

FEUFAR

THE FUTURE OF EUROPEAN FISHERIES AND AQUACULTURE RESEARCH



INTRODUCTION



Project no. 044178

FEUFAR

The Future of European Fisheries and Aquaculture research

Instrument SPECIFIC SUPPORT ACTION

Thematic Priority 8.1. B.1.3. Modernization and sustainability of fisheries, including aquaculture-based production systems.

DO INTRODUCTION

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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)	



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This report does not necessarily reflect the view of the European Commission nor does it anticipate the Commission's future policy in this area

The FEUFAR Project

Background

The goal of the project is to define the research required in the medium term (here taken as 10 years), to permit exploitation and farming of aquatic resources set against the context of key challenges and risks for meeting sustainability requirements. The main output of the exercise will be a publication outlining key challenges, strategic options and the research needs of capture fisheries and aquaculture in European waters and in waters in which European fleets operate under bilateral or multilateral agreements. The project is expected to contribute to the development and subsequent implementation of a European Maritime Policy and to further strengthen the European marine research area through anticipation of research needs in the field of fisheries and aquaculture.

Research Methodology

Basically, the methodology consists of three steps: (i) describe the system, (ii) detect the driving forces in the system and, (iii) by constructing hypotheses about the driving forces, sketch potential scenarios for the future. These different scenarios will provide the basis for the identification of issues, from an economical, ecological, societal and managerial (governance) perspective, which may need attention or be the key challenges in future. Based on the analysis, some of the key future needs for research in capture fisheries and aquaculture will be identified.

Contributions

FEUFAR will seek the opinions of appropriate stakeholders, and the analysis will consider the possible implications of gradual or catastrophic climate change, new technologies, changes in societal values and organizational structures, globalization of markets for fish and other marine products, food security and health, and changes in management practices or fishing techniques.

Stakeholder participation and dissemination of results is fully integrated into the project. An expert committee consisting of representatives of the research and funding communities will assist in providing feedback into the analysis, and stakeholder groups will be invited to formal brainstorming activities during the course of the project. One forum will set up a stakeholder network of representatives of research, industry and management areas at a regional, European and international scale. A second will take the form of an expert workshop, including a broad selection of (representatives of) research and advisory organizations across Europe. The wider audience (including Regional Advisory Council representatives, and hence representing production, processing, societal, and environmental interests) will be invited and/or consulted in order to present draft findings and to generate educated feedback.

CONTACT

You can log on to our project website where you will find more information about the project, the results of the activities as they become available, and a discussion forum:

www.feufar.eu

Funded by:  

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1 Preface

The **FEUFAR project** was implemented between January 2007 and September 2008. The aim of the project was to develop a research agenda defining the research required in the medium term (10 years), to enable a sustainable exploitation and farming of aquatic resources. What we have developed is a set of publications outlining the key challenges and opportunities for fisheries and aquaculture and the research needed to meet the challenges or exploit the opportunities.

In this introduction we present a brief walk through of the project and the output generated. The final project report in fact consists of a series of sub-reports:

Report 1: The **FEUFAR Project: Introduction** includes

- Executive Summary
- The project in a nutshell (extended summary)
- Introduction
- Methodology

Report 2: **Literature review** consists of two parts:

1. Synthesis
2. Overview of foresight studies in fisheries and aquaculture world wide

Report 3: **Systems & Drivers: Trends and Developments** (including hypothesis)

Report 4: **Micro-scenarios**

Report 5: **Macro-scenarios**

Report 6: **Research agenda** including policy brief and dissemination plan

Report 7: **Annexes**

2 Executive Summary

The goal of the FEUFAR project was to define the research required in the medium term (10 years), to enable exploitation and farming of aquatic resources in the context of key challenges and risks for meeting sustainability requirements. The main output of this exercise is this publication outlining the key challenges, strategic options and research needs concerning fisheries and aquaculture in both European waters and waters in which European fleets are operating under European agreements.

The FEUFAR project has applied a foresight analysis using scenarios, building a step by step analysis of the most important factors influencing the future of fisheries and aquaculture. The process of foresight analysis was embedded and founded on two core pillars; the first corner stone was the development of a series of scenarios. These scenarios have been built step by step based on an analysis of the main factors influencing fisheries and aquaculture.

The second cornerstone was the involvement of peer experts and stakeholders. In all the steps of the process workshops with stakeholders from the fishing and aquaculture industry and their representative organisations, environmental NGOs and consumer organisations were organised. Workshops for experts from the fisheries and aquaculture science community have been organised, and joint stakeholder and expert workshops have been held.

This results in a research agenda that is logically argued and based on an analysis by stakeholders and experts in addition to the work of the project team. Hence the priorities described in the research agenda have both a scientific analytical basis and societal reference.

The main output of the whole exercise as reported in the following pages is a document outlining, in the opinion of the core group, the key challenges, strategic options and research needs concerning fisheries and aquaculture in European waters and waters in which European fleets are operating under European agreements.

