Appendix 1 – Technical Annex

SIXTH FRAMEWORK PROGRAMME
PRIORITY 8

INTEGRATING AND STRENGTHENING THE EUROPEAN RESEARCH AREA - POLICY-ORIENTED RESEARCH (SSP)

SPECIFIC TARGETED RESEARCH

Description of Work

(Public version)

Project acronym:	**EFIMAS**
Project full title:	**Operational Evaluation Tools for Fisheries Management Options**
Proposal/Contract no.:	**502516**
Project Period:	**1 April 2004 – 31 March 2008**

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Central Terminology used in the project contract:

Fisheries management evaluation framework:	The overall management evaluation framework consisting of WP3, WP4 and WP5 (see overview figures in section 7).
Operating Simulation model:	The stochastic management simulation operating model developed in WP3. This is actually a strategic evaluation tool.
Descriptive models and analysis tools:	Existing or modified and further developed existing fisheries assessment descriptive models and analysis tools applied to case study fisheries. These are actually tactical management tools.

1. Project summary

The objective of the EFIMAS project is to develop an operational management evaluation framework that allows evaluation of the trade-off between different management objectives when choosing between different management options. The evaluation framework will be developed to inform an exploratory, adaptive decision- making process. Evaluation tools will be developed to appraise the biological, social and economic effects of fisheries management measures in the EU, and these will be applied to important fisheries. The tools will take account of the dynamics in the fisheries systems, as well as of uncertainties and will include risk assessments.

The overall approach uses stochastic simulation techniques. These cover the full scope of the fisheries system from the fish resources, through data collection, assessment and management, and the response of the system to management. The input data to the management system are generated by a descriptive model, which is assumed to represent the “true / real” system. The input data are then processed by a traditional assessment model, or by an alternative model, which is used to generate management advice. By simulating the effect that the resultant management actions would have on the ”true / real” system it is possible to generate a range of performance measures, covering the resource and the fishery. These measures can then be compared across different assessment models and management approaches.

To give an example, a change from stock-based to fleet-based management would represent a change in paradigm of fisheries management. Such a change would allow advice to be given in the form of effort limits, and would account for technical interactions and might also involve economic and social parameters. In this case the evaluation tools would simulate both stock-structured input data and fleet-structured input data; it would perform the traditional assessment with stock-structured data and alternative assessment with fleet structured data. Replicate runs including stochastic variation would be used to estimate probability distributions of the performance measures of the two alternative management scenarios so that their performance could be compared.

The operational evaluation tools will be developed in parallel with an evaluation of their utility in informing a decision making process and will be modified according to experiences from their use by stakeholders. The tools will be implemented in a range of case studies including important European demersal, deep-sea and pelagic fisheries and will be modified on the basis of experiences from case implementation.

2. Project objective(s) – and Background and State of the Art

Task and strategic objectives addressed :

Task: SSP (Scientific Support to Policies), Integrating and Strengthening the European Research Area.

1. Sustainable Management of Europe's Natural Resources

1.3 Modernisation and sustainability of fisheries, including aquaculture-based production systems

Scientific Basis for Fisheries Management

Task 1: Operational Evaluation Tools for Fisheries Management Options

Objectives Research is to develop operational evaluation tools to appraise the biological and social and economic effects of fisheries management measures in the EU, and apply these tools to important groundfish, deep-sea and pelagic fisheries. The tools must take account for uncertainties and should include risk assessments.

Background and State of the art

European fisheries management is under pressure and in a process of reform. While several important stocks are depleted and fleets are facing reduced catch options there are increasing demands for management decisions to be more inclusive for stakeholders and to include fleet interactions, environmental effects on fisheries and the effects of fisheries on the environment and the ecosystem in decision making. There is, thus, both a pressure for better informed and more inclusive decisions and an expanding scope and inclusion of an expanding range of objectives for management. The challenge is to ensure that the best available knowledge is synthesized and made available to the decision making process in a way which informs and assists decisions and communicates complex insights effectively to the increasing number of stakeholders involved in these decisions.

Fisheries management pursues various objectives through a range of management measures. Decisions about management measures are choices between different sets of expected outcomes which relate to these objectives. It is important that such decisions are informed by the best possible assessment of expected outcomes for a multitude of objectives for the various management options. Decision making should therefore be based on explorations of options informed by an evaluation tool which compares expected outcomes relative to management objectives for various management options. Although the effects of some specific management options may be relatively easy to predict, others are more difficult to envisage due to uncertainty in the dynamical processes, our limited ability to monitor, assess and control natural systems and because the adaptations of fishing fleets to management measures and the efficiency of management implementation are difficult to predict. This creates a difficult situation for managers and stakeholders alike when debating different management options (e.g. TACs, effort control, technical measures and on the longer term recovery plans and harvest control rules). There is thus a need for an evaluation framework to be available to structure and communicate existing knowledge in terms of data and knowledge about processes, enable exploration of options within specific management procedures with an evaluation of trade-offs between various objectives and of the robustness of the options (to assumptions, model and data error) and risks involved.

It is increasingly recognized that management strategies can only be developed in a close dialogue between stakeholders and science, where the role of science will be both to evaluate proposed strategies, but also to advice on which kinds of strategies that can be worth considering. The interaction between science and management or policy decisions is not trivial and there has been a range of studies of the conditions for a constructive interaction. The effectiveness of any given policy is determined not only by the scientific validity of its modeling tools but by the processes by

which policies are identified and implemented. Simply designing an accurate modeling alone does not ensure effective policy. If the tool is not carefully presented and used it can have an un-intended impact on achieving overall policy goals. Good models can give decision makers a better handle on the risks of decisions, but the public perceptions more often focus on how decisions are made than they do about questions of risk (Chess and Lynn 1996). Research has shown that the public can perceive experts as overly confident about their data, having narrow definitions of problems, and hence overlook important information (Waller 1994) and these perceptions can undermine or even work against a rational public reception of the decision (Kaminstein 1996). Complex models can potentially exacerbate these problems. Distrust of scientists and scientific information is particularly acute in fisheries (Pederson and Hall-Arber 1999). The role that quantitative models play in these issues of perception has only recently begun to receive attention as a distinction subject within studies of effective communication of science-based policy (Yearley 1999). The research proposed here will not only seek to ensure that the evaluation tool that is created take issues of stakeholder perception into account, but it will also make direct attention to scientific communication in other fields.

The framework proposed here will be based on the use of computer-based simulation to explore options through a comparison of the expected performance of candidate management and assessment strategies relative to the management objectives. The development and use of such frameworks was pioneered by the International Whaling Commission (IWC 1992, 1993, Kirkwood 1997) which used this approach to test the potential future performance of alternative proposals for new whaling management procedures.

Scenario modeling is not yet implemented on a routine basis in Europe but there are examples where scenario simulations have been used to evaluate management strategies before implementation. A scenario modeling approach was used to decide upon Harvest Control Rules for Iceland cod. The HCR for Icelandic cod is now being revised incorporating knowledge obtained from the implementation of the original HCR, for example changes in selection pattern when the TAC is limiting. Two studies commissioned by the EU evaluated multi-annual management strategies through simulation for seven major flatfish (MATACS) and eight major roundfish stocks (MATES) in the ICES area. A HCR for North Sea Herring was evaluated and adopted in the agreement by Norway and the European Community in 1997. For Norwegian Spring Spawning Herring, a harvest strategy was adopted in 1999, based on evaluations done by a study group appointed by the Coastal States in 1999 (Bogstad et al 2000). The harvest strategy has since then been extended, based on simulations done by ICES.

The present project will build on these experiences.

Objectives and expected achievements:

The objective of the project is to develop an operational management evaluation framework that allows evaluation of the trade-off between different management objectives when choosing between different management options.

This project will facilitate the exploration of management options in the decision making process by developing an operational fisheries management evaluation framework to consider plausible hypotheses about the dynamics of the stocks and fleets and explore the relative expected merits of different management options on basis of these hypothesis. The evaluation framework will thus be developed to inform an exploratory, adaptive decision making process rather than to pretend to predict specific outcomes of single management options.

The evaluation framework will appraise the biological and social and economic effects of the existing fisheries management measures in the EU, which can be applied to important demersal, deep-sea / widely distributed and pelagic fisheries, under a range of plausible hypotheses about stock and fleet dynamics. The evaluation will compare different management options in respect of their trade-offs between objectives and their expected outcomes. The intention is to only recommend for implementation of management options that have been evaluated through the framework.

The framework will be based on an understanding of the processes contributing to the overall performance of a fishery and it will be used to consider a range of management options that explicitly take account of uncertainty (parametric as well as structural uncertainty) and assessments of outcomes will be associated with risk assessments.

The management evaluation framework will be developed so that stakeholders can evaluate management options in relation to specific objectives and desired properties of the management procedures. This process will enable participants in the decision-making process to explore management options by comparing the expected performance and expected outcomes of various management options on the basis of an evaluation and simulation framework.

The framework will be tested through evaluation of the relative effects of the application of different specific management options to specific case studies.

The evaluation framework will comprise two parts, a model of the fishery to be managed (i.e. the operating model) and the management procedure (which includes methods for monitoring and assessing the status of the system as well as the management options). The evaluation framework will include an operating model and will be able to evaluate and simulate different management options using output parameters and results from statistical hypothesis testing and from analyses performed with relevant descriptive models and analysis tools addressing main fisheries advisory and management problems as well as dynamics of the system. Consequently, output and results from the analyses will be used in the evaluation framework partly to parameterise the operating model and run the simulation trials and partly to perform overall evaluation where parametric simulation of parameters is not possible. As a prerequisite to the development of the management evaluation framework, a range of research questions will be addressed in the project. Questions will be determined by the main, typological advisory and management problems encountered with important EU fisheries. They also depend on the scope and role of simulation models to inform management decision processes and how various types of knowledge are best brought to use in management decisions.

The evaluation framework will be refined by work on specific case studies covering key EU demersal fisheries, widely distributed fisheries and semi-pelagic fisheries. For each case study, specific advisory and management problems will be selected and the evaluation framework will be developed to address these problems for that case.

The framework will be developed with the decision making process in mind by enabling exploration and comparison of management options in relation to their performance in relation to various objectives. The effectiveness of the evaluation framework to inform stakeholders in the decision making process and assist their exploration of management options will partly be evaluated in processes where stakeholders use the framework for exploration. The outcomes of these evaluations will be used iteratively to improve the capabilities of the evaluation framework to inform and assist decision making processes further.

The framework will include a range of options relating to the fisheries system and management measures. Fisheries can be modelled as mixed fisheries (multi-species / multi-fleet fisheries). Spatial aspects can be modelled thus enabling consideration of Marine Protected Areas options (e.g. closed boxes). The modelling of fisheries includes the bio-economics of fleets, and economic instruments for fisheries management are taken into consideration. Consequently, the common framework will allow to integrate i) biology, population dynamics, ii) economy, bio-socio-economy while addressing specific fisheries and fleet capacity and considering the environmental impact of fishing actions (e.g. by-catch and discarding).

The project will not make development of entirely new descriptive models or of a new management procedure or new basic management paradigms or totally new specific management models outside the CFP, but rather development of a framework to evaluate options within the present CFP. The expected evaluation framework will thus move the present approach toward an approach that

integrates in some respect that of the International Whaling Commission Management Procedure. The evaluation framework developed here will be able to explore the most innovative options possible within the present CFP, including e.g. multi-annual, multi-fleet management, Marine Protected Areas. Note that presently the CFP does not recommend whether TAC's must be set on the basis of annual short-term predictions or could be based on longer-term adaptive approaches and the framework will be developed to evaluate the relative merits of both these options.

The aim of the project should be to guide fisheries managers and different stakeholders, including the catching sector, in their capability to make strategic choices. Hence, the project should provide outputs that enable to compare alternative options, e.g. in terms of stocks and economic returns, but it is not aimed at providing absolute performance measures for each option to address e.g. the questions: which strategy is likely to give better returns relative to objectives than another strategy? The output from the evaluation and simulation framework will be a suite of measures of performance of fish stocks and fishing fleets. Alternative management regimes and assessment parameters can be evaluated by comparing the performances. The expected prediction power of the simulation will not lead to quantitative results, but rather relative measures. The end result of this project is aimed to be valuable in providing guidance not only for fisheries managers but also other stakeholders in making strategic choices.

The performance of the candidate management options used in the evaluation framework will be evaluated and further recommendations made on research and management options to be explored. This will proceed as a feed-back system (for each case study) with respect to recommendations on further investigations needed, more relevant alternative hypotheses to be addressed, alternative descriptive models to be applied, etc. as well as recommendations on other more relevant or desirable management options and objectives.

Research objectives

Within the present research programme the research questions/hypothesis and objectives will be stated at two levels – one relating to the general level, to the evaluation process and the overall development of a management evaluation framework, and one relating specifically to the case specific advisory and management problems to be addressed with selected descriptive models and specific analyses.

As a prerequisite to the development and refinement of the evaluation framework, the project will address the following general research questions about the evaluation framework:

- What are the critical limitations in informing management decision processes in the CFP in the present management setup – in terms of outcome evaluation, trade-off between objectives, robustness, cost-efficiency and efficacy? This question will assist the project in focusing on specific properties of development of an operational evaluation framework so that it can make a difference and be useful by overcoming these limitations.
- How can outcomes (in the light of the different objectives) be evaluated in a way which best conveys information on trade-offs between objectives? Fisheries management is basically about balancing conflicting objectives. Evaluating the trade-off between different objectives with different time horizons is therefore central to management decisions, and the evaluation framework should be able to inform the management decision process in this respect. However, informative comparison of outcomes for different objectives will require that the framework is able to analyse disparate types of outcome, and that results can be communicated. This question does thus have both a technical and a communicative dimension. This question will assist the project in ensuring that the evaluation approach and communication is relevant to the central aspects of management decision making.

Research and technical questions relating to specific cases:
Within the various case studies a suite of main generic advisory and management problems as well as main issues specific to the case will be addressed. The case specific issues relate to the specific management problems and the characteristics of the fisheries system. Research questions which will be addressed in one or more case studies relate to

The characteristics of the stocks and the fisheries – what are the specific outcomes for management options in special cases such as:

- Multi-fleet mixed fisheries
- Fisheries dependent on strong year classes
- Simultaneous management of fisheries targeting stocks with very different biological characteristics

The Management options – what are the trade-offs between protection and exploitation and the time sequence of recovery versus economic and social indicators for various types of management:

- multi-annual, multi-fleet management procedures versus annual management
- effort management versus TAC management or combinations of these and including specific technical measures
- area-based management versus effort or TAC management

The assessment and decision making process:

- What are the consequences of not including certain types of knowledge (economic, social, environmental) in the decision making process
- What are the shortcomings of assessment, decision making and management implementation which have led to failure
- What is the balance between cost and accuracy and how does this relate to the requirements of various management procedures
- What are the evaluation and management options in data-poor situations

These research questions are presented in detail in section 7 under WP4 as well as in Annex B to the project contract under the relevant case studies. Scientific hypotheses about the dynamics of the systems to be addressed in the project will be identified and tested based on these scientific and technical questions relating to specific types of main advisory and management problems, as well as to the descriptive models involved in advising and management. The various cases are used as a test-ground for specific parts or features which are to be evaluated by the management evaluation framework.

Details of overall project objectives and aims in relation to specific project work packages:
In continuation of the above described overall project objectives and aim of the project detailed and specific project objectives in relation to the different project work packages are presented and thoroughly described in section 7 (section 7.1 and especially section 7.6) of this technical Annex 1 under the work package descriptions. Furthermore, the basis and objectives of different work packages and the interaction and the continuous cyclic feed back system between the different work packages and the workshops are described in Section 7.1 of Annex 1.

References to Background and State of the Art Section:

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3. List of Participants

List of Participants

Partic. Role*	Partic. no.	Participant name	Participant short name	Country	Participant responsible person	Email address	Date enter project**	Date exit project**
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CR	4	Institut Francais de Recherche pour l'Exploitation de la Mer	IFREMER	F	Dominique Pelletier	dominique.pelletier@ifremer.fr	Month 1	Month 48
CR	5	The Scottish Ministers act. thr. Fisheries Research Services Marine Laboratory	FRS	UK, Scotl.	Coby Needle	c.needle@marlab.co.uk	Month 6	Month 45
CR	6	Finnish Game and Fisheries Research Institute	FGFRI	SF	Sakari Kuikka	skuikka@mappi.helsinki.fi	Month 1	Month 48
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CR	23	IREPA ONLUS – Istituto Ricerche Economiche Pesa e Aquacoltura	IREPA	I	Vincenzo Placenti	placenti@irepa.org	Month 6	Month 45
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*CO = Coordinator
CR = Contractor

** Normally insert “month 1 (start of project)” and “month n (end of project)”
These columns are needed for possible later contract revisions caused by joining/leaving participants

4. Relevance to the objectives of the specific programme and thematic priority

The project addresses the scientific, technical, wider societal and policy objectives of the priority eight. As regard to Task 1, Priority 8, the following objectives are stated in the task description:

"Research is to develop operational evaluation tools to appraise the biological and social and economic effects of fisheries management measures in the EU, and apply these tools to important ground-fish, deep-sea and pelagic fisheries. The tools must take account for uncertainties and should include risk assessments"

(An introduction to this section in form of description of Background and State of the Art in relation to the objectives of the specific programme and thematic priority is given previously in section 2 of this document).

Scientific objectives:
The project will develop and operational evaluation framework (evaluation tools) to appraise the biological, social and economic effects of fisheries management measures in the EU.

The evaluation framework (tools) will be generic in the sense that it will be able to evaluate most existing management systems and descriptive models and analysis tools used for production of management advice (fisheries/stocks evaluation models and tools), as well as systems not yet implemented, but which can be simulated. The evaluation framework can compare alternative management systems producing relative measures of performance applying output from either currently used or appropriate alternative descriptive models and analysis tools in question.

The framework will be applied to important EU fisheries. Several case studies will be carried out in this project. For each case study specific advisory and management problems will be addressed. The selection of case studies will be made to serve the purpose of testing the evaluation of the generic management evaluation framework. The criteria for selection are not to cover the entire spectrum of European fisheries, but to select cases which represent the spectrum of management problems. In addition, the main features of different fisheries systems will be covered (i.e. demersal / pelagic / widely distributed, Northern / Southern Europe, data availability (good/poor), etc. As a second priority for selection will be importance in terms of value and biomass of catches.

The framework will be based on an understanding of the processes contributing to the overall performance and it will take account of uncertainties (parametric as well as structural uncertainty) and it will include risk assessments.

The five main types of uncertainties to be evaluated are

1) The dynamic processes (phenomena not fully understood, e.g. variation of recruitment)
2) Measurement errors (error arising from sample-based estimation)
3) Estimation errors (errors arising from incomplete or biased samples)
4) Model mis-specification (inadequate model, e.g. use of single species model to describe mixed fisheries systems)
5) Implementation errors (error arising from management measures not having the expected effect)

The project will perform risk assessments by stochastic simulation of the errors listed above. The framework will evaluate "descriptive models" and "analysis tools" assumed to represent the "true world". The framework will through the operating simulation model simulate collection of samples from the "true" system, which in turn will be used as input to the simulation of management. The creation of stochastic input data will be repeated a large number of times, which will allow for estimation of probability distributions of output from the management systems (the measures for system performance). These probability distributions will form the basis for risk analysis.

Technical objectives:

The project will provide a software package with full documentation, which can be used by scientists, managers, industry and other stakeholders if fisheries. The package will contain options for different levels of presentation, accommodating a wide range of stakeholders.

The highest level of user-friendliness will be attempted when developing the software. The user interface will become intuitive and readily available for potential users.

Emphasis will be given to the presentation of results, and the input and assumptions behind the results. Transparency will become a key-issue when developing the presentation module of the software tool.

The software tool will be distributed together with a suite of case study documentations, representing important EU-fisheries systems.

This evaluation framework can be used to evaluate results and output generated from other software packages (descriptive fisheries/stock assessment models and analysis tools), analyses, and existing databases being used for production of advice to management bodies.

The software package will take both data and parameters and results from models representing alternative management strategies as input. The alternative models will appear in the form of software developed outside or (partly) inside this project (e.g. modification of existing software). Therefore, the evaluation software tools will include standard formats for output from fisheries management models and harvest control rules. This standardisation is required for the comparison of alternative management strategies.

Wider societal objectives:

The evaluation framework will improve the transparency of the scientific background of fisheries management, and thereby help in facilitate and structure the discussions of fisheries issues on all levels. The evaluation framework will target at a wide range of stakeholders, from scientists / experts, administrators, managers (on national and EU level) i.e. offiecials concerned with policy management issues, industry including catching sector, environmentalists to the society as a whole.

The framework can be used in evaluation of the performance of institutions involved with fisheries management as well as with provision of the knowledge background of fisheries management.

The evaluation of alternative management strategies will be made by comparisons of measures for performance. These measures for performance will cover a wide range of objectives in addition to the traditional measures. These additional measures can cover almost any social or economic issue, such as employment, fisher's income, effect of decommission, acceptance of regulations by stakeholders, compliance with regulations, implementation of regulation, income per fisher, etc.

The evaluation framework will extend the range of fisheries management issues which can be evaluated on a scientific ground, including societal objectives, in particular socio-economic objectives.

Policy objectives:

This framework can be used to evaluate management options within the present CFP. The framework will not be limited to current management policies but will also take into account the most innovative options possible within the present CFP.

Strategies to achieve the main objectives of the CFP:

(1) Responsible and sustainable fisheries that contribute to healthy marine ecosystems
(2) An economically viable and competitive fisheries industry.
(3) A fair standard of living for those who depend on fishing activities

can be explored by the evaluation framework.

The common framework will allow to integrate i) biology, population dynamics, ii) economy, bio-socio-economy addressing iii) specific fisheries and fleet capacity and iv) consider environmental impact of fishing actions (e.g. by-catch and discarding). The evaluation framework will thus cover a major part of the issues in the CFP.

The purpose is to develop an operational management evaluation framework that allows test of plausible hypotheses about the dynamics of the stocks and fleets before implementation of planned regulations.

The project outcomes will therefore improve the scientific basis for fisheries management and (will also take into account the economic dimension of sustainable fishing). Scientific advice on medium- and long-term effects of different management tools will benefit greatly. Through analysing and modelling of key biological parameters, exploitation patterns and socio-economic implications, the processes behind these factors can be better understood.

Enhancement of technical measures like introducing more selective fishing, reduction of discards, measures to protect non-target species and habitats, will rely on new scientific discoveries and developments. This project will, however, not cover experiments related to technical measures.

The project will through case studies address actual problems of fisheries management and discuss various means to resolve them.

5. Potential Impact

5.1 Contributions to standards and contribution to policy developments

The overall impact of the project is expected to be a change of paradigms of fisheries management. This, of course, is based on the assumption that the current regime of fisheries management can (and should) be improved. The improvements will be identified by comparative evaluations of alternative management strategies. The project will provide a management evaluation framework (tools) to execute alternative evaluations, and thereby become an instrument for innovations in fisheries management and a support to the implementation of the CFP.

The project will have impact on the capabilities of scientists to provide useful advice on a wider spectrum of management issues. The tools currently available for advisory bodies like the ICES have their limitations, a feature which has been increasingly exposed in recent years. An impact of the project will be the much needed innovation and extension in the scope and quality of management advice provision.

The project will also have impact on the capabilities of managers, stakeholders and others to formulate questions to scientists and to explore alternative management options. The questions and suggestion formulated by managers, stakeholders, etc. will be formalized as explicit “measures for the performance of fisheries (or ecosystems)” and these in turn will impact the perceptions of fisheries management, and lead to possible implementation of more efficient management strategies.

The project will have impact on the communication between scientists, managers, industry, stakeholders, and more general, the society as a whole. The impact of the project will extend to all major stakeholders in the ecosystem and the fisheries system. It will connect groups which used to be separated, and thus facilitate the discussion of technical aspects of the CFP. The project will provide a tool for presentation of management problems and will evaluate solutions to problems.

The management evaluation framework will improve the transparency of scientific advice. Stakeholders which may have conflicting objectives will get the opportunity to apply the evaluation framework with a suite of (possibly conflicting) measures for the performance. Also alternative descriptive models and analysis tools will be compared and evaluated, so that the project may have impact on the choice of descriptive models. In general the project will get impact on the much needed reorganisation of the current provision of management advice, to meet the requests in time and substance of the managers.

As an example: The major strategy applied so far has focused on the management of fish stocks and the measures of performance have been spawning stock biomass and fishing mortality. A change of focus from stocks to fishing fleets would represent a change in paradigm of fisheries management. This change would allow for advice to be given in the form of effort limitation to be used as management measure. The use of technical management measures would also be facilitated by fleet-based management. The fleet based management would involve the prediction of fleet behaviour, which would call for economic and social parameters. Should the comparative evaluation of the traditional stock based system and the emerging fleet based management show trade-offs in the favour of fleet based systems, the impact of the project will be to accelerate that development. In addition to the above mentioned potential benefits from fleet based management, an additional benefit would be an improved communication with the industry, which in turn could lead to better exchange of information and knowledge between research/managers and the fishing industry. In that case the project will have an impact by narrowing the gab between fishers and scientists/managers and strengthening the interaction between them.

The project will have impact on the assignment of priorities to management issues, and thereby also on the assignment of resources (manpower and data) for provision of advice. These priorities will be established through the comparative evaluation of the data collection programs and the processing of data associated with the management issues.

As a change in fisheries management is likely to change the demand for and quality of data, the project may also have an effect on the data collection programmes. The project may suggest more cost efficient programmes for collection of fisheries data useful for fisheries management. Likewise it may have an impact on the procedures for provision of advice. The failure of ICES to meet the full extend of requests from the EU fisheries Commission can to a certain degree be explained by the limitations of the ICES databases and tools for provision of advice. The project will have impact on this situation by improving and extending the toolbox needed for provision of adequate and timely advice.

To summarise: The project aim at having impact on the development of the tactical as well as the strategic implementation of the CFP, by provision of a management evaluation framework (tools) for evaluations of alternative fisheries management regimes. The project will develop an operational evaluation framework (evaluation tools) to appraise the biological, social and economic effects of fisheries management measures in the EU. The tool can be used to execute alternative evaluations, and thereby become an instrument for innovations in fisheries management and a support to the implementation of the CFP. A suite of measures for the performance will point at the management options leading to a better exploitation of living recourses and management of fisheries as well as investments in the fishing industry, as perceived by a suite of stakeholder, which may have conflicting objectives.

In relation to the project Policy Impact, contractors will also, through the project coordinator, submit at the end of the project a Policy Implementation Plan (PIP) detailing how the research group proposes the application of the results at the fishery management level. The specific content of the PIP will detail the initially expected policy related results from the proposal and be measured against the obtained results. It will describe the potential application of the results within policy frameworks (e.g. legislation, control, potential cost savings, and economic impacts) on the time scales of short-, mid-, and long-term, and the oveall policy guidance conclusions. The format of the PIP will be a freestyle text document written as an executive policy summary of typically 3 A4 pages. The consortium will deliver a concise PIP describing the policy relevant research findings and a proposal on how these might be applied with the EU and national policy frameworks. The targeted readers of this deliverable (see also deliverables list in section 7.5 of this annex) would b policymakers, stakeholders, and officials concerned with policy management issues.

5.2 Risk assessment and related communication strategy

There will be no risks to the EU Community of this project.

In this project a strong group of participants has been gathered in order to form the critical mass needed to reach the project objectives and to ensure maximum value of the results. The consortium consists of renowned fisheries research institutions and Universities in the EU and EEA. It is therefore clear that the consortium has the multi-disciplinary scientific and technical capability to carry out the proposed work and also the impact to disseminate and exploit the results throughout the European community.

The overall composition of the EFIMAS project ascertain that success of the project, i.e. carrying out the tasks of the project and production of results from this, is not depending on any single

partner alone. If a project consortium partner leaves the project, or do not deliver specific input as planned during the project period, then the consequences will not be that any important task or overall project objective which this project partner participates in will not be fulfilled or reached. Consequently, it will not result in that a given work package (e.g. WP3 or in WP4) or a main task will not be accomplished. For each work package (and each case study under WP4) there is a broad supplementary and multi-disciplinary expertise with contributions from a group consisting of several partners which to some extent have overlapping and supplementary expertise ensuring that output and results from the work packages, tasks and case studies do not exclusively depend on one single partner.

If a case study under WP4 against expectations is unable to deliver the requested output parameters to be used as input in the simulation model developed under WP3 then the project will not fall on that basis because the project involves several case studies under WP4 from which results can be used in WP3.

Connected projects and activities within EU and on national level to support and supply knowledge to this project

The project will interact with ongoing national and international projects, and will receive and make impact on these. The obtained results from these projects will accordingly lower the risk of not obtaining the goals in the present project. The EFIMAS project will in particular take advantage of the developments in the EU-funded projects (EU FP5) EASE (European advisory system evaluation), FEMS (Framework for the Evaluation of Management Strategies), PKFM (Policy and Knowledge in Fisheries Management- the North Sea cod case), and TECTAC (Technological developments and tactical adaptations of important EU fleets). These projects all have elements in common with EFIMAS, and the preparation of this proposal reflects experiences from them.

A number of initiatives to evaluate current fisheries management have been made under the STECF, such as the cod (and hake) recovery plan(s) and the analysis of mixed fisheries, and this project is expected to deliver inputs to this ongoing development. This cooperation will strengthen the present project. Also mixed fisheries and multi-species models developed under the ICES Working Groups will be considered in relation to the EFIMAS project.

Several national projects on fleet-based management could be mentioned. An example is the national Danish project TEMAS (Evaluation of Technical Management Measures), which aims at modelling the reaction of fishers to technical management measures combined with other management measures. The EFIMAS project will interact with the TEMAS project and several similar national projects (e.g. the French ISIS project and other), and is expected to impact the modelling work carried out under TEMAS and other projects. The use of results and cooperation with other projects will strengthen the whole fundament and basis for the EFIMAS project.

Most of the ten tasks (1st Call for Proposals) under EU FP6 Priority 8, have elements in common, as suggested (tentatively) on the figure below. As suggested in the figure, in particular task 1 contains elements of the other tasks, and is therefore expected to have impact on almost all of them and benefit from exchange of results.

