement new models or to adapt existing models whose aim will be, on one hand, to assess the ecological status of ecosystems and the ecological effects of changes occurring in the related fisheries and, on the other hand, to simulate biological, economic and social consequences of various management options. A scientific committee could be set up (or identified if already existing) to coordinate the approaches developed in the various ecosystems and to validate models as reference to be used within the scientific advice framework. Models agreed as reference will clearly have to improve over years according to progress occurring in modelling approaches and in the quantity or quality of the available data.

2. A specific and probably permanent working group should be set up to run the reference models every year (or on a regular basis) updating the diagnosis on ecosystem health in addition to approaches based on stocks-synthesis and ecosystem indicators. The simulation of various options for fisheries management should be performed according to the fleet-based analysis. The STECF EWG on EAFM considers this working group could also be in charge of investigating compromises between simultaneous and often incompatible biological objectives (such as the objective to reach the FMSY simultaneously for every stock). Models should be especially used to identify, simulate and analyse best possible compromises between ecological, economic and social objectives. In practice, the working group suggests such a group should be set up rapidly, starting with a very limited number of ecosystems (those where reference models can be identified; maybe only one for the first year) and implying both ecologists and economists. On the medium term, as far as models may be developed, more ecosystems will have to be considered and several working groups will become necessary. The STECF working group on EAFM suggests either to split the group, for instance according to RACs, or to run models alternatively each year for a subset of ecosystems.

The working group highlights that the development and the use of models for ecosystem based management will require a significant raise of collected data and the availability of existing data to modellers. On one hand, economic data must refer specifically to a given ecosystems which implies an in-depth modification of the DCF (see above). On the other hand, the improvement of ecosystem models clearly requires new and more data, especially on diets or trophic relationships and on the ecology of the poorly studied components of the ecosystem. The working group notes that the required ecological observation of European seas has a significant cost since specific sampling programs have to be developed. However, several sampling programs that already exist could be used, at least as a first run to build and update ecological models without additional costs (such as MEDITS program).

15.3 General recommendations - Conclusion

The STECF working group considers that setting up a new organisation of working groups devoted to the scientific advice in the field of fisheries ecology and economy, on an ecosystem basis, is a requirement to enforce implementation of the EAFM, and eventually a requirement for the sustainable development of European fisheries.

The feasibility analysis conducted during this working group using the seven ecosystems as case studies confirms that such ecosystems represent the appropriate level:

- To draw syntheses on stock status and analyse trends in ecosystem or environmental indicators,
- To study the ecological impacts and economic performances of fleet segments,
- To analyse trade-offs between the economy and ecology in order to develop a fleet-based management of fisheries,
- To develop models devoted to scientific advices in both ecological and economic frames.

Ecosystems also appear to be the right entities to improve the dialogue and involve stakeholders (including of course fishermen representatives and especially with regards to RACs) and to build integrated management plans.

The group recommends that inputs of both ecologists and economists are required. This report clearly demonstrates that ecosystem-based and fisheries-based management approaches are complementary. It also shows that these approaches have to be developed not in order to replace more classical single-species approaches (which are part of EAFM) but as additional tools required in order to enforce the ecological, economic and social pillars of the sustainable development of fisheries.

Defining the reference list of European marine ecosystems was a first important step to implement EAFM in European Seas. Two major improvements should now be promoted, as the next steps. On one hand, reference ecosystems should be considered in all data collection programs related to fisheries, resources, habitats, etc. This clearly applies to the DCF that should be revised. On the other hand, reference ecosystems should be considered as the functional units used in many working groups from ICES and STECF. It could imply changes in the organisation or in the terms of reference of several working groups. More generally, the STECF working group on EAFM recommends that the reference list of European ecosystems should be considered in many research programs. The use of a single geographical level in various groups, projects, programs or committees should allow a more efficient aggregation and/or synthesis of results, experiences and knowledge as well as driving data collection at the appropriate aggregation level.

From a practical point of view, the STECF working group concludes that three key aspects constitute the work that has to be performed on a regular basis to implement a scientific-based EAFM in European Seas:

1. Diagnoses on ecosystem health have to be defined and regularly updated for each of the 14 European ecosystems. This should be done in close cooperation with the implementation of the MSFD and related works on the GES(if conducted at the level of the ecosystems considered by STECF). It should also include the analysis of long term trends observed in catch and fishing effort, in stock-based indicators (see the stock-synthesis in Chapters 5 to 11) and in the specific ecosystem indicators related to fisheries (see Chapter 13).