In terms of aquaculture, the deliberate decision was made at the start of the project to focus on marine aquaculture only. Although acknowledging that freshwater aquaculture is an important issue, we felt that we could not do justice to it within the resource and time constraints of the programme. However, unlike aquaculture, European fisheries focus almost entirely on the marine environment, although a few non-marine (generally anadromous) fisheries resources are important and did find their way into the dialogue and the report that follows, generally as an aside.

A second issue contained in the project's main terms of reference is an acknowledgement that European fishing fleets operate not only in European waters, but also, in some cases extensively, in waters elsewhere in the world under bilateral agreements, some of long standing. Therefore, although the dialogue with stakeholders and other interested parties tended to be focused on Europe rather than operations elsewhere, for reasons relating to their own main interests and experience, core-group dialogue continually drew on knowledge of fishing operations of EU fleets in non-European waters, seeking to discern whether the same principles were relevant and being applied there as at home. Some of the core group have experience of fisheries production and management elsewhere in the world, so could contribute to the dialogue and analyses on the basis of personal knowledge. It was obvious to the whole team that the drivers for and many of the scenarios addressing sustainable and healthy fishing were the same wherever in the world EU fleets operate, and it is therefore essential that the EU not only maintains its commercial and bilateral interests in those countries, but also be seen to be responsive to the need to develop the same principles of optimal and sustainable management as in their own waters. In many cases, as can be seen from the content of the report that follows, fish consumer preferences and aquaculture and product development depend as much on fish imports and EU fleet catches from non-European waters as they do on EU wild fish production itself. Two-way interaction between representatives of those countries in all aspects covered in the report that follows is therefore

essential, because without it, the credibility of European commercial interests and managers will be undermined.

The reader will therefore discover that the final chapter, on future research needs, returns to this issue in detail, addressing EU fisheries and aquaculture operations at home as well as operations of EU fleets and partnerships around the world in the same fields.

As starting point of the process the project implemented an analysis of existing foresight analyses in fisheries and aquaculture world wide. This analysis has shown both a form of congruency among the studies as well as providing an initial list of topics for future research.

The methodology of the foresight process consists of 6 logical steps. In the first step we defined the system: the boundaries and the horizon of the world of fisheries and aquaculture was set, and split into 7 subsystems.

In the next step, for each part of the system key driving forces and relationships between them was determined. After these drivers had been determined, each driver was documented. For each driver we determined the most important indicators and described how this driver had developed over the past 20 years. Then, for each driver, a set of different hypotheses, or a number of “possible futures” was elaborated.

Based on the hypotheses for each driver we constructed hypotheses for the development of each of the subsystems. These are called ‘micro-scenarios’, possible developments for each of the subsystems.

Connecting in a logical way the micro scenarios of the different subsystems results in the “macro-scenarios”: possible futures for the entire system. The scenarios developed could be distinguished along 4 perspectives; scale of management, either regulating issues at a global/international scale or at a international-regional scale or even national-local scale; the main objective of production to be centred upon feeding people or mainly on conservation of the marine ecosystem; the extend to which society is based on environmental awareness and the main fabric of the governance system, be it free market or strict government planning and control.

Research priorities have been identified in five main areas:

- Fisheries
- Aquaculture
- Ecosystem approach to marine resource management
- Consumer preference and Market development
- Socio-economics and Governance

In addition three cross cutting themes have been developed:

- Data collection and analysis
- Risk management
- Outreach and extension services

Research Priorities for Fisheries

Gear and operational technology

Making gears more efficient and able to mitigate bycatch and discards, limit ecosystem impacts and improve selectivity (with better survival of escaping resources) and at the same time improving fuel consumption is the main challenge to be addressed.

Management and governance

In order to address the management challenges development of multi-annual and multispecies management models and approaches, taking trophic relationships and ecosystem health into consideration, and addressing uncertainty in a clearly understandable manner is needed. Next to

this further development of research into the socio-economics of the fishing communities is required.

A market issue in relation to the better use of marine resources taken from the ecosystem and to address the growing demand for marine proteins is the **valorisation of currently underused components of the catch**. This relates both to discards as to waste of processing.

Basic research on populations of lower trophic level resources is both needed for understanding better their place and role in the ecosystem as well as the fact that fisheries exploitation patterns are changing to other species.

Research Priorities for Aquaculture

Research on new species; diversification of production based on regional characteristics and consumer's choice is desired. This will include research on species biology (e.g. reproduction, larval stages, fish health and welfare). As for fisheries research on low trophic level species, including bivalves, is needed.

Research on the development of system technologies. Considering the high competition for the use of coastal areas development of offshore technologies and on-land recirculation technologies is highly required. Associated with renewable energy resources. Research on life cycle analysis for the whole system. Study of risk aspects (insurance, theft).

Improvement of the present technologies for inshore aquaculture. Net cages represented around 99% of the present production. Recirculated systems have potential but research is needed to improve fish growth in this system.

Alternative food for the farmed resources. Replacement (as much as possible) of fish meal and fish oil. Development of strains able to grow on diets with lower protein content and lower omega 3 level.

