MareFrame

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Deliverable No. 6.1

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MareFrame

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[2] PU: Public, PP: Restricted to other programme participants (including the Commission Services), RE: Restricted to a group specified by the consortium (including the Commission Services), CO: Confidential, only for members of the consortium (including the Commission Services)

[3] The initials of the revising individual in capital letters

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Deliverable 6.1

Characterisation and preparation of case studies for decision support

03/02/2015

(rev 23/10/2015)

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Executive Summary

Deliverable 6.1 summarizes outcomes obtained for Task 6.1. For each case study this task aimed to specify management issues, characterise decision environments, and specify interest variables and decision variables. Following the co-creation approach, adopted as the basic method for participatory involvement in MareFrame, the decision issues have been identified and elaborated at meetings held throughout in 2014. The key interest and decision variables should capture the main interests and concerns by all stakeholder groups, and funnel towards tentative management options as solutions. Ideally they are a set of ecological, economic and societal variables indicating the fisheries performance and impact in the ecosystem context.

The launch of the case studies provided a good basis for the decision support, in particular when combined with follow up meetings between stakeholders and researchers in WP5 and WP6. Follow up meetings were necessary because the stated objectives at the launch of the case studies were not reached because of overloaded meeting schedules and rich discussions, underlining the importance of iterative interaction in relation to decision support work.

Depending on the decision environment and mainly the ecosystem models adopted in each case study, three methods for decision support have been chosen to be pursued further: a) multi-criteria analysis, 2) a three-stage fisheries-participatory model and 3) Bayesian Belief Nets. The major concern is that in the ecosystem context, more focus has been put on the ecological and fisheries part than on the socio-economic implications. Consequently, further effort is clearly necessary to better identify socio-economic indicators and the anticipated trade-offs associated with alternative management strategies.

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Introduction

The case studies in the MareFrame project cover a wide range of latitudes, oceanographic environments and involve high degrees of ecosystem complexity (figure 1). They also involve different governance settings, and diversified fisheries and fisheries management practices, and they differ in terms of richness in data and the state of scientific knowledge. The complex and diverse settings call for a structured approach to analysis and support of planning initiatives. This is the purpose of decision support work. Deliverable 6.1 summarizes results obtained for Task 6.1. This task was aimed at the characterization of decision environment, problem scope, and the specification of interest variables and decision variables for each case study. The deliverable may be regarded as a repository for this information for each case study, although the details will be elaborated through further work.

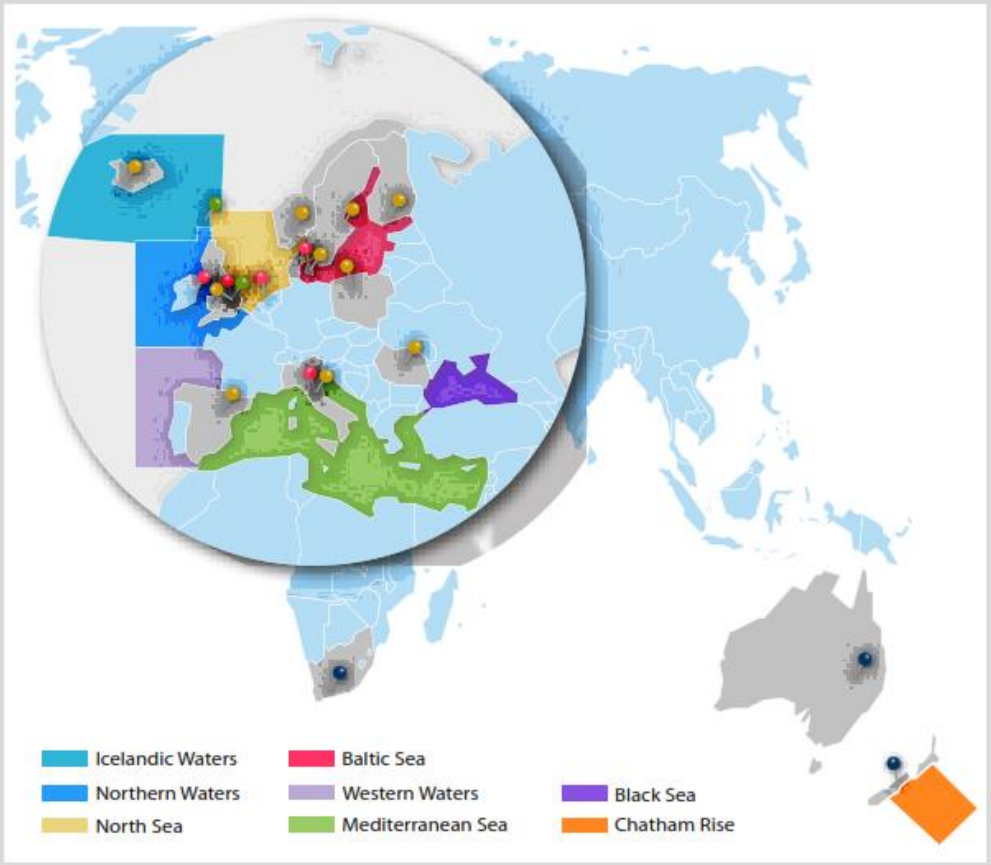

Figure 1. The 8 case study areas in MareFrame. The colored areas display the ecosystem seas of each case study. The specific case study area will for the purposes of this report in some cases be a subset of this area.

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The key attributes of the ecological and socio-economic environment have been discussed and documented by the launch of each case study in the summer 2014 as well as in following meetings with stakeholders. This provides a starting point for the decision support work in the MareFrame project, which deploys a co-creation approach.

Decision support has to be put in the management context, and requires characterization of decision environment and specification of objectives, interest variables and decision alternatives. The decision environment is characterized through an analysis of decision making processes, policy goals, timeframes and legal constraints for decision-making. The elaboration of these issues are elements in the preparation for decision support and have been the key targets of a number of meetings between researchers and stakeholders in the MareFrame project.

For each case study, the characterization and preparation for decision support has included at least one participatory group meeting and in most cases an additional meeting conducted as a videoconference. In addition, several personal contacts have been established. The meeting key objective was to identify and clarify the pivotal management issues in need of support. Only in one case study, the Black Sea case, the management issue was defined prior to the initial stakeholder meeting.

Decision support basically helps to identify the problem and subsequently supports the design of a solution. In the analysis phase, the decision alternatives are ranked according to the stated objectives, selected criteria and ranking rules. It is necessary to go through these phases again and again till satisfactory solution is found (McIntosh et al. 2011). The need for a continuous scoping and re-scoping of problems, objectives and solutions is particularly prevalent in a highly dynamic and complex, and uncertain problem context such as that of an ecosystem approach to fisheries management (Dickey-Collas 2014).

Decision support does not provide a decision in itself. The aim of the so far carried out meetings has been to prepare a conceptual model of the management issue in each case study. This model links the stakeholders and their objectives with the ecosystem and it's descriptors in a causal form, and will support later development of management plan proposals.

Three methods will be applied for decision support: a) multi-criteria analysis (Keeney & Raiffa 1976, Huang et al. 2011) – tentatively the approach to be used in Strait of Sicily case, 2) a three-stage fisheries-participatory model in the North Sea case and 3) Bayesian Belief Nets (BBNs) in all the other case studies.

The rationale for choosing the BBN approach for the majority of cases is the following: scientific understanding of complex ecosystem, including bio-economic components, is limited for various reasons. These include parameter uncertainty, model inadequacy, process variability, and code uncertainty (O'Hagan & Oakley 2004). BBN is represents one among others methods that has a capacity to take such uncertainties into account while providing support for rational decision making (Jensen 2001).

Some of the advantages of BBNs are that they provide mathematically rigorous method to express uncertainty in knowledge; probability as a measure of uncertainty is intuitive; BBNs are quantitative and enable using several types of data simultaneously: data sets, expert knowledge, parameter estimates in literature, and modelling outputs; BBNs can easily include multidisciplinary knowledge and, therefore, suit for evaluating the multidisciplinary large scale environmental management challenges; The effect of the managers' risk attitude (risk averse, risk neutral, risk prone) can be included and analyzed in a BBN, and they are graphic models that enable linking several components and their management options in one model.

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Very importantly, stakeholder perspectives can be included through participatory modelling, and BBNs can be helpful in communicating uncertainty to stakeholders (Spiegelhalter et al. 1993, Kuikka et al. 1999, Barton et al. 2012).

One of the drawbacks of using BBNs is that using probabilistic approaches in risk assessment and management modeling is typically more time-demanding than the more traditional methods with point estimate output, and critically, there is a limited amount of stochastic versions of the MareFrame related ecosystem models available, so far, to produce probability distributions as an input for BBN.

A roadmap and a template were developed in collaboration between UH, UiT and CETMAR to be used at the launching events in the case studies. This purpose of the template was to ensure that relevant information about the decision environment was obtained; to harmonize the participatory process (co-creation) and to contribute to full documentation of it; and to avoid ad-hoc approaches in the decision support process. The decision environment is characterised by an analysis of decision making processes, policy goals, timeframes and legal constraints for decision-making. Also the key interest variables were to be identified in the launching events. These variables should capture the main interest by all stakeholder groups. Ideally they are a set of ecological, economic and societal variables indicating the fisheries performance and impact in the ecosystem context. They could include variables such as probability of reaching MSY by the desired year, industry profit levels, risks of bankruptcy, and selected GES indicators. In addition, the potential decision variables, i.e. the management related variables, were also expected to be screened in the launching events. As an example, they may have been variables such as effort, stock exploitation rate, and gear selectivity (e.g. mesh size and minimum landing size).

The launch of the case studies provided a good basis for the decision support work. Follow up meetings proved to be necessary because the high number of stated objectives for the launch of the case studies could not be reached in practice due to overloaded meeting schedules and rich discussions. In many cases, the several case study problems were identified, creating a need for agreement on ways to prioritize problems. In general, there is a need to characterize and specify the case study problems further, giving consideration to options to model the problem dimensions and the availability of data.

Management alternatives and objectives have so far been roughly defined, and need to be discussed in further detail to help to select and develop appropriate decision tools and models. To address these issues, the WP6 case leaders arranged a (Skype or face-to-face) meeting with the stakeholders and WP5 researchers involved in each case study in late 2014 (in few cases the meetings were suspended till February 2015). Progress will dependent on sustained dialogue between stakeholders and researchers in WP5 and WP6.

The decision support case study preparation follows the Decision Support Framework (DSF) outline described in Figure 2.

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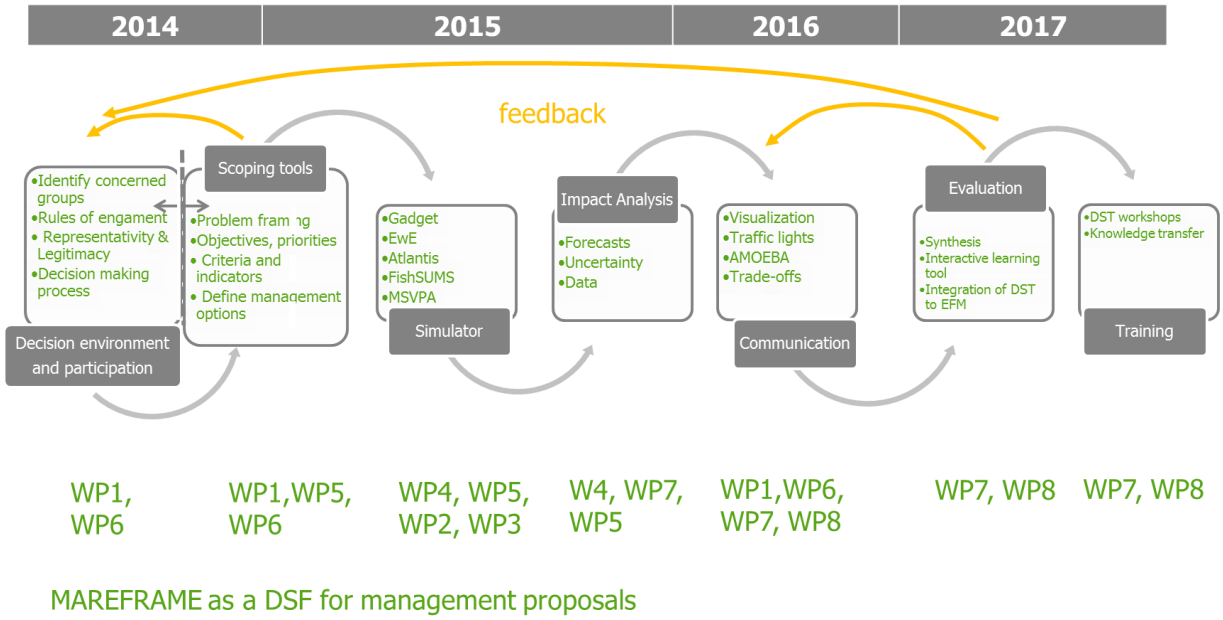

Figure 2 : The DSF in MareFrame. See text for explanation.

Following the co-creation approach in MareFrame, the scoping of problems, tools and management proposals is developed in dialogue with stakeholders. Accordingly, the Decision Support Framework (DSF) includes several interactions between researchers and stakeholders, and it utilizes different types of methods.

Figure 1 describes the main interactions between the Work Packages (WPs) and stakeholders, and which will end up with management plan proposals. The general approach to taken draws the FAOs approach to EAF (FAO 2003) and the FAO toolbox for EAF[4].

Moving from left to right, this process involves:

- Decision environment and participation (Launch of case studies; Descriptions of the governance context for EAF in the case areas; deliverables D1.1 and D7.1). Scoping tools (Problems, objectives, and priorities (Launch of case studies with stakeholders and case leaders; WP6-W5- stakeholder dialogues; DS workshops with WP6 and stakeholders);
- Simulations and impact analysis (Data and model work in WPs 2,3,4, 5,and 7)
- Stakeholder review and discussion, and further elaboration of proposed plans (WPs5 and 6)
- Communication (WP 8; all project members; WP7 (DSF prototype evaluations))

In addition to the process depicted in figure 1, a computerized Guided User Interface (GUI) will be developed as a decision support tool. In this interface, the user will select a case area, read about the governance context, select a problem, explore tradeoffs etc. Among other things, the GUI will serve as a tool for stakeholders for the DS workshops that will be held with stakeholders in summer 2015, for instance by

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

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helping them to identify the most relevant scenarios and management strategies to be evaluated in detail in the longer and more comprehensive planning process.

Scoping, decision environment and participation

As indicated in the figure 1, screening of the relevant stakeholders and their objectives cannot always be dealt with as prior to, and independent from, the subsequent scoping step. Sometimes it is necessary to start with the problem and then go back to complete the analysis about decision environment and participation. This step should include response to the following issues:

- The identification of decision makers (e.g. EU parliament and Council of Ministers; the Icelandic Ministry of Fisheries; the Black Sea Convention etc.)
- The identification of concerned groups. Having the identified problem in mind: Which affected interests were represented at the meeting? Which were not? Choices may have implications for other interests groups, although this may not be fully realized for the planners or decision makers.
    - FAO's EAF toolbox[5] recommends that the following issues are considered in relation to stakeholder analysis:
        - Who is directly affected by the problem situation being addressed?
        - What are the interests of various groups in relation to the problem?
        - How do groups perceive the management problem to affect them?
        - What resources do groups bring to bear (for good or bad) on the problem?
        - What organizational or institutional responsibilities do the groups have?
        - Who should benefit, or be protected from, management interventions?
        - What conflicts may groups have with each other and management strategies?
        - What management activities may satisfy the interests of the various groups?
- Reflections on legitimacy, representativity and participation issues (Biegelbauer & Hansen 2011, Coffey 2005, Hatchard 2005): How should these issues be dealt with this in practice? Possible deficiencies of the approach should be characterized but also addressed and discussed at the upcoming decision support workshop. The general legitimization of the DSF in MareFrame could be along the following lines: Any user or constellation of users can use the DSF in support of proposal development (as opposed to decision-making by authorized decision-makers). However, it is clearly the case that a proposal that does not take account of significant interests of users/stakeholders that have not been accommodated into the proposal development process, will have a low prospect of being adopted by decision makers.
- Reflections on the appropriate process for decision making within the stakeholder group that wishes to engage with the DSF for management proposal development.

Scoping involves response to the following issues:

- The identification of the case study problem or problems.
- If more than one problem is identified, stakeholders and case study leaders were encouraged to prioritize problems, or ideally, to select one issue to be dealt with as the MareFrame decision support case.

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

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- Considerations on what makes the selected problem an EAF type problem (i.e. as opposed to single species approach).
- What is the decision problem involved here (e.g. as opposed to estimation of parameters)?
- The identification of relevant policy objectives with a bearing on the problem (MSY, GES descriptors) and if available, the identification of relevant indicators and defined threshold levels.
- The identification of potential socioeconomic indicators
- Specification of the resources, and relevant ecosystem components
    - fleets (their gears, size, nation, ownership, home ports)
    - stocks (assessment and management area)

- The identification of appropriate DS tools (for instance Bayesian Belief Net or Analytic Hierarchy Process). The tools should support a transparent and rational way to identify management options/alternatives to be tested in WP4 models. These alternatives will ultimately be identified in terms of parameters/variables of at least one WP4/5 model.

Simulation and impact analysis

Decision support relates to the expected outcome of alternative management actions. Hence it is important that each case study is described by a modeling approach which adequately represents the ecosystem and the fisheries system with their causal linkages, to be relevant in the decision support context.

The process outlined in figure has been used to structure the work with task 6.1. This has mainly addressed the issues of scoping, decision environment and participation, but has also had some bearing on other issues, e.g. the identification of preferred model outputs. These refer to a critical task for efficient communication between experts and stakeholders.

The follow-up to this deliverable will be D6.2, which will provide a manuscript describing the MareFrame decision support tool. The manuscript will include theoretical background about the decision support approaches and a description of their capabilities in the context of MareFrame project.

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Case studies

Baltic Sea case study

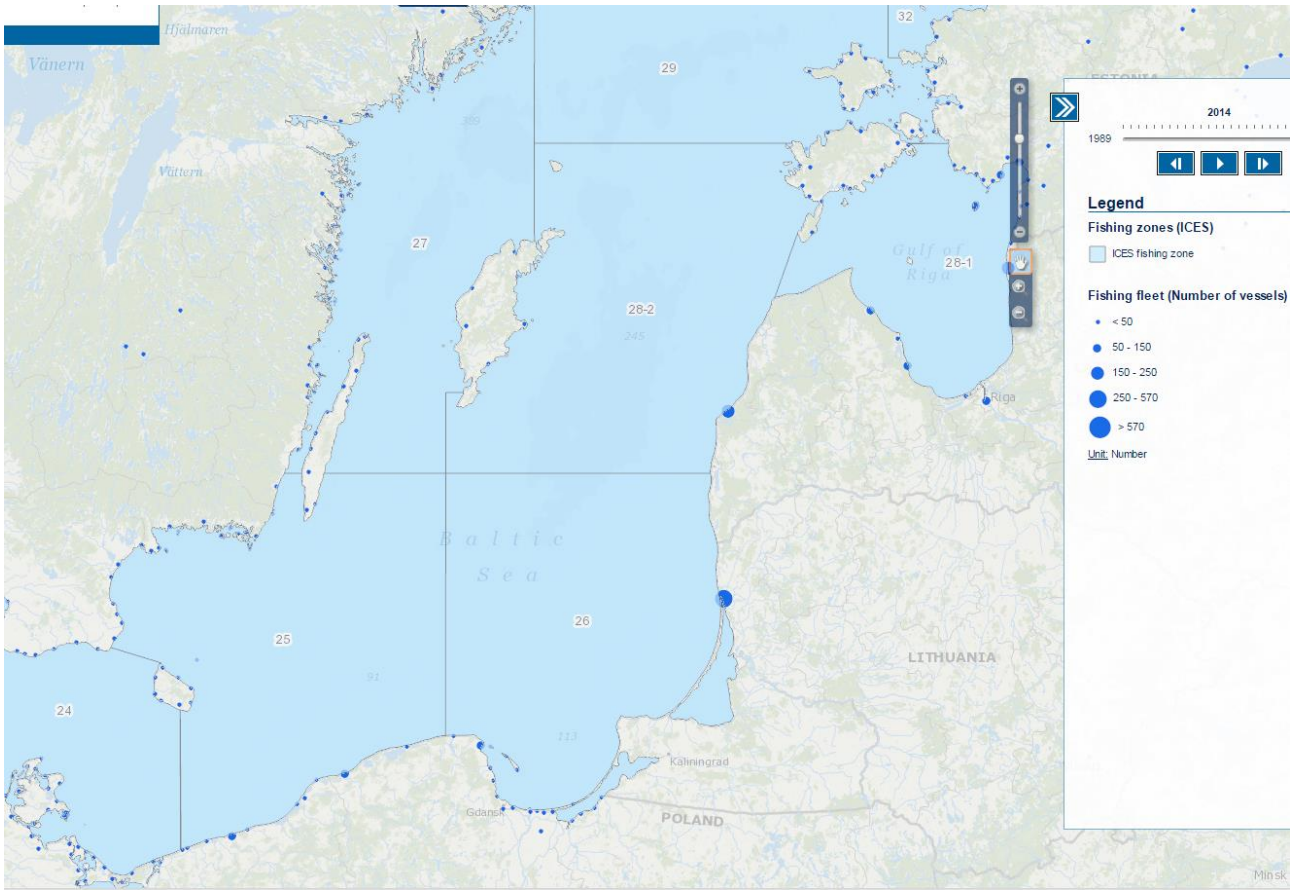

Figure 1. Map of the Central Baltic Sea with ICES sub-divisions 25-29. Source: http://ec.europa.eu/maritimeaffairs/atlas/maritime_atlas.

1. Initial case study focus and problem context

The Baltic Sea presents a species-poor and data-rich case study. Cod, herring and sprat comprise the large majority of the fish community in both biomass and numbers.The geographical focus is in the Central Baltic Sea (Fig. 1). In there, ICES sub-divisions 25-28 cover the current distribution of the eastern Baltic cod stock which provides majority of value in the commercial harvest fisheries. The cod spawning habitat is limited by environmental conditions, specifically the oxygen concentration and salinity in the pelagic area of the southern Baltic Sea. The area of cod distribution is positively correlated with the stock abundance. The average weight-at-age and "condition", i.e. weight-length relationship, have markedly declined recently. Spawning of cod occurs in summer in a very narrow water layer with sufficient salinity and oxygen to allow for the egg development. Cod is mainly caught by demersal and pelagic trawls, and gillnets. There is some by-catch, which has been discarded so far. However, the Common Fisheries Policy (CFP) based landing obligation will impact this practice as national legislation is developed and implemented from 2015 onwards. The main fishing nations for cod are Denmark, Poland, and Sweden.

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The cod fishery was intensified in the early 1980s when the stock biomass substantially increased due to favourable reproductive conditions. The landings increased in the mid 1980s as a consequence of the large year classes of the 1976, 1977 and 1980. During this period a considerable part of the catch was taken in the subdivisions 28-32. In the 1990s the stock had a progressive decline which resulted in overall lower catches, but the high proportion of old cod in that period promoted an expansion of the gillnet fishery. Further change in the stock composition towards younger fish during the late 1990s and early 2000s generated a reduction of gillnet and an increase in demersal trawlers. During the recent two decades, the cod catches were largely taken in subdivisions 25-26 with approximately 30-40% being taken by gillnets. The importance of longlines has increased recently, probably due to cheaper running-costs of vessels involved in this fishery, and mostly at the expense of the gillnet fishery. In the last 5 years the use of passive gears has generally increased in relation to trawls, which is probably a reflection of the rising fuel prices.

Cod is the main predator on herring and sprat (Köster et al. 2003). On the other hand, herring and sprat in particular prey on cod eggs. Herring and sprat are schooling pelagic species and prey item for salmon also, and seals. The trophic interactions between cod, herring and sprat may have a strong influence on the dynamics of these stocks in the Baltic (Köster and Möllmann 2000a). Herring spawns in coastal areas on gravel or aquatic vegetation while sprat spawns in the pelagic area.

Herring and sprat are captured by pelagic trawlers in a mixture. The proportion of the two species in the catches varies according to area and season. To a minor extent, a predominantly herring fishery is carried out with trap-nets/pound-nets and gill nets in coastal areas as well as with bottom trawls. Discards are negligible for both of these species. Main fishing nations for herring are Sweden and Poland. Main fishing nations for sprat are Poland, Sweden, and Denmark. The catches of the pelagic species are used for human consumption, reduction to oil and meal, and to animal fodder. The allocation of the catches into these categories differs not only by country, but also over time, mostly driven by market demand. Approximately 2/3 of the central Baltic herring landings are evenly distributed between subdivisions 25,26, and29. In recent years landings of herring are increased in subdivisions 25-26, decreased in subdivision 27 and 28.2, and unchanged in SD 29 and 32. Baltic sprat landings are reported from all the whole Baltic, SD22-32. However, landings are largely represented by catches in subdivision 25, 26 and 28 followed in order of importance by SD 29, 27 and 32. During the 2000s it has been observed a progressive decrease in landings from SD25 and increase in SD28.

Climate driven changes in the salinity, temperature and oxygen concentration affect the recruitment and growth of cod, herring and sprat. In the past, the eastern cod stock spawned in the Bornholm (in ICES sub-division 25), Gdansk (in ICES sub-division 26), and Gotland Deeps (in ICES sub-division 28). The cod spawning habitat (also referred as "reproductive volume") has generally been very low or zero since the mid-1980s in the Gotland and Gdansk Deeps (MacKenzie et al. 2002). In the later years the salinity and oxygen conditions have only allowed successful reproduction in the Bornholm Deep (Köster et al. 2005). The drastic reduction of the cod population abundance since the late 1980s resulted in a contraction of it distribution towards the south-western Baltic Proper (ICES 2013), also changing the area of operation of the commercial fleets.

To conclude, the major ecological and fisheries resource considerations are:

- Trophic interaction among cod, herring and sprat
- Large-scale hydrographic fluctuations and the decrease of the reproductive volume impairing cod recruitment
    - Large Atlantic water inflow in winter 2014-2015
- Cod overfishing during the past decades, reduced spawning stock abundance

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- Reduced growth rate of cod (hypotheses: environmentally driven and/or fisheries induced and/or intensified parasite (codworm) infection driven by the increasing grey seal population?)
- Eutrophication influencing oxygen concentration and quality of the coastal spawning habitats

The case study is led by Valerio Bartolino at Swedish University of Agricultural Sciences (SLU). Decision support task is led by Mika Rahikainen at University of Helsinki (UH).

2. The governance context

The Baltic Sea major fisheries are governed by the EU as guided by CFP, MSFD, Habitats Directive, Marine Spatial Planning, and Baltic Sea Action Plan. The EU Commission and fisheries directors constitute the BALTFISH High Level group putting forward fisheries policy initiatives. Regionalization and participatory processes are carried out in the BALTFISH Forum where Advisory Committee (BSAC), representing all relevant stakeholders and interest, and ICES, HELCOM, Member States, and the EU Commission interact in a structured manner.

Commission drafts proposal, Council and Parliament approve or reject proposal. There are bilateral agreements between the EU and Russia about Baltic fisheries. These agreements define the allocation (fixed) of the TAC between the EU and Russia, before the EU part could be split among EU countries using the relative stability principle. This rule maintains the TAC shares fixed among the countries, although they are allowed to exchange the national quotas with bilateral agreements.

The nations involved in the Baltic Sea fisheries include Sweden, Finland, Russia, Estonia, Latvia, Lithuania, Poland, Germany, and Denmark. At the national level, governance of maritime ecosystem and fisheries is sectored, also with respect to science and management advice. In Finland, for instance, fish stock assessment is assigned to Finnish Game and Fisheries Research Institute; environmental monitoring to Finnish Environment Institute; updating and development of fisheries and environmental statistics is assigned to Statistics Finland; and monitoring contaminants of sea food and carrying out risk analysis for human health is assigned to the Finnish Food Safety Authority. These national sectorial institutions cooperate with, and to some extent are coordinated by intergovernmental organizations such as ICES, HELCOM, and STECF to produce holistic scientific synthesis and management advice at larger geographic areas for shared fish stocks and other natural resources.

Five fish species are commercially exploited at the higher scale in the Baltic: cod, herring, sprat, flounder, and salmon. ICES working group WGBFAS carries out an analytical stock assessment annually. The precautionary reference points are applied to evaluate whether a stock has full reproductive capacity and if its exploitation is sustainable.