2. Both the environmental impacts and the socio-economic performances of the various fleets operating within each ecosystem have to be assessed and monitored. Results of such analyses should be considered by stakeholders (including the European Commission) in the definition of management options and especially in the frame of long term management plans (which should evolve from a stock-based to an ecosystem-based approach).

3. For each European ecosystem, one or a limited set of ecosystem and bio-economic models should be set up and used on a regular basis in an advice-oriented purpose. Similarly that assessment and forecast models are used for stock-based management (and TAC recommendations), ecosystem and bio-economic models should be updated each year and would constitute a key step to assess the ecosystem impacts of fisheries, to simulate various management options and to analyse their potential effects on fisheries social-economic performances and on the ecosystem as well.

Obviously, such a work cannot be performed by a single working group meeting once a year. Changing from a feasibility phase to an operational EAFM will probably require a substantial reorganisation of the working groups, within STECF and possibly within ICES. In the medium term, two options can be foreseen. The first one would be to set up one working group by ecosystem or for a limited number of ecosystems, each group being in charge to cover the three previously mentioned aspects on a multi-annual basis, leading to EAFM operational advices. The second option would be to organise three working groups according to the three aspects, the work being organised each year for a subset of the 14 European ecosystems. In such a case, an additional working group could be in charge of aggregating results and formulate operational advices for EAFM.

The working group recognizes that such a new scientific advice system cannot be created immediately and that more work is required on methods before defining and agreeing operational tools. As a priority, the group considers that three aspects should be more precisely analysed during the next meetings.

1. A workshop or working group should be established by STECF or ICES before the revision of the DCF in 2013 to provide advice on options to revise the indicators (and their calculation methods) of the impacts of fishing on the marine environment in relation to the requirements of the MSFD. Once the initial set of GES indicators being applied by MS will be specified, this working group should also consider how these indicators can be incorporated into the development of EAFM to support achievement of GES. In particular it could be considered whether the indicators applied are sufficient to monitor the predominant impacts of fishing on marine ecosystems and gaps identified. This working group could also analyses IndiSeas proposed indicators of fishing impact (www.indiseas.org) and consider the interest to include such indicators in future analysis and efforts.

2. An experimental working group should be organized on the feasibility and usefulness of ecosystem and bio-economic models in an advice-oriented perspective. As a case study, such a working group could consider a specific ecosystem where ecosystem and bio-economic models already exist and could be easily adapted. Its objective would be to test models' ability to provide diagnoses of the fishing impact on the ecosystem functioning, to analyze various management scenarios (possibly defined by a specific request of the Commission) and to try to develop a fleet-based feasibility modeling approach in order to improve the trade-offs between ecological impacts and economic performances. More generally, this should be a test of models' ability to provide useful advices in the frame of EAFM.

3. The methods used to assess ecological impacts and socio-economic performances on a fleet-segment basis and the establishment of trades-off between various indicators still requires developments. A specific working should be organized on these methodological matters under the auspice of STECF. Such a working group should concentrate on a single ecosystem or on a very limited number of ecosystems. In case where 2 or 3 ecosystems would be considered, it could be an opportunity to test the feasibility of such an approach in the Mediterranean Sea (taking into account one of the 5 Mediterranean ecosystems and provided the minimum data requirements are available).

Finally, the STECF working group, being informed that no working group on EAFM will be organized by STECF in 2012, considers that the 2 last meetings on methods could usefully be organized in 2013. At the same time, improvement in the DCF enforcement will take place and coordination and/or complementarity with EAFM should probably be discussed during STECF plenary meetings. The objective would be to organize a further operational and complete advice-oriented system of working groups for EAFM, starting in 2014.

References

AER 2011. Scientific, Technical and Economic Committee for Fisheries 2011 Annual Economic Report on the EU fishing fleet. Luxembourg: Publications Office of the European Union.

Bailey, N., Bailey, D.M., Bellini, L.C., Fernandes, P.G., Fox, C., Heymans, S., Holmes, S., Howe, J., Hughes, S., Magill, S., et al. (2011). The West of Scotland Marine Ecosystem: A Review of Scientific Knowledge Marine Scotland Science Report Vol. 09/11. (Aberdeen: Scottish Government,), p. 292.