Species enhancement through selective breeding, hybrid, triploid. Research on GMO to understand if and how species can be improved by this technique.

Spatial consideration. Considering the high competition for the use of coastal areas research is needed to define priorities.

Research on the environmental impact of aquaculture activities. Taking into account that this is the main criticism, research is needed to evaluate and reduce the negative impacts of aquaculture on the environment and other uses of the coastal zone (nutrients loads, use of energy, escapees, chemicals, diseases, aesthetics).

Aquaculture for other purposes than food production. Production of constituents and molecules for medicine, cosmetics. Culture of species (e.g. algae) to eliminate pollution from certain depth zones. Culture of species used as pollution indicators.

Research Priorities for the Ecosystem Approach

Climate Change focuses on 2 separate topics: (1) understanding impacts, (2) adaptation by fisheries and aquaculture sectors. Concerning the impacts we need to address the combined effects of anthropogenic activities and climate change on stocks (distribution, behaviour, growth, food-webs), habitats (carrying capacity, hydrodynamics, oxygen depletion, food availability etc.). Knock-on effects for higher predators (birds, mammals). This raises the question of how fisheries and aquaculture will be affected and how will they need to adapt.

MPAs and habitat enhancement. Understanding the effect of MPAs (established for conservation, fisheries other reasons), their benefits and socio-economic implications (biodiversity,

resilience of the ecosystem, 'spillover' effects, trophic cascades, effect of fishing effort displacement) is needed. Methods, tools, monitoring, siting methodologies need be developed.

In **Coastal Zone Management** there is the need for tools for spatial planning (GIS, VMS). Matching particular activities to the most suitable locations requires appropriate methods for impact analyses of activities and for example for the interaction between fisheries and aquaculture (for space).

Modelling ecosystems: Important to understand ecosystem dynamics including implications of aquaculture and fisheries for other ecosystem components. This will require multispecies and ecosystem modelling approaches (to establish indirect predator-prey effects, e.g. on other fish species, seabirds, mammals etc.). Very often models have been developed but data to parameterise the models is lacking and they have never been used operationally for management.

Research Priorities for Consumer preference and Market development.

Starting point for market development are the consumer demands for fish and fish products. Important in the food and non-food **Product development from fish and fish products** is research into additional and new products as well as research in food processing to improve/maintain taste and texture. The development of new types of food for niche markets but also "From waste to taste": New products from by-products are important. In the non-food segment main research is to focus on functional and healthy food ingredients and bioprospecting: to bring out ingredients from both fish and non-fish marine resources, algae, plants for new and novel uses of compounds including ingredients for functional food and pharmaceuticals.

Concerning **Consumer health** focus is to be on the positive health aspects, such as beneficial health effect of seafood and knowledge of health benefits of farmed fish (new feeding) and shellfish, for example by detecting components beneficial to human health and development of functional food – producing new components with health beneficial effects. On the other hand the combined effects of pollutants should be subject of study, next to the further development of quality control technologies (freshness, pathogens or contaminants contents, for breeding) that are cheap and quick (automation).

Traceability is important for several purposes, to assure consumers, to document sustainable harvesting, to document origin, to document all sources of input, days since catch. On the technical side, the further development of standards, procedures and systems is needed. The focus on traceability is moving towards the business side, seeking new applications to ensure competitiveness of European producers.

Concerning **Certification and branding (labelling)** main concern is on addressing the question of the desire for information: what do consumers need and want of information. This leads up to needed research for effective labelling systems, including health, fish welfare, origin, treatment and the scientific development of labelling and certification standards.

Research Priorities for Socio-economics and Governance

Socio-economic analysis & impact assessment There is a clear need for implementing general socio-economic studies, provided a sound data base is established and available, and have impact assessments be executed. This entails rather standard and continuous research into the economics of activities of harvesting marine resources (i.e. fishing, aquaculture, recreational fisheries) to maximize efficiency and production as well as into more specific issues such as:

- Socio economic structure and effects of activities within sustainable ecosystem management
- Socio-economics of the coastal zones and coastal communities (alternative uses of the coasts and resources and alternative employment)

- The development of socio-economic tools to gather views of stakeholders (e.g. 'mind-mapping' techniques) and promote understanding among different 'users'.

Addressing **governance** issues has already become a rather standard feature in marine research, dealing with cases of multiple stakes and stakeholders and integration of domains in integrated management tool development such as the ecosystem approach to marine management. A major area of further research in this light is the further bringing together the triangle of stakeholders, management and scientific support to policy. Development of innovative, adaptive, context specific (regional) management tools and systems based on inclusion of stakeholders and geared at the creation and acceptance of shared knowledge is called for.

The above is related to the more general development of **new management tools** and the further application of newly developed management instruments. This includes the further development and implementation of integrated coastal zone management, including optimization of use of instruments such as MPAs, optimal spatial location of activities and conflict resolution techniques and the search for more efficient and (cost) effective methods of management and enforcement through enlarged legitimacy and compliance through for example co-management arrangements, co-creation in policy development and multi-stakeholder evaluation of impact assessment.