Task	Title	1	2	3	4	5	6	7	8	9	10
1	Operational evaluation tools for fisheries management options								…	…	
2	Operational fishery independent assessment tools										…
3	Operational multi-annual management methodologies										
4*	The relationships between fleet capacity, fishing effort and fishing mortality										…
5	Species-selective fishing in Nephrops fishery										
6*	Operational, cost-effective and secure electronic logbook transfer system	…									
7	Influence of husbandry and environment. condition on health of farmed sp.										
8	Ecosystem-based approach to fishery management	…									
9	Developing indicators of environmental performance of the CFP	…									
10*	Potential of marine protected areas for marine environmental protection		…		…						

Suggestion for the strength of impact and relationships between the ten tasks under priority 8.

… Strong relationship
...
....
Weak relationship
No relationship

***** Not included in the successful project proposals from First Call for Priority 8 but they are very likely to be realised (and changed to other task numbers) under the Second Call for project proposals under EU FP6 Priority 8.

Technical risk assessment within the present project:

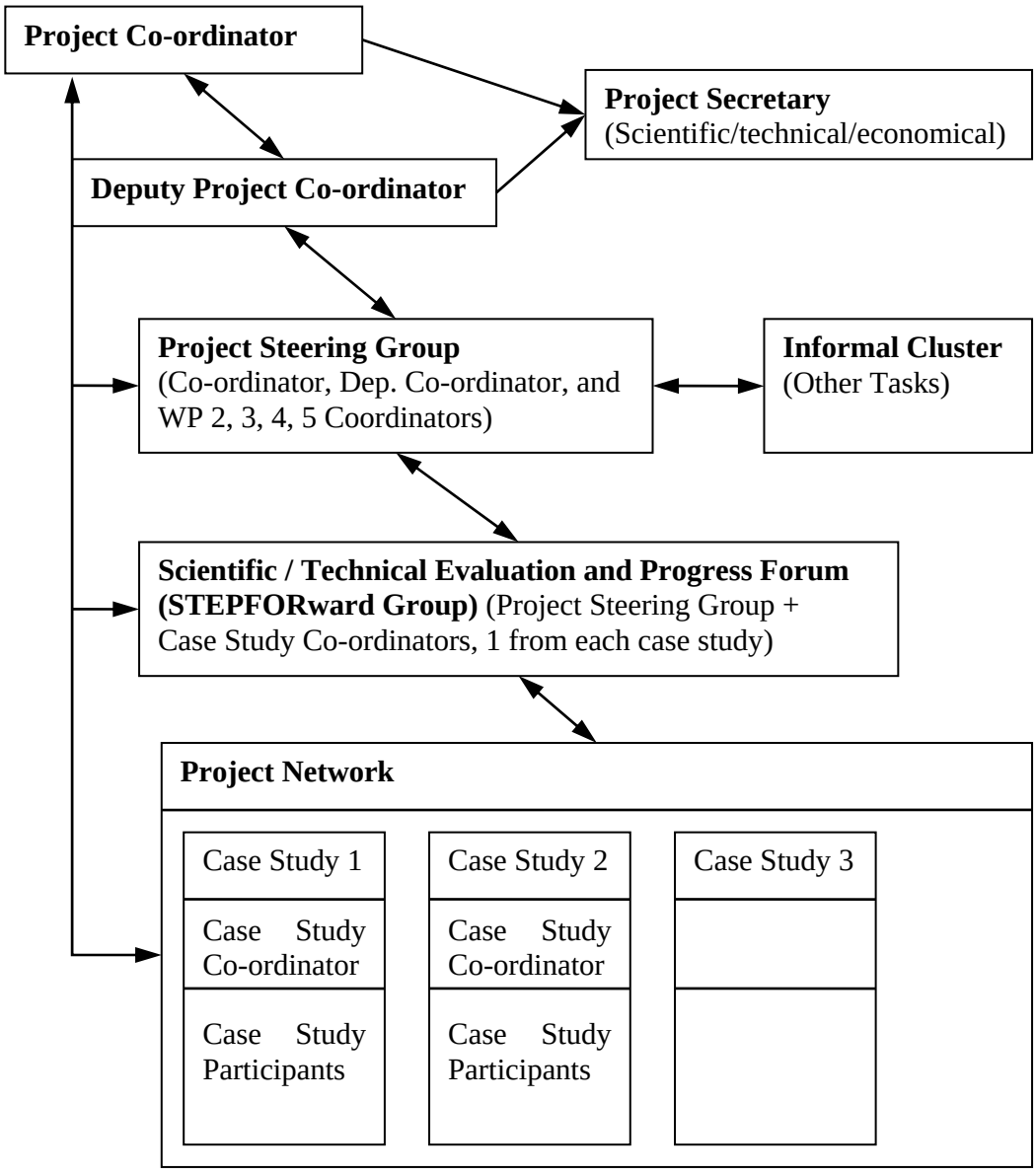
The project will perform risk assessments by stochastic simulation of the errors listed above. The framework will evaluate "descriptive models" and "analysis tools" assumed to represent the "true world". The framework will through the operating simulation model simulate collection of samples from the "true" system, which in turn will be used as input to the simulation of management. The creation of stochastic input data will be repeated a large number of times, which will allow for estimation of probability distributions of output from the management systems (the measures for system performance). These probability distributions will form the basis for risk analysis. In this context it should, however, be noted that good models can give decision makers a better handle on the risks of decisions, but the public perceptions probably more often focus on how decisions are made than they do about questions of risk.

6. Project management and exploitation/dissemination plans

6.1 Project management

The overall management and coordination of the project will be conducted through establishment of a functional hierarchic project organisation and decision making structure. This will ascertain that the project aim, work, deliverables, milestones, and meetings are planned, conducted and fulfilled as scheduled in the project. Furthermore, it will through the work of the coordinator, the steering group, and the scientific / technical evaluation and progress forum (as well as through the work in the planned regional workshops) ascertain communication, feedback, and evaluation of project issues and results within and between work package and case study groups as well as feed back from regional workshops. It will ascertain that the suggested scheme will take advantage of state of the art, experiences and knowledge from relevant similar international approaches as well as from industry, managers and stakeholders (through e.g. workshops), relevant national and international (e.g. ICES, ICCAT) data, and relevant models and tools to be used and further developed in accordance with the scope of the project. (See also section 8 about the consortium and project resources in the present document).

Project Management Overview: Hierachical Project Organisation, Management, and Decision Making Structures (including arrows visualizing continous, cyclic feed-back mechanisms)



The project steering group will be responsible for the work package and case study groups consist of participants with multi-disciplinary specific and generic expertise and skills in order to implement that in the project work. Through project management it will be assured that the project meetings as scheduled below are coordinated, organized and held, as well as the planned regional project workshops including communication of project output to and feed back from invited relevant stakeholders (fishing organizations / industry, NGOs, etc) and advisory and management bodies, relevant scientists, etc. are organized and held.

These meetings will assist in performing project organisation, management, coordination, decision making and communication, organization of the scientific and technical activities, data delivery, communication of methods and results, and assure that the continous, cyclic feed-back and evaluation system between work packages - and feed back to the work packages from the workshops - actually functions. See also section 8.

An overview of the hierarchical project organisation, management, coordination, and decision making structures are shown in the figure above.

The overall project management and coordination also includes coordination between relevant EU FP6 Priority 8 project Tasks. The relationships and impacts between different tasks of Priority 8 (1st Call for project proposals) are shown schematically in the figure given in section 5. Coordination of models developed in Task 1 can be communicated and used for analyses in other tasks under priority 8 (particularly Tasks 2-5). The coordination with other work tasks will be performed in selecting and analysing case studies (particularly Tasks 3-5). This includes coordination of the delivery and use of results from other tasks (e.g. Tasks 2-5 & 8-9), and that these results are included in the evaluation framework and the descriptive models and analysis tools developed under Task 1. Finally, it includes coordination of meetings in Task1 with project meetings in other tasks (particularly tasks 3-5).

WP1, Overall project coordinator: DIFRES
WP1, Deputy project coordinator: DIFRES
WP2 coordinator: AZTI
WP3 coordinators: CEFAS and DIFRES
WP4 coordinators: CEMARE and RIVO
WP5 coordinator: IFM

Project Meeting Overview Table including project management and coordination meetings:

Plan for project meetings to perform

i) project organisation, management, coordination, decision making and communication,
ii) organization of the scientific and technical activities, data delivery,
iii) communication of methods and results, continous and cyclic feed-back between work packages as well as from regional workshops,
iv) assure continous, cyclic feed-back between work packages (and from workshops) actually functions.

This is performed both from the overall general level and down to the case study level.

Project management and coordination will include travel costs for participants in steering group meetings (SGM meetings) as scheduled below, while travel costs for coordination of the innovative work under the innovative project work packages (e.g. STM meetings) as scheduled above will be included under the respective innovative work packages (WP 2-5).

SGM: Steering Group Meeting. **Meets 2 times per year**
STM: STEPFORward Meeting **Meets 2 times per year**
NM: Network Meeting **Meets 1 time per year which is connected to SGM, STM and CSGM**
CSGM: Case Study Group Meeting **Partly included in the NM meetings**

Meetings	**Month**								
	1	**6**	**12**	**18**	**24**	**30**	**36**	**42**	**48**
SGM	2 days	2 days	2 days	2 days	2 days	2 days	2 days	2 days	2 days
STM	1 day	2 days	1 day	2 days	1 day	2 days	1 day	2 days	1 day
NM incl. CSGM	3 days		3 days		3 days		3 days		3 days
Venue	Crete, GR	Copenh., DK	Open	Open	Open	Open	Hirtshals DK	Open	Open

RWSM: Regional Workshop Meetings **All the planned 4 workshops (see below) meets 1 time (in month 36 at the same venue as SGM, STM, NM, and CSGM in month 36) during the project period**

In the meeting plan given above is included two mid-term (month 24 and 36) and a final (month 48) project meeting with participation of all contractors and the EU Commission. The midterm meeting in month 24 will among other address the midterm report delivered in month 18 of the project period. The meetings held in month 12 scheduled below will address the planned implementation report of the project in month 12. The EU Commission will be informed about the mid-term and final project meetings at least six weeks in advance.

In addition to the annual meetings scheduled for the 48-month duration of the project, local CSGMs on regional basis can be held to the extent found necessary.

In month 36 there are planned 4 regional workshops to be held in connection with and overlapping to the STM, NM, and CSGM meetings here at the same venue where all contractors (the EFIMAS network) are assembled anyway. Travel costs for the project contractors to attend the workshops during the scheduled meetings will accordingly already be covered. It is planned to perform regional workshops covering the project work dealing with partly the Baltic Sea, the North Sea, the Mediteranean Sea, and the (residual) North-East Atlantic (incl Mediteranean Sea for Nephrops) – one for each region. The workshops will be a part of the interaction and the continuous cyclic feed back system between the different work packages as well as deliver direct feed back from stakeholders, etc. to the work packages (WP3-5), see section 7.

In general all project meetings will be organized in a way that travel and subsistence are kept as low as practically possible.

General communication, project management and co-ordination will also to a large extent be carried out through the Internet Electronic Mail Systems which is an efficient way to communicate precisely in writing, to exchange material, methods and results as well as discuss project issues within a broad forum.

6.2 Plan for using and disseminating knowledge and raising public participation and awareness

Management of knowledge, of intellectual property, and of other innovations arising from the project

The knowledge, intellectual properties and other innovations arising from the project will be made available to the public through:

1) Computer software
2) Documentation of software (Manuals)
3) Scientific publications
4) Newspaper articles
5) Technical reports
6) Reports to the EU
7) Reports from the evaluation from 4 regional workshops
8) Project Web page
9) Leaflet / Flyers (newsletters)
10) Project Implementation Plan (PIP)

Computer software with manuals will be made freely available to the public, whenever this is possible. Source code of computer programs will be made open, whenever this is possible.
As the evaluation tools will use other (independent) software packages as input, the project may not possess the intellectual property rights of these. Only easily accessible commercial or public software will be used for the development of the evaluation framework.

Data for selected case studies will also be made available to the public on the same conditions as for software. But care will be taken before any set of recent data, for which the interpretation is still under discussion, is made public. Thus, data for illustration of software should not be too controversial. Furthermore, the project may use data, the property rights of which belong to independent parts

Access to databases and software (whenever possible) will be made free through downloads from an internet site. Also manuals and reports will be made available through the web-site.

Results of the project will be presented at relevant international scientific conferences and symposia and through scientific publications as well in newspaper articles. Scientific hypotheses have been formulated in the project (this Annex 1). Details of the specific papers and articles will depend of the results coming out from the continuously performed research within the work packages. This project will give good opportunity to continue research within the relevant research areas addressed, also as a continuation of the research and results produced and published under the directly related and ongoing EU FP5 projects and relevant national projects which many of the contractors are also involved in. Consequently, there will be made a row of publications based on this project. The major aim of this project is to produce a management evaluation system, and the output from the project in the project formulation in Annex 1 (technical annex) is focused on visualizing this output.
The involvement of the European Commission in this project will be demonstrated by adding the following sentence to each publication:

> This study (report, paper, workshop, …) has been carried out with financial support from the Commission of the European Communities, specific RTD programme “Specific Support to Policies”, SSP-200n-xxxxx “Title”. It does not necessarily reflect its views and in no way anticipates the Commission’s future policy in this area.

In addition to the items mentioned above, knowledge and innovations from the project will be disseminated through conferences and workshops with participation of representatives of stakeholders.

During the project (month 36) there are planned 4 regional workshops to be held in connection with and overlapping to the STM, NM, and CSGM meetings here. Project funding has been allocated to cover partly travel costs for selected and specially invited representatives for stakeholders including the industry / catching sector, experts, managers (on national and EU level) i.e. officials concerned with policy management issues, other interest organizations, etc, which covers broadly representative stakeholders for each region as sufficient in relation to the purpose of the workshops, and partly costs to logistics and planning of these workshops. It is planned to perform regional workshops covering the project work dealing with partly the Baltic Sea, the North Sea, the Mediterranean Sea, and the (residual) North-East Atlantic (incl Mediteranean Sea for Nephrops) – one for each region. The workshops will be a part of the interaction and the continuous cyclic feed back system between the different work packages as well as deliver direct feed back from stakeholders, etc. to the work packages (WP3-5), see section 7 for details of the contents of the workshops.

A project web page will be created by the coordinating institute and the project steering group. The web-site will contain various information about the project, and the progress of it, as well as lists with publications and other outputs of the project.

During the project period leaflets / flyers (newsletters) will be produced. A 2-4 page newsletter, glossy leaflet for flyer will be made by the project coordinator and steering group. This will contain e.g. general information about the work of the programme, participants, published or public results, and exploitation strategy. This leaflet is scheduled to appear 3 times, and will be broadly distributed (EU, participants, stakeholders including the industry / catching sector, scientific bodies and meetings, etc.).

Project Implementation Plan (PIP): Contractors will, through the coordinator, also submit at the end of the project a Policy Implementation Plan (PIP) detailing how the research group proposes the application of the results at the fishery policy management level. The specific content of the PIP will detail the initially expected policy related results from the proposal and be measured against the obtained results. It will describe the potential application of the results within policy frameworks (e.g. legislation, control, potential cost savings, and economic impacts) on the time scales of short-, mid-, and long-term, and the overall policy guidance conclusions. The format of the PIP will be a free-style text document written as an executive policy summary of typically 3 A4-pages. The consortium will deliver a concise PIP describing the policy relevant research findings and a proposal on how these might be applied within the EU and national policy frameworks. The targeted readers of this deliverable would be policymakers, stakeholders (including industry / catching sector), and officials concerned with policy management issues.

Results and models from the Task 1 will be made available for use in other Tasks (particularly Tasks 2-5) within the EU FP6 Priority 8 and vice versa as far as possible. This includes coordination of meetings in Task1 (1st call for proposals) with project meetings in other relevant Tasks to the extent possible.

7. Workplan– for whole duration of the project

7.1 Introduction - general description

Implementation plan introduction – explaining the structure and the overall methodology to achieve the objectives.

The EFIMAS project will develop an operational fisheries management evaluation framework that allows test of plausible hypotheses about the dynamics of the stocks and fleets before implementation and which can appraise the biological and social and economic effects of the existing fisheries management measures in EU. The evaluation framework can be used to evaluate results and output generated from other software packages (descriptive fisheries and stock assessment models and analysis tools), analyses, and existing databases being used for production of advice to management bodies, and can be applied to important EU fisheries. The evaluation framework will be developed as a process through which stakeholders can evaluate management options in relation to specific objectives and desired properties of the management procedures. The evaluation framework will be based on an understanding of the processes contributing to the overall performance of a fishery / fishery system and be used to evaluate a range of management options that explicitly take account of uncertainty (parametric as well as structural uncertainty) and include risk assessment. This process will enable participants in the decision making process to use information about tendencies in the expected outcomes and performance of various management options on basis of output from the operating simulation model and evaluation of this.

The framework will be established and implemented through the project work packages described in detail in section 7.6 and given in overview here:

Work Package 1: Work package 1 will perform overall project management and coordination, as well as establish and conduct hierarchical project organisation and decision making structures. It will ascertain fulfilment of project aims, deliverables and milestones and that the planned work is conducted as scheduled. It will monitor progress of the project through a steering group, and ascertain communication structures and delivery of relevant data, tools/models and methods within and between work package and case study groups, and coordinate project meetings including communication of project output to and feed back from invited relevant stakeholders (fishing organizations / industry, NGOs, etc) and advisory and management bodies, relevant scientists, etc. Furthermore, it will ascertain that project participants with multi-disciplinary expertise and skills are grouped and that the suggested scheme will take advantage of state of the art, and experiences and knowledge from relevant similar international approaches, models, and data. This work package will finally finance and ascertain that the project resources and economy is evaluated by auditing certification of accounting for each project contractor performed once (probably month 48) during the whole project contract period.

Work Package 2: Work package 2 will review the available knowledge base for fisheries systems, and to compile and describe it for use by WP 3-5, review existing frameworks for evaluation of the performance of fisheries management systems, as well as explore and describe how the present fisheries management systems perform and how the management decision making processes are using knowledge to inform decisions. The evaluation tool to be developed is a mechanism to synthesize complex knowledge, to communicate this synthesis, and to use it as the information base for management decisions. The project will therefore include a review of the knowledge to be synthesized and communicated, and a description of how knowledge can be communicated and used to inform decision making processes. Work package 2 will categorize fisheries management systems and describe the adequacy of the present management systems and present management decision processes in terms of their use of knowledge. This leads to identification of the context in which fisheries/stocks evaluation tools for production of advice to management bodies are to be

used, which problems they are to assist in solving, as well as of the knowledge which the tools are to communicate. This work package will deliver information to be used in WP 3-5

Work Packages 3 - 5:
The operational fisheries management evaluation framework will be continuously tested through evaluation of the relative effects of the application of different specific management options to specific case studies. The intention is to only recommend for implementation of management options that have been evaluated through the framework.

The evaluation framework will comprise two parts, a model of the system to be managed (i.e. the operating model), and the management procedures applied (which includes methods and descriptive models for monitoring and assessing the status of the system as well as the management options). The evaluation framework will include an operating simulation model, which will be developed in Work Package 3, and will be able to evaluate and simulate different management options runningly using case specific output parameters and results from scientifically based tests of hypotheses and analyses performed in Work Package 4 with relevant descriptive models addressing main fisheries advisory and management problems.

As a prerequisite and continous input to the development of the management evaluation framework a range of research questions will be addressed in Work Package 4. They relate to main, typological advisory and management problems within managing important EU fisheries and relate to the scope and role of simulation models to inform management decision processes and how various types of knowledge are best brought to use in management decisions.

Work Package 3 will build the operating model in the evaluation framework, and Work Package 4 will runningly apply the model to specific cases studies and will in that process also be used to generate hypotheses, perform tests and analyses about the dynamics of the system (fisheries system) in question, and running output (e.g. standardised fisheries assessment parameters) and results from these analyses will be used partly to parameterise the operating model where appropriate and run the simulation trials and partly to perform overall evaluation where parametric simulation of parameters is not possible. The framework will include enough complexity to capture the behaviour of the system but will not include complexity for complexity's sake.

The descriptive models used in Work Package 4 will not be included in the framework directly but continuously run the simulation trials and perform evaluation with relevant descriptive models and analyses based on development of relevant scientifically founded hypotheses, testing and investigation on specific selected management and assessment problems and dynamics of the system (mainly using existing or modified descriptive models and analysis tools). For different fisheries (case studies here) specific selected types of main (general) management and assessment problems will in Work Package 4 be identified (with help from the review in Work Package 2, and the continous, cyclic feedback from the evaluation under Work Package 5, as well as from the feedback from the progresses in Work Package 3), where case study experts with multi-disciplinary expertise will be responsible for generating relevant hypotheses about the system based on specified scientific and technical questions, make relevant scientific based analyses in relation to the dynamics in the system, and will based on the results and feedback accordingly be responsible for continuously proposing candidate management options for evaluation in the framework (exemplification on case study basis).

Work Package 3 will be developed in parallel to Work Package 4, which will test and apply descriptive models and analysis tools on selected case studies under different management systems, and thereby interact.

Work Package 5 will review and discuss the performance of the candidate management options and objectives and be responsible for making research and management recommendations. Furthermore, the evaluation in Work Package 5 will continously give feed-back to Work Package 4 (e.g. further investigations needed, alternative hypotheses more relevant, etc. or other management options and

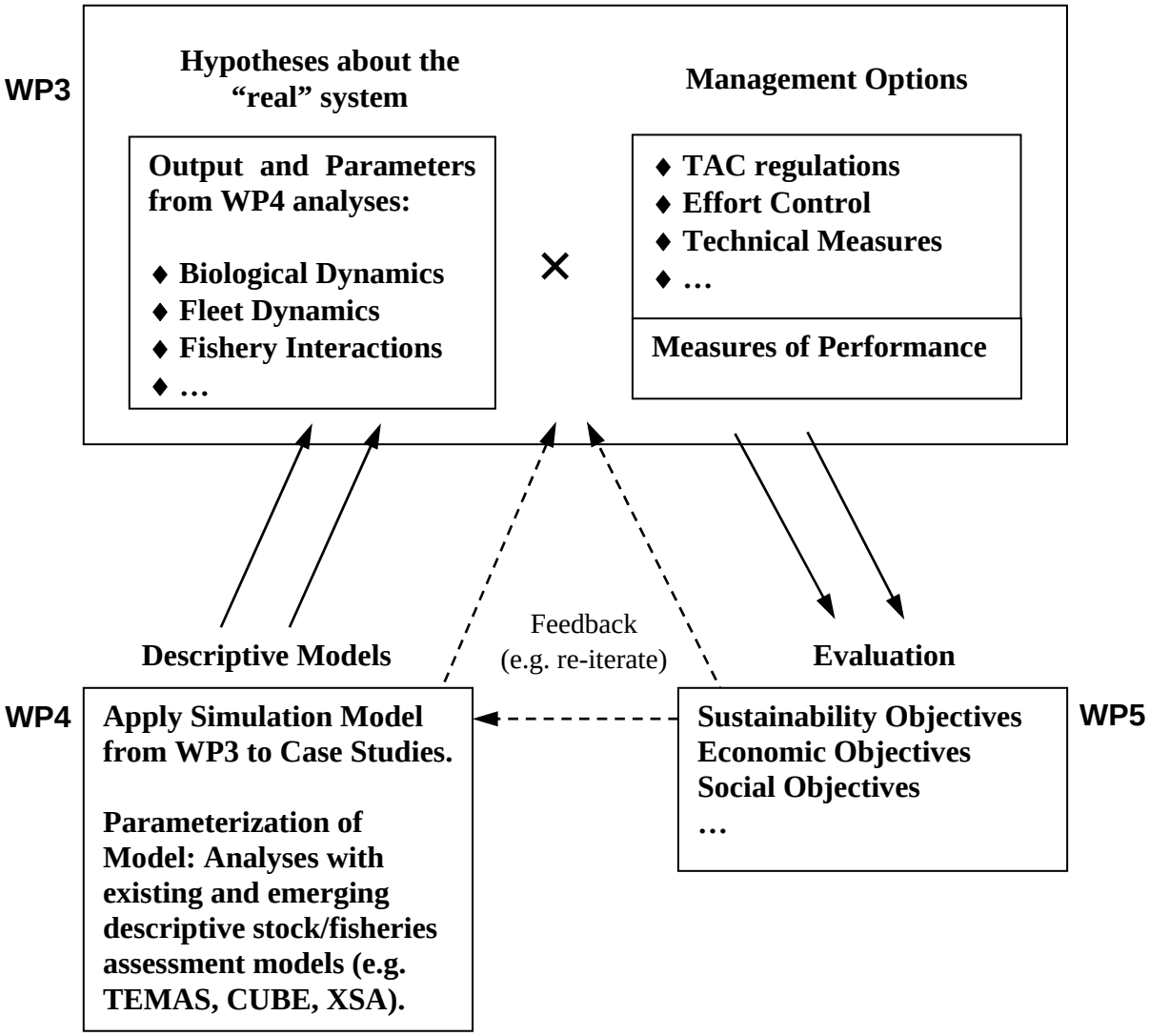
objectives more relevant or desirable, etc.). Additionally, Work Package 5 and Work Package 4 will continuously give feed back to Work Package 3 with respect to performance of the operating simulation model developed and possible suggestions for improvements. This will lead to continued approaches under Work Package 3 and Work Package 4 in a cyclic process.

The performance of the candidate management options used in the evaluation framework will runningly be discussed and evaluated in Work Package 5 when applying the operating model to case studies in Work Package 4, and further recommendations on research and management recommendations will be made in a feed-back system (cyclic process) with respect to e.g. recommendations on further investigations needed, more relevant alternative hypotheses to be addressed, alternative descriptive models to be applied, etc. as well as recommendations on other more relevant or desirable management options and objectives. This makes the processes in the whole evaluation framework iterative and cyclic (on a case specific basis) addressing diverse types of general management and assessment problems. Consequently, the whole analysing framework is made iterative and cyclic on a case specific basis addressing diverse types of general management and assessment problems. There will be performed continuously and iterative evaluation of outcome from Work Package 3 and Work Package 4 in Work Package 5 through such a cyclic feed-back system.

Under Work Package 5 there are project month 36 planned 4 regional workshops to be held in connection with and overlapping to the STM, NM, and CSGM meetings here with participation of selected and specially invited representatives for stakeholders including the industry / catching sector, experts, managers (on national and EU level) i.e. officials concerned with policy management issues, other interest organizations, etc, which covers broadly representative stakeholders for each region as sufficient in relation to the purpose of the workshops. The workshops will be a part of the interaction and the continuous cyclic feed back system between the different work packages as well as deliver direct feed back from stakeholders, etc. to the work packages 3, 4, and 5. It is planned to perform regional workshops covering the project work dealing with partly the Baltic Sea, the North Sea, the Mediteranean Sea, and the (residual) North-East Atlantic (incl Mediteranean Sea for Nephrops) – one for each region.

As another prerequisite to the development of the management evaluation framework and development of descriptive fisheries / stock models and analysis tools it is necessary to do that in the context of present knowledge, experience and state of the art. In order to include this knowledge within the development processes in the present project Work Package 2 will review the available knowledge base for fisheries systems and review (evaluate and discuss) the performance of existing fisheries management systems and the management decision making processes. Accordingly, Work Package 2 will categorize and compile this information for use in the other work packages (Work Packages 3, 4, and 5). Such an review and evaluation of the adequacy of the present management systems and management decision processes will lead to identification of the context in which fisheries/stocks evaluation tools for production of advice to management bodies are to be used, which problems they are to assist in solving, as well as of the knowledge which the tools are to communicate.

Fisheries Management Evaluation Framework



The fisheries management evaluation framework will be generic in the sense that it will be able to evaluate most existing management systems and descriptive models and analysis tools used for production of management advice (fisheries/stocks evaluation models and analysis tools), as well as systems not yet implemented, but which can be simulated. The evaluation framework can compare alternative management systems producing relative measures of performance applying output from either currently used or appropriate alternative descriptive models and analysis tools in question. Further, the framework will compare output from different descriptive models or analysis tools within the same management system. Consequently, the result will be comparative evaluation of alternative management systems and instruments producing relative measures of performance, and it will take account of uncertainties (parametric as well as structural uncertainty) as well as include risk assessments. The framework will be based on an understanding of the processes contributing to the overall performance.

Output from the simulation and evaluation will be a suite of measures of performance of fish stocks and fishing fleets which can be used for production of advice to management bodies. Alternatives management regimes can be evaluated by comparing the performances. The expected prediction power of the simulation or evaluation will not lead to quantitative results, but rather relative

measures. The level of ambition should be to guide fisheries managers in their capability to make strategic choices. The simulation framework should not only simulate projection that output what level of stock biomass or economic returns would be generated from a given management measure. Rather the output should be in relative terms: which strategy is likely to give better returns on the required system indicators than another strategy?

The evaluation will, accordingly, not only be a parametric prediction, but will be able to synthesize knowledge of how the fisheries management system will react and what the outcomes in reality will be.

The output from alternative descriptive models and analysis tools to be evaluated by the framework can focus both on fleets and stocks and depend on the actual management systems to be tested. Fisheries can be modelled as mixed fisheries (multi-species / multi-fleet fisheries). Spatial aspects can be modelled (e.g. closed boxes). Implementation of regulations and fleet adaptation (e.g. behaviour of fishers: how do fleets react on management measures) as well as impact on system can be modelled. The modelling of fisheries includes the bio-economics of fleets, and economic instruments for fisheries management are taken into consideration. Consequently, the common framework will allow to integrate i) biology, population dynamics, ii) economy, bio-socio-economy addressing iii) specific fisheries and fleet capacity and iv) consider environmental impact of fishing actions.

Context of the conceptual framework:
There are previous projects commissioned by the EU that have evaluated management strategies and options (EVARES, MATACS and MATES). These studies used an approach that is able to consider the processes contributing to the overall performance in an integrated framework. The approach models both the "real" and observed systems, and considered individual systems as well as interactions between system components. The main advantage is that this approach is better able to investigate the robustness of candidate management strategies to both the intrinsic properties of the systems and our ability to observe, monitor, assess and control them.