Fishery in the Baltic is regulated mainly by TACs. ICES is the main external advisory body on stock management while STECF provides internal advice and evaluations. For stocks for which analytical assessment exists ICES advises TACs using the following hierarchy of options:

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- TAC resulting from management plan, if such plan exists and has been evaluated by ICES as precautionary
    - management plans are based on single-species considerations/targets and have been developed using single-species analytical approaches
- TAC resulting from MSY approach, i.e. TAC determined by Fmsy
- TAC resulting from precautionary approach, i.e. TAC determined by Fpa or TAC under which SSB is expected to be above Bpa, if fishing at Fpa leads to lower biomass than Bpa.

For herring and sprat stocks catch limits are set using MSY approach, if Fmsy has been estimated. Annual catch quota for cod stock has been set on the basis of the management plan which has been evaluated by ICES as precautionary. At present, taking into account negative pattern in cod growth and the concern about uncertainty in the recent assessment output, ICES does not consider the cod management plans as being precautionary. In addition to single species F_{msy} the multispecies F_{msy} has been estimated for cod, herring and sprat, and it is usually presented as range of values. In the ICES, the Baltic is one of the most advanced cases in terms of integrated assessment. However, the advice for setting annual TACs is still based on single-species models.

Cod recovery plan

EU has agreed on a multiannual plan for cod in the Baltic Sea in 2007 (EC, 2007). ICES has evaluated the management plan in 2009 and considered it to be in accordance with the precautionary approach. Cod management plan consists of the following main elements:

- Target fishing mortality set at 0.3 for eastern stock and 0.6 for the western stock
- Yearly reduction of fishing mortality by 10% until target levels are achieved
- Limits in annual changes of catch quota set at +/- 15% (the limits are not applied if their application would lead to fishing mortality higher than F of 0.6 for eastern stock or F of 1.0 for western stock)

In addition to the rules presented above, some limitations on fishing effort have been imposed. Some of these measures, especially the time and area closures have been different between years and also not involved always all the gears.

- Closure of fishery from 1 July to 31 August for eastern stock and from 1 to 30 April for western stock
- Yearly decrease of fishing days by 10% until difference between current and target F is lower than 10%
- Areas closed for any fishing activity from 1 May to 31 October were established on spawning grounds (Bornholm Basin, Gdańsk Deep, Gotland Deep).

The implementation of the plan for eastern cod stock and increased recruitment to the stock has led to substantial decline in fishing mortality to levels close to target F of 0.3.

The agreed multi-annual plan was developed under the assumption of unchanged growth. However, the cod growth rate declined dramatically in recent years, thus this assumption is no longer valid. It is one of the reasons, that ICES has not used the EU-agreed multiannual plan as the basis for advice in 2014 (ICES, 2014).

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Multispecies management plan

Cod multispecies management plan has not been developed so far, although multispecies simulations showing effect of cod biomass on clupeids mortality and effect of clupeids biomass on cod cannibalism (decline in clupeids biomass may lead to higher cod cannibalism) have been conducted using SMS (Stochastic Multispecies Simulations) or stock-production models. Simulations indicate that yield of cod as a function of fishing mortality is relatively flat for range of Fs from 0.4 to 0.6 but effect of such Fs on cod biomass is substantial. Thus, one option for setting the fishing mortality on cod and clupeids in multispecies context could be to have relatively high F on cod to keep bigger clupeids biomass and have higher catches of herring and sprat. This is just an example of possible trade-offs a decision maker has to consider. Many other options for Fs in multispecies context are possible and they would depend on decision what we intend to maximize/optimize (e.g. sum of catches, sum of catches weighted by specific weights for cod, herring and sprat).

The above simulations assume that there is full spatial overlap between cod, herring and sprat in the central Baltic. However, at present cod is mainly distributed in southern areas (sub-divisions 25 and 26) while clupeids extend also to northern areas (sub-divisions 27 and 32). This is where sprat is actually increased most in recent years, in practice the core of distributions of sprat and cod have moved in opposite directions. These patterns have fisheries implications – the fleets are heterogeneous and, for instance, mobility of a vessel tends to decrease in synchrony with vessel size.

The lack of full overlap of the sprat and cod stocks should be considered in management advice and the tools for spatial management should be developed. In MareFrame, EwE ecosystem model will be elaborated to include the spatial component capable of considering the spatial distribution of these fish stocks.

The multispecies effects are to some extent included in Baltic stocks management as assessment and catch projection for herring and sprat use variable natural mortality dependent on cod biomass and provided by multispecies model (SMS). A variable M is applied, based on SMS output, for the assessment of herring and sprat. However, catch projections (especially the projection for the "intermediate year" which is the year for the advice) are not based on projections of the cod stock. This would be in essence a major step forward that could only be achieved within a multispecies model.

3. Stakeholders and participation in the case study

The Baltic Sea case study was launched in Gothenburg on 26th, May 2014 with 14 participants. One of them (MareFrame researcher) was linked with a video conference system. To summit a representative group of participants, a fairly comprehensive list of Baltic Sea stakeholders, directly related to fishery issues, was derived from the ODEEM project (http://www.liv.ac.uk/odemm/about_odemm/). This list comprised approximately 90 institutions from 8 different countries. Given such complexity, we identified in the RAC a good opportunity to reach a variety of parties which are represented in the RAC (especially because we have been able to reach the Baltic Sea AC chair). Because of the broad and multi-faceted perspective of the Baltic Sea AC on fisheries management issues, and the large array of stakeholder groups represented there in, we believe the Baltic Sea RAC would be an ideal stakeholder for the workshop. In addition to the RAC we found of relevance having also stakeholders which could represent the managers, which explain the participation of the Swedish Agency for Marine and Water Management (SWAM). SWAM is considered an ideal representative of the managers group (though every country has a similar institution) because of its broad

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role and because of logistic convenience, they hosted the launch of the CS. In addition, we invited also an external scientist from Gothenburg University dealing with fishery issues but from a different perspective (socio-economy).

At launching event, the stakeholders identified a prioritized list of management issues that they recommend to be explored within the case study:

i) Poor condition and growth of eastern Baltic cod
ii) Competition and conflict between seals and fisheries
iii) Identification of maximum sustainable yields in an EBFM
iv) Implications of landings obligations
v) Influence of contaminants on fish populations, food quality and security.

Of these alternatives, identification of maximum sustainable yields in an EBFM was selected to as the MareFrame case study issue. The stocks in question are cod, herring, and sprat in the Central Baltic. Identification of MSYs implies a multispecies perspective as the dynamics of these stocks are linked to each other. A request was made that to investigate scenarios where fishing mortality is allowed to vary among the species.

Table 1. Types of stakeholders involved in the launch of the Strait of Sicily case study at national and regional level. See text for clarification.

Level	Meeting details	Stakeholders / competences
International	• Launch of case study in Gothenburg on 26th May 2014.	• BSAC: Chair • Danish Fishermen Association • SWAM, national manager (7 participants) • Independent university researcher from Gothenburg Univ. • MareFrame scientists from SLU, SU, UH • no NGO
International	• Skype meeting on 28th November 2014	• BSRAC: Executive secretary • SWAM, national manager • MareFrame scientist from SLU and UH

Limitations and challenges regarding participation in the case study

The participation in the launching event in May 2014, and in this Skype meeting, was considered to suffer from lack of breadth. The project would benefit from including certain viewpoints including environmental NGOs and sales organizations. BSAC Executive secretary provided contact information about the relevant persons who will be invited to participate in the project during the next meeting in which is scheduled in March-April 2015. However, the case study has been launched with many representatives present, covering the key interests in the Baltic Sea fisheries.

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4. Elaboration of the scope of the case study problem

The launch of the case studies provided a starting point for the decision support work. Progress with this work will depend on sustained dialogue between stakeholders and researchers in WP5 and WP6. There is a need to characterize and specify the case study problems further. For this purpose, the case study leader will arrange a stakeholder meeting in March-April 2015 to receive feedback about the conclusions drawn after the Skype event, and to iterate with the management objectives, including spatial considerations, and the interest variables.

At the Skype meeting in November, the issues identified and the links among them were discussed further. Changes in the condition and growth of cod have implications for MSY and for the quality of landed fish. Considering the alternative hypotheses about drivers (changes in climate, hydrology and eutrophication, and density-dependent processes) of cod growth and the associated scientific uncertainty, evaluation of the capacity of alternative management strategies could also appear useful. With respect to the Baltic grey seal population, it can be seen as a fleet competing with harvesters for the fish resource influencing MSY, but this was not considered to be the major management issue.

The landing obligation will come into effect at the beginning of 2015, but there is no national legislation yet. Developing an operational modeling approach would be difficult because the landing obligation may induce strategic behaviour among fishers and it is challenging to anticipate how this will be. It is also expected that the EU will allocate resources for in-depth research into this topic, so the landing obligation will not be dealt with specifically in MareFrame. It was recognized that the discard ban should provide new data about the by-catch rate of undersized salmon in the pelagic fisheries and about flatfish by-catch in the cod fishery.

The influence of contaminants, dioxin and such like in herring (and salmon) on consumer health attracted some discussion. For the time being, it is not clear whether the available ecosystem models are adapted to describe metabolism of the toxicants, mainly as a function of growth rate. So this issue was not perceived to be of major importance.

Whatever model is used to analyse the management scenarios, it should have the capacity to forecast the economic effects that changes in the multi-species reference points (Fmsy, Blim etc.) will cause for fisheries. These reference points have high potential to impact fishing effort as well as fleet and gear composition. In addition to models with relevant fleet métiers[6] included, data about fishing costs and landing prices should be acquired with a relevant level of disaggregation. The pragmatic questions are: how much landings and their value, profits, and resource rent will be impacted among the fleet segments and at national level? A major concern is that it would be very difficult to estimate the real costs of fishing, and therefore, the profits. Fishing cost data is a sensitive issue and it may appear inaccessible. The economic evaluations will be based on outputs of the ecosystem model about the catches and ecological dimensions, but they have to conducted separately, outside the ecosystem model code.

[6] A métier is a group of fishing operations targeting a specific assemblage of species, using a specific gear, during a precise period of the year and/or within the specific area. The European Data Collection Framework defines métiers according to a hierarchical structure using six nested levels: level 1, activity (fishing/non-fishing); level 2, gear class (e.g. trawls, dredges); level 3, gear group (e.g. bottom trawls, pelagic trawls); level 4, gear type [e.g. bottom otter trawl, bottom pair trawl]; level 5, target assemblage based on the main species type [e.g. demersal fish vs. crustaceans or cephalopods]; level 6, mesh size and other selective devices.

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The fishing industry has concerns that the issue of identifying MSY targets could be interpreted as trade-off between fisheries, especially at a whole stock level, because of high variability in the catch composition. Under this perspective, it has been argued that the management issue could be reduced to a political issue which could be limitedly informed by biological considerations.

Variability in catch composition is difficult to be understood, and effects of multiple drivers disentangled, as it is the combination of high temporal and spatial variability in the availability of fish resources, fluctuations in price and market request, and changes in the fishery management.

The Baltic Sea supports important commercial and recreational fisheries. The volume and value of commercial landings are evaluated and recorded by national statistics agencies in a reasonably uniform manner, but there are differences among countries with respect to evaluation of recreational fisheries. Although there are some confrontations between these fisheries sectors, in this Baltic Sea case study review we focus on the socioeconomic indicators of commercial fishers' society.

Member states compile statistics of some socioeconomic indicators on annual basis. Despite the economic database possessed by EuroStat (http://epp.eurostat.ec.europa.eu/portal/page/portal/fisheries/data/database) and JRC (https://fishreg.jrc.ec.europa.eu/web/datadissemination/home), it appears that holistic analysis of the potential usefulness of these data is yet to be commenced.

It is known from previous research that Baltic fisheries are dynamic systems driven by market demand and resource supply (Stephenson et al. 2001). Also STECF (2012) addresses that the economic performance of fleets is usually affected more by external factors, like fuel prices and fish prices, which are driven mostly by overall price levels and consumption, than by biological factors. Therefore, socioeconomic should be valuable for any evaluations of EAFM.

Much of the current knowledge in this respect is mostly qualitative. STECF (2012), for instance, forecasts that economic performance of the Baltic Sea commercial fishing fleets is likely to be more affected by external factors as global fuel prices, fish meal and fish oil prices, and competition between Asian and European production. They also anticipate that increase of stock abundance and catchability could increase volume and value of catch per fishing effort, leading to the improvement of economic situation of the fleet. Also, "the overall quality (and thus attractiveness) of jobs depends among others on stability (part time vs full time/full season) and remuneration. The management plan affects not only current employment, but also employments expectations."

Evaluations and forecasts of alternative management strategies seem to be lacking from the literature with respect to the Baltic Sea fisheries. There are time series of some socioeconomic indicators available, but these are judged to include shortcomings. These issues include short length of the data series, lack of updated data, limitations on FTE, engaged crew and number of vessels data availability (affecting in various ways all indicators), and the effect of data allocation influencing mainly the indicators for the demersal trawlers (STECF 2012). In an earlier project, it was observed that fishing cost data, in particular, is very often not available for science (Rahikainen et al. 2009). The general problem is that available economic data are aggregated to on national and gear type level, but these attributes do not allow taking into account the true mosaic in the fleet structure and dynamics. MacKenzie at al. (2007) synthesize that there are many complexities and uncertainties in understanding how industry and fishing communities will respond to changing environment.

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As an overview, there are economic data available, referenced in the MareFrame deliverable D2.1, currently including variables such as capacity (avg. vessel age, avg. length, engine power, total number of vessels, tonnage); economic performance (avg. wage, capital productivity, profit, employment, fuel efficiency, GVA, revenue, etc.). These variables are then used to calculate some social indicators, called balance indicators, such as fleet overcapacity and current revenue to break even revenue. The challenge is the high level of aggregation in these data making all segment –based forecasts about potential trade-offs very difficult.

There are available some project based works related to socioeconomic issues in the Baltic Sea. As an example, an earlier project, COEXIST, has identified that conservation of fish-eating animal species, particularly the grey seal and the cormorant, has aroused conflicts. The basis for these conflicts is the damage induced by the seals and cormorants to fishing livelihood and aquaculture. Grey seals are commonly regarded as the main threat in Finnish coastal fisheries and there are persistent discussions about options for mitigating cormorant-induced damages in fisheries. The seals and cormorants eat fish completely or partly from fishing gear, making commercial use of landings impossible. The animals also break the fishing gear. Moreover, fishermen claim that seals scare fishes away from the fishing sites. The problem is seen differently by the fisheries and hunting groups on one hand and nature protection NGOs and environmental administrators on the other.

5. Objectives, indicators and criteria

Management of the Central Baltic fisheries in a multispecies context has received earlier research effort by ICES (2013) and JRC (2012). ICES has applied two multispecies models, MSI-SOM and SMS, in addition to XSA and SAM type single species models in the Baltic. A bioeconomic analysis by Nieminen et al. (2012) is available as well. Many stakeholders who did participate in the MareFrame launching event in May 2014 have been involved in the ICES WKBALT work. In the meeting, some stakeholders challenged the MareFrame efforts for developing management advice because we are a project only, not a prestigious institute like ICES. Therefore, it will be vital to point out that we can achieve something beyond the ICES WKBALT, WGSUM and the STECF evaluations. MareFrame needs to network with these workgroups and prove what are Gadget and EwE capable of doing that is not feasible with the models ICES has applied (Table 2).

The analysis by Nieminen at al. (2012) points out the major difference between MSY and MEY, and the trade-offs will be dramatic if MEY would drive the management advice. Inclusion of economic aspects is suggesting that cod fishery should be the priority and sprat and herring fishery should be strongly limited to allow enough prey for the cod stock. Their work highlights the influence the selected target has on conclusions, also, whether it is the society's or fishing sector's utility which matters.

There certainly are many interactions among the acknowledged management issues and scenarios. I anticipate that explicit consideration of these interactions would help in scoping the issue to receive further decision support. Brain storming to identify the key factors, potential conflicts, the causes, the consequences, and the causal links among them may appear useful. It seems that it is not easy to formulate a single problem reflecting the stakeholder concerns but we should move to that direction. You might consider with the stakeholders what is it that they are trying to avoid, and what are they trying to reach, and what needs to be done to meet these circumstances.

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Operational objectives, indicators and criteria

The operational objectives are still under development considering that a new stakeholder meeting will be held next late winter-early spring (s Skype meeting), and the second case study meeting (test of prototype I) will be organized May or June 2015. The first Case Study meeting was aimed basically at identifying the main management issues in the Baltic Sea fisheries. The next meeting will be more focused on possible objectives and the alternative management measures.

It is necessary to include the harvester interests in the framework and to include an analysis of fisheries induced pressure on those MSFD descriptors related to biodiversity and bottom integrity. In the meeting, Ylva Engwall at SWAM was pointed out as someone highly informed about indicators for the good ecological status (GES) in the Baltic ecosystem.

MSY, BPA Blim, Flim, FPA defined for the most relevant species; GES descriptors indicators which mostly mirror fishery indicators (i.e., SSB and F), and possibly Large Fish Indicator could be used. Reference levels are given by MSY or proxy in the absence of reliable estimates.

As a topical guideline, a variety of potential biological and economic indicators has already been identified in the West of Scotland case study:

- Trends in biomass: do all species in the ecosystem reach a stable and sustainable status (% of species stabilised at the end of simulation)?. However, predator-prey systems inherently fluctuate and stabilization should not be expected.

- Abundance trends of functionally important species/groups

- Trends in landings: is economic sustainability achieved?

- Fishing revenues: using mean price/kg

- Fishing mortality (species specific)

- Catch to biomass ratio

- Number of overfished stocks (assessed stock only)

- Proportion in weight of large species

- Number of species with significant landings (Gascuel et al., 2014): landings higher than a minimum level (to be set for all models/ecosystem to be compared)

- Shannon's diversity index (Shannon, 1948): biodiversity index based on the proportion of species in the landings

- Mean Maximum Length (MML) (ICES, 2009): based on maximum asymptotic length $L\infty$ from Fishbase (www.fishbase.org) and the weight (biomass) of species

- Mean Trophic Level (MTL) (Pauly et al., 1998): based on the mean trophic level from Fishbase (www.fishbase.org) and the weight (biomass) of species

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- Marine Trophic Index (MTI) (Pauly and Watson, 2005): MTL of predatory fish i.e. species with a trophic level of 3.25 or higher

- Pelagic to demersal ratio: indicator of nutrient input and quality of benthic habitat (de Leiva Moreno et al., 2000)

6. Models

ICES has already applied two multispecies models, MSI-SOM and SMS, in addition to XSA and SAM type single species models to the stocks that MareFrame is dealing with. Now, more understanding is needed as to whether Gadget, EwE, and the multispecies stock-production model have capabilities beyond the ones applied by ICES. MareFrame project should link with the modeling efforts being carried out by ICES working groups and learn from these other experiences. These models also are using the same fisheries data.

WP5 & WP6 personnel have to evaluate which components of the management issues can be modelled, and to what extent, and whether relevant data will be available. Ideally, the problems should be identified by stakeholders based on their relevance. However, it must also be practically possible to conduct research in support of the problems identified. Hence, a common ground between problems and research possibilities must be ensured.

Currently, only EwE has a working parameterization for the cod, sprat, and herring stocks in the Central Baltic Sea but it is not spatially resolved so far. A multispecies stock-production model still needs more development effort to run. Gadget is the least ready model. Valerio Bartolino has tackled difficulties in acquiring (i.e., landings, age-structure, length-structure, weight-at-age) data with applicable spatial and seasonal disaggregation.

None of the modeling frameworks actually include socio-economic parameters *per se*. These could in principle be added to the model specifications. Currently Maciej Tomczak is evaluating how to implement socio-economic considerations in EwE[7]. Gadget models may be interpreted in a socio-economic way. The Icelandic case study team has informed that Gadget does, for example, allow for processes in fleet structure which can have an impact on both profitability of the harvesting sector – and thus economic rent – and regional effects.

Table 2. The match between the identified management issue (Identification of maximum sustainable yields in an EBFM) and ecosystem models. **These are subjective prior judgments by WP6 case leader and needs to be reconsidered by case study leader and WP5 researchers**. The list may ignore relevant variables and include irrelevant ones. Contributions are welcome. Fleet denotes here vessels targeting cod, herring or sprat - gear, country, home port, length, ownership, or any other attribute is not considered.

[7] STECF-12-06 report suggests that assessment of socio-economic effects may be possible with Ecopath and advices to see Blenckner et al. (2011)

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The Baltic Sea Ecosystem model[8]	Gadget	EwE	MSPM[9]	SMS	FishSum	MSVPA	Size-based Bayesian	Pope model
Potential variables linked to the identified management issue								
Multispecies MSY (cod, sprat, herring)								
Multispecies MEY								
MSY disaggregated by fleet segment								
MSY disaggregated by country								
Value of landings by fishery								
Profits								
Employment								
Number of full time jobs								
Incentives for discarding								
Total allowable landings								
Spatial considerations								
Salmon stocks								
Seal stocks as a fleet								
Zooplankton								
Biodiversity								
Habitats, bottom integrity								
Effects on other trophic levels								

7. References

ICES 2013. Report of the Benchmark Workshop on Baltic Multispecies Assessments (WKBALT) ICES CM 2013/ACOM:43.

Köster, F.W. & Möllmann, C. 2000. Trophodynamic control by clupeid predators on recruitment success in Baltic cod? ICES J. Mar. Sci., 57: 310-323.

Köster, F. W., Möllmann, C., Hinrichsen, H-H., Wieland, K., Tomkiewicz, J., Kraus, G., Voss, R., Makarchouk, A., MacKenzie, B. R., St. John, M. A., Schnack, D., Rohlf, N., Linkowski, T., & Beyer, J. E. 2005. Baltic cod

[8] Green color denotes model is applicable to inform in management issue in the current set up, yellow denotes that model reparameterization or additional modules are necessary, but possible, before application. Red color indicates model is not capable of adequately addressing the issue. Finally, grey color implies current lack of knowledge.

[9] Multispecies stock-production model

recruitment - the impact of climate variability on key processes. ICES Journal of Marine Science, 62: 1408-1425.

Köster, F.W., C. Möllmann, S. Neuenfeldt, M. Vinther, M.A. St. John, J. Tomkiewicz, R. Voss, H.-H. Hinrichsen, B. MacKenzie, G. Kraus & Schnack, D. 2003. Fish stock development in the central Baltic Sea (1974-1999) in relation to variability in the environment. ICES Mar. Sci. Symp. 219: 294-306.

MacKenzie, B.R., J. Alheit, D.J. Conley, P. Holm, & Kinze, C.C. 2002. Ecological hypothesis for a historical reconstruction of upper trophic level biomass in the Baltic Sea and Skagerrak. Ca. J. Fish. Aquat. Sci. 59: 173-190.

Nieminen, E., Lindroos, M. & Heikinheimo, O. 2012. Optimal bioeconomic multispecies fisheries management: a Baltic Sea case study. Mar. Res. Econ. 27: 115-136.

STECF 2012. Multispecies management plans for the Baltic. Eds. Simmonds, J & Jardim, E. Report. 123 pp.

Appendix

General Ecosystem Description

General Ecosystem Description		
Management	Main fisheries (fleets, metiers), targets species and catch composition	Bottom trawl, purse-seine, gillnet, see WGBFAS report (ICES 2013) for details by country
	Single species or mixed fisheries	A suggested simplification: - the pelagic fisheries catch a mixture of herring and sprat (this is particularly true for certain fisheries, areas and seasons) - the bottom trawl fisheries targeting cod have often a by-catch of flounder and other flatfish but likely it which won't be considered in our models
Socio-economic issues	Socio-economic indicators (performance) by species, fleet and métier. Provide time series when relevant	JRC provides annual reports of socioeconomic status about the EU fleets (http://stecf.jrc.ec.europa.eu/data-reports)
	Value and amount of landings	Assessment data and STECF data, look at also http://epp.eurostat.ec.europa.eu/portal/page/portal/fisheries/data/database. However, national statistics may prove to more detailed than the ones by EuroStat http://epp.eurostat.ec.europa.eu/portal/page/portal/fisheries/data/database

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General Ecosystem Description		
	Turnover and profits	Look at https://fishreg.jrc.ec.europa.eu/web/datadissemination/economic-indicators. However, national statistics may prove to more detailed than the ones by JRC and EuroStat
	Person/years in fisheries	Look at https://fishreg.jrc.ec.europa.eu/web/datadissemination/economic-indicators
	Person/years in processing and fish wholesale and retail trade sectors, ain in the fisheries related sectors (shipbuilding, etc.	https://fishreg.jrc.ec.europa.eu/web/datadissemination/economic-indicators
	Regional/local importance of fisheries (settlement, social stability, etc).	Not available from the literature; not treated at the launch of the CS
Other issues	Other human drivers (cumulative anthropogenic stressors)	Eutrophication
	Energy sector	Windmill park
	Conservation priorities (protected habitats, species, etc.). IUCN classified species impacted by fisheries (threatened or vulnerable species/populations)	Natura2000

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Case study details for decision support work

Ecosystem/Regional Sea:					
	Species/ stock				
	Central Baltic herring	Gulf of Riga herring	Baltic sprat	Eastern Baltic cod	Baltic Sea grey seal
Management unit/area	ICES SD 22-27, 28.2, 29 and 32	ICES SD 28.1	ICES SD 22-32	ICES SD 25-32	National regulations
Assessment unit/area	ICES SD 22-27, 28.2, 29 and 32	ICES SD 28.1	ICES SD 22-32	ICES SD 25-32	Whole Baltic, vaguely defined
Assessment agency (specific working group also)	ICES WGBFAS	ICES WGBFAS	ICES WGBFAS	ICES WGBFAS	Only project work, ECOSEAL
Notes on quality of assessment based on ICES 2014 advice (retrospective pattern, uncertainty; assessment concerns, etc.)	No specific concerns	No specific concerns	The fishing mortality in 2013 is above both FMSY and Fpa. None of the recent four year classes (2009–2012) are strong and the 2013 year class is estimated to be average	ICES advises was done on the basis of the data-limited approach	Stochastic population dynamics model, unpublished
Stock status based on ICES 2014 advice (within/outside safe biological limits)	Harvested sustainably, full reproductive capacity	Harvested sustainably, Stock size above trigger, PA approach to stock size is undefined	F_{MSY} is above target, PA approach to F is "increased risk", Stock size above trigger, full reproductive capacity	F qualitative evaluation – stable at low level; Stock size qualitative evaluation - decreasing	recovering stock
Ownership of the resource	Approx. shared of the EU TAC in 2013: Sweden 33% Poland 25% Finland 22% Estonia 11% Latvia, Lithuania, Denmark, Germany <5% each	Approx. 50%-50% between Latvia and Estonia	Approx. shared of the EU TAC in 2013: Poland 29% Sweden 19% Latvia 14% Estonia 11% Denmark 10% Germany 6% Latvia and Finland 5% each	Approx. shared of the EU TAC in 2013: Poland 26% Sweden 23% Denmark 23% Latvia 9 %, Germany 9% Lithuania 6% Estonia and Finland <3% each	Hunting quotas set by national authorities
Management strategy or HCR based on ICES 2014 advice	No specific management objectives are known to ICES	No specific management objectives are known to ICES	The IBSFC long-term management plan for the sprat stock was terminated in 2006 and has not been replaced.	EU has agreed on a multi-annual plan for cod in the Baltic Sea in 2007	Not specified, increasing seal abundance causes fisheries conflicts
Reference points based on ICES 2014 advice	MSY $B_{trigger}$=600 000t F_{MSY}=0.26 Multispecies F_{MSY}= 0.25–0.35 B_{lim}=430 000 t B_{pa}= 600 000 t	MSY $B_{trigger}$= 60 000t F_{MSY} =0.35 B_{lim}=not defined B_{pa}=not defined	MSY $B_{trigger}$= 570 000t F_{MSY}=0.29 Multispecies F_{MSY}= 0.25–0.32 B_{lim}=410 000 t	MSY $B_{trigger}$= 88 200t F_{MSY}=0.46 Multispecies F_{MSY}=0.4–0.6 B_{lim}=63 000 t	None

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			B_{pa}=570 000 t	B_{pa}=88 200 t	

Classification to be used to characterize the stakeholders in the fisheries section[10]:

Stakeholder group	Stakeholders
Fishing companies	Fishing company owners
	Fishing company associations
Fishing company employees	Fishing companies' employees
	Labour unions
Suppliers and processors	Suppliers to the vessels
	Processing company owners
	Processing companies' employees
	Processing company associations
Sales organizations	Retailers
	Merchants
	Organizations promoting the sector
Consumers	Consumer organizations
Policy-makers	Local municipalities
	Governments' fisheries departments
	Inter-governmental policy makers
	Certifiers of stock sustainability
Non-governmental organizations	eNGO
Scientists	
	MareFrame researchers
	Non-MareFrame researchers
Other, what?	