Research Priorities cross-cutting themes

Data collection and analysis

Currently data on the socio-economic aspects for fisheries, aquaculture, recreational fisheries (costs, earnings, investments) and ecosystem goods and services are often not available. Next to the sheer collection of the data, there is a research issue on building a 'knowledge base' (applied and fundamental research) to improve understanding of how systems (from individual animals, through population and ecosystem and from individual economic agents through to socio-economic communities) work.

Risk management

Risks and uncertainties occur throughout the production and ecosystem on different scales and impacts varying between impact of climate change, invasive species, pathogens, Harmful Algae Blooms through to uncertainties in stock assessments and policy impact. Risk analysis is to be a basic component of impact assessments of policies as well as the basis for the development of policies.

Outreach

Under a number of research issues the need for demonstration and promotion is identified. Areas that can easily be identified lay in the field of health effects of fish consumption, promotion of sea food and in general the communication of the results of scientific research to the wider public in a way and format apt for the target group.

Output

The main output of the project has been a discussion between the experts in the project team, peer experts and stakeholders on developing research priorities in the field of fisheries and aquaculture. This process has been documented and continuously being disseminated through the project website.

In the process a number of project documents and workshop reports have been made. In addition members of the project team have frequently given presentations on the scope, process and results of the project to an even wider audience.

With the production of the final report a start can be made to further discuss the priorities developed in the project. In order to facilitate this further discussion a simple leaflet presenting an

overview of the project and its process and methodology and the final outcome: a research agenda will be prepared and distributed widely both in the research and stakeholder community.

In addition the draft final report will be sent to experts and stakeholders for comments. These comments will be listed in an addendum to the final report.

The results of the project are starting point for a discussion on the political priorities and the funding of relevant research. A number of topics mentioned above are already part of current national and international research programmes. However, what becomes clear in the analysis is that although attention is already given to fisheries and aquaculture topics, total effort in these fields of research should rather be on the increase than on the decline.

In addition, especially in the fields of management and governance the scenarios present a pressing need for the development of integrated multi-disciplinary and multi-stakeholder tools in order to address (spatial) planning and prioritisation issues. And when tools are developed they are in urgent need of being operationalised.

Also pivotal in the entire research effort has to be an understanding of the position of the consumer and their preferences next to incorporating an understanding of societal view on the sustainable utilisation of marine resources. Utilisation and conservation of marine resources in a sustainable way requires a sustainable management system balancing ecological, environmental and societal aspects. None of the research priorities presented above can be taken up in isolation, but should be considered integrated with the other aspects.

3 The project in a nutshell

3.1 Project definition

The starting point of the project was a project team meeting held in february 2007. Beside scheduling the full project and its methodology, the boundaries of the FEUFAR project were defined more precisely during this meeting.

Time: explore how wild fisheries and aquaculture might look in 2020 (by making scenarios) and determine the most effective research priorities for the next 10 years to meet these scenarios.

Geography: seas and oceans bordering Europe, including the overseas European territories and long-distance fleets. The main focus is on marine fisheries and mariculture. Therefore, although inland fisheries and freshwater aquaculture should be included in terms of common issues (global fish supply, feed demand, genomics), the inland freshwater ecosystems are not considered in the system.

The list of organizations to invite at the different workshop and involve in the project was also discussed.

The following were invited to the expert workshops (acting as peers to the research team) : EFARO, ESF-Marine Board, EAFE, EAS, Marifish, Marinera, EIFAC, NACEE, ICES, GFCM, CIESM and ICCAT, EATP, IMR, RCN, LEI.

The following were invited to the stakeholder workhops : ACFA, Baltic Sea RAC, CNPMSM, CONSENSUS, Distant Waters RAC, EBCD, European Anglers Alliance, European Consumers Organisation (BEUC), FEAP, FEFAC, Greenpeace International, Hellenic Society for the Study & Protection Monk Seal, Invest in Fish South West, IUCN, Marks & Spencer, MED AQUA, MED RAC, Medisamak, Mediterranean RAC, Moshi moshi, MSC, NFFO, Nireus Aquaculture, North Sea RAC, North Sea Women's Network, North Western Waters RAC, NSRAC, NUTRECO, Office for preservation, diversification and development of Slovene Marine Fisheries, Pelagic RAC, PEPMA, PFA , NVZ, Skretting, South Western Waters RAC, South Western RAC, TEST ACHATS and UNICOOPESCA.

3.2 Foresight system definition

The first six months of the project were dedicated to describing the system in drivers including relationships between them.

A world wide "State of the Art" of existing foresight analyses covering fisheries, aquaculture and related marine science and technologies was performed. It provided ideas but also an overview of drivers being taken into account (or not) in previous foresight studies.