Such an approach is used extensively within the IWC where management tools are developed and tested using simulation. This is done by testing their performance against plausible hypotheses about the system to be managed. In this way, it is possible to evaluate the benefits of changes in current fisheries/stock evaluation (assessment) and management procedures against a range of objectives. The methodology being developed or the analyses being performed by the EU FP5 projects in the informal cluster the EASE, FEMS and PKFM, are of direct relevance and this project will take advantage of this fact.

Framework for the evaluation of management strategies (FEMS) is collaboration between ICES, ICCAT and NMFS**,** using a simulation framework to test hypotheses about the relative importance to management of

Dynamical Processes
Sampling or monitoring schemes
Assessment and/or management models
Assessment or Estimation procedures
Implementation of management
and the interactions between them.

The operating simulation model to be developed must be based on an understanding of the processes contributing to the overall performance and it must take account of uncertainties (parametric as well as structural uncertainty) and it includes risk assessments. The five main types of uncertainties to be evaluated are:

The dynamic processes
Measurement errors
Estimation errors

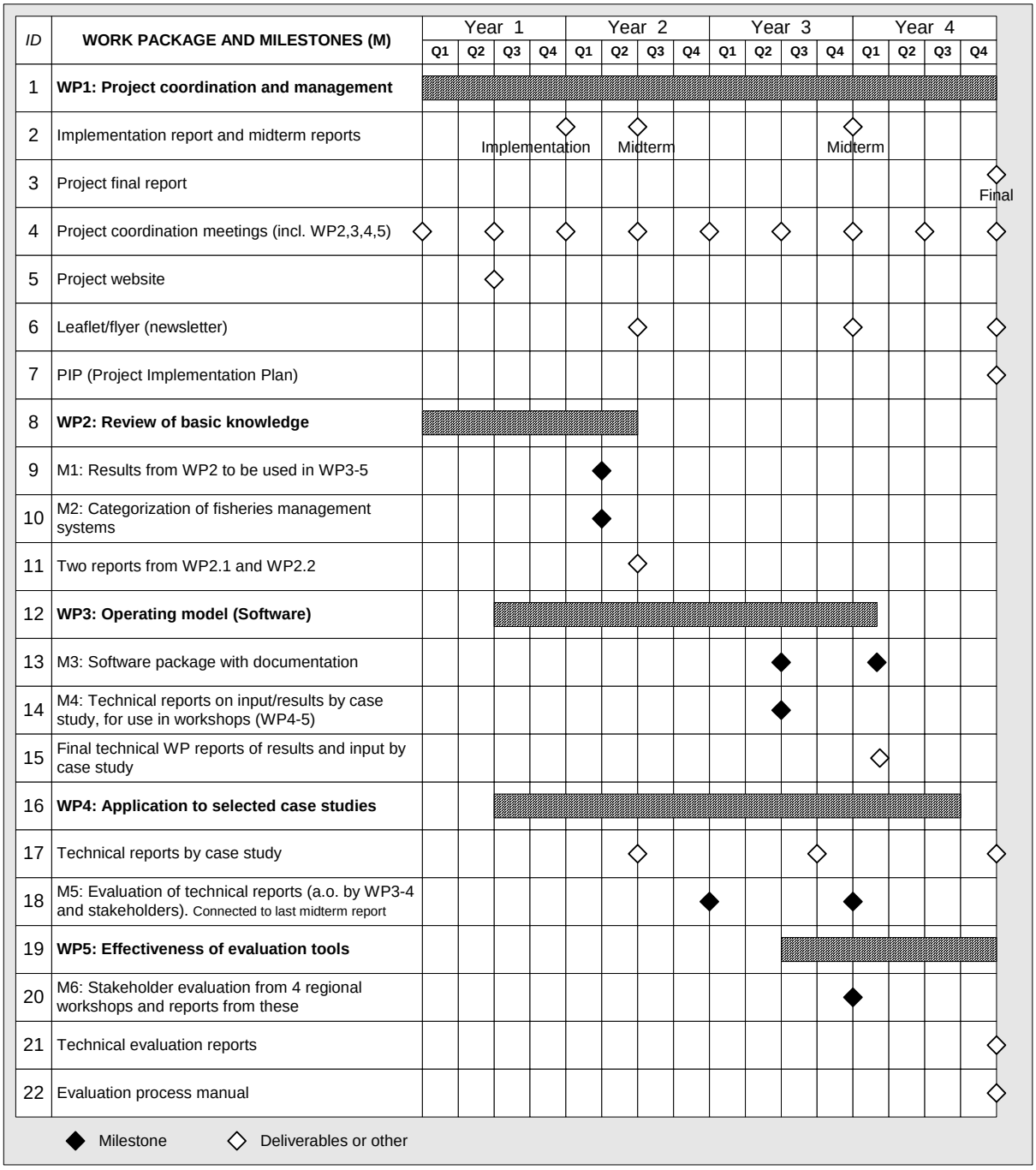
Model mis-specification
Implementation errors

This requires an operating model to evaluate and simulate output and results from descriptive model development and evaluation. Furthermore, it requires the use of a complex framework to evaluate and test simpler descriptive models and the formulated / developed hypotheses and output from analyses. The choice of simpler descriptive models and their parameterisation will then be made of the basis of desirable properties and the trade-offs between objectives.

The project will not make development of entirely new descriptive (e.g. assessment) models or of a new management procedure or new basic management paradigms or totally new specific management models outside the CFP, but rather development of a framework to evaluate options within the present CFP. The appropriate level will thus be somewhere between just projecting what is done now and changing entirely to a new IWC RMP approach or similar. The balance is that the evaluation framework developed here will be able to explore the most innovative options possible within the present CFP. This will bring the state of the art quite far – there are openings for e.g. multi-annual and multi-fleet management and the CFP does not say anything about whether TAC's must be set on basis of annual short-term predictions or could be based on longer-term adaptive approaches.

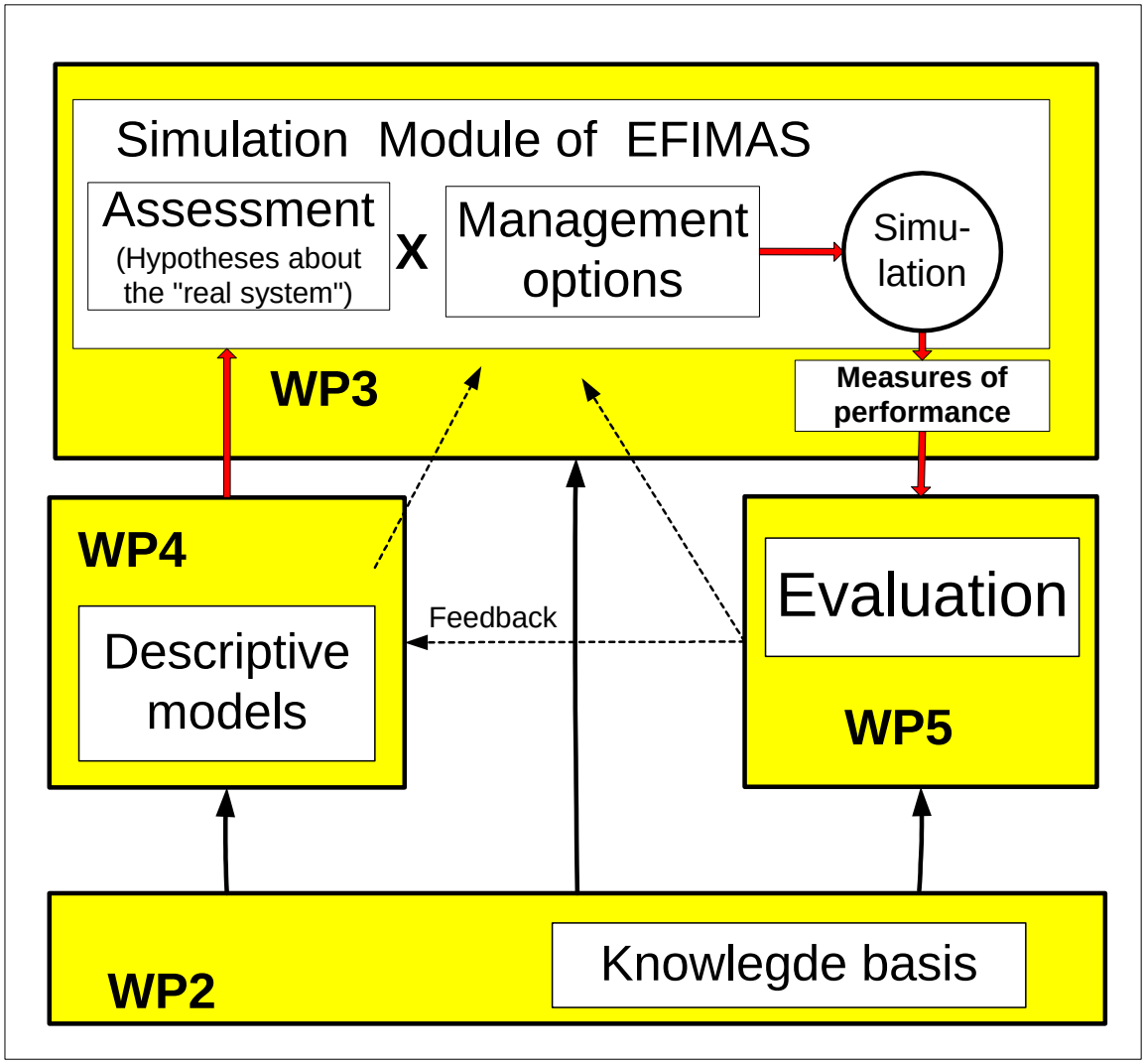
7.2 Workplanning and timetable

Gantt Chart: Work planning, showing the timing of the different WP's and their components



7.3 Graphical presentation of work packages

Graphical presentation of the components showing their interdependencies (Pert Diagram or similar)



This graphical presentation is in accordance with the figure shown above in section 7.1.

7.4 Work package list /overview

Work package list (full duration of project)

Detailed work description broken down into WP's

WP list (full duration of project)

WP No[1]	WP title	Lead contractor No[2]	Person-months[3]	Start month[4]	End month[5]	Deliv-erable No[6]
WP1	**Project Coordination and Management**	**1**	15	1	48	1.1-1.7
WP2	**Review of knowledge basis**	**17**	31	1	18	2.1-2.2
WP3	**Operating model (software).**	**1 & 2**	215	6	38	3.1–3.4
WP4	**Application to selected case studies**	**3 & 19**	458	6	45	4.1–4.2
WP5	**Effectiveness of evaluation tools**	**18**	77	30	48	5.1–5.3
	TOTAL		796			

[1] WP number: WP 1 – WP n.
[2] Number of the contractor leading the work in this WP.
[3] The total number of person-months allocated to each WP.
[4] Relative start date for the work in the specific WPs, month 0 marking the start of the project, and all other start dates being relative to this start date.
[5] Relative end date, month 0 marking the start of the project, and all ends dates being relative to this start date.
[6] Deliverable number: Number for the deliverable(s)/result(s) mentioned in the WP: D1 - Dn.

7.5 Deliverables list.

Deliverables list

Del. no.[7]	Deliverable name	WP no.	Lead partic-ip-ant	Estimated person-months	Nature[8]	Dissemination level[9]	Delivery date[10] (project month)
1.1	Coordination and management meetings.	1	1		O	RE	**Every 6 months**
1.2	Short implementation report.	1	1		R	RE	**12**
1.3	Midterm report(s) (periodic activity report + midterm-review + reported costs).	1	1		R	RE	**18 & 36**
1.4	Final report(s) to the EU Commission (final acti-vity report + reported costs + audit certificates)	1	1		R	RE / PU	**48**
1.5	Project Web Page	1	1		O	PU	**6**
1.6	Leaflet / Flyer (Newsletter)	1	1		O / R	PU	**18, 36, 48**
1.7	PIP (Project Implementation Plan)	1	1		O / R	PU	**48**
2.1	Report from WP 2.1: Review and compilation of published evaluations of management systems.	2	17		R	PU	**18**
2.2	Report from WP 2.2: Review and description of present management and management decision making process.	2	17		R	PU	**18**
3.1	Delivery of prelimenary software package with documentation (milestone as well).	3	2 + 1		P / O / R	RE	**30**
3.2	Technical reports of input/results by case study, for use in work-shops and in WP4-5.	3	2 + 1		R / P	RE	**30**

[7] Deliverable numbers in order of delivery dates: D1 – Dn

[8] Please indicate the nature of the deliverable using one of the following codes:

R = Report
P = Prototype
D = Demonstrator
O = Other

[9] Please indicate the dissemination level using one of the following codes:

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).

[10] Month in which the deliverables will be available. Month 1 marking the start of the project, and all delivery dates being relative to this start date.

3.3	Delivery of final software package with documentation (milestone as well)	3	2 + 1		P / O / R	PU	**38**
3.4	Final Technical WP reports of results and input by case study.	3	2 + 1		R / P	PU	**38**
4.1	Prelimenary technical reports by case study.	4	19+3		R	RE	**18, 33**
4.2	Final technical reports by case study	4	19+3		R	PU	**48**
5.1	Report(s) from evaluations from 4 regional workshops	5	18		R	PU	**36**
5.2	Technical evaluation reports.	5	18		R	PU	**48**
5.3	Evaluation process manual	5	18		R	PU	**48**
Total				796			

[1] Deliverable numbers in order of delivery dates: D1 – Dn

[1] Please indicate the nature of the deliverable using one of the following codes:

R = Report
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O = Other

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[1] Month in which the deliverables will be available. Month 1 marking the start of the project, and all delivery dates being relative to this start date.

(*Without prejudice for obligations arising of Article 7 of the contract, the consortium will submit an implementation report before the end of month 12 from the starting date of the project*).

7.6 Work package descriptions

WP1 Project Coordination and Management
(See also overall description of project coordination and management in sections 6 and 8)

WP description (full duration of project)

WP number	1	**Start date or starting event:**		1			
Activity Type	Management activities						
Participant id	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Person-months per participant:	14,9 + TC+AC	TC+AC	TC+AC	AC	AC	AC	AC
Participant id		**9**	**10**	**11**	**12**	**13**	**14**
Person-months per participant:		AC	AC	AC	AC	AC	AC
Participant id	**15**	**16**	**17**	**18**	**19**	**20**	**21**
Person-months per participant:	AC	AC	TC+AC	TC+AC	TC+AC	AC	AC
Participant id	**22**	**23**	**24**	**25**	**26**	**27**	**28**
Person-months per participant:	AC	AC	AC	AC	AC	AC	AC
Participant id	**29**	**30**					
Person-months per participant:	AC	AC					

TC=Travel costs (SGM: Steering Group Meetings)
AC=Audit costs (Auditing certification costs)

Objectives:
Perform overall project management and coordination
Establish and conduct hierarchical project organisation and decision making structures
Ascertain fulfilment of project aims, deliverables and milestones, and that planned work is conducted as scheduled
Monitor progress of the project through a steering group
Ascertain communication structures and delivery of relevant data, tools and methods within and between work package and case study groups, and coordinate project meetings including communication of project output to and feed back from invited relevant stakeholders (fishing organizations / industry, NGOs, etc) and advisory and management bodies, relevant scientists, etc.
Ascertain that project participants with multi-disciplinary expertise and skills are grouped and that the suggested scheme will take advantage of state of the art, and experiences and knowledge from relevant similar international approaches, models, and data
Coordination of meetings within and between work package and study groups, as well as coordination of reginal workshops
Ascertain that the project resources and economy is evaluated by auditing certification of accounting for each project contractor performed once (probably month 48) during the whole project contract period. The auditing certification for each project contractor will be financed under project management in this work package by costs up to 1750 EURO per partner covering one expected audit for each partner during the whole contract period.

Description of the work:
1.1 Overall project coordination
This work package will perform overall project management and coordination. It will establish and conduct a hierarchic project organisation and decision making structure. It will ascertain that the project aim, work, deliverables and milestones are planned, conducted and fulfilled as scheduled in the project. Furthermore, it will through the work of the steering group and the scientific / technical evaluation and progress forum ascertain communication and evaluation of project issues and results within and between work package and case study groups as well as from feed back from regional stakeholder workshops. It will ascertain that the suggested scheme will take advantage of state of the art, experiences and knowledge from relevant similar

international approaches, relevant national and international (e.g. ICES, ICCAT) data, and relevant models and tools to be used and further developed in accordance with the scope of the project. The project coordination will be responsible for the work package and case study groups consist of participants with multi-disciplinary specific and generic expertise and skills in order to implement that in the project work. Through project management it will be assured that the project meetings including regional stakeholder workshops as scheduled in section 6 are organized and held. These meetings will assist in performing project organisation, management, coordination, decision making and communication, organization of the scientific and technical activities, data delivery, communication of methods and results, and assure that the continous, cyclic feed-back system between work packages, and feedback from the workshops to work packages (WP3-5), actually functions. An overview of the hierarchical project organisation, management, coordination, and decision making structures are shown in the figure in section 6.
The overall project management and coordination also includes coordination between relevant EU FP6 Priority 8 project Tasks. The relationships and impacts between different tasks of Priority 8 (1st call for proposals) are shown schematically in the figure given in section 5. Coordination of models developed in Task 1 can be communicated and used for analyses in other tasks under priority 8 (particularly Tasks 2-5; 1st Call for Project Proposals under Priority 8). The coordination with other work tasks will be performed in selecting and analysing case studies (particularly Tasks 3-5). This includes coordination of the delivery and use of results from other tasks (e.g. Tasks 2-5 & 8-9), and that these results are included in the evaluation framework and the descriptive models and analysis tools developed under Task 1. Finally, it includes coordination of meetings in Task1 with project meetings in other tasks (particularly tasks 2-5).

1.2 Project management and coordination meetings
Allocate resources to conduct management and coordination meetings by the steering group within the project. Coordination meetings will be held according to the meeting plan shown in section 6. WP1 will include travel costs for participants in the scheduled management meetings of the steering group (SGM).

1.3 Auditing certification
Project management includes costs for performing auditing certification of accounting for each project contractor performed once (probably month 48) during the whole project contract period.

Deliverables:
D1.1: Coordination and management meetings (every 6th month of the whole duration of the project period)
D1.2: Short implementation Report (month 12)
D1.3: Midterm report 1 and 2 including cost reporting (month 18 and 36)
D1.4: Final report(s) including cost reporting and audit certificates for each contractor (draft, month 48)
D1.5: Project Web Page / Site (month 6)
D1.6: Project leaflet / flyer / newsletter (month 18, 36, 48)
D1.7: Project Implementation Plan, PIP (month 48)

Milestones:
The project coordination meetings and the implementation, midterm and final reports are off course also some kind of milestones assuring that the project is continuously evaluated, that progress is continued, as well as that the cyclic, continous interactions and feed back systems between work packages 3-5 as well as beteen the workshops and work packages 3-5, are ascertained and followed up on.

WP2 Review and exploration of knowledge basis and performance of fisheries management as well as of management decision processes

WP description (full duration of project)

WP number	2	**Start date or starting event:**			1		
Activity Type	RTD / Innovation activities						
Participant id	**1**	**2**	**7**	**10**	**17**	**18**	**20**
Person-months per participant:	1,4	1,3	1,4	4,5	9.8	1,7	3,2
Participant id	**21**	**27**					
Person-months per participant:	4,2	3,8					

Objectives:
The purpose of this WP is to review the available knowledge base for fisheries systems, and to compile it for use by WP 3-5, to review existing frameworks for evaluation of the performance of fisheries management systems, as well as to explore and describe how the present fisheries management systems perform and how the management decision making processes are using knowledge to inform decisions. The evaluation tool to be developed is a mechanism to synthesize complex knowledge, to communicate this synthesis, and to use it as the information base for management decisions. The project will therefore include a review of the knowledge to be synthesized and communicated, and a description of how knowledge can be communicated and used to inform decision making processes. Purpose:
- review of available knowledge base for fisheries systems
- review existing frameworks for evaluation of the performance of fisheries management systems
- explore and describe the performance of existing fisheries management systems
- review and describe how management decision making processes are informed by knowledge and the limitations in communicating knowledge

Description of the work:
The work package 2 will take advantage of results from past EU-projects (e.g. EMAS, EVARES, and MATES EU Projects) as well as from ongoing activities (e.g. EASE EU Conc. Act. and the FEMS and PKFM EU Projects).
The reviews will cover biological (stock dynamics), ecological, technical, economic and sociological aspects of fisheries management as well as management policies.

2.1 Review and compilation of knowledge basis for fisheries management (global)
Review of the available knowledge base for fisheries systems, and compile it for use by WP 3-5

2.1.1 Identify, categorize and catalogue all relevant management systems
To identify, categorize and catalogue all management systems of interest to European fisheries as well the involved management instruments. This refers to both national and international management systems. It refers to management systems actually implemented as well as emerging management systems and hypothetical systems, which are deemed to be possible candidates for future management.

2.1.2 Identify and catalogue all formulation of management objectives
To identify and catalogue all formulation of management objectives, and to evaluate their implementation and verification

2.1.3 Identify and catalogue management regulations
To identify and catalogue management regulations (national and international), and to evaluate the control and enforcement of regulations

2.1.4 Identify and catalogue data currently collected to implement and control management systems.

2.1.5 Identify and catalogue models and software packages used to provide management advice
To catalogue the models and software packages (including data bases) used for provision of advice to managers, and describe the context in which they are used

2.1.6 Describe current use of databases and software packages for fisheries management.
To describe the current use of databases and software packages for fisheries management. This includes an exploration and description of the users understanding of the models and methods, such as the assumptions behind models and their limitations.

2.1.7 To catalogue published evaluations of the performance of management systems and frameworks for evaluation of management systems

2.1.8 To review literature in fisheries management
To review the literature in fisheries management, in particular literature on evaluation of management systems

2.1.9 To perform dialogues in relation to WP2 (e.g. e-mail, phone-interviews, etc.)
To investigate and obtain information in relation to existing management from relevant scientists, stakeholders (fishing organizations/industry, NGOs, etc) and advisory and management bodies

2.1.10 Reporting

2.2 Review, description and evaluation of the adequacy of the present management and management decision processes and especially how it is informed by knowledge

2.2.1 Description of information required and data requests compared to existing information used for provision of management advice (in relation to review in 2.1).

2.2.2 Review and description of reactions from stakeholders to management regulations

2.2.3 Consideration of ecological side effects of fisheries (un-wanted by-catch) in relation to fisheries management

2.2.4 Description and evaluation of fisheries management systems failures in historic perspectives

2.2.5 Review and description of the contents, structure and function of the management decision making process

Review and describe

- how models are used to inform management decision making in other sectors,
- what management problem to solve,
- understanding of management decision processes,
- the delivery processes and mechanisms,
- the utilization of scientific advice,
- the utilization of other types of existing knowledge potentially useful,
- the integration of knowledge from stakeholders and management bodies,
- the knowledge production process for fisheries management (tactical, strategic

2.2.6 Dialogues in relation to WP2 (e.g. e-mail, phone-interviews, etc.)

To investigate and obtain information in relation to management decision processes and delivery processes from relevant scientists, stakeholders (fishing organizations / industry, NGOs, etc) and advisory and management bodies

2.2.7 Summary and conclusions in relation to understanding problems and context of present management and management decision (global problems)

Synthesis including:

- identification of the context in which fisheries management tools are to be used
- identification of which problems they are to assist in solving
- identification of the knowledge which management tools are to communicate

Establish working hypotheses to be used in WP3, WP4 and WP5 (case specific)

Reporting

The output will be a compilation of the current knowledge on as well as a categorization of fisheries management systems. Furthermore, the output will be a review and description of performance and adequacy of the present management systems and present management decision processes in terms of their use of knowledge. This will include a review of existing performance evaluation frameworks. This leads to identification of the context in which fisheries/stocks evaluation tools for production of advice to management bodies are to be used, which problems they are to assist in solving, as well as of the knowledge which the tools are to communicate. This work package will deliver information to be used in WP 3-5

Deliverables:

D2.1: Report and catalogue with review, compilation and categorization of identified and published evaluations of management systems relevant for fishery

D2.2: Report with review and description of contents, structure and function of present management and management decision making processes focusing on how knowledge informs the processes. This includes overall identification of the context in which fisheries/stocks evaluation tools for production of advice to management bodies are to be used, which problems they are to assist in solving, as well as of the knowledge which the tools are to communicate.

Milestones:

M1: Results from WP2 to be used in WP3, WP4 and WP5

M2: Categorization of fisheries management systems

WP3 Development of the operating model within the fisheries management evaluation framework

WP description (full duration of project)

WP number	3	**Start date or starting event:**			6		
Activity Type	RTD / Innovation activities						
Participant id	**1**	**2**	**3**	**4**	**5**	**19**	**20**
Person-months per participant:	45,6	42,2	33,3	11,5	10,9	23,5	22,0
Participant id	**21**	**24**					
Person-months per participant:	18,9	7,3					

Objectives:

The purpose of this WP is to develop and build the operating model within the operational management evaluation framework that allows test of plausible hypotheses about the dynamics of the stocks and fleets before implementation and which can appraise the biological and social and economic effects of the existing fisheries management measures in EU. The operating model will be a simulation model of the system to be managed and the management procedures applied, which includes parameters and outputs from methods for monitoring and assessing the status of the system as well as relevant management options. The operating model will be able to evaluate and simulate different management options continuously using output parameters and results from scientifically based tests of hypotheses and analyses performed in WP4 (cyclic process) with relevant descriptive models addressing main fisheries advisory and management problems. Consequently, the operating model within the evaluation framework can be used to evaluate results and output generated from other software packages (descriptive fisheries/stock assessment models and analysis tools), analyses, and existing databases being used for production of advice to management bodies, and can be applied to important EU fisheries.

The simulation part, or the operating model, of the evaluation framework will be based on stochastic simulation techniques and take account of uncertainties (parametric as well as structural uncertainty) as well as include risk assessments. It will simulate the data collection using existing databases, calculate variance in data, perform pre-processing of data, perform assessment of the system (with use of output from currently applied descriptive models and analysis tools, alternative existing models/tools, or modified existing (alternative) models/tools for fisheries/stock evaluation), and provide advice according to harvest control rules, management options and objectives. Simulation will mainly be performed using an integrated suite of software facilities with implementation of a common language (e.g. R) and interface, i.e. a common simulation model, which can handle output and results from a variety of descriptive models and analysis tools for analyzing different management scenarios, options and objectives.

Description of the work:

(Specific tasks in relation to WP3):

3.1 Discuss and select criteria for development of and setting up an operating simulation model within the conceptual fisheries management evaluation framework by using results from WP2 as well as information and continous, cyclic feedback evaluation from WP4-5 including feedback from planned regional workshops with selected relevant stakeholders (fishing organizations / industry / catching sector, NGOs, etc) and advisory and management bodies, relevant scientists, etc.

3.2 Establishment of research questions relating to the general level, to the evaluation process and the overall development of a operating simulation model as described in section 2.

3.3 Develop and establish an operating simulation model within a conceptual fisheries management evaluation framework in context of the overall approach described above taking into account continous, cyclic feedback from WP4-5 as well as from regional stakeholder workshops in an iterative process.

The operating simulation model will be able to:
- perform simulations and evaluation of output and results from fisheries/stock evaluations (assessment) with descriptive models and analysis tools;
- simulate implementation and impact of management systems and management instruments (e.g. fleet adaptations, reactions from fishermen);
- give output from simulation and evaluation in form of a suite of measures of performance of fish stocks and fishing fleets which can be used for relative evaluation of the alternative management systems and instruments by comparing the performances;
- that is, to perform comparative evaluation of alternative management systems and instruments producing relative measures of performance applying either currently used or appropriate alternative fisheries/stock evaluation models / analysis tools to the fisheries/stocks in question;
- take account of uncertainties (parametric as well as structural uncertainty) as well as include risk assessments.

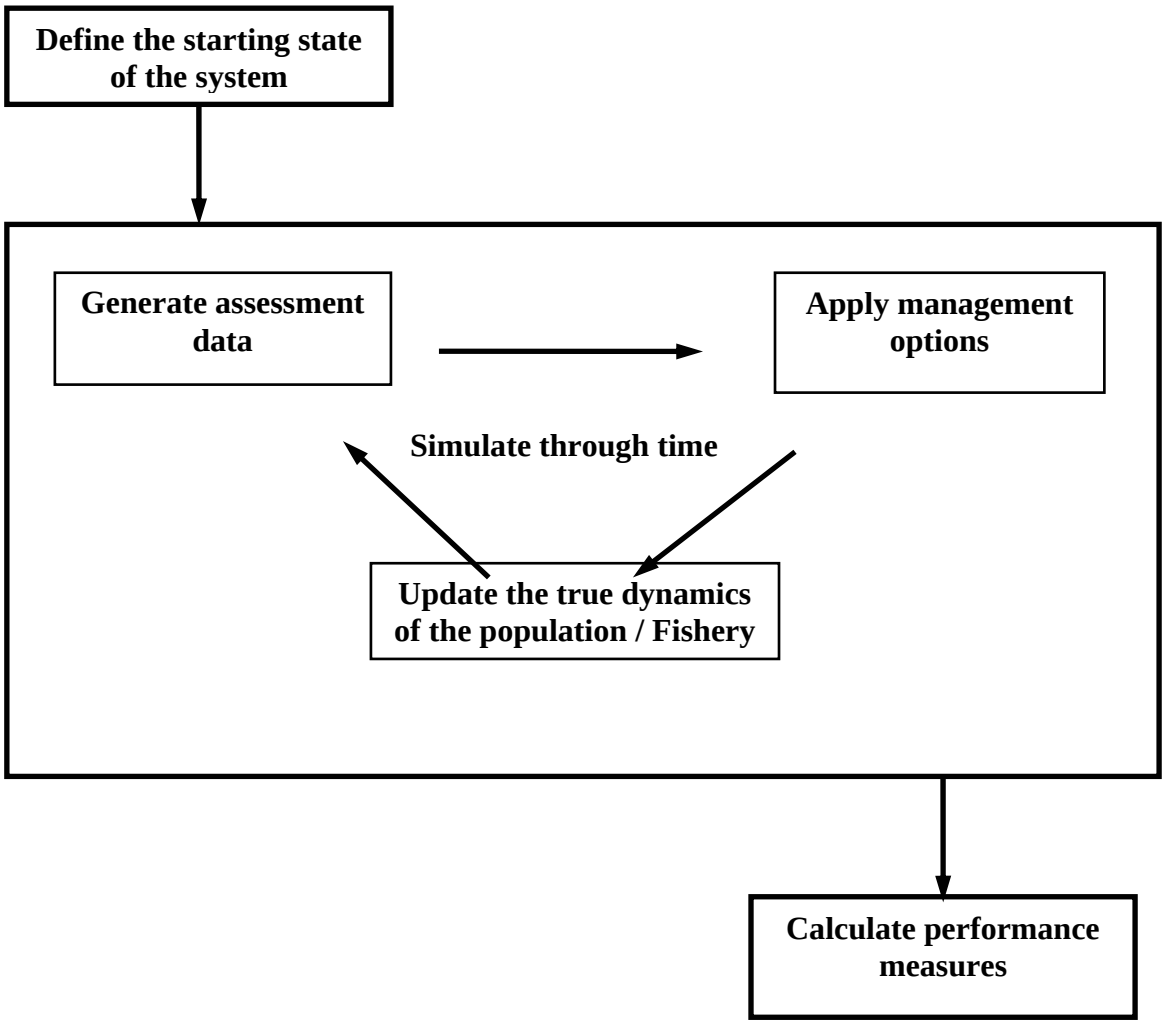
The operating simulation model will take advantage of previously developed approaches (EVARES, MATACS, MATES EU Projects) that are able to consider the processes contributing to the overall performance in an integrated framework. These approaches model both the "real" and observed systems, and consider individual systems as well as interactions between system components.