[10] Veldhuizen, Berentsen, Bokkers, de Boer. Social sustainability of cod and haddock fisheries in the northeast Atlantic: what issues are important?

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North Sea case study

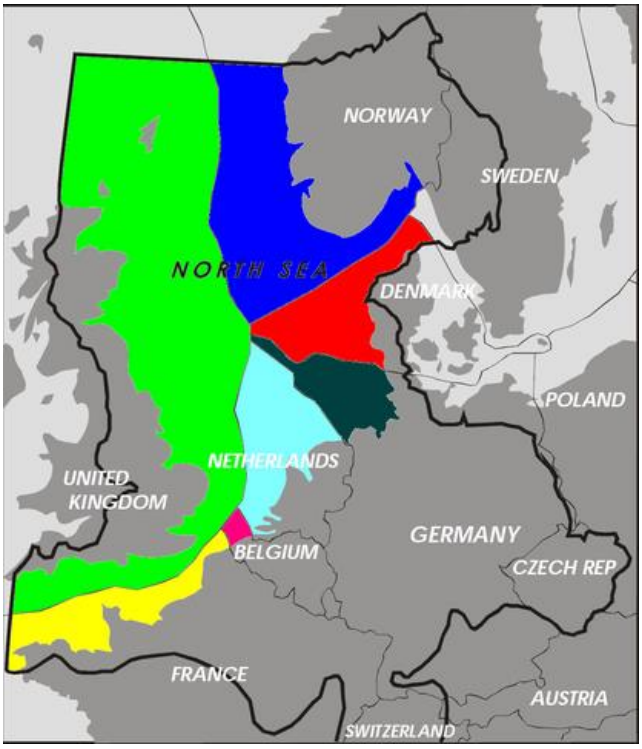

Figure 1: Map of the North Sea, the Exclusive Economic Zone, and the drainage area (black line). Source: Wikicommons [11]

1. Initial case study focus and problem context

The preliminary approach to the North Sea Case Study (NS CS) Case study has been described in the MareFrame proposal:

> *"This case study will start from a very simple model of how the overall size structure of fish community is affected by mortality on different sized species. The second step in the modelling approach is to build a more detailed model that describes how management actions will generate time changes in relevant species subpopulations, their interactions with each other and the consequent impacts on fishing fleets on the scale of interest to stakeholders. The GADGET model is proposed for this. Finally we will build a summary model that captures the main behaviour of complex model so that stakeholders will be able to explore alternative ways of approaching their often competing objectives. All models will to the extent possible be designed to respect the constraints implicit in new knowledge of the behavior of the size spectrum based system and of the tropic levels of species by size. The models will also attempt to incorporate stakeholder information on fishing fleet structure and behaviors when scenarios demand that these need to be more disaggregated than existing statistics allow."* (DoW, pag. 23-24)

[11] "North sea eez" by Inwind - Own work. Licensed under Public Domain via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:North_sea_eez.PNG#mediaviewer/File:North_sea_eez.PNG

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The total fish biomass of North Sea fish is dominated (ICES, 2007) by relatively few species (Figure 2). These species dominate both the biomass flow through the fish system and the commercial landings. As fishing intensity has increased larger species have tended to come under pressure and some have become very rare (Pope et al, 2003).

EU fisheries in the North Sea are governed by a combination of input and output regulations. Particular Total Allowable Catches (TACs) management and the principle of "relative stability" giving catch shares to Member States for most stocks aim to limit fishing mortality rate on individual species. TAC management has led to excessive discarding of fish, as well as overfishing, and TACs have been supplemented by restrictions on the fishing effort for various fleet segments. In addition, a mixture of technical measures, e.g. mesh size and gear restrictions, minimum landing size and closed areas are applied for management. At present, a new framework for technical measures is being developed. Furthermore, the reformed Common Fisheries Policy (CFP) has introduced landing obligations for the North Sea from 1st January 2015 for the industrial fisheries and certain small pelagic fisheries and from 1st January 2016 for the first set of demersal species[12].

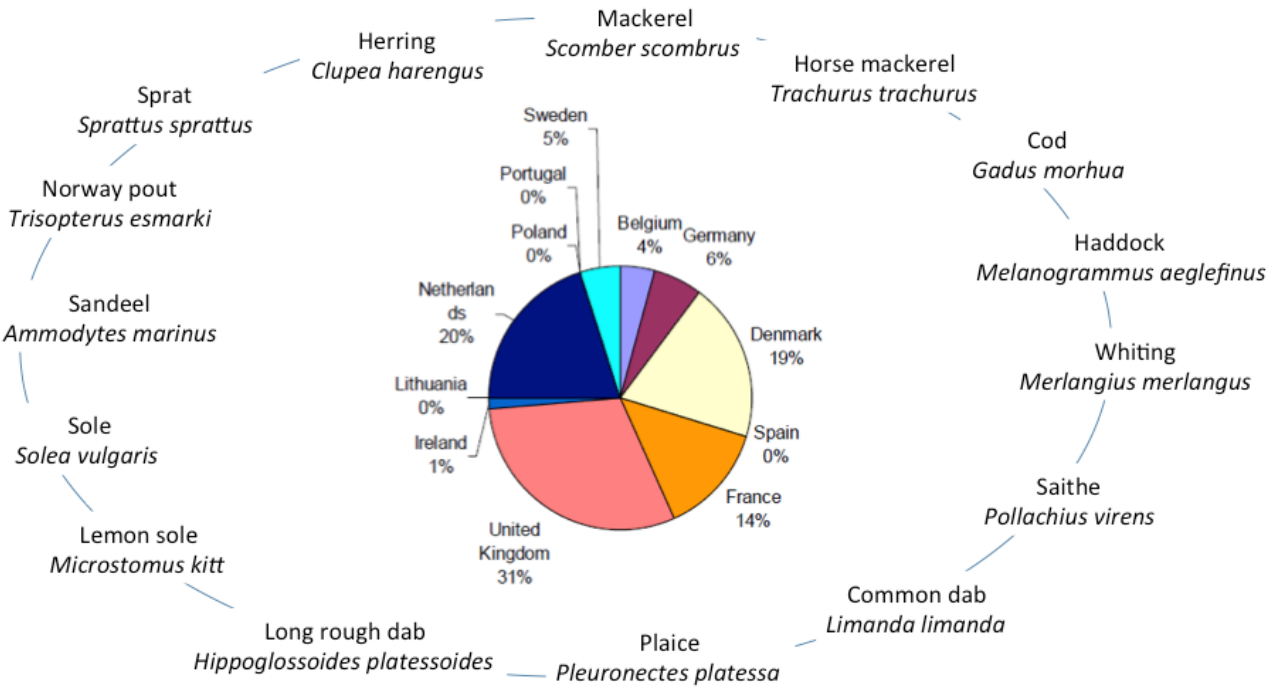

Figure 2: Fish species which dominate the total biomass of the North Sea (ICES, 2007). The percentage of the national shares (excluding Norway) of the North Sea catch values (STECF, 2012) can be seen in the inner part of the figure. Source: MareFrame D5.1

Almost all commercially important stocks and fisheries are managed by means of a multi-annual plan. The plans contain the objectives for fish stock management, expressed in terms of fishing mortality and/or targeted stock size. Some multi-annual plans include fishing effort restrictions as an additional instrument to the annual total allowable catches (TACs), and specific control rules. Multi-annual plans under the new CFP will include the target of fishing at maximum sustainable yield (MSY) and a deadline for achieving this target.

[12] **Commission Delegated Regulation (EU) No 1395/2014 of 20 October 2014**

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They will also contain measures for the implementation of the landing obligation. Multi-annual plans may also include technical measures. Multi-annual plans in the North Sea have been adopted for cod, northern hake, sole and plaice (Commission, 2014)

The main gear types used in the North Sea from 2006 to 2010 were dominated by the mobile fishing gears, i.e. demersal trawls, pelagic trawls and beam trawls.

2. The Governance context

The North Sea area is politically complex with 8 coastal nations (here Scotland is best regarded as a nation) each with its distinctive but overlapping fisheries. Within the European Union (EU), the CFP regulates fisheries. Another set of EU Directives which also have an influence in the management of fisheries are Habitats Directive, Birds Directive, Marine Strategy Framework Directive, and Water Framework Directive. For example, one particularly cumbersome element in the Natura 2000 programme (which implements the Habitats and the Birds Directive) is on how to agree on fisheries management measures in the offshore sites (Norden, 2014). There exists also an agreement between the EU and Norway on the management of shared fish stocks in the North Sea. The arrangement is said to grant both EU and Norwegian fishermen with valuable access to fish stocks, providing stability to the sector and strengthening the relationship with Norway (European Commission, 2014).

The EU CFP specifies that Commission proposals must be accompanied by a scientific analysis of the problem and if possible, science is invited to advice on appropriate management measures. Scientists thus have a special role in the negotiation process apart from the stakeholders. Management authorities base their proposals on the best available information and scientific advice. At national level, the authorities will draw primarily on national information and advice. At EU-level, the Commission draws on the European Topic Centre on Biological Diversity for the assessment of conservation of biodiversity in Natura 2000 sites and on ICES for the assessment of fisheries measures. The Scientific, Technical and Economic Committee (STECF) advises the Commission on fisheries management issues. These organisations are network organisations based on national institutes. They provide an umbrella that assures coordination and joint analysis of the input that is generated nationally (Norden, 2014).

Main players in the negotiation process are public servants representing national governments or the Commission, and stakeholders such as non-government representatives for industries, environmental NGOs, and regional or local communities, among others.

Other relevant stakeholders could be NEAFC (North East Atlantic Fisheries Commission) and OSPAR Convention ((Protection and conservation of the marine environment of the North-East Atlantic) Region II – Greater North Sea).

3. Stakeholders and participation in the case study

Several interactions between the case study leader John Pope and the stakeholder groups from the North Sea Advisory Council (NSAC) and Pelagic Advisory Council (PAC) have taken place in 2014. Two specific meetings took place with the NSAC to introduce the MAREFRAME North Sea Case Study (May 14th, 2014, London) and to present a follow up on the development of the case study (November 12th, Brussels) The stakeholders who attended the introductory meeting are presented in **Error! Reference source not found.**,

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and those who were not present but that are potential stakeholders for the project can be seen in **Error! Reference source not found.**.

Table 1. Stakeholders present at the May 2014 meeting.

Name	Organisation	Main interest
DEAS, Barrie	NFFO	DEMERSAL
DUGUID, Lorna	NSAC	DEMERSAL
DUNN, Euan	RSPB	ENVIRONMENT
MYNES, Sander		DEMERSAL
O'BRIEN, Carl	CEFAS	ALL
OHMS, Verena	Pelagic RAC	PELAGIC
PARK, Mike	SWFPA	DEMERSAL
POPE, John	NRC(Europe)Ltd	MAREFRAME
RANDALL, Andrew	DEFRA	ALL
SPARREVOHN, Claus	DPPO	PELAGIC
VAN BALSFORT, Gerard	PFA	PELAGIC

Table 2. Stakeholders who could not attend the May 2014 meeting and further potential stakeholders.

Name	Organisation	Main interest
ANDERSEN,Michael	DKFISH	DEMERSAL
BIRGER JORGENSEN, Jan	Norwegian Fishermens Association	DEMERSAL
BRECKLING, Peter	DEUTSCHER-FISCHEREI-VERBAND	DEMERSAL
BROUCKAERT, Emiel		DEMERSAL
GAMBLIN, Caroline	COMITE-PECHES	DEMERSAL
HOPKINS, Peter	EU	ALL
SVERDRUP-JENSEN, Esben	DPPO	PELAGIC
VISSER, Pim		DEMERSAL

4. Elaboration of the scope of the case study problem

The focus of the NS CS has been refined after two meetings with stakeholders (May and November 2014). It can be concluded that there are three topics with which the stakeholders are most concerned with: 1) The need to achieve Fmsy; 2) Meeting the Landings Obligation; and 3) Avoid the Risks of Incompatible Regulations. Stakeholders asked for a case study of the North Sea Multispecies Fish System that would help clarify the three points just mentioned. The pelagic fisheries might additionally be considered as a segment to study in greater detail. The *Scenario* to be developed will be a case study of the North Sea Multispecies Fish System that helps clarifying the above mentioned general concerns by providing an interactive tool for stakeholders to explore trade-offs between (as far as possible) any plausible management measures.

After attendance to the Demersal working group of North Sea AC (NSAC) in both January and November of 2014, it was concluded that while the NSAC is well committed to the long term management aims of the EU, their immediate attention is focused on the practical details of what to do next. John Pope expressed this situation as "*very understandable since "When you are up to your neck in crocodiles it is sometimes difficult to remember your job is to drain the swamp" I am convinced if we want to help we have to provide tools that help fend off the crocodiles but also helps them to see how the swamp may be best drained*". This will mean

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spelling out short term and long term trade-offs (including EAFM and economic ones) of the (often complicated) transitional measures they need in order to make progress while keeping the fishing industry and other stakeholder onside.

5. Objectives, indicators and management measures

Three groups of *Indicators* are planned: a) Fishing mortality (F), spawning stock biomass, size or age structure; b) Predation mortality rate; and c) Ecosystem structure. This last indicator group –which definition is at the moment still in the process of being developed, will refer to the size structure of the overall fish composition of the ecosystem, that is, sensible size, spectrum slope and meeting LFI, among others. There is also the possibility of aiming cover that the various feeding guilds are suitably represented, as well as other biodiversity measures.

Besides biological information other kind of information, such as economic information might be included as well. However, there was some reservation on this from some stakeholders who feared that the more factors are being built in, the less credible the outcomes will be.

6. Models

Three models of increasing complexity have been proposed to the stakeholders with which they can use themselves to explore the trade-offs on the various players caused by any proposed management actions. Figure 3 shows a general development scheme for these models.
The first, (green) model -*Single Interactive Overview*, is a simplified model of the North Sea multi-species multi-fleet system. The model is based on published work (Collie, Gislason, & Vinther, 2003) and there are working examples from earlier years. Currently John Pope is updating the model in cooperation with ICES WGSAM (Working Group on Multispecies Assessment Methods). The goal is to provide a prototype of the first green model early in the year (2015) for stakeholders to use and provide feedback.

The second, (amber) model –*Area Explicit and Size Based*, is an expanded version of the green one which takes into account area effects. John Pope is in the process of developing new methods as far as possible with WGSAM. Progress has also been made with acquiring STECF fleet data and IBTS survey data and contacting key scientists involved with this work.

The third, (red) model – *Regulation Grid Lock Detector*, is expected to be developed as the first two models progress. Currently it has been identified the need of investigating when the various complex regulations that govern fishing North Sea are likely to become mutually incompatible (given the multi-species and multi-fleet nature of the problem). Identification is recommended preferably before they do and cause economic inefficiency or even perhaps force fishers to return to less law-abiding practices.

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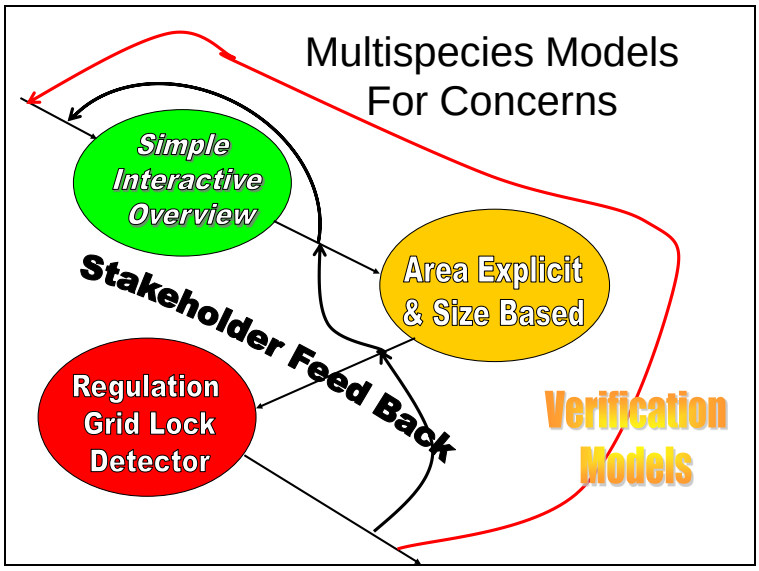

Figure 3 Schematic of propose model development for the North Sea CS and the role of stakeholder feedbacks.

The intention with the models is that different management options are explored so that it could be seen how the goals of MSY and landing obligations, among others, could be reached. However, it is important to note that it might be possible that the stakeholders (NS AC) might prefer to argue for some other solution than Single Species MSY after they have seen the options that the green model suggests.

Another objective which is expected to be achieved with the models, is to be able to grasp the constraints which are characteristic of the mixed fishery nature of the North Sea, as well as the various constraints that the various management measures put on and which may prevent the achievement of MSY -or any other objective, simultaneously for all species, particularly in the light of the landings obligation (this last most likely by means of the amber model). Ideal would also be to explore whether any changes (for example, simplifications to the regulations) might help them achieve the goals they aim to achieve.

At the same time, the goal is also that when the stakeholders explore the options using the model, they can perceive the wider GES implications, as well as the implications to TACs and fleet incomes, among others

The explanations of these models were presented at the NSAC Demersal WG held in Brussels on November 2014. Among the feedback obtained from the stakeholders regarding the models, is that a computer game type of model they could use to explore trade-offs themselves was attractive, and that there was a real need for the second (amber) model which considers an area breakdown of the North Sea. During the meeting with stakeholders in May 2014, some of the participants stressed the need for a more ecosystem-based model since focusing on commercial species would not help with descriptors on biodiversity.

Biodiversity is not an easy area to cover in the models and much cannot be promised at this moment on how this issue will be addressed. None of the proposed models deals in detail with much more than the approximately dozen main commercial species for which relevant data exists, hence, not much could be predicted about the effects on biodiversity. Nevertheless, questions about the size structure could be given, and an indication about the strength of various feeding guilds based on the limited number of species in the models could be provided. Information about the impacts on the seabed depending upon the mixture of gears chosen (e.g. more or less beam trawls and dredges) could also be obtained. Equally, significant by-catch changes of vulnerable species such as marine mammals could also be predicted depending on the mix of

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gears chosen (more or less gill nets and trammel nets). Some indication could also be given about the amount of food discarded for scavenging sea birds.

In the spirit of co-creation, the detailed scope and output of these models will need to be refined by continual interaction between John Pope and the stakeholder groups from the NSAC and PAC.

7. References

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ICES, 2007. ICES ADVICE BOOK VI NORTH SEA (http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2007/may/North%20Sea.pdf)

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Northern & Western Waters – Iceland Waters case study

1. Inititial case study focus and problem context

The Icelandic case study was selected to species and data rich case, aiming at stuying impacts of changing stock dynamics on the whole system in terms of EAFM. The key species to be modelled and addressed are the gadoids and the pelagic fish stocks such (capelin, herring and mackerel). Other demersal stocks will be included as their productivity may be important in the mixed fisheries. The role of top predators such as whales and seals will also be modelled (MareFrame DoW: 15, part B).

2. The Governance context

The Ministry of Industries and Innovation (formerly the Ministry of Fisheries) is responsible for management of the Icelandic fisheries and implementation of the legislation. Each fishing year (September-August), the Ministry issues regulations for each commercial fishery, including the total allowable catch (TAC) of each stock. The TAC for each species is set on the recommendations of the Marine Research Institute (MRI) which also advices the government on other regulatory issues, such as spatial and seasonal closures, gear restrictions and where applicable days-at-sea. Additional, non-biological regulations, are set by the government without consultation with the MRI.

3. Stakeholders and participation in the case study

The stakeholders involved include representatives from the harvesting and processing sectors and local and national government and international and domestic NGOs. Due to the overriding importance of the fisheries for the Icelandic economy it might, however, be appropriate to count every single person living in Iceland among the stakeholders. In keeping with this principle, invitations to attend the launching of the Icelandic case in June 2014 were sent to a wide audience. As shown in Table 1, the list included policy makers, scientists, fishing companies, NGOs, labour unions, certification agencies, association of owners of coastal areas and a provider of computer services to domestic fish markets. However, only a few of those invited attended the meeting, namely The launching of the Icelandic case in June was attended by representatives from the Ministry of Industries and Innovation, Directorate of Fisheries, The Federation of Icelandic Fishing Vessel Owners (LIU), The National Association of Small Boat Owners (NASBO) and the Federation of Icelandic Fish Processing Plants (SF)[13]. Representatives from other stakeholders declined the invitation to attend. Notable absentees included the following: Harvesters that do not hold any quota shares (SIF / Samtök Íslenskra Fiskimanna) and are thus not allocated any annual quota entitlements each year but rely instead completely on the market for quota; association of fish processers and exporters that do not operate their own vessels (SFÚ / Samtök Fiskframleiðenda og Útflytjenda) and thus rely completely on the market for access to raw material; individual harvesters and processors; labour unions; local government; Regional Development Institute; Eco-labelling schemes (MSC and IRF), environmental organization's, consumer organization and NGOs. Although the views of these stakeholders are well documented it would have been desirable to include them in the case study right from the beginning. However, their absence should not constitute a serious problem and should not affect the legitimacy of the use of this case study in the DSF-process. It should be noted that the failure of these stakeholders to attend the launching of the Icelandic case will not exclude them from participating in the MareFrame project.

[13] As of 31.10.2014 LIU and SF have merged into one association that is to represent the entire seafood sector. The name of the new association is Samtök Fyrirtækja í Sjávarútvegi (SFS) e. Fisheries Iceland.

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Table 1. List of those invited to attend the launching of the Icelandic case in June 2014. Stakeholders coloured in blue or red attended the meeting in June.

Stakeholder group	Stakeholder	Name	Competences on the management priority	Level
Policy makers	Government ministry and agencies	Ministry of Industries and Innovation	Management of fisheries, based on advice from the Marine Research Institute (MRI) and ICES.	National
	Government ministry and agencies	Ministry for the Environment and Natural Resources	Formulates and enforces policy for environmental affairs	National
	Government ministry and agencies	Directorate of fisheries	Monitoring of fisheries, daily administration of the fisheries management system.	National and local
	Government ministry and agencies	Iceland Regional Development Institute	Monitors and researchers regional develoment	National and local
	Government ministry and agencies	Icelandic Association of Local Auhorities	Joint representative of the country's local authorities	National and local
Scientists	MareFrame researchers	Marine Research Institute	Research & development, Scientific marine data	National
	MareFrame researchers	MATÍS	Research & development, Scientific marine data	National
	MareFrame researchers	University of Iceland	Research & development.	National
Fishing Companies	Harvesting companies	Federation of Icelandic Fishing Vessel Owners (LIU)	Owner of larger vessels	Natinal and local
	Harvesting companies	National Association of Small Boat Owners (NASBO)	Owners of small vessels	National and local
	Fish processing companies	Federation of Icelandic Fish Processing Plants (SF)	Processing and exporting of frozen fish	National and local
	Fish processing companies	Association of fish processors and exporters (SFU)	Processing and exporting of frozen fish - firms with no quota	National and local
	Fish processing companies	Iceland Seafood International ISI)	Processing and exporting of salted fish	National and local
	Fish processing companies	Sæmark Seafood	Exporter of fresh food	National and local

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Table 1. List of those invited to attend the launching of the Icelandic case in June 2014, *continued*. Stakeholders coloured in blue or red attended the meeting in June.

Stakeholder group	Stakeholder	Name	Competences on the management priority	Level
NGO's	e-NGO	Icelandic Environmental Association	Lobby and opinion leadership, education and awareness	National
	e-NGO	Icelandic Nature Conservation Association	Lobby and opinion leadership, education and awareness	National
Other, what?	Labour Union	Iceland Seaman's Union	Price formation and wages	National and local
	Labour Union	Icelandic Seamen's Federation (SSI)	Price formation and wages	National and local
	Labour Union	Association of Icelandic Fishermen (SIF)	Price formation and wages. Quota auctions. Free access for coastal fleets.	National and local
	Labour Union	Ship officers' association (FS)	Price formation and wages	National and local
	Labour Union	Akanes Trade Union (VLFA)	Price formation and wages	Local
	Certification	Iceland Responsible Fisheries Certification	Certification	National
	Certification	Maine Stewardship Council	Certification	National
	Land owners	Association of Owners of Coastal Areas	Recognition of coastal properties' fishing rights.	National
	Computer service of fish markets	Fishmarkets' computer service (RSF)	Computer service	National and local

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4. Elaboration of the scope of the case study problem

Icelandic policy on ocean issues is based on maintaining the future health, biodiversity and sustainability of the ocean surrounding Iceland, in order that it may continue to provide resources that sustains and promotes the nation's welfare. This means sustainable utilisation, conservation and management of the resource based on scientific information and applied expertise guided by respect for the marine ecosystem as a whole. The health of the ocean and sustainable utilisation of its living resources provides the main basis for Iceland's economic welfare. In view of the importance of the waters surrounding Iceland, the government considers ocean issues to be central to its activities for the foreseeable future. The main objectives of the Icelandic Fisheries Management Act[14] is to promote the conservation and efficient utilisation of the marine resources, thereby ensuring stable employment and settlement throughout Iceland.

At the launching of the Icelandic case in June, stakeholders identified some problems that they would like the MareFrame project to further address. In general, there is a good consensus within the stakeholder group with both the objectives and the implementation of the Icelandic Fisheries management act. The main concerns of the stakeholder group was the effects of increased taxation and apparent uncertainty which frequent regulatory changes have for the fishing industry and the Icelandic community. Other issues raised by the stakeholder group include removal of the quota consolidation barriers (currently 12% of TAC), effects of municipality controlled quota, aggregation of quotas in both the small (jig and line) and large type ITQ, and whether the industry should in general take socio-economic factors into account. Based on this co-creation, the objectives for the management plan and candidate operational objectives and indicators are presented in Table 2.

[14] http://www.fisheries.is/management/fisheries-management/the-fisheries-management-act/

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Table 2. Objectives and candidate operational objectives for management plan proposal to be developed within the Icelandic case study.

Objectives for the management plan defined by stakeholders (interest variable)	**Candidate operational objectives and indicators**
Increasing cod stock	B_{4+} = 1,106,000 $B_{trigger}$ = 220,000t B_{lim} = 125,000t TAC = 218,000t
Stable haddock stock	B_{3+} = 104,000 $B_{trigger}$ = 45,000t B_{lim} = 45,000t TAC = 30,400t
Stable saithe stock	B_{4+} = 296,000 $B_{trigger}$ = 65,000t TAC = 58,000t
Maintain biodiversity	
Maintain food web integrity	
Maintain sea floor integrity	
Stable employment and settlement throughout Iceland (social sustainability)	• Less migration of jobs opportunities in fisheries.
Ensure strong economic performance of fisheries (economic sustainability)	• EBITDA / Revenue $\geq$ 20

The case study problems to be addressed in decision support work has been focused on how a strong cod fishery can be ensured, and on socioeconomic impacts of different arrangements for distributing the cod resource.

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Event	Date and Place	Participants	Methods and output
Launching of case study	10. June 2014 Matís headquarters, Reykjavík	8 (marked in red and blue in previous table)	Deliberation and dialogue
Case study meeting	27. November 2014 Matís headquarters, Reykjavík	5 (maked in blue in previous table)	Stakeholder liason meeting

5. Model and scoping tools

The main focus of the modelling effort within the Northern waters case study will be on cod on the Icelandic continental shelf and its significant interactions to other species, in particular capelin and marine mammals. The cod stock has been growing in recent years, and it is hoped that a responsible management will make it possible to increase each year's TAC to an excess of 250 thousand tonnes in the near future. Although there are those that believe the current stock would tolerate more intensive fishing, the views of the MRI are in general respected and followed by policy makers.

Neither the biological health of the stock, nor issues like discarding or high-grading have received much attention in recent years. Instead, attention has focused more on socio-economic issues such as the potential resource rent and how it should be taxed, vertical integration, concentration of quota holdings, the effects of transfers of permanent quota shares on fishery-dependent communities, allocation of quota between fleet segments and communities, entry and exit. Most of these issues were discussed at the launch of the Icelandic case in June.

The marine scientists involved in the modelling will be able to use Gadget to analyse the biological and, in collaboration with economists at the University of Iceland, some of the socio-economic effects that changes in fishing effort and fleet and gear composition may bring about. In particular it will be possible to define different multi-species reference points (Fmsy, Blim etc.). This would most definitely represent an EAF type model.