The project team built its own foresight system made of drivers assembled by subsystem (or topics). But, to compare the project team views to others and make sure no important driver might be missing, two workshops were organized in may 2007 : an Expert workshop and a Stakeholder workshop. The same question was asked to participants in both workshops : what are the main factors that drive the future of fisheries and aquaculture to 2020.

The systems of drivers built by the experts, then by the stakeholders challenged the views of the project team and helped to define a system of around 40 drivers taking into account a broad range of views and opinions. The fisheries and aquaculture system was settled by june 2008.

FEUFAR Foresight system : 42 drivers, 7 subsystems

WORLD CONTEXT

- A1 climate change inc ocean productivity
- A2 International agreements (Johannesburg, Kyoto, maritime access, WTO)
- A3 world food security including demography

REGULATION

- B1 EU policies (CFP, maritime, marine strategy)
- B2 Governance policies (inc. Stakeholders cooperation)
- B3 management tools (inc. subsidies and relative stability, property rights)
- B4 national policies
- B5 Politics

SOCIAL DYNAMIC

- D1 Recreational fisheries
- D2 public perception of fisheries/aquaculture
- D3 activities in coastal areas (inc fishery act employment)
- D4 competing uses of seashore
- D5 Fishfolk attitude towards future
- D6 social capital (skills and expertise)

PRODUCTION

- F1 Marine "ingredients", by-products, bio prospecting
- F2 fleet structure size and technology (inc. selectivity, discards)
- F3 stocks development
- F4 fish feed development and availability
- F5 aquaculture hardware technologies
- F6 species diversification aquaculture
- F7 Genome manipulation breeding and selection
- F8 health of animals
- F9 seed availability (tuna and eel) ranching
- F10 health risk of seafood

SEAFOOD MARKETS & ECONOMICS

- C1 Product diversification
- C2 processing
- C3 distribution channel (value, quality, custody inc. Traceability)
- C4 consumer choices (prices, preferences, ethics, safety...)
- C5 world production of fish (finfish and shellfish) by region
- C6 EU trade within world trade in fish and fish products
- C7 costs and earnings for fisheries (inc risks)
- C8 costs and earnings of aquaculture (inc risks)

ECOSYSTEMS

- E1 pollutants and contaminants (inc. nutrients)
- E2 recruitment
- E3 invasive species
- E4 escapement
- E5 Impact of gears on habitat and organisms (including deep sea)

RESEARCH

- G1 sources and allocation of funding
- G2 Governance of european research (research organisation)
- G3 access to infrastructures (data bases)
- G4 Research training and management
- G5 information flows (including IPR)

3.3 Drivers, trends and developments

After the system and the drivers were defined the project team prepared documentation on each of the individual drivers. For each driver a definition was given and indicators to measure the development were identified. For each driver the development over the last 20 years was analysed and hypotheses about the development of the driver towards for 2020 were generated.

The documentation of each driver was shared among the members of the FEUFAR team. A project team meeting was held in October 2007 to discuss future hypotheses for each driver (2 to 5 hypotheses) and agree about the different possibilities.

3.4 Building scenarios

Scenarios were elaborated in a two-step process. First, scenarios were built for each of the 7 identified subsystem. These scenarios were constructed by taking the hypotheses for each one of the drivers belonging to the considered subsystem and assembling a storyline by connecting for each driver a hypothesis to a hypothesis of the next drivers. This assembling is done with consistency which means that for every set of hypothesis thus put together a storyline can be given that bears logic and is explainable. This step was performed during a second expert workshop held in November 2007. Based on the input from the experts the project team documented and edited these subsystem scenarios.

For the second step, the identified subsystem scenarios became the input (or perhaps "large" hypotheses) for the entire system. Hence each of the 7 subsystems' scenarios are driver for the larger system.

Presented in the figure below are the different hypothesis for each of the subsystems. The subsystems are further document in part 4 of this final report.

	Hypothesis 1	Hypothesis 2	Hypothesis 3	Hypothesis 4	Hypothesis 5	Hypothesis 6
A- World Context	Free trade and production specialties	Short term economy	food	World Governance		
B- Regulation	Industry	Integrated Europe	Local solutions for local problems			
C-EU Seafood Markets and Economics	Responsible world	Innovative world	Shopping world	Expensive fish	Ready made fish meal	
D – Social Dynamics		Environmental views dominate	Tourist rather than fisherman	Fishermen know better	We need the sea production	
E- Ecosystems	Starts bad gets better	Global meltdown	Local solutions for global problems	Supergreen		
F - Production	Free market	EU promotes aquaculture	Healthy and diversified (science solves the problem)	Fisheries bounce back (natural food)	Fishing feeds poor people and aquaculture	Big fish is a luxury
G-Research policies	Pop Idol (a change in priorities)	European drive to technological paradox)	Funding Nemo	C'est la vie (business as usual)	Public money rules research (competition overtakes cooperation)	

As in the first step, hypotheses for each subsystem are chosen to build now the global scenarios with a storyline consistency. This second step was performed during a workshop gathering experts as well as stakeholders. This workshop was held in March 2008. The aim of this workshop was to achieve a limited number of contrasting scenarios describing the range of possible futures for fisheries and aquaculture.