Chuenpagdee, et al., 2003, "Shifting gears: assessing collateral impacts of fishing methods in US waters", Frontiers in Ecology and the Environment, 1(10), 517-524

Dinter, W.P. (2001) Biogeography of the OSPAR Maritime Area – A Synopsis and Biogeographical Distribution Patterns described for the North-East Atlantic. – Bonn (Federal Agency for Nature Conservation): 168 pp.

Dulvy, N. K., Rogers, S. I., Jennings, S., Stelzenmuller, V., Dye, S. R., Skjoldal, H. R. (2008). Climate change and deepening of the North Sea fish assemblage: a biotic indicator of warming seas. J. Applied Ecology. DOI: 10.1111/j.1365-2664.2008.01488.X.

E Evans, G.L., le B. Williams, P.J., and Mitchelson-Jacob, E.G. (2003). Physical and anthropogenic effects on observed long-term nutrient changes in the Irish Sea. Est. Coast. Shelf Sci 57, 1159-1168.

Gascuel D., Accadia P., Bastardie F., Döring R., Goti L., Macher C., Merino G., Soma K., Druon J.N., Guénette S., Mackinson S., Mehanna S., Piet G., Travers-Trolet M., 2010 - Development of the Ecosystem Approach to Fisheries Management (EAFM) in European Seas.STECF/SGMOS-10-03 Working Group report, Office for Official Publications of the European Communities, Luxembourg. EUR – Scientific and Technical Research series, ISSN 1018-5593, 144 p.

Gascuel D., Bez N., Forest A., Guillotreau P., Laloé F., Lobry J., Mahévas S., Mesnil B., Rivot E., Rochette S., Trenkel V., 2011 - A Future for marine Fisheries in Europe (Manifesto of the Association Française d'Halieumétrie).Fisheries Research, 109: 1-6

Gascuel D., Merino G., Doëring R., Druon J.N., Guénette S., Machere C., Travers-Trollet M., Goti L., Soma K., Mackinson S., (2012). Towards the implementation of an integrated ecosystem fleet-based management of European fisheries. Marine Policy, 36:1022–1032. [doi:10.1016/j.marpol.2012.02.008]

Gowen, R.J., Tett, P., Kennington, K., Mills, D.K., Shammon, T.M., Stewart, B.M., Greenwood, N., Flanagan, C., Devlin, M., and Wither, A. (2008). The Irish Sea: Is it eutrophic? Est. Coast. Shelf Sci 76, 239-254].

Greenstreet, S. P. R., Helen M. F., Stuart, I, R. Verena, M. T., Stephen, D. S., and Pinnegar, J. K. (2012). Redundancy in metrics describing the composition, structure and functioning of the North Sea demersal fish community. ICES Journal of Marine Science, 69(1), 8–22. - doi:10.1093/icesjms/fsr188.

Heather, C., Husrevoglu, S., and Nolan, G. (2009). Distinguishing global warming from natural variability in Irish sea surface temperature records. IOP Conference Series: Earth and Environmental Science 6, 072017.

Kenny, A. J. (2012). Analysis of long-term trends in selected environmental indicators associated with the descriptors of the MSFD. *Ad hoc* report prepared for STECF EWG11-13, European Commission, DG Maritime Afairs and Fisheries, Unit MARE A2, B-1049 Bruxelles, January 2012. pp 60.

Köster,FW., Mollmann, C., Hinrichsen, HH., et al., (2005). Baltic cod recruitment - the impact of climate variability on key processes. ICES Journal of marine science, 62: 1408-1425.

ICES. 2012. Marine Strategy Framework Directive – Descriptor 3+, ICES CM 2012/ACOM:62. 173pp

Le Quesne, W.J.F., Frid, C.L.J., Paramor, O.A.L., Piet, G.J., Rogers, S.I. and Velasco, F. 2010 Assessing the impact of fishing on the Marine Strateagy Framework Directive objectives of Good Environmental Status: Developing and testing the process across selected RAC regions: The North Sea. MEFEPO project report, EC FP7 project #212881. 58 pp.

Mackenzie, BR., Koster, FW., (2003).Fish production and climate: Sprat in the Baltic Sea. Ecology, 85:784-794.