3.4 Set-up relevant databases in common format (no extensive new data collection programs, but compilation and processing existing data). The operating model will primarily use existing databases and use output from existing integrated suites of descriptive models and analysis tools for fisheries/stock evaluation (software). Iterative process between WP3 & WP4.

3.5 Develop the operating simulation model to:
- have common interface
- be able to be operated from the same overall framework language and software (e.g. the computer language R)
- provide an intuitive user interface
- allow comparative exploration of management scenarios and fisheries/stock evaluation descriptive models and analysis tools and output from these
- utilize scenario modelling if data shortage occurs
- be able to perform data processing to simulate alternative data post-stratifications and methods of data processing by using e.g. bootstrapping.
- be able to calculate variability and uncertainty by using e.g. Bayesian methods
- accommodate for uncertainty
- allow for risk analyses and include risk assessment
- consider influence of errors from modelling
  - The dynamic processes
  - Measurement errors
  - Estimation errors
  - Model mis-specification
  - Implementation errors
- minimize possibilities for mis-interpretation of output by managers and stakeholders

All this will be done in processes using continous, cyclic feedback from WP4-5 as well as from regional stakeholder workshops.

3.6 Specification of standard types of output parameters and results obtained from WP4 to be lifted into WP3 in order to perform evaluation and simulation by the operating model developed under WP3. This will be an iterative process between WP3 and WP4, as well as based on continous cyclic feedback from WP5 and regional stakeholder workshops.



3.7 Develop and define a suite measures of performance of the management systems and instruments applied for the fish stocks and fishing fleets under study as an iterative process between WP3 and WP4 as well as based on continous, cyclic feedback from WP5 and regional stakeholder workshops by comparison and relative evaluation of alternative management systems. Further, in cooperation with WP4 and WP5 to make a standardization of the output from the operating simulation model, i.e. the suite of measures of performance of the management systems and instruments under study, to allow for comparison and relative evaluation. The operating simulation model should in principle be able to handle any measure of performance. These measures will comprise biological, ecological, economic and social measures as well as environmental impact of fishing actions (by-catch, discarding). Such measures can be the traditional ones of the biologists (spawning stock biomass and fishing mortality), economic measures (e.g. profitability, investments, cash flow), sociological (e.g. employment / unemployment, income per fisher) and ecological (e.g. unintended by-catch of other species or marine mammals). (See also section 4.4 under section 7.6). Consequently, such measures of performance are in nature reference points and key indicators for management. Further, it should be able to evaluate effect of monitoring, control and surveillance (MCS). Alternative management regimes can be evaluated by comparing the performances. The expected prediction power of the model will not lead to quantitative results, but rather relative measures. The output will be in relative terms: which strategy is likely to give better returns on the required system indicators than another strategy? Consequently, the result will be comparative evaluation of alternative management systems and instruments producing relative measures of performance. The intention is only to recommend for implementation options that have been tested through simulation or

evaluation within the management evaluation framework. All this will be accomplished through a continous, cyclic feedback between work packages 3-5 including feedback from the regional stakeholder workshops carried out under WP5.

3.8 Evaluation of output of operating simulation model by use of an iterative and cyclic feed-back process between WP3, WP4 and WP5 including regional stakeholder workshops, and by use of results from WP2. The evaluation will not only be a parametric prediction, but will synthesize the best knowledge of how the fisheries management system will react and what the outcomes in reality will be. Furthermore, development of protocols for the comparison of alternative management systems and instruments applying different descriptive fisheries / stock assessment models and analysis tools in cooperation with WP4 and WP5, including presentation and communication of results. There will be produced publications containing the results from a set of case studies.

3.9 Develop further the documentation and user-interface of the operational fisheries management evaluation framework (the software part). This will be an iterative and cyclic feedback process between WP3, WP4 and WP5 including feedback from the regional stakeholder workshops. Among other this work package will interact with WP4 and WP 5 on the development of a user-friendly interface of the software. It will develop three standards of interfaces:

1) The “experts interface”, allowing for all details and computations to be inspected, and controlled.
2) The “managers interface”, focusing on the summary presentation of results, which are of interest for making on management decision. This will also allow the manager to manipulate some basic input parameters and options.
3) The interface for “public presentation of results“ will be developed. This presentation will attempt to cover the needs of all stakeholders, fishers, fishing industry, managers, environmentalists, governments, the public, etc.

Schematic overview of the planned simulation module of the EFIMAS project:

Databases**:** E.g. research surveys, sampling from commercial vessels and market samples, effort, (including spatial distribution of effort), prices and costs of fishing operation, etc. Data can be obtained by random number generators, or they can be bootstrapped from existing databases. Measurement errors can be imputed. This module allows for simulating increased/reduced sampling intensity, as well as change of stratification. The framework will use existing databases.

Data Processing: Can be used to simulate alternative data post-stratifications and methods of data processing. This can be done by boot-strapping.

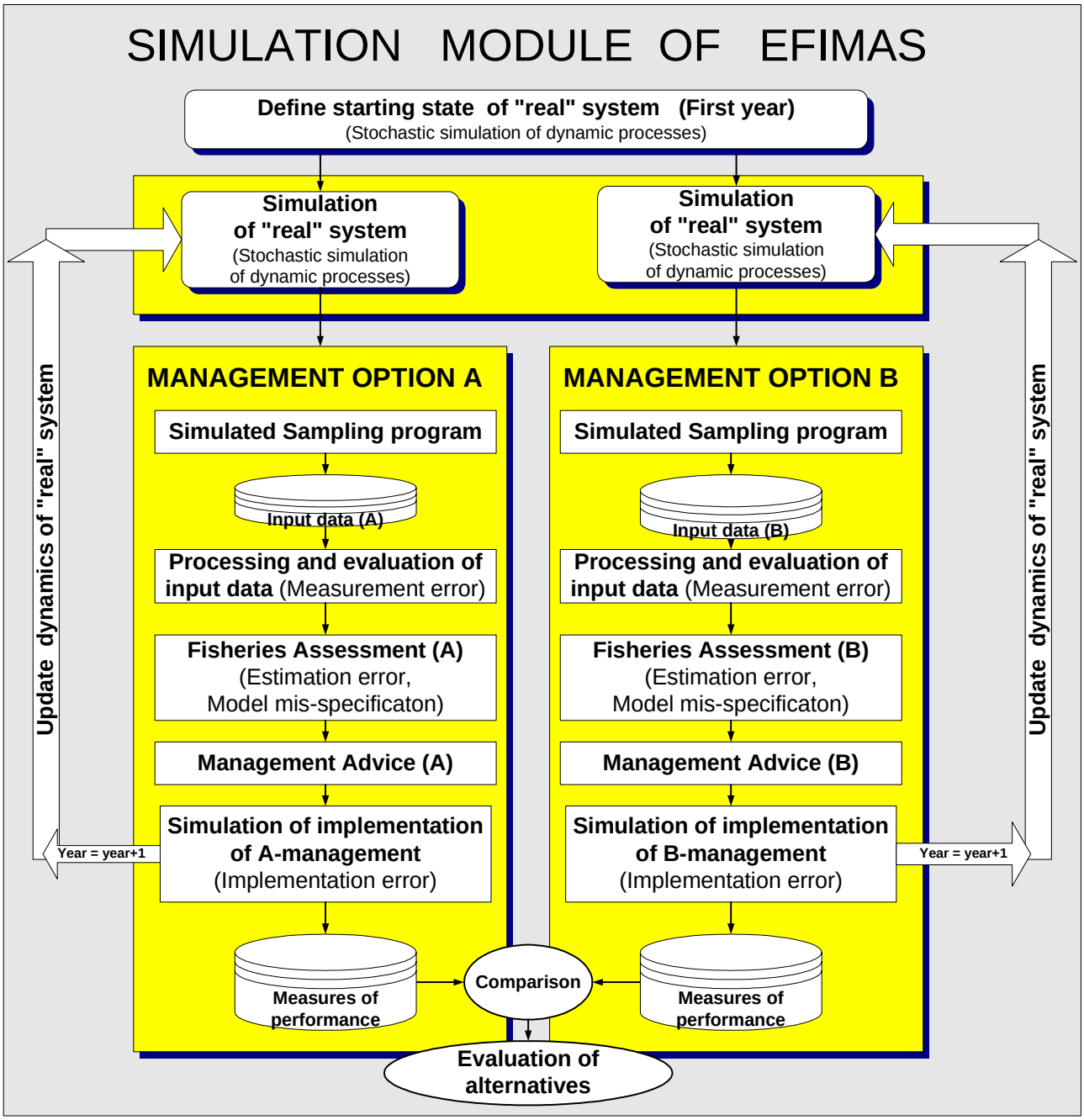
Data Evaluation: Variability and uncertainty in data can be calculated, e.g. by using Bayesian methods.

Simulations of output from fisheries/stock evaluations (assessment), which include output from fish stock assessment along the lines of ICES Working Groups supplemented by bio-economic analysis or other descriptive fisheries / stock assessment models and analysis tools. The impact of process errors will be evaluated.

Management advice will be based on a suite of harvest control rules, most of which can be fleet or stock specific. This module will simulate the advisory functions of e.g. ACFM and STCEF.

Simulation of implementation. This module can simulate or evaluate the reaction of fishers to management regulations. It consequently can simulate or evaluate the behaviour of the fishing industry. “Implementation errors” imply modelling or evaluating the un-intended effects of regulations, lack of effect (compliance) and control. Behaviour cover “strategic or structural behaviour” and “tactic or trip related behaviour”. Structural behaviour accounts for the investment in new vessels and withdrawal from the industry (e.g. decommission). Trip related behaviour accounts for the decisions made by the fishers in relation to fishing operations (e.g. choice of gear and fishing grounds).

Output from the simulation or evaluation: (See below).



Deliverables:

D3.1: Delivery of prelimenary software package with documentation (milestone as well) (month 30)
D3.2: Technical reports of input/results by case study, for use in regional workshops and in WP4-5 (milestone as well) (month 30).
D3.3: Delivery of final software package with documentation (milestone as well) (month 38)
D3.4: Final Technical WP reports of results and input by case study (month 38)

Milestones:

M3: Provide a software package with the operating simulation model with full documentation (month 30 and 38).
M4: Technical reports of input/results by case study, for use in regional workshops and WP4-5 (month 30)

WP4 Application of the management evaluation framework to selected case studies

WP description (full duration of project)

WP number	4	**Start date or starting event:**			6		
Activity Type	RTD / Innovation activities						
Participant id	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Person-months per participant:	18,7	11,9	18,4	13,8	6,5	19,7	11,1
Participant id		**9**	**10**	**11**	**12**	**13**	**14**
Person-months per participant:		1,4	28,7	40,2	9,0	6,0	10,6
Participant id	**15**	**16**	**17**	**18**	**19**	**20**	**21**
Person-months per participant:	10,3	35,7	14,8	5,3	11,8	13,3	15,2
Participant id	**22**	**23**	**24**	**25**	**26**	**27**	**28**
Person-months per participant:	0	14,7	5,5	8,2	43,3	14,6	51,9
Participant id	**29**	**30**					
Person-months per participant:	16,0	1,9					

Objectives:

In this WP the evaluation framework will be refined by work on specific case studies covering key EU fisheries. Specific research questions relate to the cases representing main, typological advisory and management problems.

The specific selected case studies are the following:

CS1: Demersal flatfish fisheries in the North Sea
CS2: Demersal roundfish fisheries in the North Sea
CS3: Salmon fisheries in the Baltic Sea
CS4: Neprhops fisheries in the East Atlantic
CS6: Northern hake mixed species fisheries in Area VI, VII and VIII
CS7: Swordfish fisheries in the Mediterranean
CS8: Hake fisheries in the Mediterranean
CS9: Cod fisheries in the Baltic Sea

Summaries and details of the specific selected case studies with respect to overview description of fisheries and stocks, main management and advisory problems, main and typological problems to address in the present project (approaches to analysis as well as purpose of the case study, methods to be used and case specific deliverables), description of the specific and generic input from various partners, and relevant references are given in Annex B Case Study Fisheries Summaries to this technical Annex1.

The purpose of this WP is to apply and test the operating simulation model developed in WP3 (and give feedback to WP3) on selected case studies, and for the selected case studies to apply appropriate descriptive fisheries / stock assessment models and analysis tools to the selected case studies within the simulation evaluation framework in order to evaluate relevant management systems and instruments for the case studies that are deemed likely to emerge. Further, the purpose is to develop further or modify or re-organize existing descriptive fisheries / stock assessment models and analysis tools by implementation in representative case studies, i.e. by applying them to the selected case studies in order to optimize the approach, and, finally, to develop further the documentation and user-interface of the software tool box, i.e. the simulation evaluation framework, by implementation on case studies. This will be done partly through an iterative, cyclic feedback process between WP4, WP3, and WP5 including feedback from regional stakeholder workshops.

Description of the work:

As a prerequisite to the development of the management evaluation framework a range of research questions will be addressed in the project in WP4 in relation to specific management procedures which includes methods for monitoring and assessing the status of the system as well as the management options. They relate to main, typological advisory and management problems within managing important EU fisheries and relate to the scope and role of simulation models to inform management decision processes and how various types of knowledge are best brought to use in management decisions.

For each case study specific advisory and management problems will be selected to be addressed. Specific hypotheses on scientific basis as well as specific objectives will be formulated addressing these specific problems. In this process relevant existing or modified existing descriptive models and analysis tools will be applied to test / investigate the hypotheses and meet the objectives, i.e. to perform scientifically based hypotheses, testing and investigation on specific management and assessment problems and dynamics of the system. The descriptive models will be used to generate hypotheses about the dynamics of the fisheries system, perform tests and analyses in relation to hypotheses, and where appropriate to parameterise the operating model. Consequently, specific problems are addressed with specific descriptive models and analysis tools. Accordingly, output and results from the analyses will be used in the evaluation framework partly to parameterise the operating model and run the simulation trials and partly to perform overall evaluation where parametric simulation of parameters is not possible.

The output from the analyses with descriptive models to be evaluated by the framework can focus both on fleets and stocks with respect to the actual management systems to be tested and supply relevant parameters. Fisheries can be modelled and analysed as mixed fisheries (multi-species / multi-fleet fisheries). Spatial aspects can be modelled and analysed (e.g. closed boxes). Implementation of regulations and fleet adaptation (e.g. behaviour of fishers: how do fleets react on management measures) as well as impact on system can be modelled and analysed.

Within the present research programme the research questions/hypothesis and objectives will be stated at two levels – one relating to the general level, to the evaluation process and the overall development of a management evaluation framework (WP 3), and one relating specifically to the case specific advisory and management problems to be addressed with selected descriptive models and specific analyses (WP 4).

Based on the various cases a suite of specific main and typological advisory and management problems as well as specific issues will be addressed, and objectives and main hypotheses are identified – in which respect the various cases are used as a test-ground for specific parts or features which are to be evaluated by the framework. This includes a description of the proposed projects scientific and technical objectives and includes a range of scientific and technical questions relating to specific types of advisory and management problems and descriptive models involved including how uncertainty is best dealt with, how feed-back features can be constructed which can accommodate many types of data and information.

The performance of the candidate management options used in the evaluation framework will be evaluated in WP4 and further recommendations on research and management recommendations will be made in a continous cyclic and iterative feed-back process / system including WP3 and WP5 and regional stakeholder workshops with respect to e.g. recommendations on further investigations needed, more relevant alternative hypotheses to be addressed, alternative descriptive models and analysis tools to be applied, data to be used, etc. as well as recommendations on other more relevant or desirable management options and objectives.

Specific tasks in relation to WP4:

4.1 Produce an overview of management systems and instruments (from WP2) considered relevant for the given selected (representative) case study, and listing of their purpose, properties and appropriateness for the case study in question.

4.2 For each case study identification of alternative management systems and instruments which have not yet been implemented, but are deemed likely to emerge.
Different types of management systems and instruments that are case study dependent could be considered in the evaluations are for example:

- TAC (single- and multi-species based)
- Effort and capacity (fisheries based; single- and multi-fleet based)
- ITQ
- EcoQO (ecological quality objectives)
- Real time management (e.g. research survey based)
- Multiannual aspects
- Technical measures
- Spatial/temporal closures
- Economic measures (price intervention, tax, licenses, MAG, subsidies, credit schemes, decommission)

4.3 On basis of the formulated scientific and technical research questions addressing main advisory and management problems specific scientific based objectives and hypotheses about the system will be defined and generated on case study basis. This will be done in relation to specific management procedures which includes methods for monitoring and assessing the status of the system as well as the management options.

4.4 Appropriate descriptive models, analysis tools and approaches to address the objectives and hypotheses will be selected from which output and results are to be used in evaluation by the simulation evaluation framework developed in WP3.

This includes production of an overview (annotated list) of relevant descriptive fisheries / stock assessment models and analysis tools (as identified under WP2), and supplying the relevant respective software packages, and give an overview of their individual purpose, properties, requirements and appropriateness for various management measures for the case study in question (i.e. for the various selected fisheries systems=case studies) as well of their uncertainties and biases.

Furthermore, this includes identification of choices made for specific case studies and criteria for selecting the descriptive models and analysis tools and approaches dependent of various types of fisheries systems (case studies) and specific problems in response to management. Identification of key tool components (parameters and relationships).

Different types of descriptive fisheries / stock assessment models and analysis tools that case dependent could be considered in the evaluations are for example:

VPA (XSA, ICA, SURBA, SXSA, etc., etc.)
MSVPA (multi-species VPA)
Fisheries based, mixed fisheries models (TEMAS (DK), ISIS-fish (F), Plaice Model (NL), etc.)
Bio-economic models

Determination of the critical management issues to be addressed in each case study and the descriptive models and methods by which they will be simulated.

While the cases studies will be based on a common generic structure, the case specific descriptive models will need to capture the particular features relevant to the policy options to be simulated in the operating model. For example, simulation of changes in technical measures (e.g. mesh size restrictions) require catchability by age/size class for the species affected. The measure can be simulated by changing the catchability coefficients to reflect catch size compositions with the new gear. Similarly, seasonal and/or area closures will require a temporal and/or spatial element to be developed in the descriptive models. Such a feature will not be necessary if these management options are not considered relevant to the fishery.

Assumptions will also be necessary regarding fisher behaviour in response to the management changes. Fishers will change their behaviour in response to the management measures and management system, and this will need to be factored into the analysis. For example, a TAC may result in over-quota catch or diversion of effort onto other species (or a combination of both). This will be informed from Task 3 (multi-annual measures) and Task 4 (1st Call for Proposals) (relationship between capacity, effort and fishing mortality), as well as from the review undertaken in WP2 and the continous, iterative and cyclic feedback process between WP4, WP3 and WP5 and regional stakeholder workshops. The case study descriptive models will need to allow for these (assumed) behavioural changes to be simulated.

Derivation of the biological relationships for inclusion in the case specific descriptive models

The key biological relationships to be incorporated into the descriptive models include stock numbers, stock-recruitment relationships, growth and weight at age, natural mortality and fishing mortality. A number of other key measures will also be required, such as biomass and spawning

stock biomass, which will be derived from the models (e.g. as a function of stock numbers at age and weight at age). In addition, key reference points will also need to be provided (e.g. Bpa or Blim).

Most of these parameters would have been estimated as part of previous stock assessments. However, not all of the information may be available for all the key stocks (and fisheries), or some of the information may be highly uncertain. Where the critical parameters are not available, assumed values will need to be derived based on existing information relating to similar species and stocks (and fisheries) elsewhere, or 'best guess' estimates based on expert knowledge within the European scientific community (partly included in the continous iterative and cyclic feedback system). It is possible that such values could be elicited through subjective methods or empirically rigorous methods for operating model parameterisation to be applied where methods and data are available, i.e. for example where the uncertain parameter is related to 'known' parameters for other species and stocks. If that is not the case then approaches that apply expert judgment will be applied as a last resort. While some of these techniques are not 'state-of- art' in the purest sense, such methods have been recently reviewed as useful tools for derivation of uncertain or unknown parameters in bio-economic models. Generally, operating models could in some cases incorporate the best available knowledge about the underlying population dynamics. Therefore, empirically rigorous methods for operating model parameterisation can for example in some cases be applied where methods and data are available. Where existing information relating to similar species and stocks is to be applied, statistical analysis methods can be utilized to identify plausible parameter values. In this overall context the attempt will be that state of the art methodology will be applied.

Derivation of key economic relationships

The key economic relationships to be included in the models are costs of fishing and prices received. Key costs to be incorporated into the models are variable costs (e.g. fuel, oil etc) that are a function of the level of effort and boat characteristics (e.g. size); and fixed costs (including capital costs). The fixed costs are costs that are incurred regardless of the level of fishing effort (e.g. onshore running costs, depreciation, administration etc). Fishing costs will be derived from economic surveys that have been previously conducted where possible. Where data are not readily available, assumptions on cost structures based on similar types of boats in nearby or similar fisheries will be used. As with the uncertain biological parameters, other (alternative) methods and techniques can be applied where data are available for doing that to derive reasonable estimates of the costs. If data and methods are not available then approaches that apply expert judgment will be applied as a last resort here as well, i.e. judgment based on expert opinion.

The prices received will, where appropriate, be modelled in relation to total landings (i.e. a price dependent demand curve will be specified in the model). This will allow prices to vary with the level of output produced – critical when assessing stock recovery programmes or measures that restrict the level of output. Studies of price formation have been undertaken in a wide range of European fisheries for a wide range of species. These existing models can be used as the basis for the analyses, or, where an appropriate time series of data are available on prices and quantities landed, fishery specific models will be developed. Price by size will also be examined, and where relevant, will be incorporated into the models (the models will allow for variable price by size, although in many cases the different size classes may have the same unit price).

Effort dynamics will also be built into the models. Fishers respond to changing conditions in the fishery through adjusting their own effort level, or diverting effort to alternative activities. Effort levels will be linked to catch rates, prices and costs (i.e. the level of profitability in the activity). These models will draw on the parallel work being undertaken in Task 3 and 4 (EU FP6 Priority 8 1st call for proposals). Other assumptions regarding fisher behaviour will be applied as well.

Other important relationships and information that need to be incorporated into the models are the fleet structure (size, gear type etc), efficiency change and capacity utilisation (related also to the effort dynamics model above). Changes in fleet size and structure will affect the average efficiency of the fleet, thereby altering the relationship between nominal effort (i.e. observable effort such as days fished) and catch. Assumptions regarding efficiency change will be developed based on studies

of efficiency distribution in various EU fisheries. Similarly, changes in fleet structure will affect the level of capacity utilisation, which again will change the relationship between the level of fixed inputs and outputs (i.e. catch).

As the models will be dynamic, an allowance will be required for the effects of technical change on efficiency. A number of studies have been undertaken on the rate of technical change and the effects on efficiency in European fisheries, although no consistent patterns have been identified. For example, the results of the EU funded project QLK5-CT1999-01295 (TEMEC) demonstrated varying trends in efficiency change over time. The current EU FP5 funded TECTAC project is also examining this issue and will help to inform this work package.

Combination of key biological and economical relationships

The different components of the descriptive models that have been used and developed separately should be combined. This will require co-ordination between the biologists and economists involved in each case study. The general framework for combining the components has been identified in WP2 and WP3 in cooperation with WP4 (cyclic system).

4.5 Make existing national case specific data available according to needs. Which data are central in order to make high quality parameterisation, modelling and analysis? This includes discussion and by data processing enhancement of the data quality. Appropriate choices in relation to specific use of data in relation to the quality and aggregation in data will be made and discussed, as well as appropriate choices in relation to data processing.

4.6 Perform relevant scientific based in depth analyses in relation to the dynamics in the system. In this process relevant existing or modified existing descriptive models and analysis tools will be applied to test / investigate the hypotheses and meet the objectives, i.e. to perform scientifically based hypotheses, testing and investigation on specific management and assessment problems and dynamics of the system.

4.7 Develop further or modify or re-organize appropriate existing descriptive fisheries / stock assessment models and analysis tools by implementation in representative case studies, i.e. by applying them to the selected case studies in order to optimize the approach. Analysis of sub-problems in order to strengthen the tools will be made. Identification of key tool components will be included. This will be an continous iterative and cyclic feedback process between WP4 and WP3 and WP5 including feedback from the regional stakeholder workshops.

4.8 Output and results from the analyses will be used in the evaluation framework partly to parameterise the operating model and run the simulation trials and partly to perform overall evaluation where parametric simulation of parameters is not possible. Discussion and selection of appropriate parameterisation of the descriptive models and analysis tools based on multi-disciplinary experiences and case specific expertise from the multi-disciplinary case study groups. What are important parameters and impacts? What should be included in the descriptive models and analysis tools in order to optimize parameterisation and to optimize quality of the results and output from the analyses when running the models? (See also section 4.4 under section 7.6). Again the iterative and cyclic feedback system between work packages 3-5 including the regional stakeholder workshops will operate in respect to this.

4.9 Evaluation of the performance of the candidate management options used in the evaluation framework, and recommendations on further research and proposal of alternative candidate management options. This will be made in a iterative and cyclic feedback system (WP3-5 and regional stakeholder workshops) with respect to e.g. recommendations on further investigations needed, more relevant alternative hypotheses to be addressed, alternative descriptive models and analysis tools to be applied, data to be used, etc., as well as recommendations on other more relevant or desirable candidate management options and objectives.

Basis for the selection of case studies and case specific analyses under WP4:

The selection of case studies has been made to serve the purpose of testing the evaluation of the generic simulation evaluation framework. The criteria for selection do not cover the entire spectrum of European fisheries, but are selected cases which represent the spectrum of management problems. In addition, the main features of fisheries systems are covered (i.e. demersal / widely distributed / semi-pelagic, Northern / Southern Europe, data availability (good/poor), etc. As a second priority, the cases selected are important in terms of value and biomass of catches.

The considerations about the cases have included: 1) science – cases with very different characteristics are compared, and the cases possess high contrast in terms of biological systems characteristics (environmentally / fisheries driven, short term dynamics, recruitment variability) the amount and accuracy of data available, the complexity of the fisheries (diversity and scale of fleets) and the characteristics of the management institutions (what is the basic approach and the main regulation tools used, are management decision making based on high information input, are they accepted, how effective is monitoring, surveillance and control MSC, is there room for adaptation etc.) 2) the need to verify that the evaluation framework is useful in a broader European context which implies both that cases should be geographically widespread and that the project through the case studies include partners from a wide range of countries. The latter is also an issue of dissemination by involving partners on local cases in order to develop capacity for further development and use of these tools.

The major and minor case studies considered and addressed within the EFIMAS project are listed above and shown in the multi-disciplinary case study matrix below. Furthermore, an overview of case studies is also shown in the overview table in section 8. Here the case specific contributions under WP4 for each project partner are summarised. The contributions by specific partners to specific case studies have been specified according to the type and area of contribution. For each case study it is shown which institutes will contribute with specific biological or socio-economic input (data, case specific expertise) and which institutes will contribute with generic biological or socio-economical expertise and input (case specific models, general skills and expertise). This overview clearly indicates that the approach within each case study is multi-disciplinary and that the contributors possess both specific and generic multi-disciplinary expertise within biology, economy and sociology.

Consequently, the case study groups are established in order to perform multi-disciplinary case specific analyses. The case study groups cover:

- Institutes with available relevant data (specific input); multi-disciplinary
- Institutes with case specific expertise (specific input); multi-disciplinary
- Institutes that have modelling experience (generic input) either on general basis or case specific basis; multidisciplinary

Multi-scale case study matrix

		Case Studies									
		1	2	3	4	5	6	7	8	9	10
Species	Single			X						X	X
	Multi	X	X		X	X	X	(X)	X		
Stocks	Demersal	X	X		X	X	X		X	X	
	Pelagic			Ana				X			X
	Widely distrib.					X					
Fleets	Single									X	
	Multi (mixed)	X	X	X	X	X	X	X	X		
Fisheries scale	Large	X	X		X	X	X	X	X	X	
	Small			X							
Data availability / quality	Rich	X	X	X	(X)		(X)			(X)	X
	Poor					X		X	X		
Management unit	Shared	X	X	X	X	X	X	X	X	X	X
	National										
MCS	Strong	X	X		X		(X)				
	Weak					X		X	X	X	
Geographic distribution	North	X	X	X	X	X	X			X	X
	South				X	X		X	X		

	Specification of case studies (arbitrary order)
1	Flatfish fisheries, North Sea
2	Roundfish fisheries, North Sea
3	Salmon fisheries, Baltic Sea
4	Nephrops fisheries, East Atlantic
5	Atlantic deep sea fisheries
6	Northern Hake, Megrim and Monkfish fisheries, area VI-VIII
7	Swordfish fisheries, Mediteranean Sea
8	Hake fisheries, Mediteranean Sea
9	Cod fisheries Baltic Sea
10	Herring fisheries, Bothnian Sea (Baltic)

Selected Major Case Study
Selected Minor Case Study

(In relation to the above matrix it should be noted that Case study no. 5 and 10 has been taken out of the project during the project evaluation and project contract negotiation processes).