Models built using the Gadget framework are typically biological models that do not specifically include socio-economic parameters, although these parameter could in principle be added to the model specification. In addition, some of the output from Gadget models may be interpreted in a socio-economic way. Gadget does, for example, allow for changes in fleet structure which can both have impact on profitability of the harvesting sector – and thus economic rent – and regional effects. Figure 1 illustrates the planned model of the commercial fish stocks and their associated fishery. This is clearly a simplified form of the ecosystem, however the focus is on statistically estimable processes related to cod in particular.

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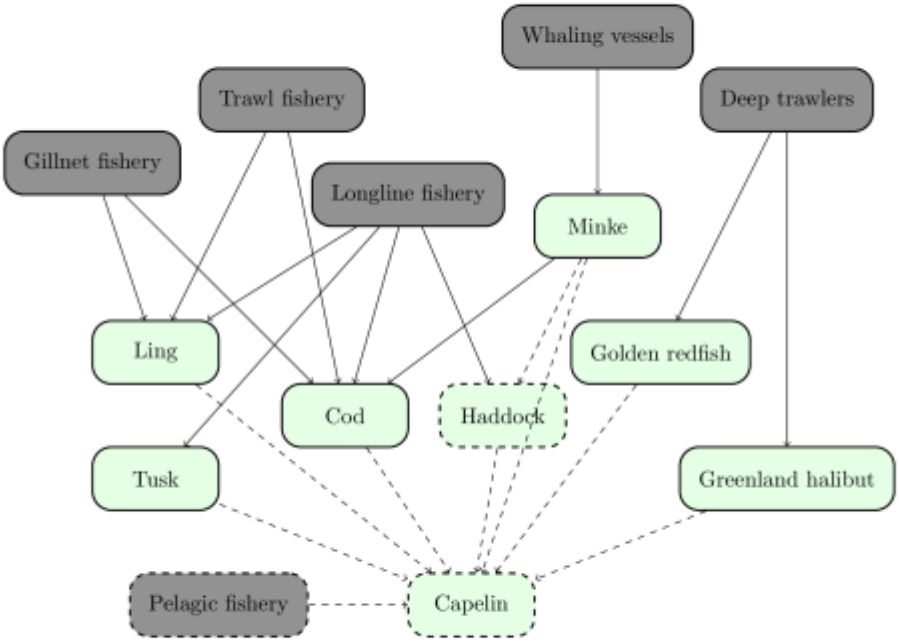

Figure 1. An overview of the planned Gadget model for Icelandic waters. Light grey boxes indicate species, dark gray boxes fleets and dashed lines indicate currently unimplemented features/stocks.

Gunnar Stefansson and his team at the University of Iceland have begun work on adapting Atlantis for the Icelandic case study and researchers have been in contact with Australian experts for that purpose. The adaption and parameterization is progressing as expected and will be able to contribute to the case study later this year (2015).

6. Decision support work

The research team at the Icelandic Marine Research Institute will employ the Gadget modelling framework to analyse the commercial fishery, the cod fishery in particular, in an ecosystem approach. The Guided User Interface (GUI) for each case study, will involve the following decision and interest variables (Table 4). The only input variables in Gadget are the fishing rate and fleet composition, where species composition in the catch varies by fleet.

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Table 4. Candidate interests variables as preferred input and outputs for the Guided User Interface for the Icelandic case study.	
Candidate input variables (decision variables)	**Candidate output variables (interest variables)**
Fishing rate by fleet	Environmental effects Economic performance Landings and value of landings SSB of key species Harvestable biomass of key species
TAC for individual species	Landings and value of landings Effects on other species SSB and harvestable biomass

The socio-economic dimensions have been profiled but are yet to be incorporated into the models.

At a meeting on November 27th 2014, stakeholder liaisons from SFS and NASBO met with project researchers to discuss progress and further steps.

During the November meeting preliminary results of the Gadget model were presented to stakeholder liaisons attending. Although the results for cod were similar to what was expected, the stakeholders attending the November meeting had difficulties in envisaging how their concerns would be addressed by the model. Despite the fact that the stakeholder liaisons had experience with similar models developed using the Gadget framework, notably the recent implementation of a harvest control rule for golden redfish, it was clear that the inclusion of socio-economic factors will require some thought. These considerations will be the focus of D4.5.

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Northern Waters - West coast of Scotland case study

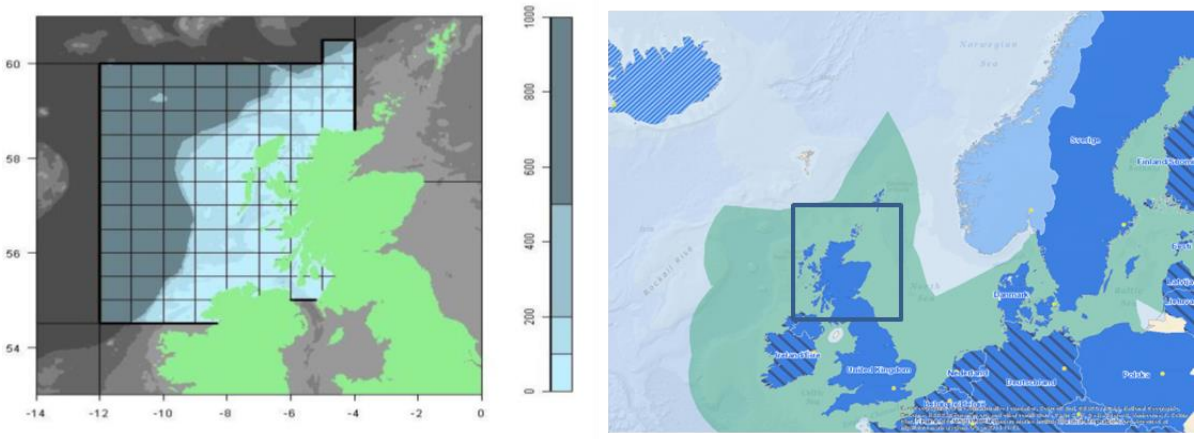

Figure 1. Map of the West of Scotland case study area (left panel), located in the North-western part of the UK EEZ (right panel). Imported from: MareFrame D5.1: 67 (left panel) and The European Atlas of the Seas[15] (right panel). The case study area represents ICES statistical area IVa, which is part of the Celtic Sea ecoregion.

1. Initial case study focus and problem context

In the MareFrame project, the West of Scotland case study was selected to represent a species and data rich case (DoW: 15). The area of this case study is represented by the ICES statistical area IVa (figure 1), which is part of the Celtic Sea ecoregion. A recent overview of this ecosystem region is provided in (ICES, 2013b). A comprehensive overview of abiotic, biotic, and anthropogenic aspects of the case study context is provided in the MareFrame deliverable D5.1 (pages 67-80).

The initial focus of the case study was centered on environmental and fisheries related impact the gadoid stocks, including the effects of seal predation, bycatch of nephrops fisheries on juvenile cod, and bottom up effects of climate change. In accordance with the co-creation approach, the focus of the case study has been modified and refined in cooperation with stakeholders the course of the first year of the MareFrame project. The focus on gadoid stocks has been retained throughout this process, a fact that reflects stakeholders' strong interests in the gadoid stocks in this area (Table 1). This interest is grounded in the high economic and cultural significance of whitefish stocks in Scotland and, in particular, in the crisis for cod and whiting stocks in the West coast of Scotland area.

The gadoid fisheries in IVa are dominated by Scotland. After quota swaps, Scotland was in 2013 entitled to 57% of TACs for cod, 94.2% of the TAC for haddock and of the TAC 70.4% of Whiting[16] (MS, 2013). Other

[15] http://ec.europa.eu/maritimeaffairs/atlas/index_en.htm

[16] Note that no direct fishery for cod and whiting has been permitted in VIa in recent years.

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countries have had significant shares in the gadoid fisheries West of Scotland, in particular France and Ireland, and in particular in the past. Historically, France has contributed to about 20 – 40% of the landings of cod from IVa but its share has been modest since 2000. Ireland has had a similar share in the whiting and haddock landings, although the former share has declined after 2007 (ICES, 2013a; ICES, 2014b; ICES, 2014a). In summary, Scotland is by presently far the most important participant in gadoid fishery in IVa, but no direct fishery for cod and whiting is currently permitted as these stocks are at a very low level and deemed to be suffering reduced reproductive capacity. The fishery for cod and haddock is limited to bycatch in other fisheries.

Table 1. Quantity and value of landings from area VIa by Scottish vessels in 2013. Information on pelagic species is not included. Information on some demersal and benthic species of limited commercial value is omitted. Source: (MS, 2013).

Fish species/group	Landings	Value (£'000)
Cod	130	249
Haddock	3810	4062
Whiting	114	106
Saithe	3506	2817
Hake	1720	5050
Ling	1327	1825
Flatfishes	540	1141
Monkfish	1038	3270
Nephrops	11400	40441
Crabs	5243	6592
Scallops	4048	8006

Although the 3 most significant sites in terms of landed value are located in the Northeast of Scotland (Peterhead, Shetland and, Fraserburgh), the West of Scotland comprises important landing sites for demersal fisheries (Lochinver, Ullapool and Kinlockberbie) as well as a range of significant shellfish sites for shellfish along the East coast (Figure 2). Fishery on the Scottish West coast represents a source of employment of some local importance (Table 2).

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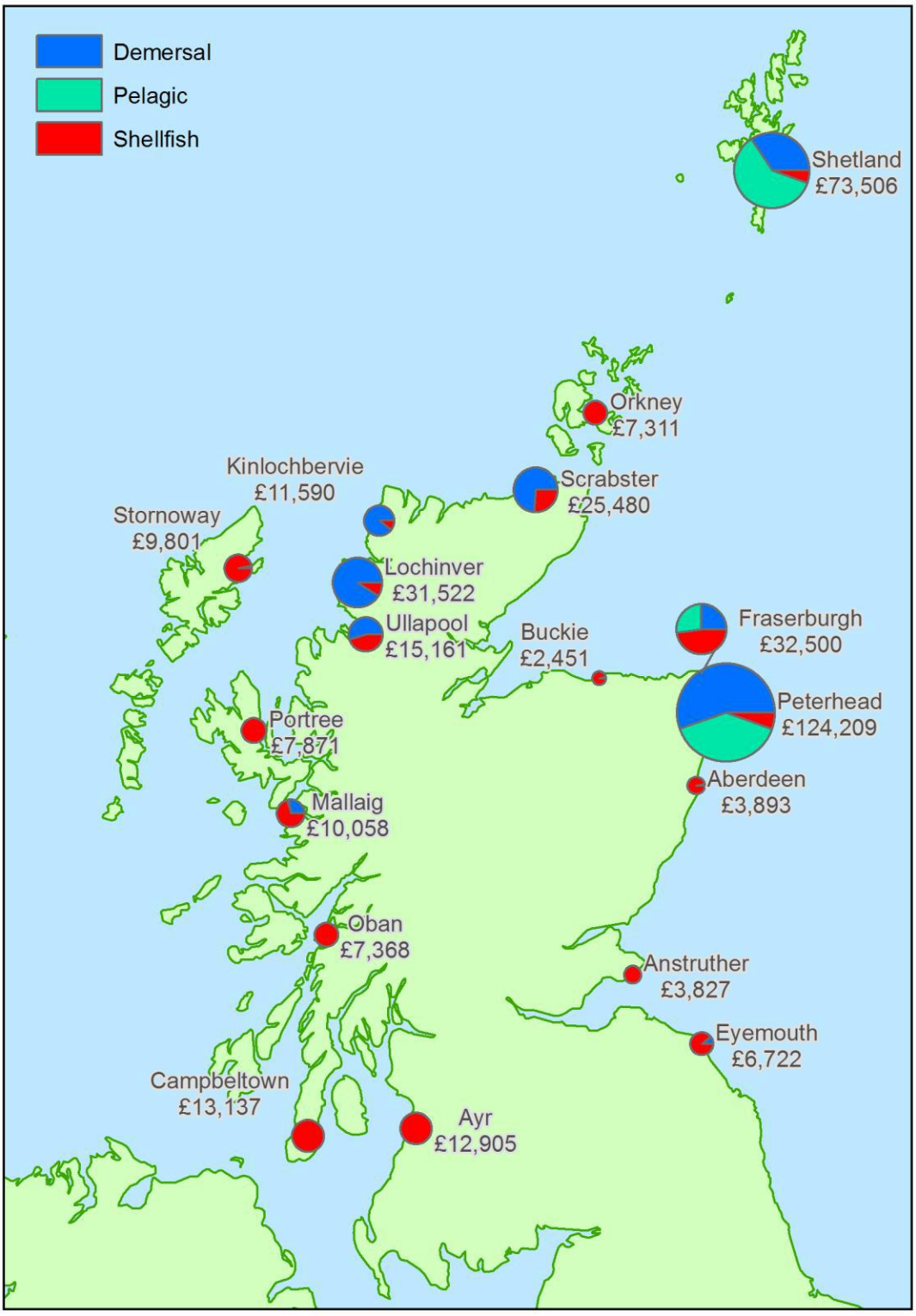

Figure 2. Value (£'thousand) of landings in 2013 into Scotland by all vessels by district and by type of landings. Blue: Demersal landings. Green: Pelagic landings. Red: Shellfish landings. Imported from: (MS, 2013).

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Table 2. Number of fishermen employed on Scottish based vessels in the Scottish West Coast area by region in 2013. Source: (MS, 2013).

District	Regularly Employed	Irregularly Employed	Crofters	Total
Ayr	642	38	-	**680**
Campbeltown	259	45	-	**304**
Kinlochbervie	37	3	-	**40**
Lochinver	20	3	2	**25**
Mallaig	102	6	-	**108**
Oban	209	37	-	**246**
Portree	152	19	34	**205**
Ullapool	185	6	-	**191**
Total West Coast	**1 606**	**157**	**36**	**1 799**

The present situation for gadoid stocks and fisheries in IVa

The latest available advice from ICES portrays a grim situation for cod (*Gadus morhua*) and whiting (*Merlangius merlangus*) in the ICES area Via (Fig. 3). In the last decade, the SSB and level of recruitment is estimated to have been at or near an all-time low, and the stocks are found to suffer reduced reproductive capacity. This has happened in spite of very low catches in the same time span. Most of the catch is currently comprised by discards as no directed fishery is permitted for these stocks. The fisheries mortality for cod is very high and is estimated by ICES not to be sustainable. The situation for the haddock (*Melanogrammus aeglefinus*) stock is better as the level of SSB and the fishing mortality are estimated to be the level associated with MSY, but catches are at a low level compared to a long term historical average.

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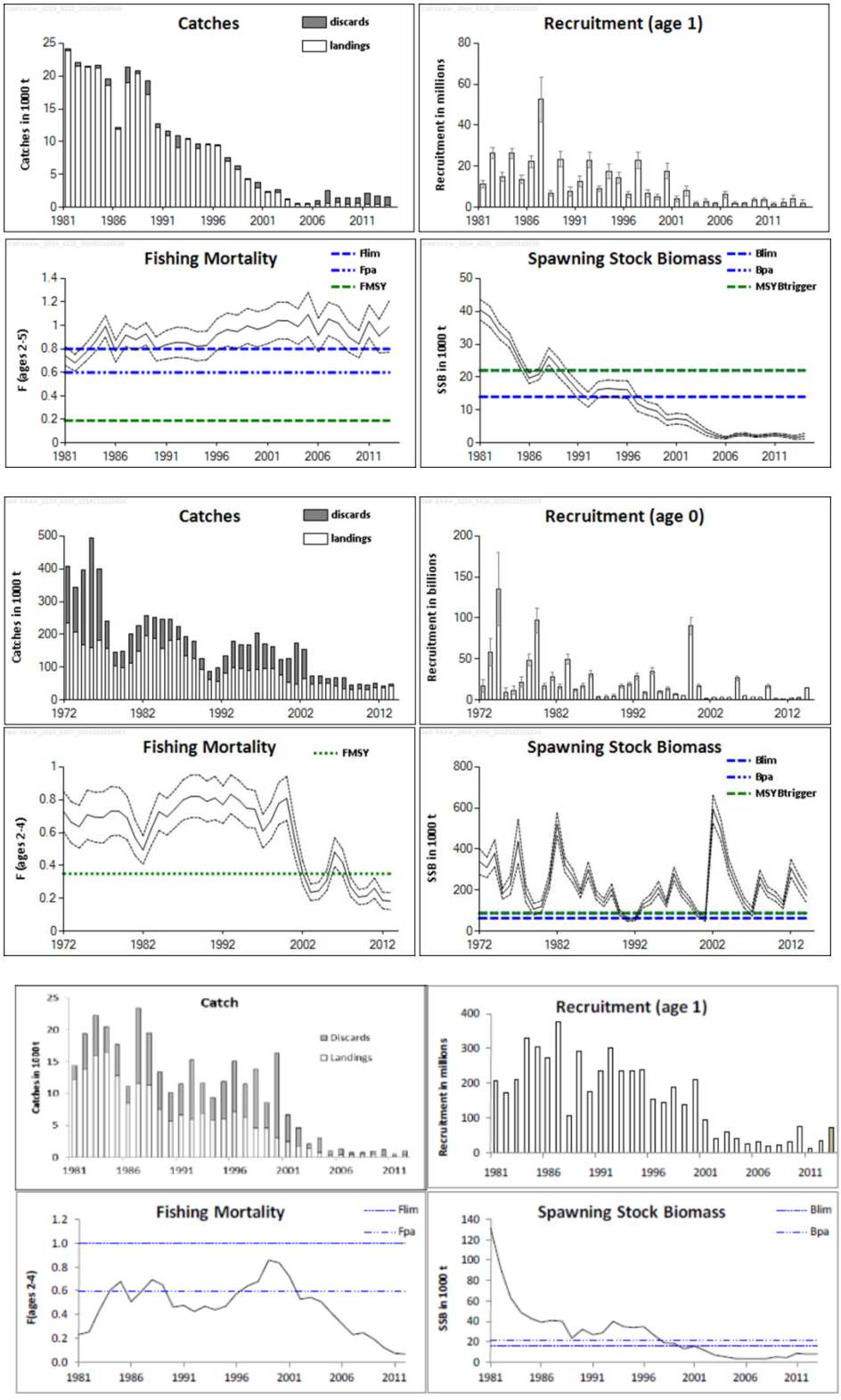

Figure 3. Stock summary plots from ICES advice, providing estimates of catches, recruitment, fishing mortality and SSB for the main commercial gadoid species in the West of Scotland area. Cod in ICES area VIa (top panel)

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(ICES, 2014a); haddock in ICES areas IV, IIIa West and VIa[17] (middle panel) (ICES, 2014b) and whiting (ICES, 2013a).

Table 3. Effort of regulated gears in the Cod Recovery Zone in kwDays ('000) by vessels > 10m based in the West of Scotland area by gear type in the period 2001 to 2013.[18] (2) Nephrops gear includes effort by vessels which are exempt from effort controls under Article 11 of Council Regulation (EC) 1342/2008. Source: (MS, 2013).

Year	Whitefish Gear	Nephrops Gear [2]	Industrial Trawl	Beam trawl >120mm	Beam trawl 80- 120mm	Gill Nets	Trammel Nets	Long lines
2001	8 523	4 903	4	-	85	14	1	88
2002	7 566	4 797	2	-	104	7	-	182
2003	5 723	5 761	30	60	-	47	1	125
2004	4 502	5 334	7	151	-	67	0	148
2005	2 635	4 587	41	120	-	39	-	307
2006	2 100	4 381	-	81	-	1	-	371
2007	1 986	4 694	0	2	-	1	-	519
2008	1 990	4 809	-	-	-	6	-	379
2009	2 229	4 525	-	-	-	-	-	703
2010	2 361	3 787	-	-	-	-	-	723
2011	2 101	3 570	-	-	-	12	-	695
2012	2 102	4 384	6	-	-	7	-	518
2013	2 200	3 731	22	-	-	7	-	306

The main aspects of this case study concern if and how recovery of the gadoid stocks in VIa can be achieved. Initially, the focus on cod and whiting might seem to be in tension with the concept of an Ecosystem Approach to Fisheries, which represents the basic orientation of the MareFrame project. However, the potential for recovery of the gadoid stocks may not only be determined by the fisheries, but might also be significantly influenced by environmental aspects such as predation by seals and temperature changes with possible impact on gadoid recruitment. Further, the EAF involves consideration of social and economic aspects of the problem in addition to considerations of fish stocks and their ecological context.

2. The Governance context

The governance of marine resources and the environment in the IVa area is complex and involves institutional arrangements and agencies at both national and international levels. A selective summary of these arrangements will suffice for the present purposes.

Although located within the UK EEZ (Figure 1) the fisheries and the marine environment in VIa are managed under the European frameworks of the reformed Common Fisheries Policy (CFP) (CEC, 2013), the Marine Strategy Framework Directive (MSFD) (EC, 2008), The Habitats Directive (EC, 1992), The Birds Directive (EC, 2009), and the Water Directive (EC, 2000).

[17] Until 2014, the cod in VIa was assessed as a separate stock. In a benchmark assessment, the assessment area was merged such that haddock is

[18] Source: (last visited 22.01.15)

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The EAF perspective of the MareFrame project suggests that the reformed CFP and the MSFD are of focal importance in the context of this case study. One of the focal requirements of the CFP is the obligation to restore commercial fisheries to levels consistent with MSY no later than the year 2020 and/or to maintain them at such levels. The MSFD in turn requires that indicators and thresholds are defined to represent Good Environmental Status (GES) in relation to 11 descriptors. Indicators and thresholds are currently most advanced with respect to descriptor 3, which can be largely seen to represent the CFP requirements of having healthy commercial fish stocks. Three other descriptors are judged to be of particular relevance for this case study. These are descriptor 1 (maintaining biodiversity), 4 (ensure integrity of foodwebs) and 6 (integrity of seafloor habitats).

In addition to biological and environmental objectives, the CFP and the MSFD seek to achieve social and economic sustainability in regard to the use of marine resources, notably fisheries. However, to the best of our knowledge specific objectives have yet to be defined to make these objectives operational for the gadoid fisheries and associated fisheries in VIa.

The EC has exclusive competence for the conservation policy relating to fisheries. However, the member states (here the UK) are granted some authority to implement conservation measures for vessels of their own nationality and within their 12m zone[19]. In contrast, the member states (in this case the UK) have a main responsibility with regard to developing local standards, developing monitoring frameworks and for implementation of the other listed environmental policies. This may create tensions, for instance as implementation aspects of the Habitat Directive and the Birds Directive may impact on fisheries resources and *vice versa* (Leijen, 2011). The UK has planned and implemented a number of marine protected areas in the VIa area (Figure 4).

The ICES VIa area is included in the OSPAR Region III. Contracting partners of the OSPAR Convention[20] (including the UK) are subjected to obligations with regard to the prevention and elimination of pollution with regard to the assessment of the quality of the marine environment, and this involves cooperation with regard to the requirements of the MSFD (OSPAR, 2012). Indicators have been suggested as having a potential for monitoring for some of the GES descriptors. But thresholds values that define achievement or non-achievement of GES have, to our knowledge, not been defined at this stage with relevance to the described case study.

[19] The preamble to the reformed CFP states that: "(40) Member States should be empowered to adopt conservation and management measures for stocks in Union waters applicable solely to Union fishing vessels flying their flag. 41) In their 12 nautical mile zones, Member States should be empowered to adopt conservation and management measures applicable to all Union fishing vessels, provided that, where such measures apply to Union fishing vessels from other Member States, they are non-discriminatory, prior consultation of other Member States concerned has taken place and the Union has not adopted measures specifically addressing conservation and management within the 12 nautical mile zone concerned" (CEC 2013).

[20] http://www.ospar.org/content/content.asp?menu=01481200000000_000000_000000 (last visited 23.01.15).

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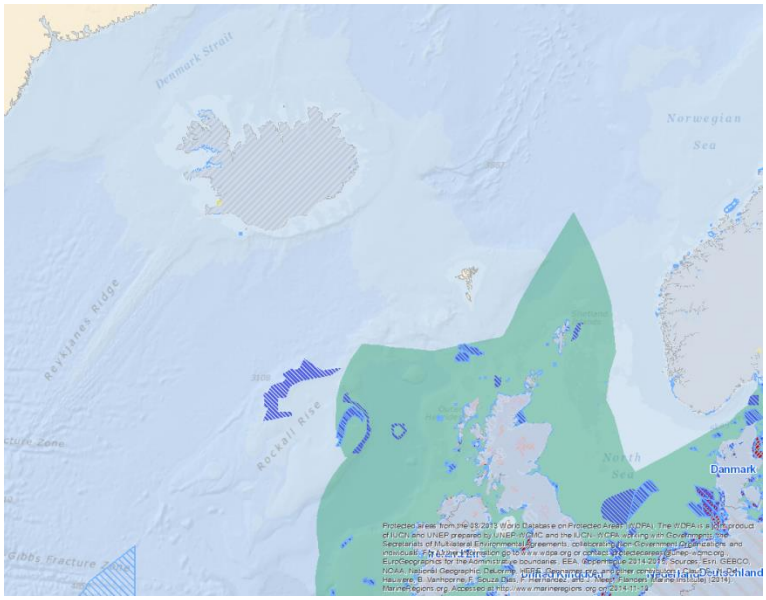

Figure 4. The hatched dark blue areas represent sites protected under Nature 2000 under the Habitat Directive. Source: The European Atlas of the Seas.

In EU waters the management of fisheries involves consultation with a regional consultative body, in this case the Northwestern Waters Advisory Council (NWWAC)[21]. As we will addressfurther below, the NWWAC represents a main partner in this case study.

Present fisheries regulations

The fisheries in VIa are managed through a set of regulations which include determining annual levels of catches of each species, restrictions and specifications of the type of permitted fishing gears, area closures, and minimum landings sizes (See MareFrame Deliverable D5.1 fur further details).

The cod fishery has since 2008 been managed through a recovery plan (CEC, 2008), which was last amended in 2012 (CEC, 2012).

A zero TAC for cod in this area and a 1.5% bycatch limit (live weight) was first implemented in 2012 and has remained in place since then. This measure applies to the retained part of the catches and therefore does not constrain discards. Discards reported to ICES (from all fleets combined) are estimated to be roughly four times greater than landings (ICES 2014a).

A voluntary initiative was launched in 2008 with the aim of reducing mortality and discarding of cod in this area (Holmes et al., 2011). This initiative involved gear requirements and real-time closures, which were deployed to discourage vessels from operating in areas with high cod abundance. Although this initiative appeared to contribute to reduce catches of cod, these reductions were less than expected.

[21] http://www.nwwac.org/english

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3. Stakeholders and participation in the case study

Details of stakeholder meetings and participation in the West coast of Scotland case study are described presented in table 4.

Table 4. Stakeholders and stakeholder meetings in the West of Scotland case study.

Meeting details	**Stakeholders / competences**
Launch of case study in Aberdeen, May 2014	The meeting included 4 stakeholder representatives, all of which are NWWAC members. In addition to being NWWAC the members respectively represented the Scottish Fishermen's Organisation (SFO) [22] ; the Scottish White Fish Producers' Association (SWFPA) [23] ; The Scottish Fishermen's Federation (SFF)[24] and the NWWAC Secretariat
Skype meeting, November 2014	The meeting included 2 stakeholder representatives, which are both NWWAC members. Of these, one is a member of the NWWAC secretariat and one represents the Irish South & West Fish Producers Organisation (IS&WFPO)[25]

Limitations and challenges regarding participation in the West coast of Scotland case study

Stakeholders find it very difficult to engage with engage with long term issues, such as those related to the implantation of the MSFD. Presently, the main reason for this is that the Landing Obligation requires the full attention of (fisheries oriented) stakeholders, including members of the NWWAC, POs, and fishermen's associations, i.e. the affiliation of the members of the stakeholder group of this case study so far.

As pointed out, a basic challenge of this case study is that it includes national as well as international dimensions. This challenge has repercussions for the involvement of stakeholders, and for the focus and objectives of the approach.

Although the case study has been launched in meetings with many representatives present, there are types of interests that have not been represented. For instance, no environmental NGOs have been present. For

[22] http://www.scottishfishermen.co.uk/index.html

[23] http://www.swfpa.com/

[24] http://www.sff.co.uk/

[25] http://www.irishsouthandwest.ie/aboutus.htm

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the decision support workshop (see below), efforts will be invested towards broader participation, including non-fisheries interest such as green NGOs. Furthermore, at the launch of the case study, there were only Scottish participants. Participation from e.g. Spanish (hake fisheries) and representatives of recreational fisheries will be encouraged for the decision support workshop.