Mackenzie,BR., Almesjo, L., Hansson, S., (2004).Fish, fishing, and pollutant reduction in the Baltic Sea. Environmental science and technology, 38: 1970-1976.

McQuatters-Gallop, A. Raitsos, D. E., Edwards, M. Pradhan, Y. Mee, L. D., Lavender, S. J. Attrill, M. J. (2007). A long-term chlorophyll data set reveals regime shift in North Sea phytoplankton biomass unconnected to nutrient trends. Limnol. Oceanogr. 52 (2), 635-648.

Olsonen, R (2008). FIMR monitoring of the Baltic Sea environment – Annual Report 2007. MERI Report Series of the Finnish Institute of Marine Research No. 62, pp109.

Pauly, D., Christensen, V., (1995). Primary production required to sustain global fisheries. Nature, 374:255-257.

Pauly, D., Watson, R., (2005). Background and interpretation of the 'Marine Trophic Index' as a measure of biodiversity. Philosophical Transactions of the Royal Society B-Biological Sciences, 360:415-423.

Piet, G., Quirijns, F., (2009).The importance of scale for fishing impact estimations.Canadian Journal of Fisheries and Aquatic Sciences*, 2009, 66:(5) 829-835, 10.1139/F09-042*

Planque, B., and Fox, C.J. (1998). Interannual variability in temperature and the recruitment of Irish Sea cod. Mar. Ecol. Prog. Ser. 172, 101-105.

SEC. 2008. Commission Staff working document. Accompanying the document Communication from the Commission to the Council and the European Parliament. The role of the CFP in implementing an ecosystem approach to marine management [COM(2008)187 final].

Trenkel, V.M., Pinnegar, J.K., Rochet, M.J. and Rackham, B.D. 2004 Different surveys provide similar pictures of trends in a marine fish community but not of individual fish populations. ICES J. Mar. Sci. 61: 351-362

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17 LIST OF ANNEXES AND BACKGROUND DOCUMENTS

17.1 Report of the EWG-11-13 preparatory contract n°1, on the estimate of time series of ecosystem indicators (Baltic Sea, North Sea and West Scotland/Ireland waters for indicators 1 to 4) Samuel Shephard

17.2 Report of the EWG-11-13 preparatory contract n°2, on the estimate of time series of ecosystem indicators (Irish Sea, the Celtic Sea, the Bay of Biscay and the Iberian coast for indicators 1 to 4) Sylvie Guénette

17.3 Report of the EWG-11-13 preparatory contract n°5, on the estimate of time series of ecosystem indicators (rate of discarding, indicator 5) Lisa Borges

17.4 Report of the EWG-11-13 preparatory contract n°3, analysis of trends in selected environmental indicators associated with the descriptors of the MSFD (indicators 6 and 7, all areas) Andrew Kenny

17.5 Report of the EWG-11-13 preparatory contract n°4, on data extract from DCF fleet economic dataset and analysis by ecosystem region - John Anderson

17.6 Background Documents

1. EWG-11-13 – Declarations of invited and JRC experts.
2. EWG-11-13 – Preparatory contract n°1,on the estimate of time series of ecosystem indicators (Baltic Sea, North Sea and West Scotland/Ireland waters for indicators 1 to 4) Samuel Shephard
3. EWG-11-13 – Preparatory contract n°2, on the estimate of time series of ecosystem indicators (Irish Sea, the Celtic Sea, the Bay of Biscay and the Iberian coast for indicators 1 to 4) Sylvie Guénette
4. EWG-11-13 – Preparatory contract n°5, on the estimate of time series of ecosystem indicators (rate of discarding,indicator 5) Lisa Borges
5. EWG-11-13 – Preparatory contract n°3,analysis of trends in selected environmental indicators associated with the descriptors of the MSFD (indicators 6 and 7, all areas) Andrew Kenny
6. EWG-11-13 – Preparatory contract n°4,on data extract from DCF fleet economic dataset and analysis by ecosystem region - John Anderson

Annexes and background documents 17.1 to 17.6 are published on the EWG-11-13 meeting's web site on: http://stecf.jrc.ec.europa.eu/meetings/2011

17.7 Codes used in the report and Economic data mapping

Data Collection for EU fishing fleets

Since 2002, two data frameworks have been used to guide the collection, management and use of data in the fisheries sector and support for scientific advice regarding the Common Fisheries Policy (CFP). Under these regulations the European Commission requires Member States to collect data on Biological and Economic aspects of many European fisheries and related fisheries sectors.