Furthermore, summaries and details of the specific selected case studies with respect to overview description of fisheries and stocks, main management and advisory problems, main and typological problems to address in the present project (approaches to analysis as well as purpose of the case study, methods to be used and case specific deliverables), description of the specific and generic input from various partners, and relevant references are given in Annex B Case Study Fisheries Summaries to this technical Annex1.

Example describing main management and advisory problems and approach to analysis on case study basis in the project (exemplification with North Sea Demersal Roundfish Fisheries):

i) Main management and advisory problems

One consequence of the mixed nature of the roundfish fisheries is that nets which retain fish of the minimum landing size of the smallest species (whiting) will also retain relatively high numbers of undersized fish of the other species, and as a result the fisheries are characterised by extensive discarding, particularly of undersized haddock and whiting, although some whiting which are above the minimum landing size are also discarded. There are also discards of undersized cod, but this has been less well studied than discarding of haddock and whiting.

The single species TACs used to manage the North Sea roundfish fisheries typically take no account of the differing stock status of the different species, and as a result boats which exhaust their quota for one species will often continue fishing to take their quota for the other species. As a result, their catches of the first species will either be discarded or landed illegally.

These two aspects of the mixed-fishery problem in the North Sea lead to problems in the quality of catch at age data that are the basis of the assessments used as the basis of scientific advice for these fisheries. As a result, it can be seen that the mixed-fishery aspects of the roundfish fisheries can be problematic for a TAC-based management system.

The stocks of cod, haddock and whiting in the North Sea have been subject to high levels of fishing mortality for many years. As a result, these stocks all have truncated age-distributions, and the stocks and fisheries are highly dependent upon the strength of recruiting year classes. One consequence of this is that if a strong year class does recruit to the fishery, the fleet may adapt its fishing practices in order to target that year class. This can cause problems for the assumptions made in fitting the stock assessment model, and thus, lead to problems with the assessment. In addition, catch forecasts can be very sensitive to assumptions about growth, discarding and maturity of these exceptional year-classes, again leading to problems in assessment performance. Such problems have recently been observed in relation to the 1996 year-class of cod and the 1999 year-class of haddock in the North Sea.

The recent depletion of the North Sea cod stock to a very low level has resulted in a series of short-term management measures which have been intended to provide some measure of protection to the cod stock. In addition to low TACs which have been intended to restrict fishing effort, a spawning closure was introduced during 2001. This involved closing a large area of the North Sea to roundfish vessels during the cod spawning season. More recently, following the ICES advice for 2003 that all fisheries for North Sea cod and associated species should be closed in order to protect the cod stock, further management measures have been introduced including effort limitations and funding for decomissioning to enable some reduction of fleet capacity. These measures have all been introduced at short notice with little attempt or opportunity to evaluate the effect they will have. Nonetheless, evaluation of the effects of these measures is required for forecast and management purposes, even though the short-notice, *ad hoc*, nature of the management actions makes this a difficult task.

As well as the problems associated with evaluating the effects of emergency management measures on North Sea cod, the recent advice that all fisheries on North Sea cod and associated species should be closed high-lighted another problem with the existing form of management advice. The advice for closure was widely criticised by the fishing industry/catching sector, not least because it took no account of the severe socio-economic consequences of such a closure. This is a specific case of a more general criticism that the current form of advice is based only on biological criteria and does not account for economic considerations.

The key management and advisory problems identified in relation to the North Sea roundfish fisheries can be summarised as follows :

- Single species TACs problematic in a mixed-species context
- Fisheries strongly dependent on recruiting year-classes leading to problems in assessments and forecasts
- Ad hoc, emergency management measures difficult to evaluate
- No socio-economic considerations in management advice

ii) Approach to analysis

There are a suite of alternatives to the single species TAC management currently in force for the management of North Sea cod, notably fleet specific effort quotas.

There are as well, management measures which can supplement the current regime, for example (1) Closed areas (2) Closed seasons (3) Increased minimum mesh size.

The mixed nature of the fishery, and the emerging extended use of technical management measures call for a fleet-structured management strategy. The problems of single species TACs in a mixed fishery, is believed to be reduced when moving from catch quota to effort quotas, and the obvious primary analysis to make is that of comparing TAC-management with effort-based management. The analysis of management by effort regulation will be combined with analysis of the effect of technical management measures or effort quotas combined with catch quotas.

The analysis of effort-regulation will focus on the fleets, including the prediction of fleet behaviour as a reaction to management measures. Modelling of fleet behaviour involves modelling of the economics of fleets, primarily costs and earnings for the short term predictions, and investments / dis-investment / decommission for the long term predictions. The bio-economic approach will allow for a suite of measures of performance to be defined, measures covering the wishes of a range of stakeholders.

The assessment of the effect of closed areas calls for a spatially disaggregated model, and the effect of closed time periods calls for model with a time step shorter than traditional time step of one year (e.g. quarters of year).

With effort as the primary management instrument, the conversion of effort into fishing mortality (through a model for catchability) will become a focal element in the model. This model will establish the catchability of all major fleets for all major species caught in the demersal fishery in the North Sea. This approach will allow for an unambiguous assessment of mixed fisheries, in the sense that it will allow for new multi-species/multi-fleet measures of performance to be defined.

The model to be tested against the traditional single species, single fishery annual model, will be a quarterly, multi-fleet, multi-species, multi-area model accounting for the reaction of fishing fleets to management regulations, including a bio-economic analysis of fisheries. There will be developed a suite of models representing various levels of extensions of the traditional ICES model. The performance will be compared to the traditional model, and the extended model will be compared. The primary comparison will evaluate effort management and TAC-management. Technical management measures will be evaluated along with the primary analysis.

The analysis will take it's starting point in the analysis of "mixed fisheries" made under the STECF and various ICES working groups. The case study will take advantage the current development in ongoing EU-funded projects (TECTAC, EASE, FEMS, etc) and national projects (e.g. TEMAS).

Detailed descriptions of all project case studies are given in Annex B of this technical Annex 1 to the project contract.

Specific research questions to be addressed covering all of the selected case studies:

Based on the various cases a suite of specific main and typological advisory and management problems as well as specific issues will be addressed. Objectives and main hypotheses will be identified – in which respect the various cases are used as a test-ground for specific parts or features which are to be evaluated by the framework. This includes a description of the proposed projects scientific and technical objectives, and includes a range of scientific and technical questions relating to specific types of advisory and management problems and descriptive models involved including how uncertainty is best dealt with, how feed-back features can be constructed which can accommodate many types of data and information.

- What is the trade-off between exploitation and protection objectives under multi-annual and multi-fleet management procedures compared to the present management procedure? Specific cases will be used to develop and evaluate multi-fleet and multi-annual aspects of the evaluation framework.
- What are the relative effects of managing multi-species (mixed) fisheries by single species TACs compared to managing multi-fleet, mixed fisheries by effort and capacity regulations with special emphasis on implications for the by-catch and discarding problems (including species, size and market dependent discarding)? What are the biological, bio-economic and socio-economic consequences of applying effort control to management of certain fisheries?
- What is the effect of not considering economic effects in management advice for certain fisheries?

- What are the trade-offs and relative effects of technical measures (e.g. closed seasons / areas, mesh size regulations) to sustainable management of mixed fisheries or single species fisheries evaluated with fisheries (fleet) based multi-fleet, multi-species, bio-economic, stochastic, dynamic simulation models both under a TAC system and an effort and capacity regulation system? What is the effect of ad hoc introduced regulations (short term management measures) such as closed seasons or areas, effort limitations, funding for decommissioning to reduce fleet capacity, and what are the problems in performing management evaluation of them considering evaluation of the effect of these measures is required for forecast and management purposes? What are the socio-economic effects of such short term management measures?
- In the case of mixed fisheries where species requiring protective action have e.g. lower economic value than the prime target species of the fisheries are there any alternative protective measures (e.g. closed areas/seasons, improved gear selectivity, minimum landing size regulations, other fishing tactics, restrictions to fishing effort and capacity, etc.) than those already applied that can achieve the wished protective goals with respect to by-catches, without affecting the economic viability of the prime target species fisheries?
- Is it likely that the less there is performed mixed fishery in certain fisheries, the bigger uncertainty is acceptable in parameter estimates and in management implementation of mixed fishery?
- What are the limitations / shortcomings in assessment procedures, decision making and implementation that led to the failure to protect certain stocks from over-exploitation by certain fisheries, e.g. recruitment failure? To which extent could alternative management approaches based on decommissioning, licences, individual quota and/or effort regulations help to achieve protection?
- What were the limitations in assessment procedures and management decision making which led to historical failure to achieve management objectives for certain cases? The development in specific cases in the 1990s can be used as a testing ground to identify shortcomings in the management procedures in place and to evaluate the evaluation framework to be developed. This will be evaluated through a retrospective study using the evaluation framework on basis of the data available at the time, simulating both the procedures used at the time and alternatives.
- What is the balance between the costs and the accuracy in relation to monitoring assessments when applying the precautionary approach? Does higher uncertainty lead to lower exploitation rate? In this sense, the definition of the needed accuracy in assessment is more a management decision than purely a scientific decision.
- What are the impacts of the strong dependence of individual year classes in managing mixed and single species fisheries under present management systems compared to multi-annual management, or compared to effort / capacity management? What is the effect of not considering fleet capacity in management of certain fisheries for in example in the above context?
- What are the advantages of a management system for certain fisheries / stocks based on catch quota and/or effort regulations set by Functional Unit, as opposed to current system of TAC's applied to large geographical areas that comprise several stocks with different states of exploitation?
- What are the effects of managing two (or more) different stocks with one TAC in a case, where both the biological features of the stocks and the environmental settings are different? Will management on basis of biologically defined units (population) in the long term perspective lead to better adaptation of stocks to fishing pressure than a one management unit system, and will it, consequently, also be beneficial for the fishery?
- What are the impacts of data uncertainty on the obtained stock information in relation to assessment and management bias? What criteria and variables are most influential when evaluating the state of certain stocks and fisheries? Natural or fishing mortality, S/R-relationships (potentially improved by historical tagging data), growth (growth un-certainty), age determination inconsistencies, maturity estimates (either being length or age dependent), migration, stock composition parameters, catch data parameters, misreporting / under-reporting, etc. ? Does assessment of stock dynamics using age-independent methods lead to qualitatively similar assessment results and management conclusions as so far used age dependent models (to investigate the impact of uncertainty from inconsistency from age determination on assessment and advice)?

- What is the role of fishermen in implementation uncertainty and with respect to misreporting in certain fisheries?
- Analysis of economical behaviour of fishermen in certain fisheries to address to which extent decreased fishing effort is due to decreased landing prices?
- In data-poor multi-species (and multi-fleet) fisheries performed by several countries over a wide area in national and/or international waters, what is the effect of introducing technical measures such as closed seasons / areas, mesh size regulations, and/or reductions in fishing effort and capacity? What are the biological, socio-economical and technical management implications of doing that? What are the effects on multi-species catches of various levels of single species TAC's?
- Which alternative assessment and management options and qualitative measures can be used for data-poor stocks and fisheries (where data from e.g. 3rd countries fishery are not available or where new fisheries do not supply long time series of data) in order to improve management of the fishery? Will international introduction of technical measures (e.g. minimum landing size, mesh size regulations and seasonal / regional closures, effort reductions) be efficient in optimizing sustainable management of the fisheries and avoid over-exploitation?

Deliverables:

D4.1: Prelimenary technical reports by case study (month 18, 36)
D4.2: Final technical reports by case study (month 48)
D4.3: Various scientific publications, popular articles, newspaper articles addressing specific hypotheses and investigations included in the project (during the project period and after completion of the project)

Milestones:
M5: Evaluation of technical reports on inputs and results by case study (among other by WP3, WP4, WP5 and regional stakeholder workshops connected to the last project midterm report).

WP5 Effectiveness of developed operational evaluation tools and test of the utility of the tools

WP description (full duration of project)

WP number	5	**Start date or starting event:**			30		
Activity Type	RTD / Innovation activities						
Participant id	**1**	**2**	**7**	**9**	**10**	**12**	**17**
Person-months per participant:	5,5	5,1	2.7	5,6	12,2	11,5	12,1
Participant id	**18**	**19**	**21**	**22**			
Person-months per participant:	12,0	1,8	3,4	4,6			

Objectives
The objective of this work package is to produce a delivery framework for information to guide management decisions by 1) evaluating the technical performance and the effectiveness of the operational management evaluation tool as a means to inform decision making processes, and 2) developing a framework for the use of the management evaluation tool in decision making processes.
Work Package 5 evaluates the operational evaluation tools and provides iterative feed back for Work Packages 3 and 4 so that tool development and implementation is modified according to these evaluations.
The evaluation to be performed is twofold:
The technical evaluation will let the performance evaluation framework and output from descriptive models and analysis tools be subject to rigorous tests of the technical validity of the model implementation, sensitivity tests and the robustness in relation to data error and to assumptions about the resource system, the fisheries and management implementation.
The technical evaluation will also evaluate the utility in terms of the technical requirements for set-up and use of the evaluation framework.

The evaluation of the effectiveness of the framework and descriptive models to inform the decision making process will prepare the groundwork for the effective implementation by optimal practices for the use of complex modelling procedures in the implementation of policy. Many strands of public policy, both within and outside of environmental governance, rely on multi-dimensional models to inform policy decisions. The role of the present work package is to identify appropriate approaches to the use of the evaluation framework and descriptive models, as well as to provide continous cyclic feedback in the later project stages (WP3-4) as well as provide feedback from regional stakeholder workshops to the other work packages about possible implications of technical design decisions for the effectiveness in real-world policy contexts. It is thus an objective of this work package to anticipate stakeholder reactions to the use of the evaluation framework and to ensure, where possible that stakeholder concerns are reflected in the design of this.

The framework for use of knowledge in management decision processes will be developed through activities which will involve selected relevant stakeholders (fishing organizations / industry / catching sector, NGOs, etc) and advisory and management bodies (decision makers), relevant scientists, etc. in exploration of management options and objectives using the management evaluation tool and other sources of knowledge. These activities will both include measures to develop the framework and provide continous, iterative and cyclic feedback (among other from regional stakeholder workshops) to the development of the evaluation tool and measures to disseminate and demonstrate the use of options exploration using the management evaluation tool for decision making.

Description of work

The technical evaluation of the management evaluation framework and descriptive models will be performed by both a thorough testing of code including alternative coding for some components and by using the framework on a diverse set of real and simulated datasets which represents a wide range of data, system and process properties. This will be performed on iterative basis between WP5, WP4 and WP3 (cyclic feedback process)

The decision process evaluation and development of exploratory framework for decision making will be achieved by discussing and testing the evaluation framework with the stakeholders (“clients” or “customers”) of the software package, i.e. selected relevant stakeholders (fishing organizations / industry / catching sector, NGOs, etc) and advisory and management bodies, relevant scientists, etc. During the project (month 36) there are planned 4 regional workshops to be held in connection with and overlapping to the STM, NM, and CSGM meetings here. Project funding has been allocated to cover partly travel costs for selected and specially invited representatives for stakeholders including the industry / catching sector, experts, managers (on national and EU level) i.e. officials concerned with policy management issues, other interest organizations, etc, which covers broadly representative stakeholders for each region as sufficient in relation to the purpose of the workshops, and partly costs to logistics and planning of these workshops. It is planned to perform regional workshops covering the project work dealing with partly the Baltic Sea, the North Sea, the Mediteranean Sea, and the (residual) North-East Atlantic (incl Mediteranean Sea for Nephrops) – one for each region. The project coordinatior will in cooperation with the WP5 coordinator and the rest of the project steering group coordinate the regional stakeholder workshops organized under WP5. This coordination will furthermore be in cooperation with the WP5 participants, and also be discussed with the entire EFIMAS Network (all project participants). The workshops will be a part of the interaction and the continuous cyclic feed back system between the different work packages as well as deliver direct feed back from stakeholders, etc. to the work packages (WP3-5) – see also section 5.2.3 below for more details on the workshops. Work package 5 will collect and compile reactions and comments from stakeholders, whereby the utility and applicability of the evaluation framework will be assessed. Specifically, the WP will carry out interviews, focus groups and workshops with these stakeholders. These three methods will be carried out in parallel with the later developments in WP3 and WP4. Individual interviews will produce information for WP3 and WP4, particularly various understandings of management objectives and performance. They will also produce information useful for preparation of focus groups functioning as contacts by correspondence and contacts in the regional stakeholder workshops. The focus groups will gather information on initial stakeholder reactions to developments in WP3 and WP4 and measures of performance of the management systems. The regional stakeholder workshops will include experiments with the use of output from WP3 and WP4, i.e. the management system and its parameters, in among other the decision making as well as in relation to some of the technical aspects of the framework to evaluate and develop further the system and framework, as well as disseminate and demonstrate the framework and management evaluation tool. This will also optimize practices in the use of quantitative evaluation tools. The WP will collect and compile reactions and comments from clients

as well as evaluate stakeholder responses, whereby the utility and applicability of the evaluation framework will be assessed. Further details of the regional stakeholder workshops is given in section 5.2.3 below.

Both the technical evaluation and the decision process evaluation will be part of an overall process of synthesis and improvements based on evaluations to be used in an iterative, cyclic feed-back system between WP3–WP5 including regional stakeholder workshops. The performance of the candidate management options used in the evaluation framework will be evaluated and further recommendations on research and management recommendations will be made in a continous, cyclic and iterative feedback system with respect to e.g. recommendations on further investigations needed, more relevant alternative hypotheses to be addressed, alternative descriptive models to be applied, data to be used, etc. as well as recommendations on other more relevant or desirable management options and objectives. This makes the processes in the whole evaluation framework continuously iterative and cyclic addressing diverse types of general management and assessment problems. As described above, this process will focus particularly on the questions of setting objectives and evaluating performance, the questions which make up the central interface between the fisheries management evaluation framework and the stakeholders who must make use of it.

Specific tasks in relation to WP5:

5 Test the general utility of the developed operational management evaluation framework

Iterative and cyclic process between WP3, WP4 and WP5 including feedback from regional workshops

Evaluation of the efficiency of the evaluation framework to capture changes

Applicability in other stocks / fisheries (general utility evaluation)

5.1 Technical tool evaluation:

5.1.1 Evaluations will be carried out on sensitivity, robustness, predictive power and limitations in use and set-up of the models

Sensitivity analyses

Evaluation of robustness

Evaluation of predictive power

Evaluation of limitations in use and set-up

5.1.2 The codes of evaluation tools will be proof-read and tested by alternative coding in critical cases.

5.1.3 Real and simulated data sets will be compiled representing a wide range of data properties, system characteristics and different hypothesis about the underlying processes.

5.1.4 Sensitivity tests will be performed and the robustness of the evaluation framework and descriptive models will be evaluated by using them on basis of these diverse data sets.

5.2 Process evaluation of the evaluation framework and the use of it and delivery process mechanisms:

5.2.1 Primary data gathering to assess best practices in the use of models in fisheries management. These analyses of best practices will focus on the entire fisheries system, with a particular emphasis on criteria for management objectives and the evaluation of success.

5.2.1.1 A series of 30-40 interviews will be carried out with scientists and fisheries managers throughout the developed world. Most of these interviews will be carried out by telephone. Q sort interviews will be carried out with stake-holders in Europe to produce a quantitative assessment of the dimensions of management performance. This information will be made available to WP3 and WP4 for use in the development of performance indicators.

5.2.1.2 Two visits will be made to places where particularly innovative approaches are being implemented to allow multiple face-to-face interviews and observations of stakeholder interactions. These visits will be made to Maritime Canada/Northeast USA where extensive government investments are being made into collaborative research between scientists nd the fishing industry, and Alaska, where innovative approaches to management that

combinations of property rights and cooperative decision making are leading to new ways to develop and use fisheries models.

5.2.2 Focus groups functioning as contacts by correspondence and contacts in the regional stakeholder workshops will be established in relation to the case studies on regional basis using the methodology developed by Yearley (1999) (see section 2). These focus groups begin with fairly broad questions to gauge how respondent's initial understandings of models and their use, and then focus more narrowly on reactions to specific model aspects. In the focus groups the late stage output from WP3 and WP4, particularly the measures of performance of the management systems, will be introduced and used and the reactions of the stakeholders gauged. Most participants in the focus groups will be participants in the regional stakeholder workshops. The results of these focus groups will be made available to WP3 and WP4 in the continous, cyclic feedback process, and the focus groups will be involved in the design of the regional stakeholder workshops.

5.2.3 Evaluation framework field testing in multiple stakeholder environments. Prototypes of the evaluation tool will be field tested through exercises with fisheries management stakeholders. Four workshops will beheld with stakeholders in each of the North Sea, Baltic, North-East Atlantic and Mediterranean areas. At these workshops versions of the evaluation tool will be presented, their use simulated, and stakeholder reactions solicited. They will explore and discuss the usefulness of the evaluation framework in relation to exploration of different management objectives. During the workshops participants will explore alternative management options and objectives, explore the delivery process mechanisms and discuss their acceptance, and implications for compliance and broad involvement. The participants will take part in interactions between explorations of options using the management evaluation tool and discussions and testing of outcomes leading to agreements on management decisions. Outcomes from these activities will interact with the development of evaluation tools (WP3) and the implementation in case studies (WP4) in order to contribute to modifications in development and implementation of evaluation tools. The regional workshops will facilitate the communication of results and implications to stakeholders addressing acceptance and efficiency of the delivery processes.

5.3 Synthesis and improvements based on evaluations to be used in the iterative, cyclic feed-back system between WP3–WP 5 including regional stakeholder workshops.

The performance of the candidate management options used in the evaluation framework will be evaluated and further recommendations on research and management recommendations will be made in a feedback system with respect to e.g. recommendations on further investigations needed, more relevant alternative hypotheses to be addressed, alternative descriptive models to be applied, data to be used, etc. as well as recommendations on other more relevant or desirable management options and objectives. This makes the processes in the whole evaluation framework iterative and cyclic (on a case specific basis) addressing diverse types of general management and assessment problems. The output from WP5 will, consequently, be a compilation of experiences from practical use of the management evaluation framework, and probably suggestions for improvements.

Deliverables

D5.1: Report(s) from evaluations from 4 regional stakeholder workshops
D5.2: Technical evaluation reports
D5.3: Evaluation process manual. A policy brief describing best practices in the use of quantitative evaluation tools in complex, multi-stakeholder policy environments.

Milestones

M6: Evaluations from 4 regional stakeholder workshops

8. Project resources and budget overview

8.1 Management level description of project resources and budget

The consortium and project resources

The overall consortium consists of participants with multi-disciplinary expertise within fisheries biological, economical and sociological science in relation to fisheries assessment and management. The project participants all has extensive generic expertise and case study specific expertise, and the consortium is in that respect highly qualified to carry out the intentions and work described in the EFIMAS project contract.

Role and commitments of the consortium (project participants)
Organizational management expertise, scientific and technical generic expertise, case specific expertise, and explanation of the various roles of the project participants:
The project will be managed and coordinated by a steering group ensuring that the multi-disciplinary nature of the project is covered. This is partly ascertained by the multi-disciplinary participation in the steering group. The steering group will consist of the following institutes:

Project Steering Group:
WP1, Overall coordination: DIFRES (DK), Fisheries Research Institute
WP2 coordination: AZTI (E), Fisheries Technological Institute for Fisheries and Food
WP3 coordination: CEFAS (UK) and DIFRES (DK), Fisheries Research Institute
WP4 coordination: CEMARE (UK), Fish. Econ. Inst., and RIVO (NL), Fish. Research Institute
WP5 coordination: IFM (DK), Fisheries Sociological and Economical Institute

The overall structure, organization, coordination, and multi-disciplinary set-up as well as the participant commitment of the consortium are schematically illustrated in the Organizational Overview figure in section 6. This figure also describes the roles of participants in section 8 as well. The consortium participants are complementary within disciplines, expertise and skills. The multi-disciplinary capacity, expertise and specific skills of the participating institutes and the key project participants are in detail described in Annex A of this project contract giving details of each institute and key participant. The links and continous, cyclic feed back systems between work packages (and workshops) and their participants are in detail described in section 7 (especially section 7.6 and 7.1).

WP1: Project Coordination and Management
Overall project coordination: The overall project coordination will be performed by DIFRES. The institute has extensive experience in coordination of national and international fisheries research projects and EU Scientific Projects, Concerted Actions, Study Projects, Tenders, etc.

The project will in praxis be managed and coordinated by a project steering group.
Project Steering Group: DIFRES, AZTI, CEFAS, CEMARE, RIVO, IFM.

The practical coordination and management involving all work packages and case study groups will be communicated out to the project network (all project participants) partly through the project coordinator and steering group and partly through the Scientific / Technical Evaluation and Progress Forum. This forum will in cooperation with the project coordinator and the project steering group ascertain that all scientific and technical issues and problems are addressed, dealt with by the appropriate expertise and communicated out to the relevant parts of the project network.

Scientific / Technical Evaluation and Progress Forum (STEPFORward Group): Project Steering Group & Case Study Co-ordinators (i.e. one person from each case study group).

Case Study Coordinators:

CS1: NS Demersal Flatf. Fisheries:	RIVO
CS2: NS Demersal Roundf. Fisheries:	DIFRES
CS3: Salmon Fisheries, Baltic Sea	FGFRI
CS4: Nephrops Fisheries, E. Atlantic	CLO-DVZ
CS6: Hake, megrim and monk Fisheries, Atl.	AZTI
CS7: Swordfish Fisheries, Mediterranean	IMBC
CS8: Hake Fisheries, Mediterranean	NCMR
CS9: Cod Fisheries, Baltic Sea	SFI

The involvement of generic and case specific, multi-disciplinary expertise and skills among participants in relation to the case study groups are in detail described under WP4 in section 7.6.

EFIMAS Network: All project and case study participants. The full group of participants will be convened several times within network meetings (see section 6 of this technical Annex 1).

WP2: Review and exploration of knowledge basis and performance of fisheries management as well as of management decision processes

Coordination: AZTI

Participation: AZTI (4), FOI (2), IMBC (2), LEI (2), IFM (2), U. Basque C. (2), CLO-DVZ (1), CEFAS (1), DIFRES (1). The AZTI and several of the project participants carrying out the work in WP2 are members of the EU FP5 EASE Concerted Action where complementary reviews of fisheries assessment are performed. The participants in this work package possess complementary multi-disciplinary, scientific expertise and skills in all of the fields and issues that are to be reviewed under WP2. Furthermore, this WP will involve dialogues with selected parties possessing additional expertise such as stakeholders (fisheries organizations/industry/catching sector, NGOs, etc.) and advisory and management bodies.

WP3: Development of the operating model within the fisheries management evaluation framework

Coordination: CEFAS, DIFRES

Participation: CEFAS (3), DIFRES (3), RIVO (2), CEMARE (2), LEI (1,5), IFREMER (1), FRS (0,9), FOI (1), IC (0,6)

This group represents institutes and key personnel with well documented expertise, specific skills and extensive experience in building operating simulation models and software packages within the area of fisheries management and assessment of fisheries and stocks. These models have both been stock and fisheries based as well as included both stock dynamics and socio-economic aspects.

WP4: Application of the management evaluation framework to selected case studies

Coordination: CEMARE, RIVO

Participation: The role and commitment of each participant in relation to the case specific analyses and work to be carried out by the project participants under WP4 is schematically shown in the case study overview table below (see also section 7, WP4*)*. Here the case specific contributions under WP4 for each project partner are shown. The contributions by individual partners to specific case studies have been specified according to the type and area of contribution. For each case study it is shown which institutes will contribute with specific biological or socio-economic input (data, case specific expertise) and which institutes will contribute with generic biological or socio-economical expertise and input (case specific models, general skills and expertise). This overview clearly indicates that the approach within each case study is multi-disciplinary and that the contributors possess both specific and generic multi-disciplinary expertise within biology, economy and sociology. In the above organization and in the extensive participation of many institutes with different, multi-disciplinary expertise it has been ascertained that the participants in the case study groups are complementary to each other in their coverage, and that all aspects of the assessment and management problems can be investigated and covered.

Furthermore, generic expertise has been ascertained across cases partly by establishment of the STEPFORward group. In Annex B of the project contract (case study summaries) and in Annex A of the project contract (capacity, expertise and skills of participating institutes and key personnel) the involvement of general and case specific, multi-disciplinary expertise and skills is described.

The contents and the organization of the case specific work are described in section 7 under WP4 as well as in Annex B to the project contract. Meetings in relation to the case specific work and coordination and management of the project are shown in the Project Meeting Table under Section 6. The links and continous, cyclic feed back processes between work packages are shown in section 7 of this technical Annex 1 of the project contract.

WP5: Effectiveness of developed operational evaluation tools and test of the utility of the tools
Coordination: IFM.
Participation: IFM (6), AZTI (4), IMBC (3), FOI (1), CLO-DVZ (1), CEFAS (2), DIFRES (2), CEMARE (1), IPIMAR (2), SNF (2), Mar. Inst. (2).
The participants in this work package possess complementary multi-disciplinary, scientific expertise and skills in all of the fields and issues that are to be reviewed under WP5. Furthermore, this WP will involve workshops with invited parties involved in the evaluation process such as stakeholders (fisheries organizations/industry, NGOs, etc.) and advisory and management bodies.

Specific skills of the participants: As explained above the institutional capacity of the participating institutes in the project as well as the expertise and skills of the participants (key personnel) covers broadly and in a multi-disciplinary way the tasks and aims of the project and the state of the art. Detailed information about institutional capacity and expertise and skills of each participant is in detail given in Annex A to the project contract.

SME's: Regional stakeholder workshops with invited representation of relevant stakeholders including SME's (fishing organizations, fishing industry, catching sector, NGO's, etc.) and advisory and management bodies will be held in relation to WP3-WP5 and organized under WP5 on regional basis as described in section 7. The project coordinatior will in cooperation with the WP5 coordinator and the rest of the project steering group coordinate the regional stakeholder workshops organized under WP5. This coordination will furthermore be in cooperation with the WP5 participants, and furthermore discussed with the entire EFIMAS Network (all project participants).