In general, it will never be possible to include the representation of all affected interests in a complex planning process. The consequent challenge for the case study will be to consider the main affected interests, including those that have not been articulated and championed by their relevant core representatives. The approach to stakeholder involvement in development of a management proposal will accordingly be substantiated as follows:

1) The problem(s) that the management proposal will address is determined in cooperation with participating stakeholders.

2) The proposal will consider the objectives and requirements of relevant policies as they apply to the case study (otherwise the proposal will be bound to fail).

3) The proposal will seek to consider the interest of affected parties, including those not represented through participating stakeholders (as this will strengthen the potential of the proposal to be taken into account by decision makers).

4. Elaboration of the scope of the case study problem

At the launch of the case study, the participants developed a list of 13 issues that ideally should be addressed in the case study. Due to the high number of case studies in MareFrame, however, the project will not have the capacity to address these all these management issues. At the second meeting (November 2014) it was therefore agreed that the focus should be on the first 6 issues, which were considered to be related as well as being the most important ones:

i. What would be required to recover the cod stock?

ii. What would be required to recover the whiting stock?

iii. What is the impact of seal predation?

iv. What is the optimum (economic) balance between the prawn and whitefish fisheries?

v. What is FMMEY (the fishing mortality associated with the multispecies maximum economic yield)?

vi. How to include the data-poor stocks?

It was recognized, however, that the last listed issue might be difficult to handle within this research project.

5. Objectives, indicators and management measures

The objectives are listed in table 5, together with a range of candidate operational objectives, relevant to gauge progress towards each of the above mentioned objectives. Quantitative thresholds have, however, not been defined for these operational objectives at this stage.

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Table 5. Objectives and candidate operational objectives for management plan proposal to be developed within the West coast of Scotland case study.	
Objectives for the management plan defined by stakeholders	**Candidate operational objectives and indicators**
To recover the cod stock	• Cod SSB ≥ MSY $B_{trigger}$ = 22.000 t (= Bpa) by end of planning period
To recover the whiting stock	• Whiting SSB ≥ Bpa = 22 000 t (no MSY trigger defined as this stage) by end of planning period
Ensure strong economic performance of demersal fisheries	• An optimum combination of MMEYs of key demersal species is suggested; • An optimum balance between shrimp and whitefish is suggested
Objectives for the management plan derived from the MSFD and the CFP	
Descriptor 1. Maintain biodiversity	• Shannon biodiversity (for all species included in the ecosystem model) index ≥ value in starting year by end of planning period.
Descriptor 3. Healthy commercial fish stocks	• All commercial stocks ≥ Blim by end of planning period • All commercial stocks ≤ Flim by end of planning period • At least 75% commercial stocks ≥ SBB MSY or: • 95% commercial stocks ≥ SSB MMSY (if these are defined later in the MareFrame project) by end of planning period
Descriptor 4. Maintain foodweb integrity	• The Large Fish Indicator (relative weight of large fish in catches) > 0,4 by end of planning period • Mean trophic level ≥ value in starting year by end of planning period.
Descriptor 6. Maintain sea floor integrity	• Percentage of untrawled area ≥ value in starting year by end of planning period.

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Social sustainability	• An appropriate indicator and threshold level has not been defined at this stage[26]
Economic sustainability	• EBIDTA (earnings before interest, tax, depreciation and amortization) was mentioned in relation to management issue no. 12 defined at the launch of the case study and could be used as an indicator of profitability if cost data are available); EBIDTA > O would imply that there is a positive profit level
Case study research objectives determined by stakeholders	
To determine the impact of seal predation on recovering gadoid stocks	• The impact of seal predation on recovering gadoid stocks is assessed to the extent possible
To establish a suitable way to include data-poor stocks	• A suitable way to include data-poor stocks is proposed - if time and resources allow (recognizing that this issue is given less priority than the other listed issues).

Management measures

No concrete management measures have been proposed or developed yet for the management plan proposal. However a particular interest in gear selectivity measures was voiced by stakeholders participating in the meeting in November 2014. Concrete management measures should be suggested prior to the decision support workshop, and should be discussed and agreed on in detail at the workshop.

6. Models

Alexander *et al.* (2014) applied the model Ecopath with Ecosim to the case study area in question. The WP 5 partners in MareFrame involved in the west of Scotland case study are currently working to improve the parameterization of this model, currently covering the 1985-2008 period, up to 2014 by updating data sources. The first runs of the updated model are expected to be made no later than March 2015.

An alternative model, GADGET, will be developed for comparative purposes for the case study area at a later stage. This alternative model will improve the understanding of certain aspects of the case study context by allowing the comparison of the outcomes of two different ecosystem models applied to the same case study.

[26] The significance fishing industry could be related to the number of jobs in the sector (at sea and at land). A study on Irish fisheries had identified a multiplier effect, relating value of catches to value of income generated in land based processing. If such a relationship is established (or assumed based on estimates from related contexts), it might be used as a crude indicator of socio-economic impacts of variation in landings. This should be explored further.

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It is currently not clear if and how social and economic dimensions can be integrated into the model framework. At least, it should be possible to calculate likely economic impacts of different levels of future catches of main species, e.g. by using current price information. To calculate profitability, cost information will be required. Employment forecast will require that some proxies can be developed in order to relate catches to employment. These issues should be explored further WP5 in order to enable the decision support work to take account of social and economic dimensions of the case study.

7. Decision support work

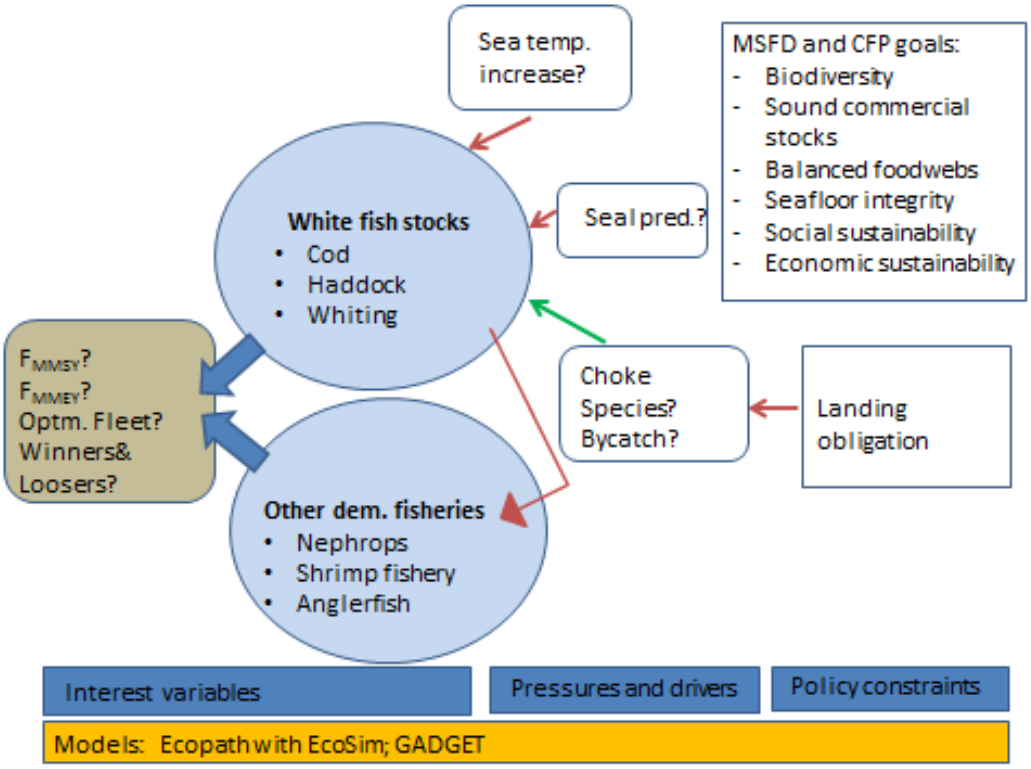

Figure 5. Simplistic mind map of the case study context.

A simplistic mind map of the case study context is provided in figure 5 as a summary of the model and general decision support approach (see above text for background). The further work with decision support in this case study will be in accordance with the common plan as outlined below (see Appendix).

Inputs for the DSF interface

A Guided User Interface (GUI) will be developed for each case study, which will allow users to explore general options and constraints for each case study. In order to develop an appropriate GUI, it is important to know the preferences of stakeholders, which are acting as clients in this respect. For this reason, stakeholders were asked which input and output variables they would like to have included in eth GUI. It turned out that this question not straightforward for stakeholders to respond to. As a result, stakeholders expressed a preference

to see prototype, as suggested by Mareframe reserachers, and then provide feedback for improvement (which is consistent with the MareFrame approach to develop and adapt two decision support framework prototypes). A number of candidate variables were nevertheless mentioned, and will be consider in the further work with developing a first GUI version.

Table 6. Candidate interests variables as preferred input and outputs for the Guided User Interface for the West coast of Scotland case study.

Candidate input variables	**Candidate output variables**
Total F on cod	Cod SSB
Total F on whiting	Whiting SSB
Effort – if possible by fleet	Landings and value of landings
Selectivity choices	(as above)
High and low estimates of seal predation	(as above)

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South West Waters case study, The Gulf of Cádiz

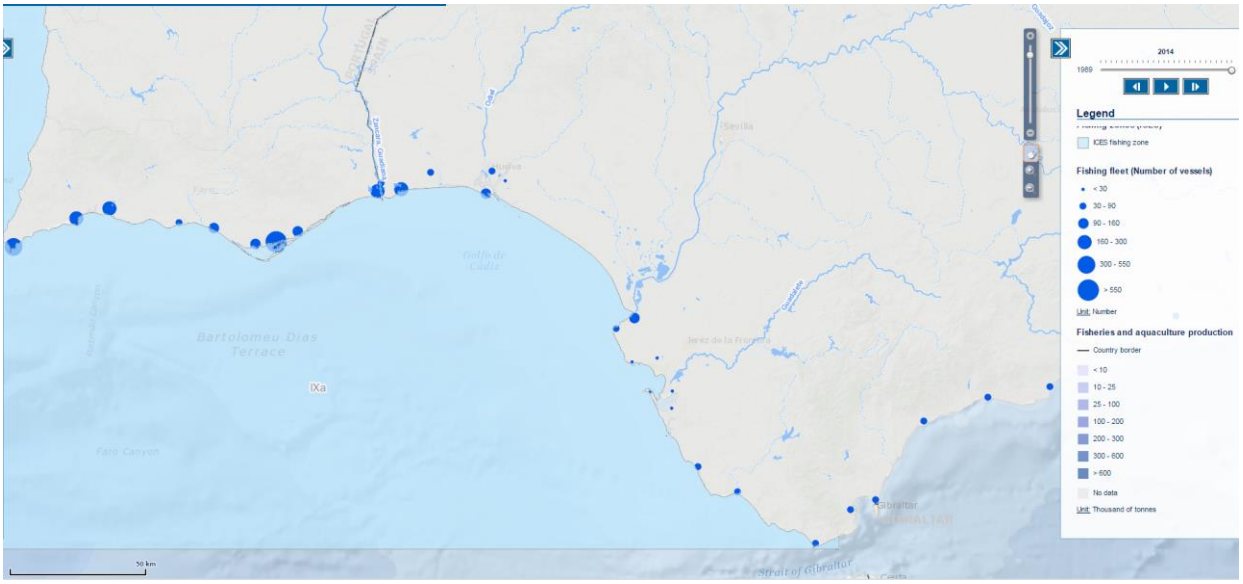

Figure 1. Map of case study area in ICES IX south with the fishing fleet information (number of vessels in 2014). Source: European Atlas of the Sea, DG-MARE. http://ec.europa.eu/maritimeaffairs/atlas/index_en.htm

1. Preliminary approach to the Case study

The focus of the South Western Waters-Iberian Waters- Gulf of Cadiz Case Study (SWW CS) is described in the MareFrame proposal: "The combined dynamics of the environment together with the trophic interactions of mammals and pelagic fisheries will be evaluated in the Gulf of Cádiz (ICES Subdivision IXa South). In this area anchovy fisheries controlled by the environment as well as significant small cetaceans population are known to occur but their relative importance and the dynamic role of their interactions are unknown" (DoW, pag. 24).

The Portuguese fishermen have not been traditionally a relevant stakeholder for anchovy in the IX.a south as most of the anchovy catch is landed in Spain Therefore, no Portuguese stakeholders were included in this case study. Furthermore, differences in genetics and stocks dynamics identified recently for the two divisions of the area (Algarve in Portugal and Cádiz in Spain) might imply separate management in this two regions of Division IXa (ICES, 2014: 3).

The purpose of the MareFrame project is to support a transition to an ecosystem based approach to fisheries management. The co-creation approach within the project envisages a close cooperation between stakeholders and researchers in order ensure quality and relevance of the project's outcomes. This approach invites stakeholders to contribute to problem definition as well as with concrete knowledge relevant for each of MareFrame's case studies. For the SWW CS the co-creation process has already redefined its focus, addressing the need for social-ecological analysis unforeseen in the initial proposal. The CS Team lead by Javier Ruiz –CSIC- is receptive to the challenges derived from this new approach to the research process.

The case study area is in ICES IX.a South (Fig. 1), where the bulk of the anchovy catch is harvested by the Spanish fleet. The Portuguese landing is negligible. This is due to the large shelf of the Spanish coast in the Gulf of Cádiz as compared with the narrow shelf in the Portuguese coast. Therefore, the national component

of anchovy exploitation in the Gulf of Cádiz only involves to Spain as acknowledge in all ICES reports. A detailed overview of the CS is provided in D5.1. "Description of a conceptual model of food web for each case study area, including the identification of key species, processes, and functional groups, environmental and human (socio-economic) drivers (pages 81-102)". The following maps show the ICES areas VIII and IX, including Member States waters within the European Union EEZ, limits of oceans and seas, country borders and the fishing fleets (number of vessels for 2014).

2. Scoping the management priority

The launching of the case study (21/04/2014) with ten stakeholders (see section 4) supported the selection of the management priority (described below). The initial list of problems and priorities addressed particular stakeholder concerns (conflicts of use, increase of demands to implement integrated coastal zone management, expansion of a marine protected area, IUU fishing, identification and valuation of ecosystem services in the area to inform decision-making, improvement of the data collection for diagnosis of the situation and analysis of alternatives and sharing information, etc.). Surprisingly, the importance given to the small cetaceans in the CS was discounted by the Cetacean NGO in the area.

In the deliberative process facilitated by MareFrame the management priorities were discussed, ranked and selected using the criteria of the co-creation approach: scientific acceptability, policy relevance and social robustness. The SWW CS is focused on the definition of adaptive management basis for the Gulf of Cádiz. The specific problem relates to the failure of the current management approach to handle short-lived pelagic species (boom and bust dynamics, Fig. 2). The anchovy has been selected as target species for the case study doe to its socioeconomic relevance for the fisheries sector. In fact, ICES WGHANSA Report (2014:79) has suggested in-year monitoring and management or alternative management measures for this specie. After the meeting, further contacts with the fisheries sector pointed out to the interaction of the anchovy-sardine species for the case study problem.

The management priority in a nutshell: To improve the adaptive capacity of both management measures and fishing behaviour to the attributes of the anchovy fishery (*Engraulis encrasicolus*)[27], namely strong fluctuations (boom and bust dynamics) that can be forecasted with the current scientific knowledge available.

Operational objectives for this management priority may include (non-exhaustive list, to be further discussed with the stakeholders):

- In-season TAC setting and in-year stock advice.
- Optimization of economic results by reducing uncertainty (resource forecast), improving market knowledge and adapting fishing behaviour to the output of both.
- Development of an insurance scheme (Rincón, M. et al, *forthcoming*) to measure and reduce economic risk.

[27] Although sardine would be included in further steps of the project (i.e. management plan) there is no actual stock assessment model for the sardine.

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The advice for management should integrate the environmental forcing (mainly fresh water discharge from Guadalquivir River[28], sea surface temperature, intense easterly wind) on the population dynamics and the socio-economic aspects directly impacted (i.e. income, employment and profitability) by the management strategy. The stakeholders requested to: "search for a tool to manage the fishery in a fashion that could help to smooth these strong fluctuations in favour of more stable incomes, including the swapping between anchovy and sardine the catches of the pelagic fleet". The stated management priority is directly linked with the CFP objective about maintaining the anchovy stock in a sustainable level (Chapter 6, specific goal C1.6).

The fisheries in a nutshell[29]: The anchovy fishery seems to have been sustainable over time although collapses are present in the historical series. ICES advice 2014 coincide in this statement (p.3) also remarking that "as this stock experiences high natural mortality and is highly dependent upon recruitment, an in-season management or alternative management measures could be considered".

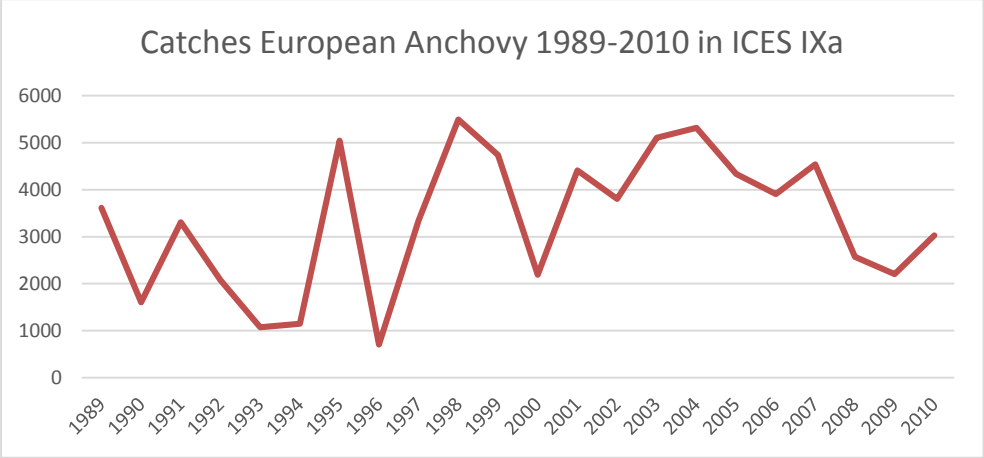

Figure 2. The catches of anchovy in 1989-2010. Source: Eurostat/ICES database on catch statistics, ICES, 2011. Historical nominal catches.

Management and assessment scheme in a nutshell: The advice provided by ICES (2014) is a survey based assessment without catch advice. Total catch and discards of anchovy are unknown. The stock status in terms of both fishing pressure and stock size are unknown as well. The target (F_{MSY}, B_{MSY}) or precautionary reference points (F_{pa}, F_{lim}, B_{pa}, B_{lim},) have not been defined for the stock. As a result ICES concludes that "no reliable analytical assessment can be presented for this stock. This is because insufficient data are available. Fishing possibilities cannot be projected (ICES, 2014: 3).

[28]. The ICES Advice 2014 (p.2) states that „the recruitment depends strongly on environmental factors. [...]. Episodes of highly persisten turbidity events, caused by a man-induced control of the Guadalquivir river flow, have negatively impacted the nursey function of the Guadalquivir estuary (one of the main anchovy recruitment areas in the whole Division).

[29]. For a detailed overview see D5.1.

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Anchovy for the area is managed through a semi-fixed TAC based in past landings; Current TAC does not seem to be restrictive as landings have been well below TAC during 8/10 of years. In 2/10 years landings have exceeded TAC (Fig. 3). That is the main reason for the request to transfer to an adaptive TAC strategy, providing flexibility for fishers. Environmental forcing made the stock size to be below the potential TAC for years. However, the landings exceeded the TAC during positive environmental years triggering penalties for the fishery, set by the EU Commission. Therefore, the semi-fixed TAC is a source of problems and the cause of conflicts. The fishers have requested adaptation of the TAC strategy to account for the socio-economic effects. A more optimal TAC should be developed, considering the environmental impact on the stock production, and the socio-economic consequences on the fisheries sector. In 2011 the TAC was reduced because there was the perception in 2010 that the population was decreasing but the 2011 was a good environmental year and the landing were very good. This shows the importance of incorporating the ecosystem view to the whole process since the combination of a reduced TAC and good environmental year for 2011 resulted in sanctions from the Commission.

To conclude, besides the TAC set annually for the anchovy fishery, no specific management objectives are defined.

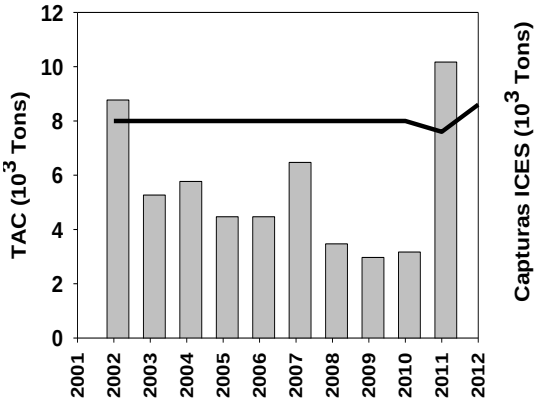

Figure 3. The Spanish landings and TAC for the anchovy stock in ICES IXa south.

Sardine fishery is not under the TAC system of the EU. Almost all catches are taken by purse-seiners in a directed human consumption fishery. Until 2014, the fisheries were managed under member states (Portugal and Spain) rules through minimum landing size, maximum daily catch, days fishing limitations, and closed areas. Since 2010, annual catch limits are set for the Portuguese fishery by the Portuguese authorities. In 2013, the catch limit was 36 000 t, following the multiannual management plan. The same principle applies for the Spanish sector. In Spain, management measures include a maximum allowable catch of 7000 kg per fishing day and a 5-fishing-days week limitation since 1997.

In both countries, fishing for sardine was banned for 45 days during the first quarter of the year, with different regional periods. (see ICES popular advise for 2014[30]).

[30]. http://ices.dk/sites/pub/publication%20reports/advice/popular%20advice/sar-soth_popular.pdf

ICES WGHANSA is in charge of the assessment, although at present analytical assessment is not implemented for this stock. Fishing possibilities are not projected. No reference points have been set.

3. The Governance context

Generally, the governance setting involves one single nation –Spain- within the European Union framework. Nevertheless, the following interactions should be considered due to their indirect effects in the fisheries:

- International quota swaps and transfers: sardine/ anchovy between Spain and Portugal; sardine/anchovy between Portugal and France.[31]
- Fisheries Partnership Agreement (FPA) with Morocco[32]: near 50% of the target fleet for the CS may alternate the fishing effort between the Gulf of Cádiz and Morocco.
- Fisheries Bilateral Agreement between Spain and Portugal (2013-2015): management measures and fishing possibilities for both countries for continental waters (12 to 200 nautical miles) and the cross-borders (Guadiana and Miño rivers).
- Management Plan for the Iberian Sardine developed by Spain and Portugal, under evaluation by ICES.

OSPAR Convention is the legal instrument guiding international cooperation on the protection of the marine environment in the North-East Atlantic. SWW CS is integrated in OSPAR's Region IV. Bay of Biscay and Iberian Coast. Other relevant international Conventions include the Bern Convention[33] (list of strictly protected and protected species of flora and fauna) and the Convention on Wetlands (RAMSAR Convention).

Additionally, Doñana is a protected area of 108.086 ha (right bank of the Guadalquivir river at its estuary on the Atlantic Ocean) that cumulates several protection figures: National Park (54.251 ha) declared in 1969; Biosphere Reserve (1980); Wetlands of International Importance (1982); natural park declared by the Regional government in 1989 (53.709 ha); part of the Natura 2000 Network in 2003 (both as a Special protection Area for birds and Site of Community Importance). Doñana is also a UNESCO World Heritage site[34] since 1994. However, this intensive protection has not been applied to its marine environment (except 4.000 ha). Several NGOs are claimed the need to extend the protection to the marine area and this was one of the potential management priorities analysed with the stakeholders.

The dynamics of the Guadalquivir river and the water management have a clear impact in the area for dynamics of the anchovy stock. Sardine dynamics is hypothesized to be related to oceanographic processes

[31]. The Member States normally save a percentage of the allocated annual TAC for SWAPS with other Member States as well as to cover potential overquotas from the inital ones; e.g. in 2015 Portugal transfered 1.300 tonnes of anchovy to Spain, which allowed for the reopening of the Anchovy fisheries in the Gulf of Cádiz.

[32] . The current FPA between the EU and Morocco entered into force on February 2007 for a period of four years. It has been tacitly renewed to February 2015. The current Protocol entered into force on July 2014.

[33]. The Bern Convention (1979) is a binding international legal instrument in the field of nature conservation, which covers most of the natural heritage of the European continent and extends to some States of Africa. Its aims are to conserve wild flora and fauna and their natural habitats and to promote European co-operation.

[34]. According to the UNESCO, the Convention fully respects the national sovereignty and property rights but recognizes protection as a duty of the international community

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of larger scale in the North-East Atlantic (see D5.1). The "Confederación Hidrográfica del Guadalquivir" is a management body created in 1927 to promote the development of the river basin. Currently managed by the National Government, it is in charge of the hydrological plan, water uses, facilities, etc. In the policy agenda there are some plans for deeper dredging of Guadalquivir estuary.

The development of a management plan for the area will involve three governance levels (European, National and Regional) and likely two realms (fisheries and environment). Besides the exclusive EU competence for the conservation and sustainable exploitation of fisheries resources and the interplay EU-member state for the implementation of the Marine Strategy Framework Directive (MSFD), the Regional government shares some fisheries competences with the National one[35]. Notwithstanding that only the European Commission and the National Government have decision-making power according to the management priority finally defined by the stakeholders (see section 4).

Currently there is a Management Plan for the Fleet of the Gulf of Cádiz approved by the National Government (Orden AAA/627/2013). The plan is focused on the allocation of fishing possibilities for the species that are subject to TAC (as the one selected within the management priority –anchovy-); it also tries to harmonize some technical measures formerly included in several regulatory texts, including temporal closures.

The plan sets specific collective rules for the anchovy. Whereas the quotas for other species are allocated globally to the whole fleet with a linear trimestral distribution, the anchovy quotas are allocated to the fishermen associations (Cofradías), reinforcing the role of this player in any alternative management plan.

[35]. The division of competences between the National and Regional government is detailed in the Constitution (1978, art. 149.1.13 and 19).

1. **Stakeholders** (Blue colour indicate those stakeholders that have participated in the meetings)

S. Group	Stakeholder	Name	Competences on the management priority	Level
Policy-makers	Governments' fisheries departments	European Commission European Council European Parliament	TAC proposal TAC approval, management plans approval Trialogue[36]	European
	Governments' fisheries departments	Ministry for Agriculture, Food and Environment, MAGRAMA - D.G. Recursos Pesqueros y Acuicultura (Fisheries) - D.G.Sostenibilidad de la Costa y el Mar	Environmental and Coastal Management Fisheries Management: maritime fisheries [37] and international relations. Maritime Spatial Planning development and implementation	National
	Governments' fisheries departments	Junta de Andalucía (Regional Government), Consejería de Agricultura y Pesca, Agencia de Gestión Agraria y Pesquera (AGAPA)	Fisheries within interior waters[38], shellfish, aquaculture and continental fisheries	Regional
Scientist	MareFrame researchers	Instituto de Ciencias Marinas de Andalucía, ICMAN. Centro Superior de Investigaciones Científicas (CSIC)	Research & development, Scientific marine data	National
	Non-MareFrame researchers	Instituto Español de Oceanografía, IEO	Research & development, Scientific marine data Stock assessment, Monitoring and surveys	National
	Non-MareFrame researchers	Métodos Department, Universidad de Huelva	Socio-economic research and development	Regional
Fishing Companies	Fishing Companies Associations[39]	Cofradía de Sanlúcar de Barrameda	Fishermen strategies. 15% TAC for anchovy. Interaction with sardine. Willingness to cooperate	Local
	Fishing Companies Associations	Cofradía de Barbate	43% TAC for anchovy. To be integrated –if feasible- at a later stage.	Local
NGO's	e-NGOS	WWF España	Marine programme, lobby and opinion leadership	National
	e-NGOS	Conservation, Information and Research on Cetaceans, CIRCE	Research, education and awareness	European
Other, what?	Government department for protected area	National Park Doñana	Planning tools: park uses. Potential expansion of the protection to the marine area (currently 4.000 ha).	Nat. & Regional

[36] Trialogues" are informal meetings between members (or associated staff) of the European Commission, the European Council and the European Parliament at technical or political levels, usually involving a limited number of participants

[37]. External waters: maritime waters under Spanish jurisdiction or sovereignty beyond the base lines.
[38]. Maritime waters under the Spanish jurisdiction or sovereignty situated with the base lines.
[39]. Fishing companies associations will not mach precisely with Cofradías. It is a particular organization that combines employees and employers that dates from the XII century.