Five scenarios were chosen and based on the input received during the workshops written by the project team.

Doomsday (negative impact of EU fisheries and aquaculture on world ecosystems)

- Rich countries scavenge the world for seafood product
- Management does not reduce fishing capacity
- Stock collapse
- Research paid for by the customer does not solve the problem
- By 2020, a decline in aquaculture through a lack of fish feed and intensive use of antibiotics
- Marine pollution and mad salmon disease
- The high temperature of the ocean (climate change) affects all ecosystems
- Environmental restrictions are lifted to obtain short-term economic gain
- Policies not enforced

Delicatessen (fish a healthy food): new opportunities for European fisheries and aquaculture

- EU prevents overfishing by high-tech surveillance
- Long-term resources important for EU
- Seafood nutritional quality is what counts
- Clean seafood (gain on health spending) also from marine ingredients and enhanced species in aquaculture
- High-tech processing industry

- Traceability as a trade barrier to protect aquaculture investments
- Fresh natural local fish is a luxury
- Stock and recruitment ultimately recover

Regionalism (local solutions for marine resources)

- Imports from aquaculture, not overseas fishing grounds
- EU regulation on ecosystems; nations manage fisheries
- High-frontier research, applied research for locals
- Demand for locally labelled products
- Stocks depend on the local regulation and size of the region
- Region specialization: tourism and MPAs or aquaculture and energy
- Expensive fish: diversification of aquaculture, plus traceability and control

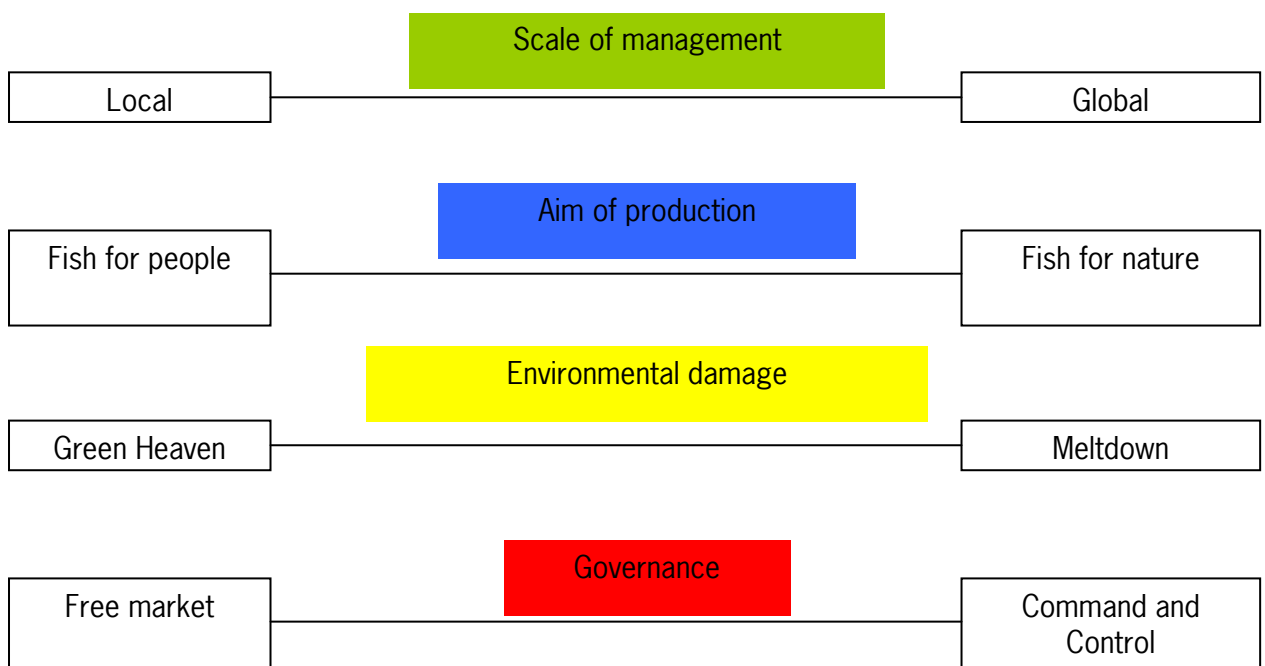
Responsibility (an adult world)