9. Ethical issues and safety provisions

There are no ethical issues or aspects related to the EFIMAS Project.
There are no ethical or gender aspects related with the subject of the project. The project does not involve persons, personal data, human tissue, genetic information or modification or animals.

There are no safety aspects related to the EFIMAS Project.

10. Other issues

The project work is carried out by several female and several male scientists, and there are in the project work equal opportunities between women and men. (Please also see Annex A describing key personnel for each participating institute documenting significant participation by women as well as men).

Annex A - Consortium description

A.1 Participants and consortium

The consortium and project resources

The overall consortium consists of participants with multi-disciplinary expertise within fisheries biological, economical and sociological science in relation to fisheries assessment and management. The project participants all has extensive generic expertise and case study specific expertise, and the consortium is in that respect highly qualified to carry out the intentions and work described in the EFIMAS project contract.

Role and commitments of the consortium (project participants)

Organizational management expertise, scientific and technical generic expertise, case specific expertise, and explanation of the various roles of the project participants:

The project will be managed and coordinated by a steering group ensuring that the multi-disciplinary nature of the project is covered. This is partly ascertained by the multi-disciplinary participation in the steering group. The steering group will consist of the following institutes:

Project Steering Group:
WP1, Overall coordination: DIFRES (DK), Fisheries Research Institute
WP2 coordination: AZTI (E), Fisheries Technological Institute for Fisheries and Food
WP3 coordination: CEFAS (UK) and DIFRES (DK), Fisheries Research Institute
WP4 coordination: CEMARE (UK), Fish. Econ. Inst., and RIVO (NL), Fish. Research Institute
WP5 coordination: IFM (DK), Fisheries Sociological and Economical Institute

The overall structure, organization, coordination, and multi-disciplinary set-up as well as the participant commitment of the consortium are schematically illustrated in the Organizational Overview figure in section 6. This figure also describes the roles of participants in section 8 as well. The consortium participants are complementary within disciplines, expertise and skills. The multi-disciplinary capacity, expertise and specific skills of the participating institutes and the key project participants are in detail described in Annex A of this project contract giving details of each institute and key participant. The links and continous, cyclic feed back systems between work packages (and workshops) and their participants are in detail described in section 7 (especially section 7.6 and 7.1).

WP1: Project Coordination and Management
Overall project coordination: The overall project coordination will be performed by DIFRES. The institute has extensive experience in coordination of national and international fisheries research projects and EU Scientific Projects, Concerted Actions, Study Projects, Tenders, etc.

The project will in praxis be managed and coordinated by a project steering group.
Project Steering Group: DIFRES, AZTI, CEFAS, CEMARE, RIVO, IFM.

The practical coordination and management involving all work packages and case study groups will be communicated out to the project network (all project participants) partly through the project coordinator and steering group and partly through the Scientific / Technical Evaluation and Progress Forum. This forum will ascertain that all scientific and technical issues and problems are addressed, dealt with by the appropriate expertise and communicated out to the relevant parts of the project network.

Scientific / Technical Evaluation and Progress Forum (STEPFORward Group): Project Steering Group & Case Study Co-ordinators (i.e. one person from each case study group).
Case Study Coordinators:

CS1: NS Demersal Flatf. Fisheries:	RIVO
CS2: NS Demersal Roundf. Fisheries:	DIFRES
CS3: Salmon Fisheries, Baltic Sea	FGFRI
CS4: Nephrops Fisheries, E. Atlantic	CLO-DVZ
CS6: Hake, megrim and monk Fisheries, Atl.	AZTI
CS7: Swordfish Fisheries, Mediterranean	IMBC
CS8: Hake Fisheries, Mediterranean	NCMR
CS9: Cod Fisheries, Baltic Sea	SFI

The involvement of generic and case specific, multi-disciplinary expertise and skills among participants in relation to the case study groups are in detail described under WP4 in section 7.6.

EFIMAS Network: All project and case study participants. The full group of participants will be convened several times within network meetings (see section 6).

WP2: Review and exploration of knowledge basis and performance of fisheries management as well as of management decision processes
Coordination: AZTI
Participation: AZTI (4), FOI (2), IMBC (2), LEI (2), IFM (2), U. Basque C. (2), CLO-DVZ (1), CEFAS (1), DIFRES (1). The AZTI and several of the project participants carrying out the work in WP2 are members of the EU FP5 EASE Concerted Action where complementary reviews of fisheries assessment are performed. The participants in this work package possess complementary multi-disciplinary, scientific expertise and skills in all of the fields and issues that are to be reviewed under WP2. Furthermore, this WP will involve dialogues with relevant parties possessing additional expertise such as stakeholders (fisheries organizations/industry, NGOs, etc.) and advisory and management bodies.

WP3: Development of the operating model within the fisheries management evaluation framework
Coordination: CEFAS, DIFRES
Participation: CEFAS (3), DIFRES (3), RIVO (2), CEMARE (2), LEI (1,5), IFREMER (1), FRS (0,9), FOI (1), IC (0,6)
This group represents institutes and key personnel with well documented expertise, specific skills and extensive experience in building operating simulation models and software packages within the area of fisheries management and assessment of fisheries and stocks. These models have both been stock and fisheries based as well as included both stock dynamics and socio-economic aspects.

WP4: Application of the management evaluation framework to selected case studies
Coordination: CEMARE, RIVO
Participation: The role and commitment of each participant in relation to the case specific analyses and work to be carried out under WP4 is schematically shown in the case study overview table below (see also section 7, WP4*)*. Here the case specific contributions under WP4 for each project partner are shown. The contributions by specific partners to specific case studies have been specified according to the type and area of contribution. For each case study it is shown which institutes will contribute with specific biological or socio-economic input (data, case specific expertise) and which institutes will contribute with generic biological or socio-economical expertise and input (case specific models, general skills and expertise). This overview clearly indicates that the approach within each case study is multi-disciplinary and that the contributors possess both specific and generic multi-disciplinary expertise within biology, economy and sociology. In the above organization and in the extensive participation of many institutes with different, multi-disciplinary expertise areas it has been ascertained that the participants in the case study groups are

complementary to each other in their coverage with respect to disciplines, and that all aspects of the assessment and management problems can be investigated and covered.

Furthermore, generic expertise has been ascertained across cases partly by establishment of the STEPFORward group. In Annex B of the project contract (case study summaries) and in Annex A of the project contract (capacity, expertise and skills of participating institutes and key personnel) the involvement of general and case specific, multi-disciplinary expertise and skills is described.

The contents and the organization of the case specific work are described in section 7 under WP4 as well as in Annex B to the project contract. Meetings in relation to the case specific work and coordination and management of the project are shown in the Project Meeting Table under Section 6. The links between work packages are shown in section 7.

WP5: Effectiveness of developed operational evaluation tools and test of the utility of the tools
Coordination: IFM.
Participation: IFM (6), AZTI (4), IMBC (3), FOI (1), CLO-DVZ (1), CEFAS (2), DIFRES (2), CEMARE (1), IPIMAR (2), SNF (2), Mar. Inst. (2).
The participants in this work package possess complementary multi-disciplinary, scientific expertise and skills in all of the fields and issues that are to be reviewed under WP5. Furthermore, this WP will involve workshops with invited parties involved in the evaluation process such as stakeholders (fisheries organizations/industry, NGOs, etc.) and advisory and management bodies.

Specific skills of the participants: As explained above the institutional capacity of the participating institutes in the project as well as the expertise and skills of the participants (key personnel) covers broadly and in a multi-disciplinary way the tasks and aims of the project and the state of the art. Detailed information about institutional capacity and expertise and skills of each participant is in detail given in Annex A to the project contract.

SME's: Regional stakeholder workshops with invited representation of relevant stakeholders including SME's (fishing organizations, fishing industry, catching sector, NGO's, etc.) and advisory and management bodies will be held in relation to WP3-WP5 and organized under WP5 on regional basis as described in section 7. The project coordinatior will in cooperation with the WP5 coordinator and the rest of the project steering group coordinate the regional stakeholder workshops organized under WP5. This coordination will furthermore be in cooperation with the WP5 participants, and furthermore discussed with the entire EFIMAS Network (all project participants).

Annex B: Case Study Fisheries Summaries

The case study fisheries summaries include a short concise description of main assessment and management problems and the background for these for each case study. Among those main problems important and typological problems have been selected to be addressed in the present project. These problems typically are general across case studies or are complementary between case studies. Relevant scientific and technical research questions have been formulated to address these problems. Descriptive models and analysis tools are briefly described, which will be applied to investigate the research questions on basis of formulation of relevant scientific based hypotheses and objectives within the project. For each case study a brief description of the role and contribution for each participant is given in relation to the case study work and analyses.

1. Demersal Flatfish fisheries in the North Sea (Major case study, No. 1)

Overview description of fisheries and stocks

The total value of landings of the North Sea was 976 million euro in 2001 (Anon. 2002). Flatfish fisheries (mainly plaice and sole) accounted for approximately 40% of this value and is regarded as a major fishery in the North Sea.

North Sea flatfish are mainly taken in a mixed demersal flatfish fishery by beam trawlers in the southern and south-eastern North Sea. Although plaice and sole are the main targets in the mixed flatfish fishery, important by-catches are often taken of other flatfish species (e.g. dab, turbot, brill) and some roundfish species (cod, whiting). Directed fisheries for flatfish are also carried out with seine and gill net, and by beam trawlers in the central North Sea. Due to the minimum mesh size (80 mm in the mixed beam trawl fishery), large numbers of (undersized) plaice and other species are discarded.

Fleets exploiting North Sea flatfish have generally decreased in number of vessels in the last 10 years, partly due to the MAGP policy. However, in some instances these reductions have been compensated by reflagging vessels to other countries.

The state of the plaice and sole stocks are annually assessed by the ICES Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (ICES 2003). Both plaice and sole have experienced relatively high fishing mortalities over a period of at least 20 years. Both stocks tend to produce occasional (very) strong yearclasses. The plaice stock has benefitted from the strong 1981 and 1985 yearclasses which led to high SSB levels (400,000 t.) in the late 1980s. In the early 1990s the stock decreased strongly, reaching a historic minimum in 1997 and has been seen to increase since then. Sole has experiences a similar high SSB level in the late 1980s but has generally been more stable than plaice.

Other flatfish stocks are not assessed because historic data has been lacking. Under the current data regulation (EC 2001), essential catch data for these species is being collected so that they can likely been assessed in the near future. A specific case study on the state of the turbot and brill stocks has been completed in 2000 (Boon and Delbare 2000) and could provide a starting point for further analysis.

The economic state of the fishing fleets are well described in the Annual Economic Reports that have been issued since 1998. The value of landings of the Dutch beam trawlers, the most important fleet segment in the North Sea flatfish fisheries, was rather stable in the years 1996-2001. Profits were modest. With the exception of the 1999, profits in the fishery have been negative or close to zero, indicating that there is considerable excess capital in the fishery. The number of vessels and employment declined, mainly due to lower catches. Similar trends occured in the Belgian beam trawl segment. A significant part of the Belgian and U.K. flatfish fleet is owned by Dutch fishermen.

The North Sea flatfish fisheries have been management by means of single species TAC's, by technical measures and by fleet capacity measures. The TAC for North Sea plaice is agreed between Norway and the EC, all other TACs are set by the EC only. The technical measures (notably mesh size) applicable in the flatfish fishery are largely determined by the catching opportunities of sole which is a highly valued species with a relatively slender build. Therefore, the minimum mesh size for beam trawl gears is set to 80 mm. Other technical measures include the "plaice box", a closed area on the Danish, German and Dutch coasts. The plaice box has been implemented in 1989 and is closed for fishing with towed gears by vessels with engine powers exceeding 300 HP.

Previous bioeconomic models of the fishery

Compared with many fisheries around the world, considerable attention has been devoted to the development of bioeconomic models of the North Sea fisheries, reflecting the relative importance of the area to the EU. Most models of

the North Sea have been multi-species. An example of this is the simulation model of the flatfish (sole and plaice) fishery in the North Sea, primarily for the Dutch beam trawl fleet (Pastoors et al. 1997b; Pastoors et al. 1997a).

The multi-species models tend to include both flatfish and roundfish, largely because of the technical interactions involved in their capture (i.e. beam trawlers catch some roundfish as bycatch while otter trawlers catch some flatfish). Kim (1983) developed a surplus production multispecies model of the demersal fishery to estimate the potential economic rent that could be achieved. Frost et al. (1993) developed two bioeconomic models of the North Sea fishery; a linear programming model and a larger simulation model to estimate levels of effort and catches. Mardle et al (2000) developed a multi-objective long run equilibrium model of the fishery that was used to estimate the optimal level of catch taking into consideration the multiple objectives of the Common Fisheries Policy. The analysis looked at trade-offs between sustainable levels of employment, discarding and fishery profitability in a long run equilibrium setting. The model was further developed by Mardle and Pascoe (2002), who incorporated a short run component to the model, and estimated the trade-off between long and short run objectives in the fishery. In addition, Pascoe et al (1999) also further developed the original model used by Mardle et al (2000) to incorporate market interactions between the North Sea demersal species and farmed salmon. The model was used to examine how market interactions between farmed and wild caught species can affect the development of the fishery.

The above models have generally relied on fairly simple biological models that are not sufficient for detailed analysis of fisheries management plans. Further, they are static in nature – estimating long run equilibrium (optimal) outcomes. In order to provide a useful management tool, the models developed in this and the other case studies will be dynamic in nature, with a more robust biological component and an explicit effort dynamics component.

Main advisory and management problems

Advisory problems

The stock assessments of plaice and sole are currently based on a VPA-type model (Shepherd 1999) and use data on landings-at-age, autumn survey data and commercial CPUE data (for sole). Given the mixed nature of the fishery for flatfish, the following main problems arise when assessing these stocks:

- discarding of undersized plaice (and dab) is considered a major problem which is mainly caused by the minimum mesh size applicable to the southern North Sea for beam trawlers. The assessments only track the developments in the landed portion of the stock. Given that growth rates may vary substantially, the discard pattern is unlikely to be stable over the years. This may give rise to biased perceptions of the stocks when discards are not included.
- single species TACs may give rise to over-quota discards. It is likely that this affects plaice and dab, but to an even larger extend, cod and whiting may be discarded in the flatfish fishery to the quota limitations.
- the mixed nature of the fishery also causes problems in indentifying commercial CPUE data as calibration series in stock assessments. The catch part of the CPUE data again refers to landings only and furthermore, the effort part often refers to the total effort expended by a certain fleet (component) and may therefore not be a realistic measure for each individual stock.
- lack of biological realism in the data used. Notably growth data and maturity data should be explored in order to include them into the assessments
- only part of the flatfish species are assessed on a regular basis. Commercially important by-catches as dab, turbot and brill are not assessed at present and can therefore not be used to explain the behaviour of the fleets.
- because of the strong dependency on recruiting yearclassess, the assessments and notably the forecasts can be relatively imprecise until the strength of these yearclasses can be well evaluated.

Overall, the stock assessments tend to be very dependent on commercial landings data. Alternative data-sources should be explored to help in understanding the development of the stocks.

Management problems

The main management problems that are identified are:

- Single species TACs are problematic in a mixed-species context because of over-quota discarding and intensive control requirements. Do TAC's limit the catches?
- The fisheries are very dependent on recruiting year-classes leading to relatively large fluctuations in TACs.
- The impact of technical measures (e.g. plaice box) and emergency management measures are difficult to evaluate
- Compliance with technical measures may be an important issue (notably mesh size).
- Over-capacity in the fleets fishing for flatfish may still be an important issue which gives rise to relatively high fishing effort even when the landings of quota species are restricted.

Main and typological problems to address in the present project

Several alternative management strategies could be explored and the case study will seek to apply elements of the evaluation framework developed under WP 3 to address the following issues:

1. What are the trade-offs between TAC-management vs effort-management for the North Sea flatfish fisheries. How can the trade-offs be expressed in biological, economic and social terms.
2. What is the bio-economic and socio-economic trade-off between multi-species and multi-fleet management approaches, in the case of mixed fisheries where the species requiring protective action (e.g. cod) have a (much) lower economic value than the prime target species of the fisheries (*sole*) ? Are there any alternatives (e.g. closed areas/seasons, improved gear selectivity, other fishing tactics) that can achieve the same protective goals with regards to the by-catch species, without affecting the viability of the *Sole* fisheries ?
3. How can the effects of technical measures (mesh size, closed areas, closed seasons) be appraised.
4. How does compliance affect the impact of management measures
5. Can overcapacity be measured and if so, can it be related to excessive fishing effort both on target and non-target species
6. Can assessment methods independent of the commercial fishery provide reliable (enough) information on stock status to be used in management

Purpose of the case study, methods to be used and case specific deliverables (bullet numbers refer to the problems listed in the previous section)

1. The analysis of TAC-management vs. effort-management will focus on the fleets, including the prediction of fleet behaviour in a reaction management measures. Modelling of fleet behaviour involves modelling of the economics of fleets, primarily costs and earnings for the short term predictions, and investments and decommission for the long term predictions. The bio-economic approach will allow for a suite of performance measures to be defined covering the interests of a wide range of stakeholders.
2. The analysis of trade-offs between high-valued species (e.g. sole) against lower valued species requiring protective action (e.g. cod) will require the application of tools that allow for economic evaluation in conjunction with relatively detailed biological processes (e.g. spatial, temporal). The approach will be to develop stylized models of biological and economic interaction that can capture the essence of the management measures to be evaluated without involving too much biological or economic detail.
3. The effects of technical measures (mesh size, closed areas, closed seasons) will be evaluated with targetted studies on the different type of measures. These studies may be in large detail when required (e.g. closed areas can be spatially detailed) but it should also be possible to aggregate them to a higher level of abstraction.
4. The effects of compliance will be addressed by developing simulation tools that will simulate the effects of compliance or non-compliance on the perceptions from the fishery and how this would affect the management system as a whole.
5. Excess capacity in the fishery will be examined from both an economic and technical perspective. The economic measure of excess capacity will be derived using a bioeconomic optimisation model (based on the model developed in the study) to determine the most efficiency level of capital in the fishery that is required to harvest the resource. Short-term measures of technical excess capacity (i.e. the difference between the potential and actual catch of the current fleet) will be derived using the data envelopment analysis approach. Changes in capacity utilisation in the fishery (and hence excess capacity) will be simulated using models relating capacity utilisation to revenue per unit of effort, which will vary with fleet size, stock size and prices (a function of catch). The effect of management on excess capacity will be assessed through incorporating these models into the dynamic bioeconomic model.
6. The evaluation of assessment methods that are independent from the commercial fisheries, will be carried out by developing to tools to be able to assess stocks from fishery indepent data (e.g. surveys, tagging) and then to simulate how these tools would behave on theoretical populations given certain characteristics of the fisheries.

Description of specific and generic input from various partners
Case study co-ordinator: RIVO

Specific input

- Biological

Data on volumes of catches, landings and discards of target and by-catch species, together with their length and/or age distributions, will be provided by all participants to the case study: CEFAS, CLO-DvZ, DIFRES and RIVO. Additional biological data (on e.g. biological parameters used in stock assessments) will be obtained from relevant ICES Working Groups.

- Economical / Sociological

Data on landings revenues for target and by-catch species, together with additional economic data on prices, employment, subsidies (if any), exploitation costs, etc. will be provided by all participants to the case study: CEMARE, IFM, FOI and LEI. In addition to providing data, this group will also be responsible for the estimation of the appropriate economic component models detailed in WP4.

Generic input

- Biological

Stock assessment models, multi-fleet fishery-based forecast models, etc. to be used in this case study will mostly be derived from sources outside the project (existing software, models developed by ICES Working Groups, STECF expert groups, etc.). Additional tools will be developed under WP 4. Main contributors: CEFAS, DIFRES, IC and RIVO.

- Economical / Sociological

The bio-economic and socio-economic models to be used in this case study will mostly be delivered by WP4. Additional modelling expertise will be provided by CEMARE, FOI, IFM and LEI.

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2. Demersal Roundfish fisheries in the North Sea (Major case study, No. 2)

Summary of objectives and methods

The study will focus on the mixed demersal roundfish fisheries in the North Sea, and will place particular emphasis on the problems that arise from the mixed-species nature of the fishery, and from fleet overcapacity and resultant over-exploitation of the stocks.

The North Sea roundfish fisheries represent a complex of mixed fisheries which are managed by single-species TACs. The mixed-species nature of the fisheries is problematic for a TAC-based system, both inherently (there is extensive discarding of some species meaning that TACs do not control catches) and due to the data-requirements of such a system (misreporting and discarding in response to restrictive TACs can lead to problems in subsequent assessments and forecasts). In addition, the stocks tend to be heavily exploited, leading to strong dependence on recruiting year-classes. As a result of the extremely depleted state of the cod stock, a number of emergency management measures have been introduced. There is a clear need to be able to evaluate the biological and economic effects of such measures.

iii) Overview

The principle roundfish species in the North Sea are cod, haddock, whiting and saithe. The distributions of these four species overlap to a large extent, with the result that they are usually taken in mixed fisheries. There is a directed fishery for saithe along the northern margins of the North Sea, but saithe are also caught in mixed catches in other areas. The fisheries take place primarily in the Northern North Sea, although the distributions of whiting and cod also extend into the southern North Sea and the Eastern Channel. The main fisheries use towed gears, primarily trawls, although there is also some gillnetting for cod.

The stock of cod in the North Sea has decreased more or less continuously since the 1970s, whereas fishing mortality has steadily increased over the same period, with the result that the stock is now at a very low level, and is considered to be well outside of safe biological limits. The haddock stock has shown more fluctuation in response to occasional very strong year classes, which do not survive to have much influence on the stock size due to the high level of fishing mortality on the stock. A recent strong year class, spawned in 1999, has increased the stock size to above the precautionary level for this stock, although fishing mortality is still too high. Following a long decline, the spawning stock of whiting has recently shown a small increase. This is partly due to a reduction in fishing mortality, although the stock is still considered to be outside of safe biological limits. The saithe stock has increased from a low point in the late 1980s which, coupled with a decreasing trend in fishing mortality, means that the stock is now considered to be inside of safe biological limits.

The North Sea roundfish fisheries are primarily managed by annual, single species TACs. In addition, they are also subject to a range of other management measures, including minimum landing sizes, and mesh and by-catch regulations. In addition, in response to the recent very poor state of the cod stock, other measures have been introduced on an *ad hoc* basis including a cod spawning closure in 2001, and days at sea limitations in 2003, as well as revised gear regulations and vessel decommissioning schemes.

iv) Main management and advisory problems

One consequence of the mixed nature of the roundfish fisheries is that nets which retain fish of the minimum landing size of the smallest species (whiting) will also retain relatively high numbers of undersized fish of the other species, and as a result the fisheries are characterised by extensive discarding, particularly of undersized haddock and whiting, although some whiting which are above the minimum landing size are also discarded. There are also discards of undersized cod, but this has been less well studied than discarding of haddock and whiting.

The single species TACs used to manage the North Sea roundfish fisheries typically take no account of the differing stock status of the different species, and as a result boats which exhaust their quota for one species will often continue fishing to take their quota for the other species. As a result, their catches of the first species will either be discarded or landed illegally.
These two aspects of the mixed-fishery problem in the North Sea lead to problems in the catch at age data that are the basis of the assessments used as the basis of scientific advice for these fisheries. As a result, it can be seen that the mixed-fishery aspects of the roundfish fisheries can be problematic for a TAC-based management system.

The stocks of cod, haddock and whiting in the North Sea have been subject to high levels of fishing mortality for many years. As a result, these stocks all have truncated age-distributions, and the stocks and fisheries are highly dependent upon the strength of recruiting year classes. One consequence of this is that if a strong year class does recruit to the fishery, the fleet may adapt its fishing practices in order to target that year class. This can cause problems for the assumptions made in fitting the stock assessment model, and thus lead to problems with the assessment. In addition, catch forecasts can be very sensitive to assumptions about growth, discarding and maturity of these exceptional year-classes, again leading to problems in assessment performance. Such problems have recently been observed in relation to the 1996 year-class of cod and the 1999 year-class of haddock in the North Sea.

The recent depletion of the North Sea cod stock to a very low level has resulted in a series of short-term management measures which have been intended to provide some measure of protection to the cod stock. In addition to low TACs which have been intended to restrict fishing effort, a spawning closure was introduced during 2001. This involved closing a large area of the North Sea to roundfish vessels during the cod spawning season. More recently, following the ICES advice for 2003 that all fisheries for North Sea cod and associated species should be closed in order to protect the cod stock, further management measures have been introduced including effort limitations and funding for decommissioning to enable some reduction of fleet capacity. These measures have all been introduced at short notice with little attempt or opportunity to evaluate the effect they will have. Nonetheless, evaluation of the effects of these measures is required for forecast and management purposes, even though the short-notice, *ad hoc*, nature of the management actions makes this a difficult task.

As well as the problems associated with evaluating the effects of emergency management measures on North Sea cod, the recent advice that all fisheries on North Sea cod and associated species should be closed highlighted another problem with the existing form of management advice. The advice for closure was widely criticised by the fishing industry, not least because it took no account of the severe socio-economic consequences of such a closure. This is a specific case of a more general criticism that the current form of advice is based only on biological criteria and does not account for economic considerations in any way.

The key management and advisory problems identified in relation to the North Sea roundfish fisheries can be summarised as follows:

- Single species TACs problematic in a mixed-species context
- Fisheries strongly dependent on recruiting year-classes leading to problems in assessments and forecasts
- Ad hoc, emergency management measures difficult to evaluate
- No socio-economic considerations in management advice

v) Approach to analysis

There are a suite of alternatives to the single species TAC management currently in force for the management of North Sea cod, notably fleet specific effort quotas.

There are as well, management measures which can supplement the current regime, for example (1) Closed areas (2) Closed seasons (3) Increased of Minimum Mesh size.

The mixed nature of the fishery, and the emerging extended use of technical management measures call for a fleet-structured management strategy. The problems of single species TACs in a mixed fishery, is believed to be reduced when moving from catch quota to effort quotas, and the obvious primary analysis to make is that of comparing TAC-management with effort-based management. The analysis of management by effort regulation will be combined with analysis of the effect of technical management measures or effort quotas combined with catch quotas.

The analysis of effort-regulation will focus on the fleets, including the prediction of fleet behaviour as a reaction management measures. Modelling of fleet behaviour involves modelling of the economics of fleets, primarily costs and earnings for the short term predictions, and investments/dis-investment / decommission for the long term predictions. The bio-economic approach will allow for a suite of measures of performance to be defined, measures covering the wishes of a range of stakeholders.

The assessment of the effect of closed areas calls for a spatially disaggregated model, and the effect of closed time periods calls for model with a time step shorter than traditional time step of one year.

With effort as the primary management instrument, the conversion of effort into fishing mortality (through a model for catchability) will become a focal element in the model. This model will establish the catchability of all major major species for all major fleets caught in the demersal fishery in the North Sea. This approach will allow for an unambiguous assessment of mixed fisheries, in the sense that it will allow for new multi-species/multi-fleet measures of performance to be defined.

The model to be tested against the traditional single species, single fishery annual model, will be a quarterly, multi-fleet, multi-species, multi-area model accounting for the reaction of fishing fleets to management regulations, including a bio-economic analysis of fisheries. There will be developed a suite of models representing various levels of extensions of the traditional ICES model. The performance will be compared to the traditional model, and the extended model will be compared. The primary comparison will evaluate effort management and TAC-management. Technical management measures will be evaluated along with the primary analysis.

The analysis will take it's starting point in the analysis of "mixed fisheries" made under the STCF and various ICES working groups. The case study will take advantage the current development in ongoing EU-funded projects (TECTAC, EASE, FEMS, etc).

Description of specific and generic input from various partners

Case study co-ordinator: DIFRES

Specific input

- Biological

Data on volumes of catches, landings and discards of target and by-catch species, together with their length and/or age distributions and other relevant biological data (maturity, etc) data, as well as data on fishing effort and capacity, will be provided by all participants to the case study: CEFAS, CLO-DvZ, DIFRES, FRS, IFREMER, IMR(N), and RIVO. Additional biological data (on e.g. biological parameters used in stock assessments) will be obtained from relevant ICES Working Groups.

- Economical / Sociological

Data on landings revenues for target and by-catch species, together with additional economic data on prices, employment, subsidies (if any), exploitation costs, etc. will be provided by all participants to the case study: CEMARE, FOI, LEI and IFM.

Generic input

- Biological

Stock assessment models, multi-fleet fishery-based forecast models, etc. to be used in this case study will mostly be derived from sources outside the project (existing software, models developed by ICES Working Groups, STECF expert groups, etc.). Additional tools will be developed under WP 4.
CEFAS, DIFRES, FRS, IMR (N), RIVO, UNEW

- Economical / Sociological

The bio-economic and socio-economic models to be used in this case study will mostly be delivered by WP4. Additional modelling expertise will be provided by CEMARE, FOI, IFM, LEI.

The economic state of the fishing fleets are well described in the Annual Economic Reports that have been issued since 1998. Previous bioeconomic models of the fishery with special attention to models of the North Sea fisheries is described in the North Sea Demersal Flatfish fishery case study. This is also relevant for the North Sea Demersal Roundfish fishery case study in the present project.

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(See also references in North Sea Demersal Flatfish Fishery Case Study which also is relevant here)

3. Salmon fisheries in the Baltic Sea (Major case study, No. 3)

1) Overview: description of fisheries and stocks in a management context

Atlantic Salmon (*Salmo salar* L.) in the Baltic is a long-migrating anadromous fish species and the life cycle can be monitored both in the mixed fishery of sea and stock specifically in the rivers. Recruitment is strongly controlled by man.

Salmon fishery is economically not on a very large scale, but it is politically very important species (high social value as indicator species, high status to describe state of nature in a local scale). Moreover, salmon has probably one of the largest and most covering data sets in Europe, and the management has both local and international aspects. One could say that the case is “Baltic Salmon management laboratory” in the sense, that several aspects can be tested by models, data sets and even on the field. Human aspects (commitment, impact of new information etc.) are dealt in a Task 3 proposal.