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2. Official policy objectives

Policy	Goal	Specific Goals
MSFD: Environmental Goals of the Marine South-Atlantic Area[40]	A1 To ensure the conservation and recovery of marine biodiversity	A1.1 To reduce the intensity and influence area of anthropogenic pressures on benthonic habitats
		A1.4 To reduce the main mortality and reduction causes of the populations of non-commercial groups of species at the top of the trophic chain (marine mammals, reptiles, marine birds, elasmobranch demersal and pelagic) as by-catch, collision with boats, marine litter, pollution, habitat destruction and overfishing.
		A1.5 To prevent the impacts over the trophic chains of the marine species culture, with special attention to the culture of non-common and non-native species.
		A1.6 To promote a regulation to avoid commercial exploitation and by-catch of deep elasmobranch included in the annexes of the national legislation, European directives or applicable international conventions.
		A1.8 To promote recovery actions for species and habitats when its damage compromises the achievement of GES for biodiversity descriptors.
		A1.9 To ensure a proper surveillance of the marine environment, through remote or in-situ systems.
	A2. To achieve a complete network of MPAs	A2.1 To promote the network of Marine Protected Areas in the area. [Relevance for the marine area of the Doñana Park]
		A2.2 To Complete the Nature 2000 network, with new Important Bird Areas (IBA) new LIC and management plans for those areas
	A3. To guarantee the conservation of species and marine habitats, particularly those considered as declining	A3.1 To maintain stable the size distribution of the species of teleost and demersal and benthonic elasmobranch considered as big.
		A3.2 To maintain the SCF (status of conservation of fish) below the 1 in the IUCN scale (0: no vulnerable, 1: vulnerable; 2: threaten; 3: endangered).
		A3.3 To maintain the range of distribution of the species, with no evidences of reductions in a number of species that statistically cannot be explained by natural and climatic variability.

[40]. The Spanish Marine Strategy has several objetives that are common to all the areas (Goals).

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Policy	Goal	Specific Goals
		A3.4 To maintain positive or stable tendencies in the populations of key species and top predators and in the case of commercial species, to maintain them with safe biological limits
		A3.5 To maintain positive or stable tendencies in the area of distribution of biogenic habitats and/or protected and singular habitats.
		A3.6 To maintain the parameters and status descriptors or conditions of benthonic communities within values that guarantee its functioning and durability, as well as the preservation of its characteristic species, key and singular species.
	C1. To guarantee that activities and uses of the marine environment are compatible with the preservation of its biodiversity	C1.6 To guarantee that fish stocks are managed properly, within safe biological limits.
	C3. To promote a better knowledge of the marine ecosystems	C3.7. To have the information that allows the evaluation (related to GES) and particularly: monitoring and gathering of information on species not yet included in the monitoring programs but in the list of species for descriptor 3; to improve the knowledge of the situation of the stocks selected that currently do not have assessments producing primary or secondary indicators; to advance in determining precautionary and management reference values.
CFP	Progressively restoring and maintaining populations of fish stocks above biomass levels capable of producing MSY (art. 2.2.)	Delays to 2015 MSY deadline accepted but not later than 2020. Anchovy is a data limited stock. Lack of available data on year classes that constitute the bulk of the biomass and catches (no survey indices for such year classes are available at the time of the formulation of the advice) No reference points have been set for the stock. The observed harvest on the southern stock has been in the range of 10–40%. These harvest rates correspond to approximately 90–66% spawning biomass per recruit (SBPR).Discard data collection is yet under implementation.
	Landing obligation	Uplift of quotas.

Other relevant policies are the Habitat Directive (species requiring designation of special areas of conservation (A.II) and strict protection (A. IV). Gulf of Cadiz ESZZ16001.[41] .and the Water

[41]. Plants: Atlantic (Gulf of Cádiz):Madreporarians communities:Dendrophyllia ramea community (banks), Dendrophyllia cornigera community (banks); white corals communities (banks), Madrepora oculata and Lophelia pertusa community (banks). Solenosmilia variabilis community (banks). Gorgonians communities: Facies of Isidella elongate and Callogorgia verticillata and Viminella flagellum ; Facies of Leptogorgia spp.; Facies of Elisella paraplexauroides ; Facies of Acanthogorgia spp. and Paramuricea spp. Filigrana implexa formations.

Framework Directive (System A. North Atlantic Ocean ecological region; also Ibero-Marcaronesian ecological region for rivers and lakes.)

4. Stakeholders meetings within the SWW case study

Event	Date and Place	Participants	Methods and output
Launching of the case study	21/05/2014 Seville, Spain. Regional Government facilities (AGAPA)	12 (marked in blue in the previous table)	Focus Group Deliberation, ranking and selection of the management priority.
Dialogue with Fishermen Associations	24/10/2014 Cádiz, Spain. Cofradía de Pescadores	4. CS Leader Cofradía Sanlúcar de Barrameda	Dialogue. Socio-economic models as part of the analysis.
Dialogue with Regional Government (AGAPA)	On-going by telephone and mail	2. CS Leader and government officials	Dialogue. Follow-up of the project
Dialogue WP5-WP6	4/11/2014 Skype 6/11/2014, Skype	3. CS Leader and WP6 case leader	Validation of stakeholders list, mind map and next steps for the DSF

5. Scoping the management plan proposal of the SWW case study: Objectives, candidate operational objectives and interest variables

Table 5. Objectives and candidate operational objectives for management plan proposal to be developed within the South Western Waters case study.

Objectives for the management plan defined by stakeholders	**Candidate operational objectives and indicators**
Optimize profitability and sustainability	• To set in-season TAC setting and in-year stock advice. • To reduce uncertainty using resource forecast • To optimize market knowledge

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Strategies to mitigate environmental fluctuations	• To simulate a mutual fund and evaluate its impact in profitability and sustainability (development of an insurance scheme)
Objectives for the management plan	
Environmental sustainability indicator	• Risk of collapse with a threshold to be determined in the next stakeholder meeting (DSF Workshop. October 29th 2015)
Social sustainability indicator	• Number of jobs in risk with a threshold to be determined in the DSF Workshop,)
Economic sustainability indicators	• Mean and standard deviation of the profit for a 30 year simulation with a threshold to be determined in the DSF Workshop . The premium value could be used also as a measure of uncertainty.
Objectives for the management plan derived from the MSFD and the CFP	
A3. To guarantee the conservation of species and marine habitats, particularly those considered declining	• A3.2 To maintain the SCF (status of conservation of fish) below the 1 in the IUCN scale (0: no vulnerable, 1: vulnerable; 2: threaten; 3: endangered).
	• A3.4 To maintain commercial species with safe biological limits
C1. To guarantee that activities and uses of the marine environment are compatible with the preservation of its biodiversity	• C1.6 To guarantee that fish stocks are managed properly, within safe biological limits.
C3. To promote a better knowledge of the marine ecosystems	• C3.7. To advance in determining precautionary and management reference values.
CFP: Progressively restoring and maintaining populations of fish stocks above biomass levels capable of producing MSY (art. 2.2.)	• Anchovy is a data limited stock, and no reference points have been set for this stock.
Landing obligation	• Uplift of quota.
Case study research objectives determined by stakeholders	
Take into account problems for the fishery as poaching, illegal fishing, military exercises acting over biodiversity	• Actually there isn't a reliable source of information to include these problems in the model. The limits linked to data availability will be carefully communicated and handled at the DSF Workshop.

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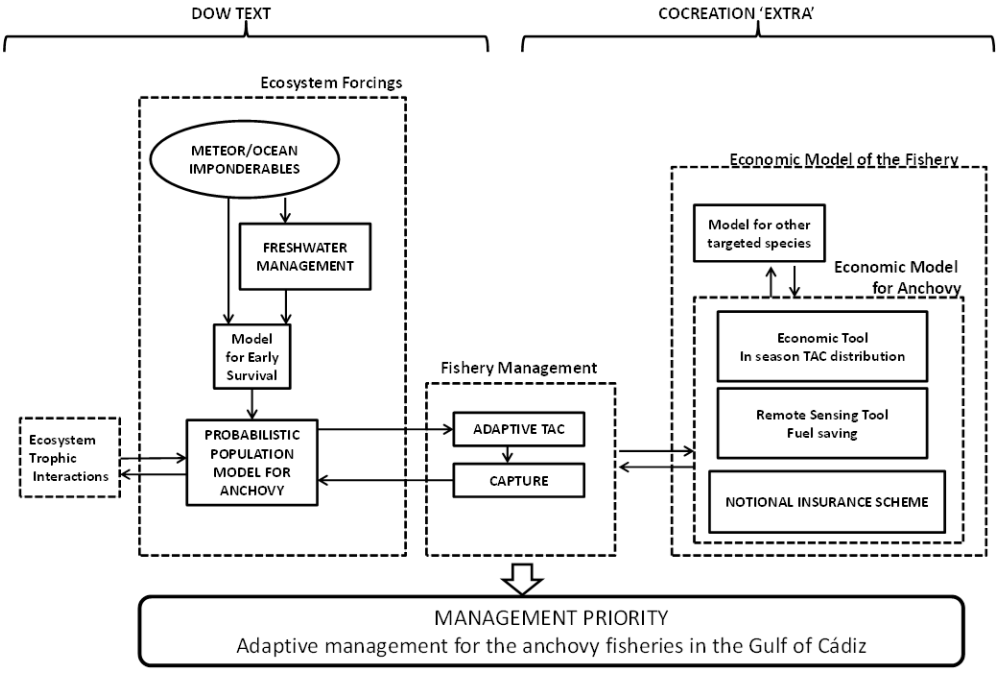
Table 6. Candidate interests variables as preferred input and outputs for the Guided User Interface for the SWW Gulf of Cadiz case study.

Candidate input variables	Candidate output variables
TAC level	Mean profit
	Profit SD
	Number of jobs in risk
	Risk of collapse
Insurance coverage	Premium

6. Ecosystem model and management priority

A priori the ecosystem model–GADGET- would be able to model the relevant problem dimensions. Additionally, on November 7th we contacted WP6 Leaders to address a specific question. Regarding the integration of the socioeconomic issues in GADGET there are two options: a) A module to be added in Gadget [option to be confirmed with the Icelandic experts] b) Gadget [en/bio]+ Bayesian Belief Networks [socioec]. Due to the CS Team expertise the option b) seems more feasible.

Currently the CS Leader is in contact with economist from the University of Huelva in other to deal with the socioeconomic dimension of the model (see mind map below).



Source: Javier Ruiz, CSIC, 2014

7. References

Rincón, M.M, Levontin, P, Leach, A., Ruiz, J. and Mumford, J. (2015), "The economic value of environmental data: a notional insurance scheme for the European anchovy", *forthcoming.*

ICES Advice 2014, Book 7, Anchovy in Division IXa.

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Mediterranean Waters - Strait of Sicily case study

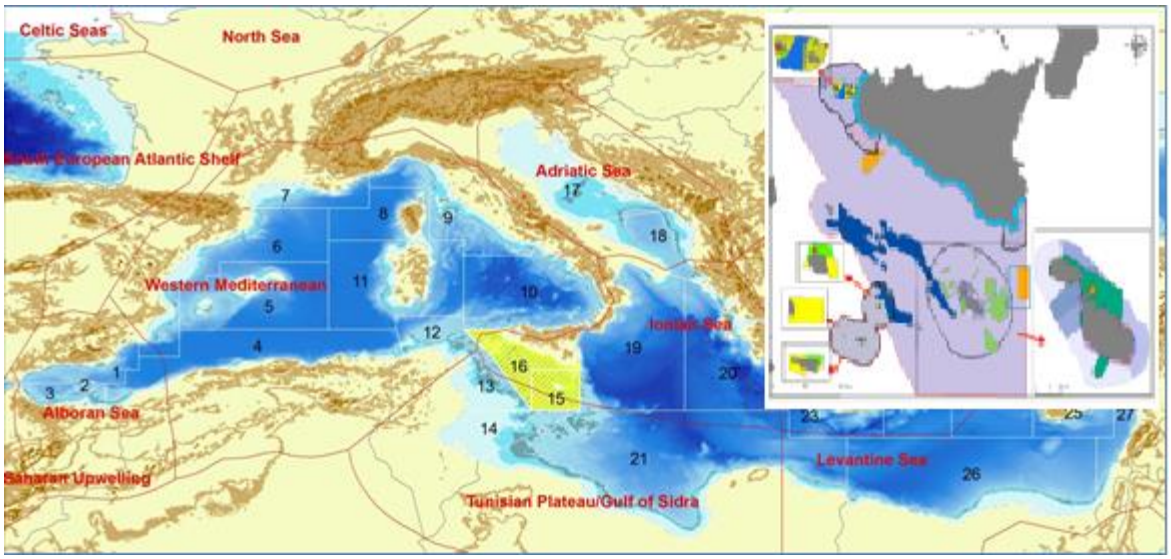

Figure 1. Map of Mediterranean with the boundaries of ecoregions (red lines) according to Spalding et al. (2007), FAO-GFCM geographical sub-areas (white lines) and the case study area (yellow polyhedron). The case study area corresponds to the North sector of the Strait of Sicily and includes the FAO-GFCM geographical sub-areas (GSAs) 15 (Malta Island) and 16 (South of Sicily). The small map depicts the spatial management regions enforced in EU waters of the Strait of Sicily. Source: MareFrame D5.1.

1. Initial case study focus and problem context

The Mediterranean Waters case study focuses geographically on the Strait of Sicily area. In MareFrame, it presents a species rich and data-poor case study.

Prominent features include deep coral assemblages, cold seep communities, coralligenous habitats, rare or endemic species (such as Maltese ray), high habitat heterogeneity, spawning and nursery grounds for large pelagic fish (i.e. bluefin tuna and sword fish), persistent hotspots of diversity of demersal species, and large fluxes of Atlantic and Indo-Pacific exotic species. Most important human uses of the area are fishing, aquaculture, conservation, shipping and tourism. Other important uses are oil drilling and extraction, deployment of gas pipelines and communication cables, and construction of wind-mill farms. The area includes the south coasts of Sicily and the Maltese waters within the FAO 37.2.2 statistical rectangle.

The Strait of Sicily is one of the most important fishing areas of the Mediterranean where fisheries still have a high socio-economic and cultural relevance. This area holds most of the main management issues affecting the Mediterranean fisheries namely: i): conflicts between artisanal and industrial fisheries, ii) ineffective management of shared stocks, iii) high impact on habitats, iv) decline of fisheries productivity and overfishing, v) high rate of environmental change and global warming, vi) ineffective management and lack of tools supporting EAFM. The most important commercial species in the area is the deep-sea rose shrimp (*Parapenaeus longirostris*) with 5 000-10 000 tons /year. The

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other important species are the giant red shrimp (*Aristomorpha foliacea*), sardine, European hake, anchovy, and swordfish.

The recent stock assessments point out a general pattern of overfishing of the main commercial stocks. The only stock that was assessed to sustainably exploited in 2012 was the Norway lobster. Even though the general trend in the area shows a reduction of the fishing mortality (F), the current F is still generally well above F_{MSY}. As in the rest of the Mediterranean, stock productivity and fleet profitability are generally impaired by a combination of high fishing mortality and poor selectivity (i.e. high mortality on juveniles) featuring the main fisheries.

The Sicilian fisheries follow the path of the general decline seen in the last few years in Italy. The sustained rise in intermediate costs, combined with a fall in production due also to overfishing, eroded added value and profits, further weakening a marginal sector already in recession. The Sicilian trawling fleet, the largest in Italy, landed 18,570 tonnes in 2011, down 5.6% from 2010. Over 80% of the fleet is concentrated on the southern side of the island. Vessels above 24 meters, based in Mazara del Vallo, have been suffering a deep crisis for years due mostly to fuel costs, but also to difficulties in accessing traditional fishing areas near Maghreb in international waters, like Libya and Tunisia. Over the last few years finding specialized workforce, especially captains, has been particularly hard for several vessels. In this segment alone, 30 vessels are due to terminate activities and others are waiting contributions for permanent withdrawal.

Fisheries and aquaculture represent 0.58% of the total economy of Sicily, compared to a value of 0.17% in the other Italian Convergence Regions (Basilicata, Calabria, Campania and Puglia) and to 0.08% in the Italian Regions not considered under the Convergence Objective of the EU. In terms of processing, Sicily has the largest number of companies dealing with fish conservation in Italy (32%), and the highest number of jobs in this field (27%). Sicily is one of the few regions in Italy where the fisheries sector has a positive Trade balance (Table 1).

Table 1. Economic performance descriptors by the fleet segments for the Sicily in 2011.

	Incomes	Intermediate costs	Added value	Labour costs	Gross profit
Fleet segment	million euro				
Bottom trawlers	132,42	81,84	50,57	26,76	23,82
Mid pair trawlers	2,57	1,61	0,96	0,44	0,52
Purse seiners	12,45	4,74	7,71	3,75	3,97
Small scale vessels	20,97	10,29	10,68	5,47	5,21
Polyvalent vessels	4,39	1,61	2,78	1,43	1,34
Longliners	17,68	5,11	12,58	5,67	6,91
Total	190,49	105,21	85,28	43,52	41,76

As regards employment in the fisheries sector, Sicily is the region which provides most jobs in Italy (26% of all seamen and 18% of those employed in the fishing industry). The fishing industry employs 18 135, of which 58% are employed directly by the sea fishing sector, 8% in processing, 1% in fish farming an d 33% in connected activities such as sales, port services and other. Aquaculture in Sicily represents ca. 20% of total Italian production, with an annual yield of about 4 000 t (IREPA 2008;

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MIPAAF 2007). It is almost exclusively based on sea bass and sea bream production, with an average ratio of 54 to 46%.

Tourism is one of the most important economic activities in Sicily and Malta. Coastal area are under a very high touristic pressure with increasing urbanization of the coasts (e.g. touristic resorts, marina, etc.) that in turn determine impact on coastal fragile habitats such as *Posidonia oceanica* meadows. Touristic activity in nesting sites of the sea turtle *Caretta caretta* is a big threat for the species in Sicily as well as in the rest of the Mediterranean (Giacoma and Solinas, 2001).

The Strait of Sicily is recognized as a high biodiversity hot spot in the Mediterranean and also associated with complex and diversified benthic communities Coll et al. (2010) found around Sicily the highest richness of marine vertebrate (375 species per 0.1x0.1 degree cell). Recent studies showed a high diversity and biomass of demersal communities over the offshore detritic bottoms of the Adventure bank. Such high diversity is linked to the nature of "crossroad" of the Strait of Sicily for species of distinct tropical origins (Atlantic and Indo-Pacific), expanding their range longitudinally within the Mediterranean. The area has been prioritized for conservation by de Juan et al. (2012) and Oceana (2011) with several sites, such as the Adventure Bank, Malta Bank, Urania Bank, Linosa Bank and Southern Sicilian seamounts identified for their future inclusion in a Mediterranean network of marine protected areas.

To conclude, the major ecological and fisheries resource considerations are:

- Overfishing
- Environmental change (global warming), acidification and change in the circulation pattern
- Change in species compositions / invasive species. Quick increasing of thermophile species.

The case study is led by Francesco Colloca at Consiglio Nazionale Delle Ricerche (CNR). Decision support task is led by Mika Rahikainen (UH).

2. The governance context

The nations involved are Italy, Malta, and Tunisia (even though the study area does not include the Tunisian waters). The regional bodies for cooperation on resource management or environmental issues are the General Fisheries Commission for the Mediterranean[42] (GFCM), EU-DG MARE, and the

[42] http://www.gfcm.org/gfcm/about/en

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International Commission for the Conservation of Atlantic Tunas[43] (ICCAT). The relevant international conventions in place are UNCLOS[44] , Barcelona Convention[45], ACCOBAMS[46], and RAMSAR[47].

The GFCM plays a key role in management of the aquatic resources. It is the Regional Fisheries management Organization that under the auspices of the FAO co-ordinate activities related to fishery management, regulations and research in the Mediterranean and Black Seas and connecting waters. It now has twenty-four members, including one non-regional State (Japan) and the European Union. The area covered by the GFCM Agreement includes both the high seas and marine areas under national sovereignty or jurisdiction. They relate, inter alia, to technical measures in line with those established by EU in an attempt to achieve compliance also in non-EU waters. Particularly notable is the recommendation 2005/1 on the management of certain fisheries exploiting demersal and deep water species which prohibits the use of towed dredges and trawl nets fisheries at depths beyond 1.000 m.

The GFCM has the authority to adopt binding recommendations for fisheries conservation and management in its Convention Area and plays a critical role in fisheries governance in the Region. The GFCM holds its regular session annually. It implements its policy and activities through the Secretariat, based at its headquarters in Rome, Italy, and operates during the inter-sessional period by means of its committees, namely the Scientific Advisory Committee (SAC), the Committee on Aquaculture (CAQ), the Compliance Committee (CoC), the Committee of Administration and Finance (CAF).

Mandate of the Scientific Advisory Committee (SAC) is to provide independent advice on the technical and scientific bases for decisions concerning fisheries conservation and management, including biological, social and economic aspects, in particular:

- assess information provided by Members and relevant fisheries organizations or programmes on catches, fishing efforts, and other data relevant to the conservation and management of fisheries;
- formulate advice to the Commission on the conservation and management of fisheries;
- identify cooperative research programmes and coordinate their implementation;

Mandate of the Compliance Committee (COC) includes to:

- review compliance with conservation and management measures adopted by the Commission;
- review the implementation of measures of monitoring, control, surveillance, and enforcement;

[43] https://www.iccat.int/en/

[44] http://www.un.org/depts/los/convention_agreements/texts/unclos/closindx.htm

[45] http://www.unepmap.org/index.php?module=content2&catid=001001004

[46] http://accobams.org/

[47] http://www.ramsar.org/

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- define, develop and make recommendations to the Commission concerning the phased development and implementation of the GFCM Control and Inspection scheme;
- monitor, review and analyze information pertaining to the activities of Non-Contracting Parties and their vessels which undermine the objectives of the Agreement including, in particular, IUU fishing.

ICCAT is competent for fisheries of tuna and tuna-like fishes in the Convention Area, which includes the whole of the Atlantic, as well as the Mediterranean as a connected sea. ICCAT has the power to adopt resolutions that are binding on its parties and establish a total allowable catch regime and national quotas for bluefin tuna fisheries in the East Atlantic and Mediterranean waters, within the framework of a multiannual recovery plan.

Italian fisheries policy is strongly conditioned by EU regulations through the Common Fisheries Policy (CFP). In conformity with subsidiarity principles decided within the EU, Italy has adopted complementary tools for the realization of specific management policy. The main management instrument for the sector is the National Plan for Fishing and Aquaculture, introduced under Act 41/82, which is reviewed every three years. Sicily is a region with autonomous status and it can rule on fisheries matters with the exception of the fleet policy which is regulated at national level. As such, the Region of Sicily can adopt plans for the protection of marine living resources designed to further reduce fishing mortality, over and beyond what is already enforced at national or Community level. The management Plans enforced in the last years however basically lack of harvest control rules to dynamically adapt the catch/effort to the resources availability.

The main regulation governing management in the EU waters of the Strait of Sicily is the EU reg. 1967/2006 related to the management of fisheries resources in the Mediterranean Sea and the new Common Fisheries Policy (EU reg. n. 1380/2013). Establishment of multi-annual management plans both nationally and at the Community level, in line with the CFP requirements are allowed for. Member States must draw up National Management Plans for the fisheries in their territorial waters. Specific EU provisions against IUU fishing has been enforced by the Regulation (EC) No.1005/2008 of 29 September 2008, establishing a Community system to prevent, deter and eliminate illegal, unreported and unregulated fishing, and Regulation (EC) No. 1224/2009 of 20 November 2009, establishing a Community control system for ensuring compliance with the rules of the common fisheries policy.

Other policy tools in the areas are related to Marine Strategy Framework Directive (MSFD), Barcelona convention (the Convention for the Protection of the Mediterranean Sea Against Pollution) and ACCOBAMS (Agreement on the Conservation of Cetaceans). MSFD descriptor 3 addresses directly the status of exploited fish and shellfish stocks. Conservation priorities are linked to two Marine Protected Areas in south Sicily (Isole Egadi, Isole Pelagie) and to several Ramsar areas. The marine spatial planning policy will also play an important role on the management aiming to sustainable ecosystem services provided by the Strait of Sicily area.

The assessment of the status of the stocks in the region is carried out both by the working groups of the GFCM and the Scientific, Technical and Economic Committee for Fisheries (STECF) of the EC. GFCM plays a key role in fostering the development of assessment on shared stocks between EU and non-EU countries also in cooperation with the FAO regional project Med-SudMed. Proxies for F_{MSY} (i.e. F01, E=0.4) and B_{MSY} are used to assess the status of the main stocks (Appendix).

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The Strait of Sicily is the most important traffic lane for crude oil crosses all the Mediterranean East-West and connects the Black Sea, Suez and Gibraltar. Therefore, the Strait of Sicily is considered as a sea area at very high risk of pollution from ships. Other potential sources of physical and chemical impacts on the marine ecosystem are linked to the development of oil extraction activities and offshore wind farms. There are three active petroleum platforms in the Strait of Sicily. The oil is extracted from 35 oil wells in three concession areas and another 16 wells are awaiting a production license. Although the Mediterranean is declared a «special area» by MARPOL Convention, where any discharge of oil or oily residues and mixtures from ships is prohibited, the so-called operational pollution, which is the marine pollution originated by routine shipping activities and intentional discharges, have become more significant.

3. Stakeholders and participation in the case study

The launch of the case study was carried out at the IAMC-CNR in Mazara del Vallo on 20th June 2014. The main issues faced by the fisheries in the Strait of Sicily were discussed in the meeting. The meeting was attended by 15 participants, including members of RACMED, Sicily Region, fishermen representatives, eNGO and fishery scientists. The discussion was focused mostly on the trawl fisheries.

Table 2. Types of stakeholders involved in the launch of the Strait of Sicily case study at national and regional level. See text for clarification.

Level	Meeting details	Stakeholders / competences
National	• Launch of case study in Mazara del Vallo on 20th June 2014.	• RACMED: Executive secretary • Fisheries Department, Sicily Region • Fishing companies associations • Fishing company owners • NGO (Greenpeace) • Fishery scientists (IAMC-CNR)

The main issues identified and agreed were related to the loss of productivity of the fishing enterprises due to a series co-occurring factors such as: i) increasing of oil price, ii) poor market condition (e.g. low gross prices of fish products), iii) increased and unregulated access at the fishing grounds of the area in international waters, iv) old age of the trawlers, v) lack of marketing actions to increase the value of the products. There is poor understanding among fishers of the negative global effect of overfishing on the economic performance of the fisheries.

The following explanations may prove useful:

i) Although the oil price in the global market has recently decreased significantly, aiding in decreasing the effort related fishing costs, there is no quantitative information available about the influence on the economic performance of fishing enterprises. Socio-economic indicators for 2014 will be available probably in May-June 2015.

ii) Poor market condition, including the reduction of prices of fish products is mostly due to reduction of the internal demand. In turn this is linked to the general economic crisis. It is

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also clear that the Italian and Sicilian fishing enterprises are also impacted by the import of low cost fish products from other areas.

iii) Reference of the trawler age is due to the increasing maintenance and running costs of old vessels, not because of expensive investments required to meet e.g. the hygienic standards the EU.

Limitations and challenges regarding participation in the case study

This case study includes local (or regional) as well as international dimensions. The latter dimension was not reflected in the launching event as the participants represented Italian stakeholders only. The main commercial fish resources are harvested also in international waters and shared between different national fleets. RACMED is an international body but, however, the other stakeholders were Sicilian and the discussion was mostly focused on Sicilian fisheries.

However, the case study has been launched with many representatives present, covering the key interests in the Strait of Sicily fisheries. Oil industry-related interests were presented and we, at MareFrame project, regard this exclusion appropriate as there is no obvious interference among the operations in the oil and fisheries sectors. In general, it will never be possible to include the representation of all affected interests in a complex planning process. The consequent challenge for the case study will be to consider the main affected interests, including those that have not been articulated and championed by their relevant core representatives.

Another challenge relates to language. MareFrame researchers based outside Italy will depend on translations in order to engage effectively with the decision support process. In the participatory meetings, simultaneous interpretations would be mandatory to include a facilitator not knowledgeable in the Italian language. So far it has not been tested whether this kind of simultaneous interpreter would be available and to which extent it would service or confuse participation in the meetings.