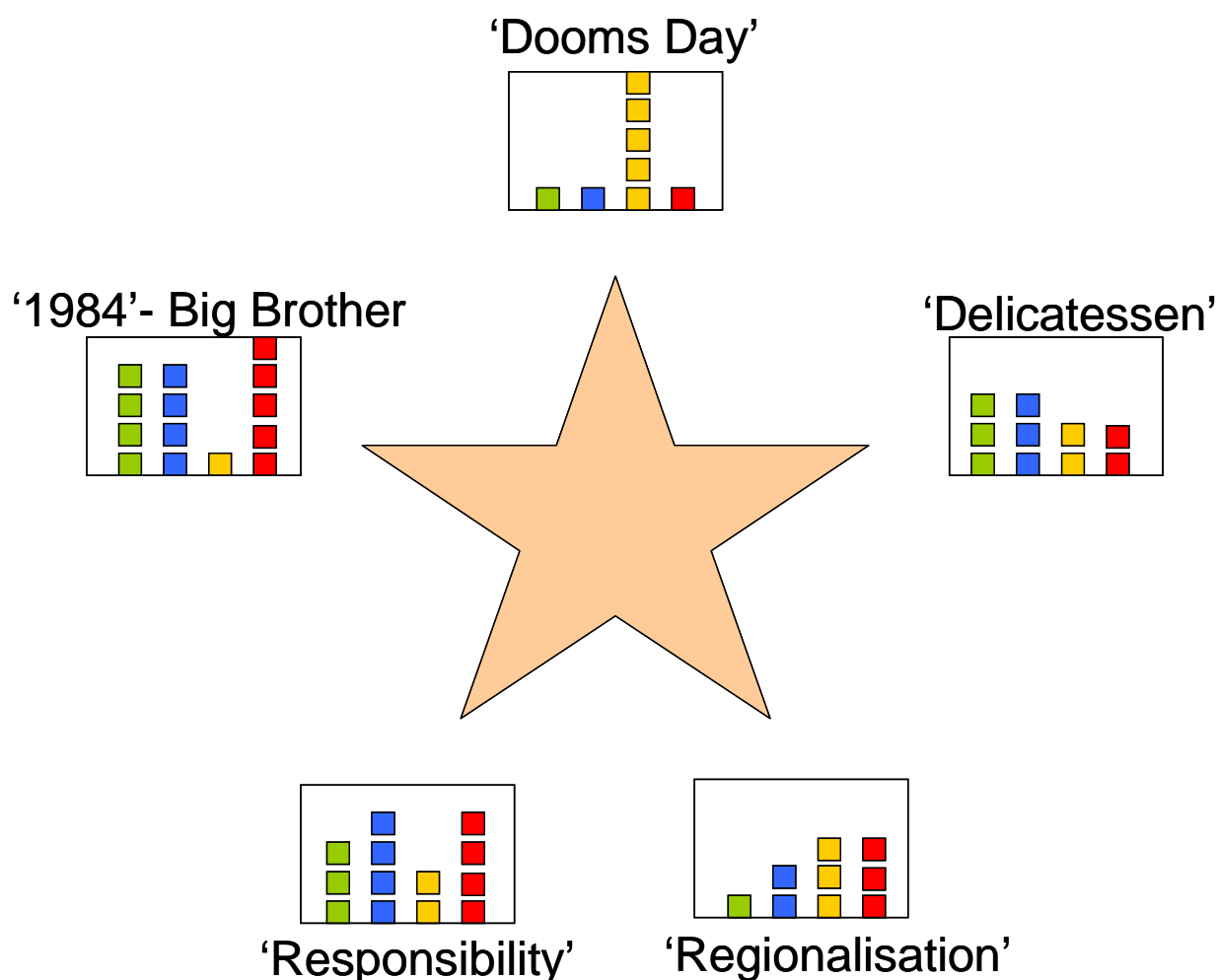
- Consumer only demands products from sustainable sources
- Fishers understand that they need to maintain stocks
- Non- (or less) polluting aquaculture; replacement of fishmeal and fish oil by vegetable and herbivorous species
- Fishers develop less damaging gears and practices
- Subsidies at the right place for the right thing
- Fishing quotas owned and traded, but some bought by NGOs and recreational fishing operatives (solving overcapacity)
- Participatory management of both fisheries and aquaculture

1984 (total European regulation and control to maintain seafood production)

- Green scenario
- Fleets are under control (high tech surveillance) and stocks can recover
- Efficiency in fishing, but standardization of products
- Understanding of species/ecosystem relationship, to develop aquaculture
- Technology-driven and technocratic system
- Binding international agreements on biodiversity conservation and climate change
- EU maritime police force (EMPF)
- Research and rigorous monitoring (surveillance, monitoring, technology)

The scenarios described above can be differentiated along four axes:





3.5 From scenarios to a research agenda

To deduce from these scenarios what would be the research needed, a two day workshop was organized in June 2008 gathering experts as well as stakeholders.

During the first day, experts and stakeholders were asked to make a list of topics for research from each scenario. They were supposed to envision the different “worlds” described in each scenario and deduce under the circumstances the research topics that would best fit the storyline, including research that would promote the positive trends or reduce the negative impacts. The first day ended with a five lists of research topics, one by scenario.

The second day was dedicated to assessing the priorities of research topics. To do so, the five research topic lists issued from the scenarios were grouped by research area:

- fisheries
- aquaculture
- ecosystems
- consumer/market
- socio-economics and governance

Participants were asked to rank, in groups, the top five research issues for each area and provide the criteria and arguments used to rank the priorities. The project team summarized these research priorities in the different areas with their related arguments to establish a prioritized research agenda for fishery and aquaculture. These priorities and the three cross-cutting issues have already been presented at the beginning of this introduction document.