> **DCR (2002-2007)**Commission Regulation (EC) No. 1639/2001 establishes the old minimum and extended Community programmes for the collection of data in the fisheries sector (The Data Collection Regulation (DCR)) and lays down detailed rules for the application of Council Regulation (EC) No 1543/2000. This regulation is the predecessor of the newly established Data Collection Framework (DCF).
>
> **DCF (2008 onwards)** Commission Regulation (EC)No. 665/2008 of the 14 July 2008establishes the Data Collection Framework (DCF). The Commission Decision (2008/949/EC) of the 6 November 2008describes in detail the Multiannual Community Programme to support the DCF.

Changes over time: mapping DCF and DCR economic fleet segments

Describing temporal changes in the economic descriptors of fishing fleets in European regional seas since 2002 requires mapping two the fleet definition of fleet segments from two data frameworks

DCR (2002-2007)https://datacollection.jrc.ec.europa.eu/web/dcf/wordef/fleet-segment-dcr

DCF (2008 onwards)https://datacollection.jrc.ec.europa.eu/web/dcf/wordef/fleet-segment-dcf

Defining the aggregation of DCF fleet segments in to DCR segment definitions (Table 1) and their length classes (Table 2), enables analysis of economic variables from 2002 onwards.

Table 1. The links between the DCR and DCF fleet segment definitions used in economic data.

DCF (2008 onward)		**DCR level 2 (2002-2007)**	
Code	**Name**	**Code**	**Name**
TBB	Beam trawlers	TBB	Beam trawl
DTS	Demersal trawlers and/or demersal seiners	DTS	Demersal trawl and demersal seiner
TM	**Pelagic trawlers**	**PTS**	**Pelagic trawls and seiners**
PS	**Purse seiners**	**PTS**	**Pelagic trawls and seiners**
DRB	Dredgers	DRB	Dredges
MGP	Polyvalent active gears only	MGP	Polyvalent mobile gears
MGO	Other active gears	MGO	Other mobile gears
PG	Passive gears only for vessels < 12m	PG	Passive gears only for vessels < 12m
HOK	Hooks	HOK	Gears using hooks
DFN	Drift and/or fixed netters	DFN	Drift nets and fixed nets
FPO	Pots and/or traps	FPO	Pots and traps
PGP	Polyvalent passive gears only	PGP	Polyvalent passive gears
PGO	Other passive gears	PGO	Other passive gears
PMP	Active and passive gears	PMP	Combining mobile & passive gears

Table 2. The links between the DCR and DCF fleet segment definitions used in economic data.

DCF (2008 onward)		DCR (2002-2007)	
Code	**Name**	**Code**	**Name**
VL0006	Vessel less that 6 meters in length. *For Supra region 2 only.	VL0012	vessels less than 12 metres in length
VL0010	Vessel between 0 meters and 10 meters in length. **For Supra region 1 and 3 only.	VL0012	vessels less than 12 metres in length
VL0612	Vessel between 6 meters and 12 meters in length. *For Supra region 2 only.	VL0012	vessels less than 12 metres in length
VL1012	Vessel between 10 meters and 12 meters in length. **For Supra region 1 and 3 only.	VL0012	vessels less than 12 metres in length
VL1218	Vessel between 10 meters and 18 meters in length. All regions.	VL1224	vessels between 12 metres and 24 metres in length
VL1824	Vessel between 18 meters and 24 meters in length. All regions.	VL1224	vessels between 12 metres and 24 metres in length
VL2440	Vessel between 24 meters and 40 meters in length. All regions.	VL2440	vessels between 24 metres and 40 metres in length
VL40XX	Vessel greater than 40 meters in length. All regions.	VL40XX	vessels greater than 40 metres in length

Clusters of gear and length categories

Under regulations for reporting, data on fleets and on length categories may in some instances be aggregated in clusters. Clustered fleets in the data are reported for Sweden and Germany. Analysis of the data revealed that these clusters contribute to only 1% of the total value of landings area 27, and principally involving Swedish fisheries in the Baltic sea.