4. Elaboration of the scope of the case study problem

The launch of the case studies provided a starting point for the decision support work. Progress with this work will depend on sustained dialogue between stakeholders and researchers in WP5 and WP6. There is a need to characterize and specify the case study problems further. For this purpose, the case study leader will arrange a stakeholder meeting in February 2015 to receive feedback about the conclusions drawn after the launching event, and to iterate with the management priorities.

5. Objectives, indicators and criteria

The case study benefits from the possibility for being associated with GFCM initiative, with the support of the MEDSUDMED FAO regional project, to develop a multi-annual management plan for shared fisheries (deep sea rose shrimp and hake) in the Strait of Sicily. The ongoing GFCM initiative adds significance to the MareFrame case study which in turn may support the GFCM initiative contributing to a relevant elaboration of the scope, operational objectives, management measures and the use of

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indicators. This critically depends on the match of timing of the GFCM initiative and MareFrame process. Currently, at MareFrame we do not possess precise information about timing of MEDSUDMED phases. There is a possibility that GFCM is able to define the management measures by the end of 2015. This will potentially serve test of the prototype II but not test of prototype I which takes place in the mid-2015.

The ecosystem context needs to be addressed in scoping the decision support work, because the key objective of MareFrame is to significantly increase the use of ecosystem-based approach to fisheries management (EAFM). EAFM is defined by Staples et al. (2014) as "a practical way to implement sustainable development principles for the management of fisheries by finding a balance between ecological and human well-being through good governance. EAFM represents a move away from management systems that focus only on the sustainable harvest of target species to a system that also considers the major components in an ecosystem, and the social and economic benefits that can be derived from their utilization". The coastal marine ecosystems provide multiple benefits to human societies, often referred to as ecosystem services.

The MareFrame management priorities, as initiated at the launching event, have a tendency to be influenced the fishery driven objectives:

i) Single species conservation targets
ii) Climate change driven effects on fisheries economics
iii) Fisheries induced variation in trophic dynamics
iv) Establishment of MPAs and protection of recruitment hot spots

The main cue of a fishery driven change is related to overfishing – there are differences in community composition and structure between heavily fished and the other areas, and observed effect on the size structure of the community. There are no quantitative data on the habitat degradation or loss, even though the negative impact of bottom trawling on the habitats is well recognized.

Trophic flows between components of the ecosystem, in particular small pelagic species and hake, will be investigated to improve the understanding of the dynamics of these stocks under different environmental scenarios. The impact of alternative scenarios of technical measures (e.g. area closure, mesh sizes, gear restrictions), on the ecosystem and fisheries will be also investigated. To give an example of the planned evaluations, it is intended to forecast the trade-offs in the ecosystem following the application of the CFP targets in terms of single species MSY. For instance, what will be the likely impacts can on the key functional groups if the stocks of predators (e.g. hake) are being rebuilt?

There is also a need to be more specific with respect to "Climate driven changes" which has been identified as a management issue and a potential scenario. What are the trophic levels, functional groups or species that are referred to? What is the anticipated climate change in terms of magnitude of change in sea temperature, and the spatial pattern of it? What is the time scale of the management considerations? The practical management considerations will be strategic (long-term) and tactical (short-term) as Atlantis is feasible for both. The short to mid-term is allegedly more interesting for the fishers and also for considering the EU targets for 2020. For the long term scenarios it is clear that they will be probably affected by uncertainty in S-R relationships. This is however a general issue for Mediterranean fisheries.

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"Fisheries induced variation in trophic dynamics" is pointing to the effects and trade-offs the alternative management decisions may have including the effect of rebuilding of a predator stocks on commercial prey species.

The fourth possible management scenario, "Establishment of MPAs and protection of recruitment hot spots", seems to compliment the technical management measures in the region. It also links strongly with "increased and unregulated access at the fishing grounds in international waters". The current and planned *ad hoc* measures to regulate the fishing effort go in the direction of a more regulated access to the fishing grounds. In addition, the GFCM MP has the mandate, also from the EU, to identify closed areas in the region. MPAs may prove to be a feasible management scenario but consideration is needed to link this scenario with the identified management issues (Figure 2. Mental map).

There certainly are many interactions among the acknowledged management issues and scenarios. I anticipate that explicit consideration of these interactions would help in scoping the issue to receive further decision support. Brain storming to identify the key factors, potential conflicts, the causes, the consequences, and the causal links among them may appear useful. It seems that it is not easy to formulate a single problem reflecting the stakeholder concerns but we should move to that direction. You might consider with the stakeholders what is it that they are trying to avoid, and what are they trying to reach, and what needs to be done to meet these circumstances.

Operational objectives, indicators and criteria

The operational objectives are still under development considering that a new stakeholder meeting will be held next February in Mazara del Vallo and the second case study meeting (test of prototype I) will be organized May or June 2015. The first Case Study meeting was aimed basically at identifying the main management issues in the Strait of Sicily fisheries. The next meeting will be more focused on possible objectives and the alternative management measures.

However, the main issues as raised by the fishers is a loss of productivity of the Sicilian fishing enterprises, first of all trawlers, mostly due to a combination of overfishing, increasing costs and poor market conditions (i.e reduction of market prices). This situation has led to an important reduction of the Italian fleet capacity over the last years, most likely as an effect of lack of management.

Recent stock assessments clearly show that Mediterranean fisheries, including the Sicilian ones, would substantially benefit by a change in the exploitation pattern through a reduction of fishing mortality on juveniles (Colloca et al., 2013; STECF, 2014; GFCM, 2013, 2014).

The ongoing reduction of fishing effort, however, yielded positive effects on the main exploited stocks in the last years. These effects, although stocks are still overfished, include a rebuilding pattern in abundance and a decreasing trend in fishing mortality. In addition, there is a positive trend of elasmobranchs that is a positive sign, considering the poor status of sharks and rays in in many Mediterranean areas.

The Sub-regional Technical Workshop on Fisheries Multiannual Management Plans for the Western, Central and Eastern Mediterranean held by GFCM (7–10 October 2013, Tunis, Tunisia) discussed the introduction of technical measures to manage trawl fisheries for the deep-water rose shrimp and hake

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in the Strait of Sicily. It was noted that minimum conservation sizes were in place for some of the countries sharing the resources, but lacking in others. The regulation of the minimum mesh size in the codend of trawling nets was practically globally adopted in the region but, as discussed, it was likely to be ineffective to reduce the catch of immature shrimp/hake and small-sized individuals of associated species. The combination of time and area closures was viewed as a more effective measure to improve the exploitation pattern of the trawling fisheries. The sustainability of the fisheries, the high rate of discards, the impact of trawling fishing on bottom habitats, the allocation and participatory rights of coastal States and the harmonization of management measures were proposed as priority issues that would need to be addressed in a regional management plan for this fishery.

MareFrame can have a very positive impact on this implementation process, enforcing the participation of stakeholders in the management process and through the assessment work that will be carried out inside WP5.

The next two CS meetings will be aimed at better define both management objectives and associated scenarios to be tested in WP5. At the same time there are explicit management targets defined by the CFP and MFSD, as part of the Europe 2020 strategy, which can be assessed within the case study for their effect on the ecosystem and fisheries. Finally, the implementation of Atlantis might offer the opportunity to explore the effects of some ecosystem drivers, such as the ongoing warming trend (i.e. IPCC scenarios), also to increase the awareness of the fishers on the risk associated to the climate changes.

Table 2. The Strait of Sicily case study management priorities, objectives, scenarios, and potential indicators.

Management priorities	Objectives	Scenarios	Indicators
Reduce fishing mortality on juveniles and by-catch	Improve the exploitation pattern	Evaluate the effect of technical measures (e.g. area closures, gear selectivity) on commercial stocks	Fishing mortality rate at immature ages, age at full recruitment into fishery, volume of by-catch
$F \leq F_{MSY}$ for the main commercial stocks before 2020 (new CFP and MSFD)	Rebuild the main commercial stocks	Evaluate the effect (trade-offs) of reduced fishing effort on catches of the pelagic and demersal fleets	$F \leq F_{MSY}$; spawning stock biomass
Improve economic performance of the trawl fleets	Increase the economic performance of the trawlers	Evaluate the effect of different exploitation scenarios on CPUE of the main commercial stocks. Effort reduction/ increased catch value	CPUE; landing value

Also note that the current operational objectives are listed in the Appendix, plus the MSFD targets. Descriptors of fishing driven change can be the classical single species indicators (e.g. F, SSB) and also

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multispecies indicators can be defined (e.g. trends in elasmobranchs, GES for descriptor 3 in MSFD, which are ecosystem indicators adopted by the EU-Data collection framework).

6. Models

Atlantis features a full ecosystem model which is capable to reflect the complexity of the Mediterranean ecosystem. Atlantis will be implemented to investigate the direct and indirect effects of multi-fleet and multispecies fisheries on the ecosystem and food web functioning of the Strait of Sicily. Gadget will be only focused on the interactions between hake and its main prey having commercial significance (deep-water rose shrimp and horse mackerel). For the time being, it is not clear if Gadget will assist in the decision support approach. The first runs of the Atlantis and GADGET are expected to be ready no later than June 2015. It is currently not clear if and how social and economic dimensions can be integrated into the Atlantis framework but it should be possible to calculate likely economic impacts of different levels of future catches, e.g. by using current price information. To calculate profitability, cost information will be required. This is not available currently. Employment forecast will require that some proxies can be developed to relate catches to employment. These issues should be explored further by WP5 in order to enable the decision support work to take account of social and economic dimensions of the case study.

It has to be considered how the problem can be modeled (WPs 4 and 5) and whether relevant data will be available. Ideally, the problems should be identified by stakeholders based on their relevance. However, it must also be practically possible to conduct research in support of the identified problems. Hence, a common ground between problems and research possibilities must be ensured.

The market related factors (fishing costs and fish price, fleet age) might be analyzed with the ecosystem models (Gadget and/or Atlantis) conditional to data availability and some model adjustments, but their interaction with the proposed management scenarios seems not very high. However, since these topics have been judged at the launching event as the most significant management issues, possibilities to decision support can be further explored. The somewhat external market factors put stress on social resilience and challenge the ability of (regional) groups and communities to cope with them. It might be possible to enhance social resilience and adapt to changing (market) environment although it is not clear whether resilient ecosystems enable resilient communities in this kind of a situation. On the other hand, if the causes for loss of productivity are evaluated as completely external to Strait of Sicily fishers' enterprises, they perhaps could be left aside and only dealt with if time, data and models allows.

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7. Decision support work

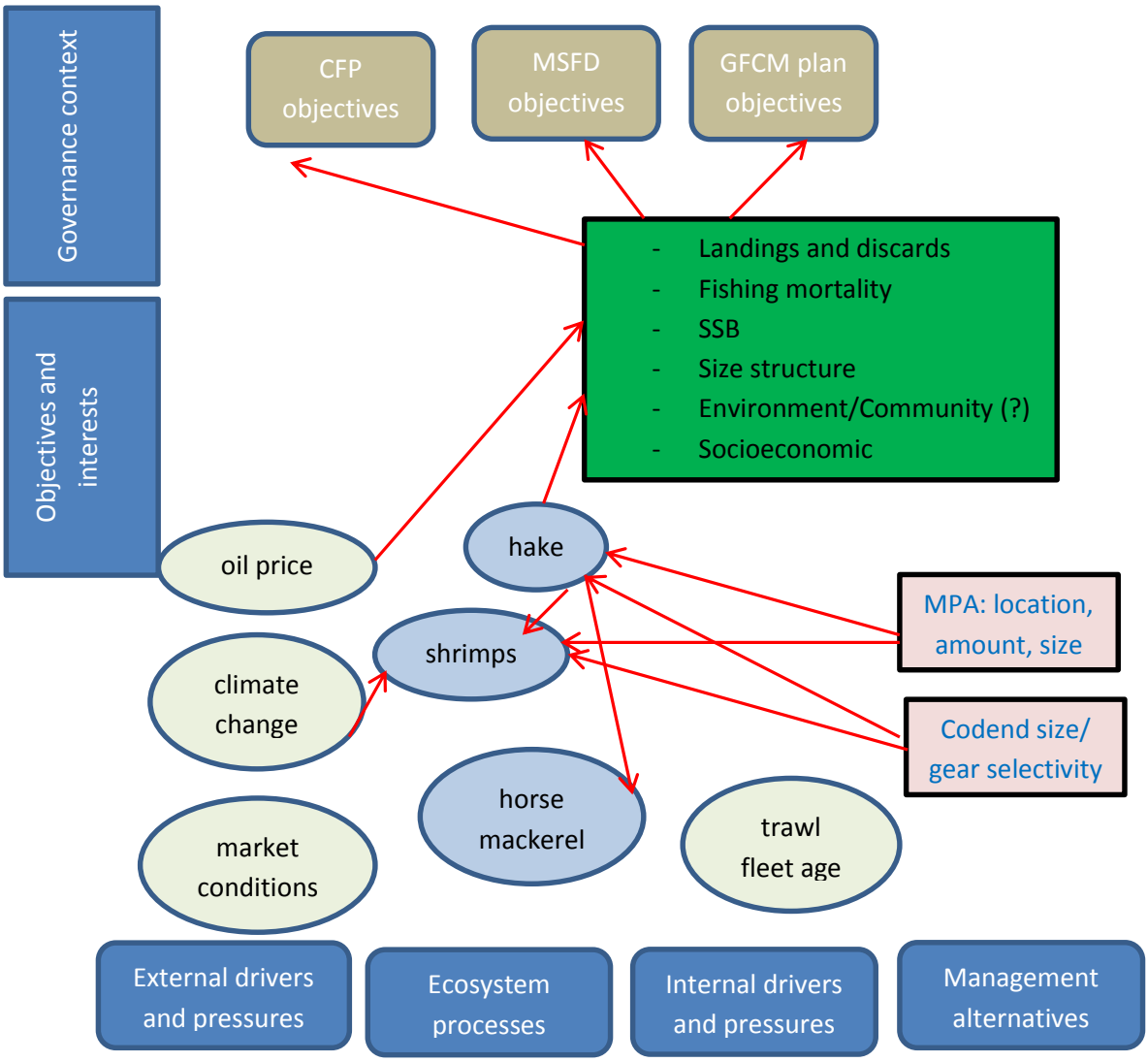

Figure 2. A mental map of the key variables and their links in the specified management issue context.

The Strait of Sicily case study is a candidate for a MCA-approach in the decision support work.

8. References

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Appendix

Ecosystem/Regional Sea:					
	Species/ stock				
	Red mullet	Hake	Small pelagics (anchovy and sardine)	Giant red shrimp	Deep water rose shrimp
Management unit/area	FAO-GFCM GSAs 15-16	EU regulations	EU regulations	EU regulations	EU regulations
Assessment unit/area	GSAs 15-16	North Strait of Sicily	GSAs 15-16	Whole Strait of Sicily	Whole Strait of Sicily
Assessment agency (specific working group also)	STECF and GFCM working groups	STECF and GFCM working groups	STECF and GFCM working groups	STECF and GFCM working groups	STECF and GFCM working groups
Notes on quality of assessment (retrospective pattern, uncertainty; assessment concerns, etc.)	No specific concerns	No specific concerns	No specific concerns	No specific concerns	No specific concerns
Stock status (within/outside safe biological limits)	F above Fmsy	F above Fmsy	F above Fmsy	F above Fmsy	F above Fmsy
Ownership of the resource	No quota enforced	No quota enforced	No quota enforced	No quota enforced	No quota enforced
Management strategy or HCR	Technical measures. No HCR	Technical measures. No HCR	Technical measures. No HCR	Technical measures. No HCR	Technical measures. No HCR
Reference points	F_{msy}=0.45	F_{msy} =0.16	E_{msy}=0.4	F_{msy} =0.4	F_{msy} =0.7

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The Black Sea case study

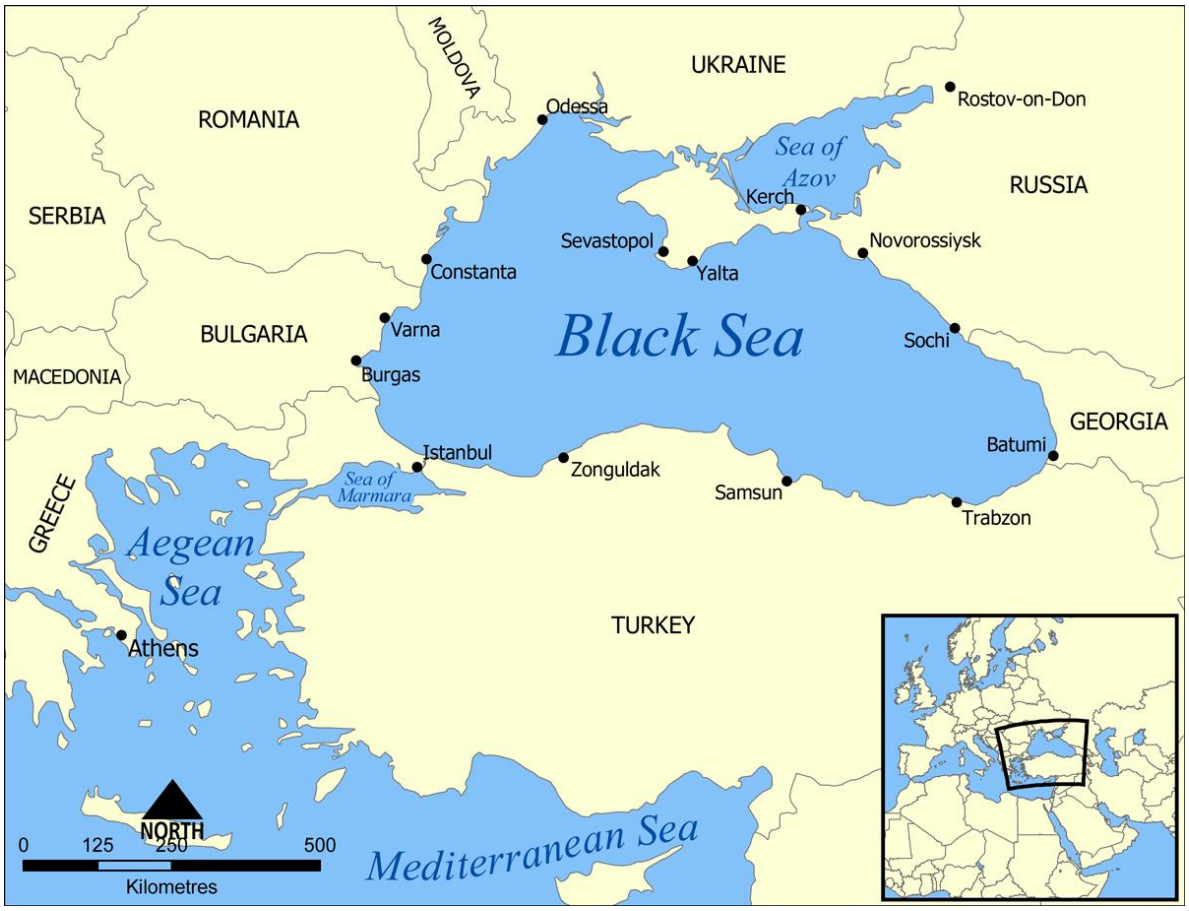

Figure 1. Map of the Black sea and surrounding countries. Source: Wikicommons.

1. Initial case study focus and problem context

In the MareFrame project, The Black Sea case study (see map in figure 1) was selected as representing a species and data-poor case. The focus of the case study is to restore the fisheries of Black Sea turbot (*Psetta maxima*) to productive levels, considering the ecosystem change that has occurred in the past 30 years (DoW – Part B: 16). The interest in this case relates to that the turbot is a highly valuable commercial species in the Black Sea, which has subjected severe declines in recent decades. The current advice for turbot of the General Commission for Fisheries in the Mediterranean (GFCM)[48] indicates the severity of the stock situation: "A recovery plan is needed. Fishing mortality has to be reduced to allow the biomass to recover" (GFCM 2014a). This advice was based on two different stock assessments, which covered different areas of the turbot population and deployed different assessment methods. The assessments nevertheless both support the conclusion and advice that there is a need for stock recovery aided by a recovery plan. The case study will benefit from, and ideally

[48] http://www.gfcm.org/gfcm/en

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contribute to, an ongoing initiative to develop a management plan for the Black Sea turbot (GFCM, 2014).

In addition to published and grey literature this note draws on information made available by deliverable D5.1 and information presented by MareFrame researchers involved in the Black Sea case study.

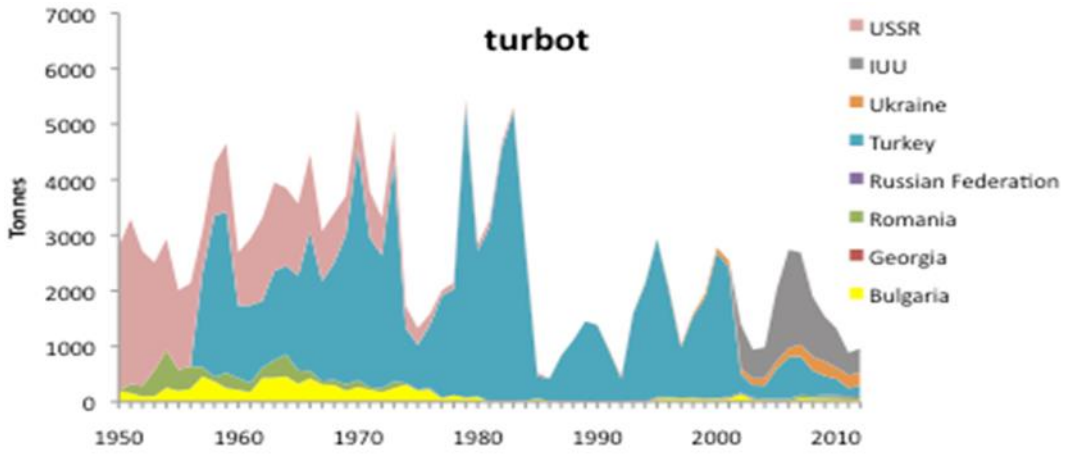

Figure 2. Catches of Black Sea turbot by country. The figure is imported from (Anon, 2014).

As described in MareFrame Deliverable D5.1, the decline in the turbot stock(s) seems to be related to anthropogenic as well as environmental factors. The main anthropogenic pressure on the turbot stock appears to be overfishing, notably the level of IUU is considered to be very high in recent years (figure 2). The focus on the restoration of turbot as a single species may initially seem to be at odds with the concept of an Ecosystem Approach to Fisheries (EAF). However, the restoration of the turbot fisheries calls for an EAF because it involves a number of environmental challenges that go beyond what is involved in a traditional single species approach to fisheries management . These challenges involve number of environmental factors that are likely to have a (negative) impact of turbot stocks in the black sea unless some remediating action is taken (Langmead et al., 2009), including:

- Eutrophication. The Black Sea was subjected to a reduced nutrient release in the 1990s after the economic collapse of East European countries, and the increased treatment of waste water in catchment areas. But in recent years nutrient release to the Black Sea has tended to increase again because of developing economies and agriculture systems.

- Invasive species. Notably the invasive jellyfish, *Mniopsis leidyi, which* predates on fish larvae and eggs of anchovy, and which competes with adult anchovy for food. Another invasive species is the rada conk, *Rapana venosa*, which predates on filter feeding mussels, and hence may exacerbate effects of eutrophication.

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One of the questions to be addressed through biological model developments concerns the structure of the turbot stock. Is there more than one turbot stocks? If so, what are their geographical limits? This question has important implications for the relevant management scope of the Romanian share of the turbot fishery, and for the identification of candidate stakeholders. As it is evident from fig. 2 , Romania is not a major player regarding the turbot fishery in Black Sea. A Romanian separate management plan therefore only makes sense if a separate turbot stock exists in the Romanian / Ukrainian area. The question of stock structure cannot be resolved at this stage, but must itself be explored through modeling and/or scenarios.

2. The governance context

The governance context relating to the Turbot fishery in the Black Sea has been described comprehensively in a recent background report written for the GFCM (Anon, 2014). This report covers the international and national agreements and regulations relating to the fishery and the marine environment it forms part of. For the present purposes, a selective summary will suffice.

The fisheries resources in the Black Sea are exploited by the 6 countries that border to the Black Sea (see above map). These countries are: Bulgaria, Georgia, Romania, the Russian Federation, Ukraine and Turkey. All these countries have claimed EEZs and (with the exception of Turkey) have signed the UNCLOS agreement, and there are no high sea areas in The Black Sea (Anon, 2014). The UNCLOS confers its signatories with (non-binding) responsibilities for managing fisheries resources within their EEZ as well as straddling and highly migratory fish stocks that are shared with other countries. Currently, however, there is no established common agreement on the management of fisheries in the Black Sea (Duzgunes and Erdogan, 2008). As EU member states, the marine resources of Romania and Bulgaria are governed by the CFP, the MSFD and the Water Directive. In addition, Bulgaria, Romania and Turkey have ratified the GFCM. Ukraine and Georgia (but not the Russian Federation) are participating in an ongoing initiative to develop a common management plan for Black Sea turbot, although they have not ratified the GFCM.

In Romania, the Ministry of Agriculture, Forests and Rural Development (MAFRD) is responsible for developing the fisheries, as enacted through the Directorate of Fisheries. The turbot fisheries is the second most valuable fishery in Romania, only surpassed by the fishery for the whelk *Rapana venosa*.

3. Stakeholders and participation in the case study

The case study is international as well as national. It is associated with the international GFCM initiative to develop a management plan for Turbot in the Black Sea. The case study is also national, with a focus on the Romanian Turbot fishery. The complicated national/international relationship is an important dimension of this case study.

The approach taken within the case study resembles the approach of the GFCM initiative for developing management plan for Black Sea Turbot (GFCM 2014): Ideally, a common plan could be developed and implemented on a regional level. However, a regional plan could also be implemented on a national basis (e.g. through resource sharing arrangements, mutual arrangements for monitoring foreign vessels in different national zones etc. Presently, no sharing agreements have been agreed on

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by the nations with fisheries in the Black sea, and there is little or no collaboration on regulating, monitoring and controlling fisheries activities, except for EU waters in so far that Bulgaria and Romania have established TACs as integrated within/associated with a plan for Monitoring Control and Surveillance plan). Economic data for the Romanian turbot fishery are presented in table 2.

Table 2. Economic data for the Romanian turbot fishery in 2012/2013. Reproduced from (Anon, 2014)

Operational Unit	Number of fishers	Turbot catches (tonnes/year)	Ex vessel price (EUR/kg)	Value of catches (EUR)
Vessels < 6 m	15	1.65	4.79	8 030
Vessels 6 – 12 m	136	31.68	4.79	20 145
Vessels 12 – 18 m	12	3.94	4.79	18 699
Vessels 18 – 24 m	7	4.25	4.79	150 154
Vessels 24 – 40 m	7	1.69	4.79	7 802

The Black Sea case study was launched internationally at a GFCM Working Group meeting on the Black Sea (WGBS). This meeting was held in Trabzon, Turkey, 24-25 February 2014 (GFCM 2014), which provided an opportunity to affiliate the case study with an ongoing GFCM initiative to foster the development of cooperative management plans for turbot and small pelagic fisheries in the Black Sea. In addition to the GFCM secretary and a representative of the EU, this meeting included participants in this meeting included representatives from national ministries and research institutions from 5 countries with fisheries interests in the Black Sea.

Subsequently, the Black Sea case study was launched May 2014 in Constanta, Romania in association with a National Coordination Meeting relating to the National Fisheries Data Collection Framework Programme.

The stakeholder group accordingly represents scientific experts, advisors and policy makers involved with fisheries management in the Black Seas, respectively on an international and a national (Romanian) level (table 3). This stakeholder group does not represent particular environmental or business interests, but mainly aims at advancing towards objectives of international and national policy frameworks for fisheries and the marine environment.

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Table 3. Types of stakeholders involved in the launch of the Black Sea case study at national and regional level. See text for clarification.

Level	Meeting details	Stakeholders / competences
National	Launch of case study in Constanza, May 2014	• fishermen and fishing organizations from Romania and from all six countries bordering the Black Sea; • National Agencies for Fisheries and Aquaculture (Romania)
Regional (Black Sea)	Launch of case study in Trabzon, Turkey, 24-25 February 2014	• Black Sea Commission/ Advisory Group on Fisheries and Other Marine Living Resources); • Black Sea Working Group • European Commission

Limitations and challenges regarding participation in the Black Sea case study

As pointed out, a basic challenge of this case study is that it includes national as well as international dimensions. This challenge has repercussions for the involvement of stakeholders. As indicated above, the appropriate scale of this case to some extent depends on the stock structure for Turbot. If this question can be resolved to some extent during the MareFrame project, it could have repercussions for involvement of stakeholders. E.g. if a Romanian stock can be established, the focus of the case study could be limited to that stock only.