Two principal types of salmon fishing are engaged in the Baltic Sea. In the coastal fishery, fishing mortality is management by technical measures (opening dates) and in the mixed off shore fishery, by TAC. Role of TAC is to feed salmon into Main Basin rivers, and to coastal fishery in the Gulf of Bothnia.

The overall management objective of IBSFC is to safeguard wild salmon stocks. Operational objective is to increase the production of wild Baltic salmon to attain at least 50% of the natural production capacity of each river with current or potential production of salmon by 2010, while maintaining the catch levels as high as possible. Salmon is likely the only species in ICES advisory system, where genetic risks are real due to low population sizes and high number of separate stock units, and genetic aspect has not been taken into account. Bayesian modelling of expert knowledge has demonstrated, that current operational objectives are too uncertain to be used in tactical management, and a re-evaluation of operational objectives is needed.

In 1992–1996 in the northern Baltic Sea rivers the M74 syndrome caused high mortality among yolk-sac fry of sea-run females. The incidence has been varying between 25 and 40% in the last three years. It is possible that the incidence of the syndrome may continue to fluctuate rapidly, without any possibility of predicting its level. This causes a major risk for wild stocks.

The growth rate of salmon is closely linked to sprat biomass in the Baltic. Therefore, the growth is impacted by a multispecies approach. Growth rate has an impact on fishing mortality (based on selectivity of gillnets) and on the probability to return to coast to unselective coastal trap-nets. Probabilistic run reconstruction models are needed to model these probabilistic dependencies.

This complicated system requires effective calculation systems, if made on a probabilistic basis in a precautionary fisheries management framework (risk averse attitude, i.e. uncertainty estimate matters).

2) Main management and advisory problems

As stated in Anon 2002, both management tools and monitoring systems are diverse in salmon fisheries, and there are several information needs (international, national and local needs in river valleys). The management tools are both national and international, and the links between these tools must be taken into account in the analysis of management. Task 3 deals with understandability of scientific information and with commitment issues, and will benefit from the modelling work here.
The main problems in the assessment and management are (Anon. 2002):

On a general level, the management – assessment dependency has been described by ICES Baltic Salmon and Trout working group (Anon. 2002) as follows: "the monitoring and assessment system should enable the monitoring of the status of the stocks and answers the management question with adequate accuracy and reasonable costs". The monitoring and assessment system should have at least the following features:
1) It should be able to evaluate the sustainability of current and future fishing
2) It should have predictive power about the state of all wild stock components, and to take into account major uncertainties (like M74)
3) It should be able to quantify the extent to which the major management aims are achieved (safeguarding of all stock components)

The balance between the assessment costs and accuracy is not easy to achieve, and when applying the precautionary approach, higher uncertainty should lead to a lower exploitation rate. In this sense, the definition of the needed accuracy in assessment is more of a management decision than purely a scientific decision.

The balance between the assessment costs and accuracy is not easy to achieve, and when applying the precautionary approach, higher uncertainty should lead to a lower exploitation rate. In this sense, the definition of the needed accuracy in assessment is more of a management decision than purely a scientific decision." This philosophy is the background of all Baltic salmon case study elements, which are divided between Tasks 1 (tactical modelling, interactive probabilistic models, role of technical measures, macroeconomics) and proposal coordinated by Laurence Kell (COMMIT) made to Task 3 (strategic planning of whole management concept, commitment of fishermen, game theory to investigate the strategic impact of ITQ system, microeconomics as part of fishers behaviour).

3) List of specific problems to focus on

The following biological problems will be studied:

1) Creation of an Bayesian operational model – assessment model – management model system, based on MCMC estimation techniques.

2) Analysis of alternative operational objectives to test, which of them achieve the overall objectives with reasonable management and assessment costs.

3) Analysis of the interactions between management actions, monitoring options and objectives. For example, it is likely that the less there is mixed fishery, the bigger uncertainty is acceptable in estimates and in management implementation of mixed fishery. Implementation uncertainty is included.

4) Analysis of roles of fishermen in the implementation uncertainty and in catch reporting, and their effects on reference points and risks for wild stocks

5) Analysis of the role of structural uncertainty (selection of S/R models, dynamics used to describe M74 etc.). Only some of these are predictable, and only for some exist shaky probability distributions. The management system must work well under all these uncertainties.

6) Development of alternative river specific biological reference points.

7) Development of salmon – sprat interaction to model the growth behaviour of salmon in the multispecies context.

8) Stock composition of current adult stock with genetic stock composition data. The impact of mixed fishery aspects on management and assessment behaviour.

The economic elements include:

1. Evaluation of historical data of price dynamics on fishermen behaviour. “Overproduction” of salmon and subsequent decrease in prices due to large smolt releases and good post smolt survival, and partly due to Norwegian salmon production.

2. Inclusion of economic behaviour of fishermen to fisheries simulation tools.

3. Collection of assessment and management costs data from various countries to be used in the management – assessment relationship considerations.

4) The purpose of the case study

Current assessment and management scheme of Baltic salmon includes several novelty aspects, which can be extended to other fisheries in Europe (Bayesian stock assessment methodology, use of tagging data, use of genetic information, use of S/R information from other stocks to decrease noise in data, evaluation possibility of several model parts, respond of fishermen to value of CPUE, impact of aquaculture on markets).

Due to high coverage of data compared to life cycle and fisheries, salmon management is a good case study to test, which pieces of information really matter in the management context, i.e. which change decisions in tactical models (operational model – management model combination) and which change decisions on strategic level (Task 3 case study). By starting from the most simple data part (=”poorly known stock”) and replacing priors by data sets and likelihood functions one can get step by step closer to the “perfectly known stock”, with real data with all randomness. This is a basic difference to other case studies: state of nature (operational model) can be done with real data, and the model outputs can be compared to several existing and diverse data sets from rivers, sea, etc. In the protocols of International Whaling Commission, an assumed functional structure or probability distribution of an operational model may be known by the persons structuring assessment model, and therefore management – assessment combinations may give too optimistic view about the controllability of the system. In real nature, these probability distributions are not known, they are just assumed by the person constracting the models.

Due to several decision variables (TAC, technical management, ITQ possibility, etc.) one can also analyse the additional value—of-information of studying more, and value-of-control, i.e. managing more. There is a strong link to Task 3 proposal by xx, where the strategic elements of salmon management are dealt, and also to Task 8 proposal, where the salmon – seal interaction has been proposed to be a fishery – mammal case study. In here, the salmon assessment – management is only of tactical aspect and <u>there is no overlap</u> between the proposals.

The current S/R knowledge is totally based on meta-analysis of Atlantic salmon stocks. The current analysis does not utilize the very old scale samples, tagging data sets and total catch estimates, which would be available from the old salmon information. However, this information enables the estimation of such fishing mortality, which caused the wild stocks to collapse (disappeareance of stock components from the mixed stocks). The old scale samples (from Denmark and from Finland rivers) enable the estimation of stock components by the genetic methods (Koljonen, 1995 and Koljonen & Pella, 1997) and the current data collection system of EU provides genetic stock component estimates for current fishery (=funded separately). This combination of genetic information to stock component analysis will remarkably improve our understanding about sustainable fishing mortality.

When considering the management options and alternative operational objectives for the future, a very close co-operation with managers is needed. This will be carried out by the IBSFC sub-group of salmon management.

5) The main deliverables of the case study

Please note that the first part of the following list is made by an assumption, that resources are like in the case study funds of total budget table.

Deliverables: 5 journal manuscripts covering all aspects of points 1 – 8 in the list of specific problems to focus on. 2 papers covering the economic aspects.

6) Description of specific and generic input from various partners

FGFRI: Generic (biological): decision analysis, probabilistic modelling, Bayesian techniques, construction of belief network models for parameter estimation, inclusion of genetic information to separate stock components. **Specific (biol.)**: biological input to salmon (data and knowledge covering whole life cycle and all aspects of the fishery); Relationships to managers through the IBSFC subgroup of salmon management.

UHEL: Generic (socio-econ): economic behaviour of fishermen (reactions to price and CPUE changes), game theory, analysis of river data sets to improve short term predictions, economic analysis of short-term advice, market analysis. **Specific (soc.econ):** compilation of socio-economic data.

Uoul (sub-contractor): **Generic (sosio-econ.)**: sociological studies of fishermen's behaviour, modelling of fishermen's reactions

Imperial College: Generic (biol.): Assembly of age-structured operating models that include mixed-stock fisheries for key wild and reared Baltic salmon populations. These models will incorporate probabilistic parameter estimates from the various data analyses, and expert judgment where empirical estimation is not possible. The different salmon fisheries will be modelled with some spatial disaggregation into river, offshore, and separate coastal regions to take into account the effects of different management measures impacting these spatially and temporally disaggregated harvests. Scenarios based on socio-economic evaluations will also be built into the operating models. Construction of the fisheries management simulation evaluation platform and running of this simulation model to evaluate the robustness of alternative management methods to plausible hypotheses for fisheries dynamics. Probabilistic analysis of the success of coastal management systems in the Gulf of Bothnia, probabilistic analysis of predictability of M74 and it's relationships to ecosystem changes, comparison of MCMC techniques and belief network models for parameter estimation.

DIFRES: Specific (biol.): Data on landings (catch data + discard data), Fishery effort and capacity data, biological samplings, tagging and re-capture data, economical data, data on fleet basis, etc. Participation in compiling some of the data into standard formats.

NBF: Generic (biol.): Development of exploitation estimates of salmon from reared stocks. Evaluation of river specific production capacities for wild salmon and development of biological reference points. **Specific (biol.)**: Input concerning all aspects of fishery and biological data concerning entire life cycle, in particular river surveys.

IMR: Specific (biol.): data compilation and provision.

SFI: Generic (biol.): analysis of oceanographic dynamics and post smolt survival, analysis of CPUE spread over the Baltic fishing grounds (statistical analysis to estimate additional statistical models to improve short term biomass predictions), multispecies modelling of sprat (link to growth and M74). **Specific (biol/econ):** time series of statistical, biological and economic data.

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4. Nephrops fisheries in the East Atlantic (Major case study, No. 4)

Overview description of fisheries and stocks

Current total *Nephrops* landings from the ICES area are around 53 000 t per year, with the largest quantities being taken from sub-areas IIIa, IV, VIa, VII and VIII (ICES, 2001). *Nephrops* has a very high market value, the result being that the *Nephrops* fisheries figure amongst the economically most important sea fisheries in northern and western Europe.

Because of its burrowing behaviour, *Nephrops* is bound to particular types of sediment, consisting of a mixture of sand and mud. As a consequence, the geographical distribution of *Nephrops* is very discontinuous, with the highest densities being found in areas of "suitable" sediment and very low or zero densities in between. In 1984, the ICES Working Group on *Nephrops* Stocks identified so-called Functional Units for *Nephrops* (ICES, 1984), which are regarded as geographically isolated biological entities. Since then, these Functional Units have systematically been used as operational units for data collecting, assessment and advisory purposes (see e.g. ICES 1999, 2001).

Fishing for *Nephrops* is mostly done with bottom trawls. In some areas, there are also creel fisheries for *Nephrops*. Fishing strategies, gear types, mesh sizes and minimum landing sizes differ between areas and Functional Units. Some fisheries are primarily targeting *Nephrops*, while others are truly mixed fisheries, where *Nephrops* is one of the target species together with a variety of roundfish, flatfish and/or other Crustacean species.

Owing to the peculiar morphology of *Nephrops*, the size selection of *Nephrops* trawls is usually poor and this results in high levels of discarding. By-catches of gadoids (mostly cod, haddock and whiting) and hake are often considerable too, the consequence being that there is a major "by-catch problem" in many *Nephrops* fisheries (in terms of both by-landings of fish of commercial sizes, and discarding of undersized or otherwise unwanted fish). Again however, there are marked differences between areas and Functional Units, with cod and haddock being the prime species of concern in the most northern areas, cod and whiting in the intermediate areas, and hake in the most southern areas.

Main assessment and management problems

Assessment problems

The methods currently employed to assess the state of exploitation of *Nephrops* stocks include:

- The analysis of long-term trends in fishery data.
- The results of age-based VPAs, applied to "age groups" that are obtained by slicing the length compositions of the removals.
- Yield-per-recruit analyses based on the output of the VPA.
- The results of fishery independent surveys.

The technique used to generate "age groups" (viz. knife-edged slicing of the length distributions of the removals) however, is questionable. The method is particularly sensitive to the input parameters for growth and may therefore produce age groups that do not fully reflect the true age composition of the stock. In turn, this may have a major impact on the outcome of the assessments and hence on the appreciation of the state of exploitation. Another source of concern in the assessments is the lasting uncertainty over the estimates of the natural mortality rates (M) for Nephrops.

In an attempt to overcome these problems, fishery independent surveys (such as underwater TV and trawl surveys) have been introduced as an assessment tool for a number of *Nephrops* stocks. The surveys have proven to be very useful in providing additional evidence on the state of *Nephrops* stocks, but they have the disadvantage of being very expensive. Therefore, the chances that they may generally be introduced as an assessment tool for *Nephrops* are remote.

As an alternative, the Working Group on *Nephrops* Stocks has explored the potential of different other techniques, such as Biomass Dynamic Models, Statistical Catch-at-age Models and Leslie's Depletion Method, albeit without much success (see e.g. ICES, 1998, 2000). Other approaches that are likely to be taken in the near future, include the exploration of the Fleksibest method – a newly developed age-length structured assessment technique (FRØYSA et al., 2002).

Another outstanding problem with the *Nephrops* assessments is the absence of reliable biological reference points (BRPs) that can help in the evaluation and decision making process. The Working Group on *Nephrops* Stocks has addressed this issue on several occasions (see e.g. ICES, 1998, 1999, 2000), but has so far not been in a position to propose generally agreeable BRPs for any of the *Nephrops* stocks.

Despite the relative success of the application of VPA to *Nephrops*, the introduction of fishery independent surveys and the many attempts to explore alternative assessment techniques, there is still need for improvement in the methodology of the *Nephrops* assessments. The development of new tools for the biological assessment of *Nephrops* stocks is beyond

the scope of this project, but it is the project partners' intention to closely follow up any new developments in the field and to take these into account in the evaluation process.

Management problems

- Problems related to the current TAC system

At present, the *Nephrops* fisheries in the ICES area are managed through a system of annual or biennial single-species TACs which are set for large management areas defined by ICES boundaries (IIIa, IV, VI, VII, etc.). Both the Working Group on *Nephrops* Stocks and ACFM have repeatedly pointed out that TACs based on these large areas are not satisfactory, since they do not allow for a type of management which takes account of the different levels of exploitation in different Functional Units.

- Problems related to the by-catch of gadoids and hake

By-catches of gadoids and hake in the *Nephrops* fisheries are often considerable. So far, however, this issue has never been properly addressed, neither by the Working Group on *Nephrops* Stocks, nor by any of the demersal fish Working Groups of ICES. Except for the *Nephrops* stocks in the southern seas (Bay of Biscay, Iberian Peninsula), there is very little evidence of over-exploitation in *Nephrops* stocks and hence very little need to reduce fishing effort in the *Nephrops*-directed fisheries (see e.g. ICES, 2001, 2002). There is, however, increasing pressure to do so, or – as an alternative – to improve species selectivity of the *Nephrops* gears, in an attempt to reduce fishing pressure on the by-catch species.

A further management problem of the *Nephrops* fisheries in the NE Atlantic is that the *Nephrops* trawlers may switch activity from *Nephrops* to other target species (usually gadoids) depending on the relative economic benefits of each activity. To factor this into an analysis, the existing fleet segments may need to be further subdivided into métiers (ICES, 2003), in relation to their directedness towards *Nephrops*. The opportunity cost of operating in each métier can be estimated using a simple constrained optimisation model, and this could then be used to influence switching behaviour in the model. A similar approach has been applied to the brown shrimp fisheries (*Crangon crangon*) in the North Sea, to assess the effects of gear restrictions on *Crangon* catches, profits and effort levels (PASCOE and REVILL, 1999).

Main and typological problems to address

1. What are the advantages of a management system for *Nephrops* based on catch quota and/or effort regulation by Functional Unit, as opposed to the current system of TACs applied to large geographical areas that comprise *Nephrops* stocks with different states of exploitation?
2. What is the bio-economic and socio-economic trade-off between multi-species and multi-fleet management approaches, in the case of mixed fisheries where the species requiring protective action (e.g. gadoids and hake) have a lower economic value than the prime target species of the fisheries (*Nephrops*)? Are there any alternatives (e.g. closed areas/seasons, improved gear selectivity, other fishing tactics) that can achieve the same protective goals with regards to the by-catch species, without affecting the viability of the *Nephrops* fisheries?
3. What were the limitations/shortcomings in assessment procedures, decision making and implementation that led to the failure to protect the *Nephrops* stocks in the southern areas (Bay of Biscay, Iberian Peninsula) from over-exploitation, c.q. recruitment failure? To which extent could alternative management approaches based on decommissioning, licences, individual quota/effort regulations, etc., have helped to achieve protection?

Purpose of the case study, methods to be used and case specific deliverables (bullet numbers refer to the problems listed in the previous section)

1. Exploration and development of a management system for *Nephrops* that is much better tuned to the peculiarities of Functional Units (in terms of state of exploitation) than the current system of large area TACs.

   Models and evaluation tools to be used include: traditional single-species stock assessment techniques (input derived from ICES Working Group on *Nephrops* Stocks), combined with an analysis of the "costs" associated with a much more refined data-collection and implementation system, and the "benefits" (if any) that can be expected from a management approach based on Functional Units.

2. Development of an evaluation toolbox that allows to balance off the "benefits" of measures aiming at the reduction of unwanted or undesirable by-catch (species) and the possible "costs" of such measures (in terms of both landings and revenues) that may be incurred by the *Nephrops* fisheries.

   Models and evaluation tools to be used include: traditional single-species stock assessment techniques (input derived from ICES Assessment Working Groups), multi-fleet forecast models (input derived from different ICES Working Groups, STECF expert groups and WP3), gear selectivity models (input derived from Task 5) and bio-economic models applicable to the *Nephrops* fisheries (input derived from WP3).

3. Development of an evaluation toolbox that allows to investigate the effectiveness of different management strategies aiming at the protection of *Nephrops* stocks from over-exploitation (TAC and effort regulations, spatial

and/or seasonal closures, decommissioning, licences, etc.) and formulation of guidelines on how these should/could be applied in the future, in an attempt to avoid decreases in stock size and fisheries potential similar to the ones that were seen most recently in the Bay of Biscay and in the Spanish and Portuguese waters.

Models and evaluation tools to be used include: traditional single-species stock assessment techniques (input derived from ICES Working Group on *Nephrops* Stocks), gear selectivity models (input derived from Task 5) and bio-economic models applicable to the *Nephrops* fisheries (input derived from WP3).

Although the above investigations are case specific, their deliverables in terms of insights, models, evaluation tools, etc., should be applicable to fisheries that show similar features and/or management problems (such as the *Nephrops* fisheries in the Mediterranean or the *Crangon* and *Pandalus* directed fisheries in NW Europe). The expertise gained from this case study can also be transposed to other mixed fisheries where technical interactions lead to excessive discarding or poor exploitation diagrams of non-target species.

Description of specific and generic input from various partners
Case study co-ordinator: CLO-DvZ

Specific input

- Biological

Data on volumes of catches, landings and discards of target and by-catch species, together with their length and/or age distributions, will be provided by all relevant participants to the case study: CEFAS, CLO-DvZ, DIFRES, IFREMER, IMR(N), IMR(S), FRS, IPIMAR, MRI and RIVO. Additional biological data (on e.g. biological parameters used in stock assessments) will be obtained from relevant ICES Working Groups.

- Economical / Sociological

Data on landings revenues for target and by-catch species, together with additional economic data on prices, employment, subsidies (if any), exploitation costs, etc. will be provided by all relevant participants to the case study: CEFAS, CEMARE, CLO-DvZ, DIFRES, IFREMER, IMR(N), IMR(S), FRS, IPIMAR, LEI and MRI.

Generic input

- Biological

Stock assessment models, multi-fleet fishery-based forecast models, etc. to be used in this case study will mostly be derived from sources outside the project (existing software, models developed by ICES Working Groups, STECF expert groups, etc.). If required, additional generic input will be provided by CEFAS, IFREMER and FRS.

- Economical / Sociological

The bio-economic and socio-economic models to be used in this case study will mostly be delivered by WP3. Additional modelling expertise will be provided by CEMARE, LEI and UNEW.

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6. Northern Hake mixed species fisheries in Area VI, VII and VIII (Major case study, No. 6)

Background: Description of fisheries and stocks

Hake, and specifically the Northern Hake Stock, is one of the most important resource for many European fishing fleets whose harvest involves a large number of vessels from several European countries. The Hake fishery is a very economically important fishery to Spain, France, UK and Ireland. In 2003, and in a very gross approximation, the value of the Hake TAC was estimated in non less than €90 m. According to ICES data (ICES CM, 2002) five main countries contributed to 98 % of Northern Hake landings in 2002: Spain (61%), France (26%), United Kingdom (6 %), Denmark

(3%) and Ireland (2%).

Northern Hake since the beginning has been assessed as an only one stock (from Sub-area II to Div. VIIIabd) but managed by output regulations (TACs and other technical measures) splitted by sea areas. Some of these technical measures have been implemented since the Emergency Plan was enforced in June 2001. A Recovery Plan for Northern Hake is also foreseen but not yet implemented.

Northern hake is caught by a number of different gears throughout all its distribution area. The main part of the fishery (close to 70% of the total landings in the recent years) is conducted by four defined Fishery Units (FU), as they were defined in the past (ICES, CM 1991): Non-Nephrops trawling in medium to deep water in Sub-area VII, Longline in medium to deep water in Sub-area VII, and Gillnets in Sub-area VII, and Trawling in medium to deep water in Sub-area VIII, representing respectively 22% (7 900 t), 20% (7 200 t), 15% (5 600 t), and 11% (3 800 t) of the total (ICES CM, 2002).

But Northern Hake cannot be considered as an exclusive target species for the most of the fleets involved in its fishery. Several other species, some of them also of great economical importance, are usually caught together with the Hake. Some of them are routinely assessed by the ICES Working Groups and their catches are regulated by the TACs and Quotas system, but others not yet. Anglerfish (both species), Megrim, Sole, Nephrops, Whiting, Cod, Horse mackerel, between others, are in the first case, and Cephalopods, Rays, Pouts, between others, in the second one. The relative importance of these "other species" in relation to the Northern Hake is very variable depending on the country, fleet and sea area involved. In many cases, "the other species" represent a major importance in terms of incomes than the Northern hake for a particular country or fleet.

Many changes have been observed in the last years in relation to the fleets (and their technical characteristics), mainly of some countries, involved in the Northern Hake and related species. Thus, the FUs defined in the past mainly for Hake, Megrim and Monkfish, do not reflect in many cases correctly at present the evolution of the real fishing effort.

On the other hand, the involvement of the fishing industry in this project is important to assure acceptability of the research results and likely would increase their applicability, representing a more efficient way to transfer research outputs to final users. Previous experiences on this subject showed that this acceptance is possible, provided that the fishing industry is informed in a comprehensive way of the development of the research (EU project AIR2-CT96-2001). The present proposal considers the liaison with the fishing industry as an important milestone of the project.

Main assessment and management problems and some considerations to be addressed

Only in relation the Northern Hake, the latest assessments made by ICES in the last three years indicated that the fishing mortality (F) on the Northern Hake stock has been above the precautionary level (F_{pa}) during the whole time period of the assessment (which started in 1978). Moreover, the spawning stock biomass (SSB) had continuously declined and had been below the precautionary level (B_{pa}) since 1989 and recruitment estimates for 1997 and 1998 were the lowest ever recorded. Thus, two main concerns raised regarding this stock: the low levels of SSB since 1992 and the very low recent estimates in recruitments (1997-2000). Taking into account all these facts, ICES concluded that this stock was outside safe biological limits.

Like the majority of stocks of the EU, the Northern Hake stock is regulated in terms of output limitations (TAC) with technical measures associated (minimum mesh size in some areas for some gears and minimum length in landings) (Council Regulation N°850/98). However, facing the stock status described above the ICES management advice in 2000 for the Northern Hake stock was to implement a rebuilding plan for this stock, including provisions to maintain a low F until a substantial increase of the SSB was documented. The multispecies nature of this fishery poses certain difficulties in drawing uniform regulation measures, since any management approach will affect all these by-catches or target species. A range of technical measures considered to be implemented included the alteration of the selective performance of fishing gears as a direct way to control the fishing mortality on the stock, both in fisheries targeting hake as well as in those which are not directed to the species but have a significant level of hake discards. Thus, from 14th of June 2001 an Emergency Plan was implemented by the Commission to recover the Northern Hake stock: two closed areas were defined, one in Sub-area VII and the other in Sub-area VIII, where 100 mm minimum mesh size has been implemented for trawlers targeting roundfish, unless Hake comprise less than 20% of the total amount of marine organisms retained onboard. The objective was to reduce the catches of small Hake in fisheries taking place in Hake nursery areas. Nevertheless, these emergency measures were not applied to vessels less than 12 m in length and which return to port within 24 hours of their most recent departure (Council Regulation N°1162/2001).

The Commission's Working Group on the preparation of future recovery measures for Northern hake (Anon. 2001a) has set research priorities in the medium to long term to adjust the Recovery Plan and improve assessments. Technical conservation measures were given high priority, including economic analyses in order to study the short term costs and the longer term consequences to fishermen of implementing conservation measures.

Any management change will impact the economical performance of the fishery in an unknown way. Those economic effects will need to be assessed in order to judge the profitability of the technical measures.
Owing to the state of the Northern Hake Stock, their fisheries should be carefully managed. Presently, as stated below, ICES advice that fisheries must be kept at very low levels until there is scientific support that stocks biomasses can sustain higher levels of effort in the long term. Lack of scientific support is due to:

- Present **knowledge of the stock dynamics is often insufficient: Uncertainties in the real relationship between recruitment and SSB, and in the recruitment and SSB levels for the establishment of accurate Biological Reference Points for Predictions. This is a main drawback of the current assessment and projections of Northern Hake in Atlantic European waters (ICES CM, 2002).**
- **Concerns over structural uncertainties of the XSA stock assessment model in relation to the age plus group.**
- Due to the fact that some fisheries are conducted in national waters, many times regulations have not been strictly implemented with regard to mandatory reporting of catches or MLS. Important **logbook information is not always available for assessment purposes** as it is considered confidential by the fishing companies. Also sometimes data reported are not truly "reliable".
- Northern Hake stock/fisheries are not limited to national zones but rather share different country waters, making management more complex. Thus, **management consensus in major international advisory bodies** is required.
- Interactions with other important fisheries (Monkfish, Megrim, **Nephrops**, …).

Problems to be addressed in the project

Possible management scenarios and evaluation tools to be explored in this case study include:

- Provide elements on profitability thresholds in terms of CPUE, biomass or in relation to several biological reference points. reliable".
- Test the effect on multi-species catches/landings, of various levels of single species TAC's for Northern Hake, and try to evaluate socio-economic and technical implications.
- Obtain estimations of associated fishing effort and direct costs associated with fishing activity for main fishing fleets exploiting hake.
- Develop and evaluate the advisory tools and the associated risk (from WP3 of the Task 1) as a result of restrictive management actions (e.g. reductions in fishing effort, closed areas for juveniles and spawners, etc.).
- Assess the extent to which further development of technical measures (such as increases in mesh size, other selectivity measures closed areas and the use of certain fishing methods) could contribute to the recovery of stocks of Hake. The advantages and disadvantages of such measures shall be evaluated. Besides this, the management of effort versus TACs system could be also tested.

These last two points will be studied based on a range of plausible hypotheses regarding population dynamics, given the lack of knowledge about the spatial distribution of hake.

Specific bioeconomic analyses to address the hypotheses

- Apply current bioeconomic approaches, including those based on models such as Yield per recruit, stock production,…, incorporating the socio-economic data.
- Take in account the considerations of a multispecies scheme incorporating trade offs among target, by-catch and economical outputs obtained from the fishery. Scenarios of low-high TAC for each species should be incorporated and analyse the consequences on accompanying species.
- Finally, the project should aim at implementing a bio-economic model for the whole fishery in terms of economic and social objective functions including biological and economic sub-models. The achievement of this objective depends on the possibility of integrating in a single model the elements relative to different fishing units, and on uncertainties about spatial dynamics.

Data constraints

- The data availability on Northern Hake and associated species is considered to be restricted to *status quo* situation, this is, at least to the same desegregation level as they appear in the Reports of the ICES Assessment Working Groups. Thus, one basic requirement must be established: the availability of the adequate data. But, is there catch composition available for Hake and associated species for all Fishing Units deploying Northern Hake?
- The split and adequate specification of the fleets conforming fisheries in which Northern Hake and associated species catches occurred is being a recurrent problem in order to achieve a more precise monitoring of all species catches. Differences in the target species even for the same fleet in the same

sea area, in the exploitation pattern, and in the dimensions of the gears used by the different fleet components, as well as changes observed in the proportion of these components in recent years, support this eventual splitting. As an example, in the case of bottom trawlers (otter and pair trawlers, trawling in medium to deep waters) all of them are included in the same FU, however mixed and target species are clearly different for each of the cases. This should be taken into account when applying technical measures to manage the Northern Hake stock and other associated stocks.

Description of specific and generic input from various partners

Specific Input

- Biological
- Data on catches (landings), for Northern Hake stock in Div. VIII a,b,d and Sub-areas VI and VII, and some other main associated species, together with their length distributions, maturity (by length), and spawning season and sex-ratio, are available from relevant ICES Working Groups. Data on landings, effort and, in some years and fishery cases, CPUEs, by statistical rectangle, could be also available in some cases.
- Economical-Sociological
- Data landings revenues and economic data on prices, for target and by-catch species, employment, licences, subsidies, exploitation costs (personnel et others), etc., by main fisheries, will be provided by all participants in this input to the case study, to the extent that they may indeed access such data from fishermen.