According to the advice of John Anderson, gear clusters were redefined according to their principal gears and mapped to DCR categories to enable analyses from 2002 onward (Table 3). Length clusters in the data were identified explicitly to show and understand their contribution to the data (Table 2)

Table 3. Re-definition of gear clusters based on principal fleet and mapping to DCR definitions

Gear Clusters	DCF Code	Name	DCR code	Name
DFN-FPO-HOK	DFN	Drift and/or fixed netters	DFN	Drift nets and fixed nets
DFN-HOK-FPO-PGO	DFN	Drift and/or fixed netters	DFN	Drift nets and fixed nets
DFN-PGP	DFN	Drift and/or fixed netters	DFN	Drift nets and fixed nets
DRB-DTS-PMP-PS	DRB	Dredgers	DRB	Dredges
DTS-DRB-PMP-PS	DTS	Demersal trawlers and/or demersal seiners	DTS	Demersal trawl and demersal seiner
DTS-DRB-PS	DTS	Demersal trawlers and/or demersal seiners	DTS	Demersal trawl and demersal seiner
DTS-PMP	DTS	Demersal trawlers and/or demersal seiners	DTS	Demersal trawl and demersal seiner
DTS-PMP-PS	DTS	Demersal trawlers and/or demersal seiners	DTS	Demersal trawl and demersal seiner
DTS-PMP-TM	DTS	Demersal trawlers and/or demersal seiners	DTS	Demersal trawl and demersal seiner
DTS-PS	DTS	Demersal trawlers and/or demersal seiners	DTS	Demersal trawl and demersal seiner
DTS-TM	DTS	Demersal trawlers and/or demersal seiners	DTS	Demersal trawl and demersal seiner
TM-DTS	TM	Pelagic trawlers	PTS	Pelagic trawls and seiners
TM-MGP	TM	Pelagic trawlers	PTS	Pelagic trawls and seiners

Table 4. Identification of vessel length clusters in the data and the connection to DCR categories.

DCF (2008 onward)			DCR (2002-2007)	
VESSEL LENGTH	**DCF Code**	**Name**	**DCR length code equivalent**	**Name**
VL0010	VL0010	Vessel between 0 meters and 10 meters in length. **For Supra region 1 and 3 only.	VL0012	vessels less than 12 metres in length
VL0012			VL0012	vessels less than 12 metres in length
VL0018			Cluster_VL0018	
VL0024			Cluster_VL0024	
VL0040			Cluster_VL0040	
VL00XX			Cluster_VL00XX	
VL1012	VL1012	Vessel between 10 meters and 12 meters in length. **For Supra region 1 and 3 only.	VL0012	vessels less than 12 metres in length
VL1018			Cluster_VL1018	
VL1024			Cluster_VL1024	
VL1218	VL1218	Vessel between 10 meters and 18 meters in length. All regions.	VL1224	vessels between 12 metres and 24 metres in length
VL1224			VL1224	vessels between 12 metres and 24 metres in length
VL1240			Cluster_VL1240	
VL12XX			Cluster_VL12XX	
VL1824	VL1824	Vessel between 18 meters and 24 meters in length. All regions.	VL1224	vessels between 12 metres and 24 metres in length
VL1840			Cluster_VL1840	
VL18XX			Cluster_VL18XX	
VL2440	VL2440	Vessel between 24 meters and 40 meters in length. All regions.	VL2440	vessels between 24 metres and 40 metres in length
VL24XX			Cluster_VL24XX	
VL40XX	VL40XX	Vessel greater than 40 meters in length. All regions.	VL40XX	vessels greater than 40 metres in length

Definition of Eco Regions

Area and subarea definitions given in the economic data were mapped to Ecosystems as defined in Table 4.1 of the general report. This enables analysis of economic data by Ecosystem to be extracted from the data automatically.

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Abstract

The STECF Expert Working Group EWG-11- 'Development of the Ecosystem Approach to Fisheries Management (EAFM) in European seas' met in Rennes, France, 16-20 January 2012. The EWG Report was reviewed and by the STECF at its 40th plenary session held in Copenhagen from 9-13 July 2012.

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The Scientific, Technical and Economic Committee for Fisheries (STECF) has been established by the European Commission. The STECF is being consulted at regular intervals on matters pertaining to the conservation and management of living aquatic resources, including biological, economic, environmental, social and technical considerations.

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