Although the case study has been launched in meetings with many representatives present, there are types of interests that have not been represented. For instance, no environmental NGOs have been present. In general, it will never be possible to include the representation of all affected interests in a complex planning process. The consequent challenge for the case study will be to consider the main affected interests, including those that have not been articulated and championed by their relevant core representatives.

Another challenge relates to language. On an international level, stakeholders from different Black Sea countries do not share a common language. Further, MareFrame researchers based outside Romania will depend on translations in order to engage effectively with Romanian stakeholders.

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4. Elaboration of the scope of the case study problem

The case study strongly benefits from the possibility for being associated with the ongoing GFCM initiative to develop a management plan for Turbot in the Black Sea. This not only adds significance to the case study in so far it might be use in support of the GFCM initiative; it also contributes to a relevant elaboration of the scope, operational objectives, management measures and the use of indicators in the case study. In practice, the MareFrame partners involved in the case study therefore decided that the GFCM management plan initiative (GFCM 2014) will be used as a starting point.

The main challenge with regard to scope of the case study seems to relate to the unresolved issue of turbot stock structure and to the potential for commitment to international management arrangements. The participants in the GFCM initiative do currently not agree on the scale and model of cooperation. Some participants were in favor of a "subregional management plan, with common objectives, indicators and management measures to be followed by all riparian States". Others prefer "the adoption of regional guidelines, with a common structure for a turbot management plan, to support the development of national management plans". In practice, the participants agreed to develop a minimal structure for multiannual management plans for turbot fisheries in the Black Sea (henceforth referred to as the GFCM template). The GFCM template (GFCM 2014: Appendix C: 9-15). includes objectives, criteria, measures and recommended priority areas for research, and might be used in support for either a national or international management plan.

The template provides details that help to clarify the scope of the case study. In addition to the turbot stock or stocks is the main subject of the plan, the template identifies 3 main associated species to be covered in the plan (mostly as bycatch species). These are the chondrichthyes species picked dogfish, thornback ray and common stingray. The level of knowledge about the stock situation for the two latter species is poor as these were last assessed in the early 1990s, but landings of the three chondrichthyes species have severely declined in recent years (Anon, 2014). In addition, the plan aims at considering the issue of incidental catches of cetaceans.

5. Objectives, indicators and management measures

The GFCM template (GFCM: Appendix C: 9-15) outlines minimum requirements for a turbot management plan, including objectives, indicators, criteria and measures. This provides a good starting point for the decision support work within this case study.

The objectives are listed in table, together with a range of candidate operational objectives, relevant to gauge progress towards each of the above mentioned objectives. Quantitative thresholds have, however, not been defined for these operational objectives at this stage.

The template notes that indicators should be developed to enable environmental aspects with relevance for the turbot fishery, including water temperature and temperature related stratification, and as related to the mapping of hypoxia.

For the purposes of MareFrame, it might be useful to introduce objectives, indicators and criteria in addition to those identified in the GFCM template. This would seem particularly relevant for a management plan on a Romanian level, in order to contribute to that Romania can fulfill policy requirements of the CFP and the MSFD. Some suggestions are listed in table 4.

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Table 4. Objectives and candidate operational objectives for the Black Sea turbot management plan initiative of the GFCM. Source (GFCM, 2014).

Objective	**Candidate operational objective**
To counteract direct and indirect overfishing in order to ensure the sustainable economic viability of fisheries	To restore the biomass of turbot above agreed precautionary biological reference points (e.g. B > Btarget).
To restore, to the extent possible, the size of Black Sea turbot stocks at least MSY levels	To maintain fishing mortality within agreed precautionary fishing mortality reference points (e.g. F<Ftarget)
To guarantee a low risk for stocks of the associated species to fall outside safe biological limits	To keep fishing mortality of associated species at levels that allow them to be within safe biological limits
To reduce the extent of IUU fishing on turbot	- To implement as a priority the actions set in the GFCM Roadmap to fight IUU fishing in the Black Sea of relevance for turbot fisheries - To develop specific cooperation at Black Sea scale regarding the control of the turbot fishery
To ensure the protection of biodiversity in order to avoid undermining ecosystems structure and functioning	- To decrease discards of commercial and non-commercial species by (x)% in (y) years - To decrease the incidental catch of protected and endangered species - To reduce the amount of lost fishing gear and cage nets

Management measures:

With regard to management measures, the GFCM template recommends that "countries should consider the adoption of the following minimum conservation measures for the turbot fisheries":

- Measures to eliminate or diminish IUU;

- Spatial restrictions;

- Temporal restrictions;

- Effort restrictions;

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- Minimum size;

- Participatory restrictions;

For further details on the above, see (GFCM: Appendix C: 9-15).

Objective	**Candidate indicator/ operational objective**
Maintain biodiversity (GES 1 of the MSFD)	Shannon biodiversity index > x
Maintain foodweb integretity (GES 4 of the MSFD)	The Large Fish Indicator (relative weight of large fish in catches) > x; Mean trophic level > x
Ensure profitable fisheries	EBIDTA > 0
Ensure coastal settlement patterns and maintain job opportunities	Jobs in fish catching sector > x

6. Models

The WP 5 partners in MareFrame involved in the Black Sea case study are currently working on developing a GADGET model for the turbot fishery and the associated environmental and fisheries context. The first runs of the model are expected to be ready no later than March 2015. The intention is to develop an Ecopath with Ecosim model for the same case study at a later stage in the project. It is currently not clear if and how social and economic dimensions can be integrated into the GADGET model framework. At least, it should be possible to calculate likely economic impacts of different levels of future catches of turbot, e.g. by using current price information. To calculate profitability, cost information will be required. Employment forecast will require that some proxies can be developed to relate catches to employment. These issues should be explored further WP5 in order to enable the decision support work to take account of social and economic dimensions of the case study.

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7. Decision support work

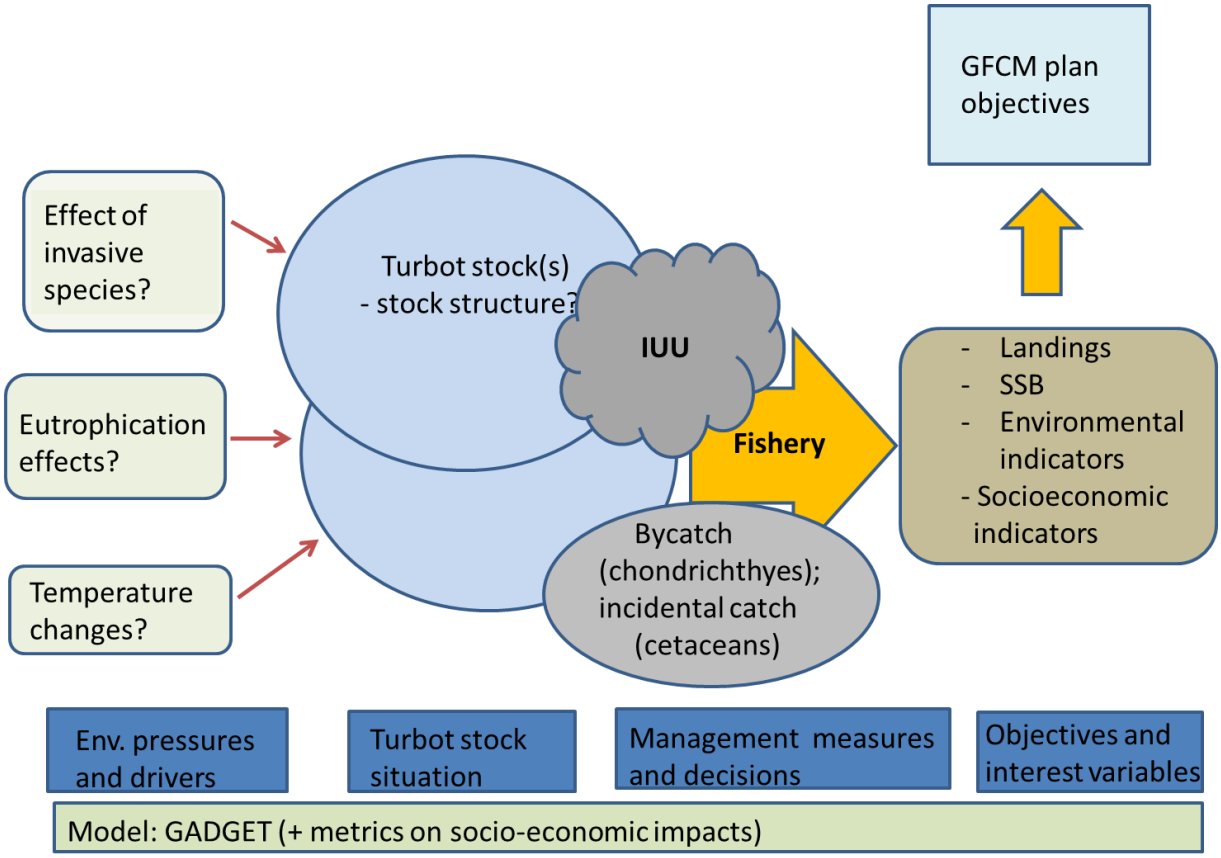

Figure 3. Simplistic mind map of the case study context provided as a summary of the model and general decision support approach (see above text for background).

The association of the MareFrame Black Sea case study with the ongoing GFCM initiative enhances the relevance of the case study, and supports it in terms of a consolidated scope and relevant information. GFCM template hence provides a good starting point for the decision support work within this case study. A simplistic mind map of the case study context is provided in Figure 3.

The further decision support work with this case study will be in accordance with the common plan outlined in the Appendix below. Notably, this involves the definition of management options the scenarios to be tested at the decision support workshop (summer 2015). Taking into account that the turbot is represented by several local populations mixing in the adjacent zones, three scenarios for the two ecosystem models seem particular relevant: a) unique stock; b) one of the stocks in western part of the Black Sea c) national stock. Scenario involving different levels of IUU will also be relevant. Other relevant aspects that could be included in scenarios include the use of management measures such as spatial restrictions; temporal restrictions; effort restrictions and limited entry restrictions.

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8. References

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Chatham Rise case study (New Zealand)

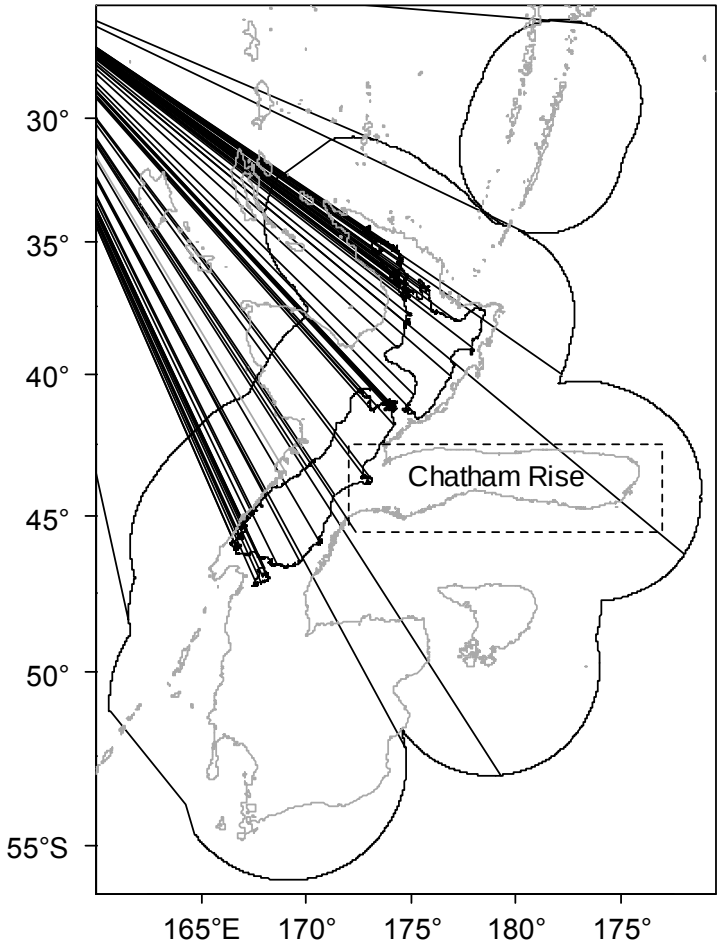

Figure 4. Location of the Chatham Rise case study area.

1. Initial case study focus and problem context

The Chatham Rise is a broad ridge lying to the east of central New Zealand and extending for c. 1400 km. Warm subtropical and cold sub-Antarctic waters meet at the western end of the Chatham Rise and then run eastwards forming the subtropical front, creating ideal conditions for primary productivity.

The subtropical convergence gives the region high biodiversity, and makes it the most productive in New Zealand waters. The ecosystem supports substantial commercial fisheries production, and also a high diversity of seabird, cetacean, and large pelagic fish species, many of which are protected under New Zealand law but threatened by human activities. The region also includes a number of seamounts, hills and knolls, which are also often sites of high productivity and the focus of some important fisheries, but often support extensive coral growths, which are very sensitive to physical impact by fishing or other disturbance. The Chatham Rise is one of the most intensively studied offshore marine regions in the New Zealand EEZ, and provides a species rich, data rich case study for the MareFrame project.

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The EAFM issues examined within this case study will include balancing multiple stakeholder (fisheries, conservation, seabed mining) interests, and the impacts of climate change, within an Atlantis model. This case study will provide important comparisons in many parts of this proposal.

2. The Governance context

The Chatham Rise case study area is exclusively within the New Zealand EEZ, and is managed under New Zealand jurisdiction. Fisheries are managed within the Quota Management System, implemented by the Ministry for Primary Industries (MPI), through individual transferrable quotas for most species (Fisheries Act 1996). Within the case study area, some areas of the seabed (along the top of the crest and some seamounts) are closed to bottom fishing methods (bottom trawling and dredging), in perpetuity [Fisheries (Benthic Protection Areas) Regulations 2007]. A number of top marine predators in New Zealand waters have been classed as threatened, and all marine mammals, almost all New Zealand seabirds, a number of sharks and rays, and deepwater hard corals are protected under the Wildlife Act 1953, administered by the Department of Conservation (DOC).

The Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012 (EEZ Act) provides a legislative framework for environmental management in the EEZ, to promote sustainable management of natural resources. The EEZ Act is administered by the Environmental Protection Agency (EPA). Fisheries are not covered by the EEZ Act (as they are covered by the Fisheries Act), but other activities of particular relevance to the case study area (prospecting, exploration and extraction of petroleum and minerals) are covered. An application to extract phosphorite nodules from a 1000 km^2 area on the crest of the Chatham Rise has been submitted to the EPA, and is currently (January 2015) under review.

3. Stakeholders and participation in the case study

Stakeholders involved in discussions on the case study include MPI, DOC, the fishing industry, environmental NGSs, and the mineral extraction industry. Discussions were held with stakeholders early in the project, and there have also been multiple additional communications through other activities. NIWA has been heavily involved in work associated with the application to the EPA to mine phosphorite nodules on the Chatham Rise, largely through provision of expert independent evidence to the EPA decision making committee.

Stakeholders were involved in the initial identification of potential scenarios to be investigated within the case study, but further discussion of these will be left until further progress is made with the development of the ecosystem models.

4. Elaboration of the scope of the case study problem

Fisheries and conservation interests have been active on the Chatham Rise for a number of years, and while conflicts over priorities occur, and there may well be potential to optimise the balance of activities, they are managed within existing arrangements. The issue likely to cause greatest

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difficulty in balancing trade offs is the potential development of seabed mining on the crest of the Chatham Rise. An application to mine phosphorite nodules is currently under review by the EPA, and has received opposition from both the fishing industry and conservation interests. Concerns have largely been raised over the impact the seabed mining and associated spoil discharge will have on the Chatham Rise ecosystem, and the ecosystem services currently provided by the area to be mined (which is currently largely protected from fishing by a Benthic Protection Area). Incorporating the potential impacts of seabed mining into an ecosystem model will be a key challenge for the case study, in order to address the trade offs appropriately.

5. Objectives, indicators and management measures

Preliminary objectives, scenarios and indicators for the Chatham Rise case study are provided below. Further discussions with stakeholders are required before this can be developed into a final list. The main scenarios associated with multiple users of the environment relate to the trade offs between fisheries, mineral extraction and conservation interests. Spatial management controls already exist within the case study area (Benthic Protection Areas), and may be a basis to manage the newer trade offs appearing.

MANAGEMENT PRIORITIES	OBJECTIVES	SCENARIOS	INDICATORS
Sustainable management of fisheries	Maintaining stocks above target levels	Investigation of different approaches to maintaining the exploitation of target stocks and bycatch at sustainable levels	Biomass based reference points. Continued MSC accreditation
Balanced trade off between fishing, conservation and seabed mining	Balancing requirements for sustainable fisheries and environment while exploiting mineral resources	Investigation of the implications of seabed mining on the Chatham Rise	Biomass based reference points.
Implications of climate change	Manage fisheries in a manner robust to climate change	Evaluate the effects of climate change scenarios	Biomass based reference points.
Conservation of seabirds, marine mammals and other protected species	Maintain seabirds and marine mammal populations at healthy levels	Examine implications of different fishing practices, including closed areas to protect benthic communities	Risk ratio (total annual potential fatalities/Potential Biological Removal, PBR)

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6. Models

There is an existing balanced foodweb (EcoPath) model for the Chatham Rise, and this has been updated, and it is planned to develop this into an EcoPath with EcoSim (EwE) model. Within MareFrame, an Atlantis model of the case study area is being developed. These models will provide contrasting approaches to compare with single species fisheries assessment models, and other relevant data.

Conclusion

The main management issue and some priorities and management measures have been identified and elaborated during the case study meetings. The launch of the case studies provided a good basis for the decision support work but further work is needed to develop management options and the related decision variables. The needed progress with this work is dependent on sustained dialogue between stakeholders and researchers in WP4, WP5 and WP6. As MareFrame approach to management is co-creation it would be vital that stakeholders consider the selected issues as a relevant and timely themes benefiting from decision support.

The so far roughly defined management alternatives and objectives have to be discussed in more depth in order to enable appropriate decision tools and models to be selected and developed. However, the candidate decision tools have been proposed for each case study.

Most of the planned modelling and decision support work focuses on multispecies fisheries considerations, in particular in identification of maximum sustainable and/or maximum economic yield in a multispecies context. The work with the case studies represent an ecosystem approach to fisheries management in so far that effects of species interactions, environmental forcing, and effects of different management measures in relation to GES descriptors are taken into account[49]. The description of all case studies bear witness to that more focus has so far been put on the ecological and fisheries technical aspects than on the potential socio-economic implications of alternative planning outcomes (Table 1). Consequently a further effort is clearly be necessary to better identify socio-economic indicators, also in collaboration with WP4, WP5 and WP7, to be included in the modelling work. Continued application of the co-creation approach to refine formulating and implementing the scope of the case study issues the way they are represented in models will be essential to providing adequate support for usable management proposals. The co-creation process in the CS also addresses the involvement of categories of stakeholders as well as fishermen representatives, to incorporate for example local and regional conservation priorities (.e.g. the use of GES indicators and threshold levels) into management scenarios.

It is important that key required outputs (the interest variables) from the ecosystem models are defined as soon as possible for two reasons: 1) It may be necessary to adapt WP5 models in order for them to deliver required types of outputs. 2) Early identification of types of outputs will help WP6 partners (MAPIX and TØKNI) with developing the DSF interface.

[49] E.g. Descriptor 3 of the Marine Strategy, criterion 3.1. and 3.2 (Commission Decision 2010/477/EU).

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Table 1. Synthesis of the identified management issues and major concern to be addressed prior to the test of prototype I.

Case study	The identified fisheries management issue	Concerns
Baltic Sea	• Identification of maximum sustainable yields (MSY) within a multispecies context for cod, sprat and herring in the Central Baltic Sea.	• EwE has a working parameterization for the cod, sprat, and herring stocks in the Central Baltic Sea but it is not spatially resolved. The multispecies stock-production model still needs more development effort to run. Gadget is the least ready model. They might not be operational in the required extent to provide forecasts at the test of prototype I in June 2015. • None of the modeling frameworks actually include socio-economic parameters per se. These could in principle be added to the model specifications but it is not clear if there are resources for this in MareFrame. • There is an apparent need to broaden the stakeholder participation in the next meetings.
North Sea	• The management issue involves the North Sea multispecies system, landing obligations, and law abiding fisheries. The pelagic fisheries might perhaps additionally be considered as a segment to study in greater detail. The essence of the study would be to explore ways of achieving EAFM that worked with the grain of the fisheries and encouraged responsible and law abiding fisheries. As part of this there is a need for identifying current combinations of regulation that act against these aims. Central to this will be providing a simplified form of the proposed models that stakeholders can use as a tool to explore various management options and see the EAFM consequences of various alternative approaches. • Questions about the size structure could be given, and an indication about the strength	• The proposed models may not serve in forecasting biodiversity or other ecosystem effects. • Issues of 'responsible and law abiding fisheries' calls for a very different sort of perspective and models, e.g. behavioral models. Is that EAF? Who could do that? Will WP4 be able to include any behavioral models? • Meaning of the word "bycatch" and "discard" may be intermingled. Also, the composition of discard matters. Taking the absolute or relative discard is not enough, but what matters is the type of discard: same species, but undersized; abundant other species; rare or even threatened other species;

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	of various feeding guilds based on the limited number of species in the models could be provided. Information about the impacts on the seabed depending upon the mixture of gears chosen (e.g. more or less beam trawls and dredges) could also be obtained. Equally, significant by-catch changes of vulnerable species such as marine mammals could also be predicted depending on the mix of gears chosen (more or less gill nets and trammel nets). Some indication could also be given about the amount of food discarded for scavenging sea birds	commercially vs. non-commercially exploited, etc. How about discard dependent species such as marine birds?
Northern & Western Waters – Iceland Waters	Stakeholders in Iceland are generally happy with the sustainable utilisation policy the government has followed. The major differences have to do with socio-economic issues. In particular how the resource rent should be divided, how and to what extent the fishery should be taxed (resource rent taxation), how much each fleet segment should be allowed to harvest, the quota ceiling currently in place and the transferability of quotas, as well as - to a certain extent - the effect the management system has on profitability, wages, employment and migration. • The main interest would be on a stable and strong cod fishery in Icelandic waters. On the economic side, relevant questions include: • Should quota consolidation barriers be removed, currently it is at 12% of total allowable catch. • Effects of municipality controlled quota. • Aggregation of small and large type fishing vessels. Currently small type vessels are treated separately. • Should the industry to take into account socio-economic factors.	• It will only be possible to model very few of the socio-economic effects of the alternative management strategies. The Marine Research Institute staff is using Gadget which can only allow for changes in effort and fleet structure. • "Changes in fleet structure" are primarily referring to increase/decrease in the share of the small-scale fleet in the overall TAC. • It is doubtful that it will be feasible to model any of these socio-economic affects in Gadget. Instead, we could interpret the outcomes that Gadget gives us on a socio-economic scale.
Northern Waters – West coast of Scotland	• Whitefish stock recovery, seal predation, by-catches of juvenile fish by the Nephrops fishery, maximum economic yield, trawling impact on seabed, climate change.	• The identification of suitable indicators and thresholds for socioeconomic performance as well as a way model the changes in these depending on management choices; the identification of concrete management measures to improve the situation for gadoid stocks.

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South West Waters, The Gulf Of Cádiz	• Increased habitat protections and the threat of dredging the Guadalquivir River estuary, emerged as priorities from the more environmental stakeholders. Less interest than expected was focussed on small cetaceans or other species conservation. The fishery sector made a very clear claim to MareFrame. They are perfectly aware of the intrinsic fluctuation nature of this fishery and that this has an imponderable environmental origin. They asked us to search for a tool to manage the fishery in a fashion that could help to smooth these strong fluctuations in favour of more stable incomes, including the fluctuation between anchovy and sardine the catches of the pelagic fleet.	• Stakeholders have addressed several management concerns. There likely will not be possibilities to consider them as the main objective is developing an in-seasons management scheme for a highly dynamic species, spiced up with an ambitious goal to link an additional pelagic stock to the management framework via application of an innovative insurance scheme.
Mediterranean Waters - Strait of Sicily	• The loss of productivity of the fishing enterprises due to a series co-occurring factors such as: i) increasing of oil price, ii) poor market condition (e.g. low gross prices of fish products), iii) increased and unregulated access at the fishing grounds of the area in international waters, iv) old age of the trawlers, v) lack of marketing actions to increase the value of the products. There is a general poor understanding of the negative global effect of overfishing on the economic performance of the fisheries. Several scenarios identified to be tested in MareFrame. • Given the ongoing crisis of fisheries in the area the key objective now is to ensure the sustainability of multispecies fisheries (effect of current effort, effect of climate change, effect of increasing running costs, etc.). Indicators can be basically F, SSB, socio-economic indicators complemented with GES for Descriptor 3 of the MSDF.	• It is not clear how some of the emerged socio-economic issues can be addressed in practise. Some of them (oil price, poor market condition) are independent by the fisheries. Probably it is possible to simulate in the short and mid-term (stock-recruitment functions are lacking and long term simulations may not be feasible) the effect of a reduction of fishing mortality/ fishing effort on the stocks and in turn on yield and the economic performance of the vessels. • The economic effect of MPAs and other technical measures can be simulated with Atlantis and to a limited extent for hake and its preys also with Gadget.
Black Sea	• To restore the Black Sea turbot stock fishery productive levels.	• The challenge of determining the Black sea turbot stock structure; the modelling of socio-economic impacts and the identification and likely effects of management measures on national and/or international scale
Chatham Rise	• The main scenarios associated with multiple users of the environment relate to the trade offs between fisheries, mineral extraction and conservation interests.	• None identified

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One of the main challenges of the project is to incorporate the good environmental status indicators (GES) of the Marine Strategy Framework Directive into models in order to forecast the possible outcome of different management and climatic scenarios. Ideally, to associate the expected impact of fisheries with the ecosystem, the links between management alternatives and the fisheries related 4 descriptors in MSFD needs to be identified and described by quantitative models:

- D1 Biodiversity
- D3 Commercially exploited fish and shellfish stocks
- D4 Marine food webs
- D6 Sea-floor integrity

The indicators and criteria for these descriptors are national. They are most likely being developed right now. Contacts to a knowledgeable person at ministry or fisheries agency, via help of CS leader, should be sought to receive more info about the status about indicator and criteria work. The questions might be, for example, whether there are they relevant w.r.t. case study issue? Are there national socioeconomic indicators, and if so, what are they? As, fisheries are multinational in many case study, we possibly need to consider these indicators jointly in several countries.

Acknowledgement

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Appendix

The Decision Support Framework timelines in MareFrame.

DSF Roadmap

When		Who
May 2014	Launch of case studies; initial definition of case problems and priorities	WP5 case researchers and stakeholders
Nov. 2014	Prepare and characterize cases for decision support (the purpose of WP6 template); contribute case text to D6.1 by 01.12. 14. Deliverable deadline 01.01.15	WP6 case leaders - in dialogues with WP5 case researchers and stakeholders
	Continous development of generic DSF and case specific DS approach. (01.01.14- 01.05.15)	WP6 case leaders - in dialogues with WP5 case researchers and stakeholders
Mar. 2015	Decision Support workshop in Helsinki	WP6 case leaders
Jul. 2015	Test of DSF prototype 1 (interface and DS tools by cases; recommended that this is done in cooperation with WP7 review work);	University of Iceland
	Case specific DS workshops. Use DSF protype; obtain specifications of case scenarios to be tested in WP4 for EAF management plan proposal.	WP6 case leaders - in workshop with WP5 case researchers and stakeholders
	[Continous case work, MP proposal work; Continous DFS development work].	WP6 case leaders - in dialogues with WP5 case researchers and stakeholders
Mar.2017	Management Plan 1 documents available for each case.	WP6 leaders and WP5 case leaders .
Jul. 2017	MareFrame DSF platform : Make all we have done available, including the DSF software, plans, reports, user guideline/instructions etc	All WP6 members
	Test of MareFrame DSF protype II	University of Iceland
Sep. 2017	M45: Final Management plan proposals reported	WP6 leaders and WP5 case leaders .
	M45: WP6 Synthesis: Report what we did and what we learned etc.	All WP6 members