Generic Input

- Biological

- Evaluation of fishery data based on spatial analysis on logbooks, shelling sheets and some survey data as a tool in relation to the evaluation of the technical measures: closed areas for juveniles and spawners, due to the importance of the differential mortality of the latest during the reproductive season and the rest of the year.
- Evolution and indicators of the eventual decreasing/increasing importance of Northern Hake catches, in the framework of the mixed demersal fisheries, between the more northern and southern areas of the present defined stock. Since sudden variations of the parental stock from one year to the next are not likely in a long life population as hake, environmental conditions might play a significant role in the realization of the recruitment strength of Northern Hake. Although, no oceanographic features will be studied, the hypothesis testing will be carried out by analysing the eventual CPUEs reducing/increasing in different ICES areas along the years.
- Other existing assessment models used in some ICES working groups, but not for Northern Hake, will be tried for this stock and associated species, if feasible.
    - Economical- Sociological
- The bio-economic and socio-economic models to be used in this Case Study will mostly delivered by WP3 of the Task-1.
- In the developing of socio-economic models it will have to be bared in mind that Northern Hake is a species of great value in terms of economical and social consequences, specially for Spain and France. Additionally, the inexistence of Spanish quotas in other demersal species, except for Megrim and Monkfish, has done the Spanish fleet more dependent in the last two decades on the Hake fishery. It makes several fleets “hake-dependant”, and forces to some kind of specialisation not only from the point of view of the flees but also from the regions and ports point of view. It makes that any managerial decision has its direct impact on fishermen communities. It should be taken into account when defining the objective function, since the maximization of profits does not necessarily take into account this issue.
- The applied economical sub-model is considered to be highly dependent to the available data to calibrate or to econometrically estimate the parameters of the relevant equations to be introduced in the stochastic simulation model: production function (yield function), cost function and demand function. In any case the next specifications ought to be stressed.
    - Multigear, multifishery and multicountry reality, which implies different catch-cost and derived productivity levels.
    - Important quota-shared conflict among countries and fleets: the quota-hoping phenomenon, which adds new incentives to overexploitation.
    - The role of the market should be considered for special attention, even the international trade of hake coming from further water.
- If feasible, social impact will be considered, for example, incorporating the maintenance of a certain desired level of employment as a restriction to the problem.

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7. Swordfish fisheries in the Mediterranean (Major case study, No. 7)

Fishery overview

Swordfish *(Xiphias gladius)* is one of the most commercially important large pelagic species and it is heavily exploited in the Atlantic Ocean and the Mediterranean Sea. In the past twenty years due to the high market demand for swordfish, the fishing pressure on the different stocks of this species has increased dramatically. In the Mediterranean, catches showed a strong upward from about 4000 metric tons in 1976 to 20000 tons in 1988. Since then annual catches fluctuate from 12-15mt. The above increase in the reported catches could be, to a certain extent, attributed to the improvement of the fishery-statistic collection systems but it is also related to the intensification of fishing effort and exploitation of new fisheries.

Genetic studies (Kotulas *et al*., 1995) have suggested that all Mediterranean swordfish form a unique stock separated from the two Atlantic ones and this is also the working hypothesis in the GFCM/ICCAT assessment groups.

The gears used for the swordfish fishing in the EU countries included drifting long-lines, driftnets and harpoons. Long-lines are used throughout the Mediterranean while driftnets, which were mainly employed by Italian fleets, are banned since January 2002 according to a EU regulation. Driftnet use is now limited to certain non-European countries. Catches of the harpoon fishery are negligible, as the gear operates in few specific areas (e.g. Sicilian Straits) by a small number of vessels.

Consequently, nowadays, the principal fishing gear used by the EU fleets is the drifting long-line. Swordfish is the primary (if not the only) target species for all those fisheries with the rates of by catch/discards being generally less than 8% in terms of numbers (Megalofonou *et. al.* 2000). On a local and seasonal basis, few tuna fisheries have also swordfish by-catches.

Historically, juveniles have made up a large fraction of Mediterranean swordfish catches (Rey et al. 1987, Di Natale 1990, Relini et al 1993, Tserpes et al. 1993). The size frequency distribution landed by each fishery in the region can vary substantially. For example, depending on the year, the area and the season, the percentage of landings below 120cm (the minimum landing size previously established by EU for the Mediterranean) can be as low as 15% or as high as 100%. Despite the differences in sizes landed by the various fisheries, it is evident that the catch of small swordfish is usually highest during the fall and winter months (Di Natale *et al*. 2002).

Main assessment and management problems

Assessment problems

The state of the stock is poorly known. ICCAT performed a preliminary assessment in 1995 that revealed that the stock might be close to over-exploitation (ICCAT 1996). However, the assessment, which was accomplished by employing a separable-VPA approach, was not considered sufficiently reliable for an in-depth evaluation of the state of the stock, as the available time series of data was rather limited.

A more recent assessment based on Greek and Italian data was performed in 2001 within the frames of a EU project. Results that were based on age-based VPAs and non-equilibrium surplus production modelling, suggested the presence of a rather stable situation in terms of mortality and recruitment (Tserpes *et al.* 2001).

As the amount of fisheries data in the ICCAT database has increased in recent years, ICCAT has scheduled an assessment of the stock in May 2003.

Management problems

Due to lack of reliable quantitative assessments, the management recommendations that have been made are largely qualitative and are based on the available knowledge on the swordfish biology and fisheries in the region. ICCAT and GFCM scientists have repeatedly stressed the need to reduce the proportion of juvenile fish in the catches. Through the frames of the Common Fisheries Policy a minimum landing size (MLS) of 120cm was established in middle 90's, but this measure is not in effect nowadays, as resulted in high discard rates (De Metrio *et al.* 2001); hence did not prove to be particularly useful in the protection of juveniles.

Certain Mediterranean countries are still imposing minimum landing size measures and/or closed seasons for the fishery but there is lack of harmonisation between countries, in terms of management measures. Apart from the lack of harmonised measures among Mediterranean countries, swordfish fishing in international Mediterranean waters by third country fleets and flag of convenience vessels makes much more difficult the rational exploitation of the stock.

The alternative management strategies mentioned in the latest report of ICCAT Scientific Committee include the adoption of closed seasons and MLS limitations (ICCAT 2002). In particular, it has been suggested the exploration of the possibility of adopting the following technical measures (Di Natale *et al*. 2002):

- A closed season between September and February, which is expected to reduce the catch of juvenile swordfish and reduce overall fishing pressure on the stock. In order to produce detectable results the closure duration should not be less than two months.
- A MLS of 110cm lower fork jaw length (LJFL) accompanied by a certain level of tolerance (e.g., 15%). It is considered that such a measure, which is based on maturity studies, takes into account the fish behavior and the current characteristics of the fisheries.

Main and typological problems to address

Taking into account, the management recommendations made by ICCAT (see previous chapter), the study will address the following problems:

- Which are the benefits in terms of juvenile catches reduction by establishing a closed season and/or a MLS of 100-110cm accompanied by a certain level of tolerance?
- What will be the effects of a seasonal closure on the overall fishing mortality rate?
- What will be the level of swordfish discards of fisheries targeting tuna-like species in case of a seasonal closure?
- Which are the socio-economic impacts of a closed season/area measure?

The above points will be considered with reference to data that are already available in the participating institutions and cover the major European fleets for the latest 10-12 years. According to ICCAT records, catches of those fleets compose a large proportion of the annual Mediterranean production (60-70% in the latest years). Data have been collected within the frames of different national and international projects and the adopted sampling schemes were based on the instructions given in the "Field Sampling Manual" of ICCAT. An effort will be also made to utilize relevant data, stored in ICCAT database, for the non-European swordfish fisheries operating in the Mediterranean.

Deliverables and methods to be used

The study will use available data to analyse MLS limitations and seasonal closures in order to assess the bio-economic effects of different management scenarios that could be adopted for the rational exploitation of the Mediterranean swordfish stock. This would allow balancing the short and medium term biological benefits of reducing the level of juvenile catches with the cost of the measures that will be employed to achieve such a reduction.

The tools that will be used include traditional analytical stock assessment modelling techniques, such as Y/R and age based VPAs, as well as non-equilibrium surplus production models. Data will be analysed by means of the relevant software packages, used in ICCAT and ICES working groups. In addition bio-economic models that will be developed in the frames of WP3 will be utilised.

Input from the various partners

Table 1 summarizes the inputs of the various partners in the present case study. IMBC and NCMR will provide

specific biological input for the swordfish fishery in different areas of the eastern and western Mediterranean. This includes detailed data on catches, size and age distributions, etc. IMBC, NCMR, IREPA, and UPO will be providing the corresponding socio-economical information, i.e. data on prices, exploitation costs etc.

IMBC and NCMR will provide generic biological expertise related with the current case study, including information on biological parameters, and methodologies that have been previously applied for analysing fisheries data and assessing the stock. IREPA, Univ. of Basque Country, UPO and Univ. of Barcelona would be offering socio-economical expertise based on their experience in the development of optimisation models for various Mediterranean fisheries using social, biological, economical and environmental relationships.

Table 1. Type of input of the various partners involved in the study.

Mediterranean Swordfish case study			
Specific input		**Generic input**	
Biological	Economical/Sociological	Biological	Economical/Sociological
IMBC, NCMR	IMBC, NCMR, IREPA, UPO	IMBC, NCMR	IREPA, Univ. of Basque Country, Univ. of Barcelona (GEM), UPO

The responsible scientists for each of the participating institutions are as follows:

IMBC (Greece) - case study coordinator: Dr. G. Tserpes

NCMR (Greece): Dr. C. Papaconstantinou

IREPA (Italy): Dr. V. Placenti

Univ. of Barcelona (Spain): Prof. R. Franquesa

Univ. of Basque Country (Spain): Prof. I. Del Valle

UPO (Spain): Prof. Ines Herrero

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8. Hake fisheries in the Mediterranean (Major case study, No. 8)

Fishery Overview

The European hake, *Merluccius merluccius* L., 1758, is a gadoid species distributed throughout the Mediterranean Sea, occurring at depths from shallow waters to 1000m. It ranks among the commercially most important demersal species in the Mediterranean Sea. It is fished with trawl nets, bottom longlines and fixed-nets. The latter tow gears are of less importance, in terms of production, than the trawl fishery, but they exploit distinct parts of the hake population in the region. Hake fisheries are of the major Mediterranean fishery in terms of output quantities, value and management options and there is considerable biological information. Economic information on this fishery is also very good e.g. costs of fishing prices, investments, subsidies, incentives and so on.

Main management and advisory problems

Assessment problems

The methods currently employed to assess the state of exploitation of the hake stocks in the Mediterranean are:

- Until 1980, the Shaefer and Fox production models were applied to those hake stocks for which historical series of catch and effort data existed.
- After 1980, yield-per-recruit analysis (Y/R) was applied in certain areas. This analysis demonstrates overexploitation of hake and a high level of current fishing mortality.
- More recently, virtual population analysis (VPA) or length cohort analysis (LCA) has been applied by Martin (1989), for some stocks, mainly off the Spanish coast, but also in the Gulf of Lions where hake is exploited by a multigear fishery (Aldebert & Carries, 1991), and Aegean Sea (Papaconstantinou et al , 1992). High levels of fishing mortality were recorded in all cases. Subsequent Y/R analysis indicated overexploitation.

As sampling of the various fisheries has been mostly carried out in the frames of different projects and not on a regular basis, there are several spatio-temporal gaps in the available data series. Besides, as there are no formal assessment groups, the assessments have been mostly carried out on in the frames of different projects; thus there is a lack of harmonisation among scientists regarding the methods and data employed.

Management problems

The Mediterranean trawl fishery is not species-specific and trawl catches are made up of a significant number of species (mixed fisheries). Thus, management strategies based on single-species calculations are of limited value and the rational management of the Mediterranean demersal resources would require an integrated multispecies approach.
All the assessments made till now in the Mediterranean Sea are based on single species models and suggest that a modification of the actual exploitation pattern is required. Particularly: (i) an increase in age of first capture and/or reduction of fishing effort, or (ii), if a multigear fishery exists, a shift from the trawl fishery to other types of fishery. These changes would produce an increase both in yields and in population biomasses.
The mixed fisheries nature of the demersal and inshore fisheries in the Mediterranean poses certain difficulties in drawing uniform protective measures. Any management approach to be implemented will affect not only the hake stocks but also other target species of the fishery and the whole ecosystem in general. Two aspects of the biology of hake complicate mixed fisheries management (i) the habitat of young hake lies deeper than the inshore zone (below 50 m), and (ii) hake length at first maturity is larger than that of other main species of the trawl fishery (Oliver & Massuti, 1995). Consequently, the current conservation schemes based on characteristics of other species are not very effective for hake.

The common management measures applied in fisheries targeting hake in the Mediterranean are the following: (a) introduction of a minimum mesh size in the trawl fishery, (b) limitations in the minimum size of marketed fish, (c) implementation of closed inshore areas and/or seasons, (d) restriction on the number of licences issued, and (e) restrictions on the fishing effort. Apart from certain technical measures (e.g. minimum landing size) there is lack of harmonized measures among the different Mediterranean countries.

Almost all the applied management measures present problems and do not allow for an improvement of the actual exploitation pattern of hake. In particular, the 40mm mesh size is insufficient for adequate protection of trawl hake fishery which requires a mesh size >40 mm (Bas et al., 1985), the minimum size increase the high discard rates (Machias et al., 2001), closed seasons and areas impose a disrupting effect on marketing, restrictions on the number of licences issued are usually introduced early in the history of the fishery (Beddington & Retting, 1983), and finally surveillance on the adoption of restrictions on the fishing effort is very poor.

Main typological problems to address

Most hake stocks are overfished by any criterion. Besides, in several cases large amounts of immature small fish are discarded at sea (Papaconstantinou & Stergiou, 1995). However, due to the lack of sufficient data and harmonised assessments, management nowadays, is based on technical measures. Bearing in mind the above situation, the following management scenarios will be explored with reference to a rational management of the hake stocks in the Mediterranean.

- Ban of trawling over the continental shelf during the recruitment period.
- Implementation of a mesh-size in trawl nets larger than 40mm.
- Restrictions to the fishing effort (time spent at sea, control of engine power).

The effects of the aforementioned scenarios will be evaluated on the basis of their impact on the stock/ecosystem, as well as on their socio-economic implications.

Deliverables and methods to be used

The study will lead to the development of an evaluation toolbox that (a) will help to assess the bio-economic effects of different management scenarios that could be adopted for the rational exploitation of the Mediterranean hake stocks. In principle, the toolbox will allow to balance the benefits of different measures aiming in the reduction of juvenile catches with the detriments of such measures, in terms of landing volumes and revenues, and (b) will allow to investigate the effectiveness of different management strategies aiming at the protection of juvenile hake from over-exploitation, and finally at sustainable hake fisheries in the Mediterranean.

The tools that will be used include traditional analytical stock assessment modelling techniques, such as Y/R, length and age based VPAs, as well as surplus production models. Data will be analysed by means of the relevant software packages, used in GFCM and ICES working groups. In addition bio-economic models that will be developed in the frames of WP3 will be utilised.

Moreover a very sophisticated general model (Moses) will be used as a basis for the development of a more detailed specific model. Modelling in Moses considers optimisation and dynamic simulation, using the underlying social, economic biological and environment relationships, allowing a range of policy questions to be addressed.

The final stage will be to incorporate the data to a GIS database, enabling a description of optimal management areas in the Mediterranean Sea.

Description of specific and generic input from various partners

Case study coordinator: NCMR

Specific Input

- Biological

Data on catches, landings and discards of target and by catch species, length and age distributions, sex ratio, maturity, total weight, biomass and abundance will be provided by the following participants to the case study: NCMR, IMBC, IREPA. Additional biological data (e.g. biological parameters used in stock assessments) will be obtained from the bibliography as well as from relevant GFCM/FAO and CIESM Working groups.

- Economical/Sociological

Data on price of hake landings and discards or by-catches, fleet, employment, exploitation costs, additional economic data on prices, will be provided by the following participants: IREPA, NCMR, IMBC.

Generic input

- Biological

Stock assessment model, abundance and biomass indices according to different methodologies, forecast models etc will mostly be derived from sources outside the project (bibliography, existing software, models developed in previous projects etc). The available information will be provided by the following participants: NCMR, IMBC.

- Economic/Sociological

The bio-economic and socio-economic models to be used in this case study will be delivered mainly by W3. Additional modelling expertise will be provided by IREPA, UPO, University of Barcelona and University of Basque.

Table 1. Type of input of the various partners involved in the study.

Mediterranean Hake Fishery Case Study			
Specific input		**Generic input**	
Biological	*Economical/Sociological*	*Biological*	*Economical/Sociological*
NCMR, IMBC, IREPA	*IREPA, NCMR, IMBC*	*NCMR, IMBC,*	*IREPA, UPO, Univ. of Basque Country, University of Barcelona*

Table 2. Group of Participants

Name	***Organization***	***Country***	***e-mail***
Dr . C. Papaconstantinou	*NCMR*	*Greece*	*pap@ncmr.gr*
Dr. G. Tserpes	*IMBC*	Greece	*gtserpes@imbc.gr*
Dr. V.Placenti	*IREPA*	Italy	*placenti@irepa.org*
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Prof. I Kerne del Valle	*University of Basque Country*	*Spain*	*ebpvaeri@bsdx01.bs.ehu.es*
Prof. Ines Herrero	*UPO/ University Pablo de Olavide*	*Spain*	*ihercha@dee.upo.es*

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9. Cod fisheries in the Baltic Sea (Minor case study, No. 9)

1. Overview description of fisheries and stocks

The main fisheries for cod in the Baltic use demersal trawls, high opening trawls (operating both pelagically and demersally), and gillnets. There has been an increase in gillnet fisheries in the 1990s and the share of the total catch of cod taken by gillnets reached 35-50%. However, the size of gillnets fleets decreased in recent years, and the trawl catches dominate cod fishery.

Two Baltic cod stocks have been separated on biological grounds: western stock in Subdivisions 22–24 and eastern stock in Subdivisions 25–32. They show differences in meristic and morphometric characters, otolith structure, and genetic characteristic. Both stocks mix the Arkona and Bornholm Basin.

The catches on western stock were relatively stable during 1970s and first half of 1980s amounting to 40-50 thousand tons. Next, the catches declined suddenly to half of that level but they have increased to the range of 30-40 thousand tons since middle 1990s. Recruitment to the stock fluctuates widely and in last decade decreased to about 50% of the values observed in 1970s and in first half of 1980s. Fishing mortality has been very high, often exceeding 1. Fishery bases to a large extent on recruiting ages. In recent 10 years the stock size was mostly above precautionary level, but fishing mortality was too high and exceeded precautionary limit.

The eastern stock shows different dynamics. The catches increased sharply in 1980s from about 150 thousand tons to 300-400 thousand tons following very strong year-classes of 1976, 1979, 1980. Recruitment to the stock is largely dependent on hydrographic conditions, which improve after major inflows of highly saline and oxygenated water from Kattegat. At early 1980s the spawning stock biomass attained record high level of ca. 700 thousand tons. Since middle 1980s recruitment has been poor and stock size and catches decreased. At present the stock size is at very low level, constituting slightly more than 10% of record high values. Fishing mortality is around 1, largely exceeding precautionary levels. From 1990s onwards the stock has been outside safe biological limits.

IBSFC (Baltic Commission) manages Baltic cod in one management unit, covering all Sub-divisions 22–32. ICES considers the stocks in Subdivisions 22–24 and Subdivisions 25–32 as separate stocks, however, and ICES provides assessment and advice on both stock separately. ICES stresses in its advice that the cod stocks should be managed separately in order to better adapt the exploitation to the present development in the two stocks.

Both stocks are managed on TAC basis. IBSFC in 1999 has agreed to implement long-term management plan consistent with precautionary approach. In 2002 a recovery plan for Baltic cod has been adopted. In addition to TAC management a suite of technical measures has been implemented. These are:

- time and area closure (summer ban, spawning area closure)
- minimum landing size
- minimum mesh size
- limits of cod by-catch in herring and sprat fishery

2. Main management and advisory problems

Assessment/methodological problems

Western stock (Sub-divisions 22-24)

Catch and stock projection uncertainty

Young ages (2-3) contribute in ca. 70% to the catch while cod becomes fully exploited at age 3 and 60-70% of cods became mature at the same age. This results in very uncertain catch and stock size projections, as most of the projected catches and spawning stock biomass comes from year classes assumed or predicted from the surveys.

Eastern stock (Sub-divisions 25-32)

1. Bias in assessment due to underreporting (misreporting).

Decrease in stock size seen in late 1980s and 1990s has led to decrease in advised and agreed TAC which thus became restrictive. This has further led to marked underreporting of cod catches. The share of unallocated catches in middle 1990s amounted up to 40%. Although many steps has been undertaken to constrain underreporting, it is believed still to exist. The indirect evidence of underreporting is well seen from the ratio of survey biomass to the catch based analytical model (XSA) estimate of biomass. This ratio shows some trend in 1990s and is higher than in 1980s. As a result the stock size is probably underestimated. In consequence, the biological reference points (BRP) basing on stock-recruitment relationship may be biased.

2. Biass in assessment due to differences in age readings

There are significant difficulties in age interpretations of Baltic cod. Since 1994 ICES has co-ordinated work on consistent interpretations of cod age reading but the progress is very limited (ICES 1994, 1999). Still two schools of age reading exist: western (Sweden, Denmark, Germany) and eastern (Latvia, Poland, Russia). These differences obviously create the biass at least in absolute estimates of stock size which should be investigated.

Management/advisory problems

General

Mismatch in management and assessment units

The IBSFC manages cod in the Baltic in one unit, covering Sub-divisions 22-32. However, two cod stocks have been separated on biological grounds: western stock in Sub-divisions 22-24 and eastern stock in Sub-divisions 25-32. Both stocks show different dynamics: western has been fluctuating widely and has been generally within safe biological limits since 1995 while eastern has been generally decreasing since middle 1980s and has been outside safe biological limits since the end of 1980s. The ICES provides assessment and advice separate for both cod stocks.

Western stock (Sub-divisions 22-24)

Catch and stock projection uncertainty

Presented in "Assessment/methodological problems" section uncertainty of catch and stock projection is also an Management/advisory problem.

3. Main problems to address, objectives and methods

Study will be focused on the western – eastern cod stocks in the Baltic area. The aim of the case study is to demonstrate the effects of managing two different stocks with one TAC in a case, where both the biological features of the stock, and the environmental settings are different.

In addition, the case study will include the impacts of the data uncertainty on the obtained stock information, like S/R relationship, estimates of BRP's, relation of stock to save biological limits. The analysis of the data uncertainty influences will comprise both assessment and management bias from misreporting of the catches and the bias from age inconsistencies (two schools of aging for eastern cod stock). The role of technical measures (minimum landing size and mesh sizes in both gill net and trawl fishery) will be included. The simulation model described in Kuikka et al (2000) will be expanded and improved to fit to two stock cases, and the alternative ways to model the environmental impacts on S/R function will be further developed and tested.

As two main types of fleets exploit cod in the Baltic (trawlers and gillneters), where relevant the emphasis will be put on the consequences of possibly different fleets behavior.

For eastern cod stock production models with explicitly treated recruitment (Deriso 1980, Horbowy 1992) will be fitted to test assessment methods independent on problematic age information for that stock.

The economic consequences of selected management options will be assessed.

Specific hypotheses

- management of Baltic cod on basis of biologically defined units (population) will in long-term perspective lead to better adaptation of stocks to fishing pressure than the present one management unit system, and thus it will be also beneficial for the fishery

- assessment of stock dynamics using age independent methods leads to qualitatively similar assessment results and management conclusions as so far used age dependent models (to investigate the impact of uncertainty from inconsistency from age determination on assessment and advice)

- technical measures adopted for the stocks will markedly contribute, if fully implemented, to stock rebuilding

Deliverables

- evaluation of biological and economical consequences of present one unit management of Baltic cod in relation to separate management of biologically identified Baltic cod stocks

- evaluation of performance in assessment and management context of age independent assessment methods for Baltic cod – if evaluation proves successful then simpler and less data demanding tool for stock assessment will be available

- evaluation of contribution of technical measures to sustainable management

Structure of the analysis

The assessment will be done by having alternatively two or one assessment units. A simulation model will be constructed, where alternatively two or only one combined stock is managed by TAC and technical measures. As the historical data of cod recruitment – environment relationship covers only few combinations, and the future dynamics of Baltic Sea water quality for cod reproduction is highly uncertain, some alternative ways to model impact of this uncertainty on the S/R relationship will be considered. There are some hypotheses about how the large scale climate changes will impact the inflow dynamics of saline water, which is the major source of uncertainty for the future management.

The bias in assessment and management from misreporting (underreporting) will be estimated by expert evaluations and by other alternative total catch estimates. These will include fishermen interviews, market data, comparing the

distributions of tagging data and total catches, comparing the CPUE data from various countries, comparing survey CPUE and catch generated estimates of stock sizes, etc.

For eastern cod stock age independent assessment models will be tested as alternatives to the present methodology based on biased age structure of the stock. Despite many efforts towards consistent interpretations of age marked differences in aging among cod age readers exist. The production models with explicitly treated recruitment (Deriso 1980, Horbowy 1992) will be fitted to evaluate stock dynamic. Next, management advice based on estimated dynamic will be simulated.

The relative effects of technical measures (with focus on closed season and mesh size regulations, e.g. Bacoma Window) will be investigated within TEMAS model. The existing selectivity data, compiled in BACOMA project, will be updated with alternative sources of selectivity data (basically data from tagging). The relative effects on Fishing mortality, Stock Biomass, and Fisheries Economical output will estimated as dependent on behavior of different types of fisheries (fleets). The analysis will be done in relation to two basic fleets: trawl and gillnets.

Economic consequences of some management options will be evaluated using EIAA model (Economic Assessment of ACFM Advise). The model is a multi-output (species) static model that calculates economic repercussions of changes in catch quotas and fish stock abundances. In addition, a rather comprehensive economic model (developed by FOI), which allows for studying changes in cost and earnings from changes in biological exogenous variables and hence effort reallocation, will be further developed and applied.

4. Management scenarios and fisheries/stock evaluation tools (existing and possible alternatives**)**

Management scenarios

Existing

IBSFC manages both stocks through TAC control as one management unit. For both stock the precautionary biomass and fishing mortality reference points has been set. The fishing mortality reference points serve also as targets - they are 1.0 for western stock and 0.6 for eastern stock. Threshold biomasses were set at 240 thousand tons for eastern stock and 23 thousand tons for western stocks. In case of spawning stock biomass fall below the threshold levels, the Commission agreed to adapt fishing mortality such to ensure “safe and rapid recovery” of stock sizes above the threshold levels. In addition, a suite of technical measures has been adopted:

- time and area closure (summer ban, spawning area closure)
- minimum landing size
- minimum mesh size
- limits of cod by-catch in herring and sprat fishery

Alternatives to be considered

1. Separate TAC management for both stocks

2. Fishing mortality scenarios

- The $F_{0.1}$ and F_{max} strategy. Both points are for both stocks much lower than presently used targets.
- The F_{msy} strategy. As it is planed to evaluate stock dynamics using production type models the F_{msy} may be estimated and the MSY scenario simulated.

Stock evaluation

Existing

Both stocks are assessed by age-structured VPA tuned with XSA (Shepherd, 1999). Incidentally the ICA (Patterson and Melvin, 1996) was used. The VPA is tuned with stock size indices provided by international bottom survey. Recruitment indices are also available and used in catch and biomass projection. Since 2001 new standard survey gear has been implemented in some countries and conversion factor for transformation of old data is to be estimated. This creates some difficulties as different approaches produce different conversion factors.

Alternatives to be considered

Production models or models robust to age misspecifications

As mentioned earlier, in case of eastern stock marked inconsistencies in age reading exist. Some simulations and analyses have shown that these inconsistencies have huge impact on estimates of stock dynamics, projections, BRP, and

thus view of the state of stock in relation to safe biological limits. The estimation of stock dynamics using age-independent or age-robust methods could help evaluate the impact of the age inconsistencies on stock management. Thus production models could be used as alternative assessment method.

Assessment of stock dynamics and estimation of BRP under options for underreporting

The justification for that alternative is still marked underreporting of catches (see section 2).

5. Description of specific and generic input from the partners

DIFRES

Specific input: Data on: Landings, catch data, discard data, effort and capacity data, biological samplings, economical data, data on fleet basis, etc.

Generic input: Within the TEMAS model DIFRES can evaluate technical measures both under a TAC system as well as under an effort regulation system, e.g. closed seasons/areas and mesh size regulations.

FGFRI

Specific input: Compilation of tagging data

Generic input:

- Short term impact assessment of technical measures, using a size-selective fishery simulation model.

- Expansion of the single stock - single management model developed by Kuikka et al. (1999) to cover the needed combinations (two/one stock, two/one management areas) and the relative differences in the impact of environmental factors on autocorrelation of S/R function on various areas will be examined and modeled. This analysis takes into account the differences of stock productivities of eastern and western Baltic cod stocks. This analysis will be finally analyzed by a decision model.

IMR (Sweden)

Specific input: Data on: landings and catch data, discard data, biological samplings, data on fleet basis, effort and capacity data, CPUE data of Swedish fleet, survey data (maturity, weight at age, etc).

Generic input: IMR will participate in modeling part of the case study

SFI

Specific input: Data on: landings; catch and weight at age; maturity data; survey indices of stock size and year-class strength; effort and CPUE data of Polish fleet by cutter length size, gear, and fishing ground; economical data

Generic input:

- Application of age independent or robust to age misspecification assessment methods (classical production models, model of Deriso 1980, approach of Horbowy 1992) for the eastern stock assessment and management to evaluate the consequences of aging uncertainty (estimation of stock dynamics and comparison with results of present assessment model, simulation of past and present advice if the stock had been assessed using age independent models in the past)

- Simulation of consequences of underreporting

FOI

Specific input: Data on landings statistics and costs and earnings statistics based on a stratified sample of around 20% of all Danish vessels on an annual basis since 1995.

Generic input: Economic analyses using developed by FOI models (EIAA and a comprehensive economic model). Price formation analyses for cod.

University of Helsinki

Specific input: Strategic analysis of fishermen behavior and economic evaluation in different management options.

Generic input: Economic analysis, game theory and numerical bioeconomic modeling.

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