4 Introduction

The overall goal of the FEUFAR project is to define the research required in the medium term (10 years), to enable exploitation and farming of aquatic resources (finfish and shellfish) in the context of key challenges and risks for meeting sustainability requirements. The project contributes to the implementation of the European Maritime Policy and the further strengthening of the European Marine Research Area through better anticipation of research needs in the field of fisheries and aquaculture.

Earlier 'horizon-scanning' initiatives have provided imagined 'futures' for capture fisheries and aquaculture around the world however there has been relatively little attention on the implications for future fisheries and aquaculture research specifically. The principle task of FEUFAR was to launch a Foresight exercise and thereby to identify research requirements in the area of fisheries and aquaculture, to define the key challenges and risks, and to develop possible scenarios for addressing sustainability targets. The project will allow better anticipation of future research needs and funding priorities and will identify knowledge gaps.

4.1 Objectives

The objectives of the project centre on 5 specific goals:

1. To provide a 'state of the art' inventory of existing foresight analyses (fisheries and aquaculture, and related marine science and technology) world wide, including the distillation of key messages, identifying themes, threats and drivers and developments in science and policy.
2. based on the 'state of the art' and through input from stakeholders from the fishing and aquaculture industry and their representative organisations, environmental NGOs and consumer organisations and from experts from the fisheries and aquaculture science community, build scenarios (possible futures) based on identified key variables and trends, taking into account interactions between ecological, economical and societal factors.
3. based on the state of the art and scenarios define key challenges, strategic options, as well as paths toward a more sustainable future and following research needs.
4. by organising a platform for discussion and priority setting, generate input from all relevant parties (fisheries and aquaculture sector, marine science and technology, research institutes, policy makers) to this process, substantiating the analysis and at the mean time generate support to the outcome. The project is to bring together relevant key players through a series of workshops to provide input to the process and discuss findings. Next to this, effort will be put in to disseminate both the outcome and the steps of the process through such means as publications, leaflets and a website.

4.2 Perspective

Recent predictions suggest that world fish consumption will continue rise to around 17 kg per person per annum by 2020 having been less than 7 kg per person in 1950 (Delgado et al 2003). In contrast, there is evidence that global capture-fishery landings have declined since the late 1980s, by an estimated 0.36 million tonnes per year (Watson & Pauly 2001). The proportion of total fish production obtained through aquaculture is predicted to increase markedly over the next two decades, reaching 41% by 2020, but capture fisheries are predicted to grow by less than 0.7% per year as many stocks have already become over-exploited.

In 2003 the EU-25 production of fishery products (capture fisheries and aquaculture production) was 5% of the world total. Four of the EU-25 Member States (Denmark, France, Spain and the United Kingdom) accounted for 56% of the total production in 2003. The production in 2003 (7.3 million tones) was about 11% less than the estimated total production in 1990 (Eurostat 2005). EU-25 aquaculture production was only 2.5% of the world production in 2003 (89% of the total production was by Asian countries).

However, the EU-25 production increased by about 35% from 1990-2003 (to 1.4 million tonnes). In the same period the production in Norway (largely of Atlantic salmon) increased by 287%. Four Member States (France, Italy, Spain and the United Kingdom) accounted for 68% of the EU-25 production in 2003.

In 2003 EU-25 capture fisheries accounted for 6.6% of the world total (~5.9 million tonnes). The 10 new Member States only accounted for 9.1% of the EU-25 catches in 2003. Between 1990 and 2003 the EU-25 catch decreased by an estimated 18%. Over the same period the combined catch of Iceland and Norway increased by 46% and the world production by 5%.

The value of landings in Spain is nearly twice as much as that of the landings in any of the other EU-15 countries. Norway's landings have a value higher than that of all the EU-15 countries except Spain. The EU-25 Member States have an overall negative balance in trade in fishery products, both in terms of volume (-3.4 million tonnes) and value (-€ 9,600 million), and this negative balance has increased in the period since 1990. Only five of the EU-25 Member States (Denmark, Estonia, Ireland, Latvia and the Netherlands) have positive balances in terms of the value. France, Germany, Italy, Spain and the United Kingdom are the biggest net importers of the EU Member States.

Of the EU-15 Member States, Greece has the largest number of fishing vessels. However on average these vessels are small (median power of 5 kW) compared with the vessels from most of the other countries (e.g. Spain with a median power of 82 kW). Since 1990 the EU-15 fishing fleet has decreased by 10% in number (to 92,422 in 2004), by 7% in total tonnage (to 2.1 million tons) and 9% in total power (to 7.5 kW). Since 1990 there has been a general reduction in the number of fishermen in most European countries to around 256,000 in 2003, (33% in Spain, 19% Italy, 8% Portugal, 7% France). A recent EU funded study (Lot No 23: Coordination and Consolidation Study) identified 343 'zones of dependency' having a measurable degree of dependency on fishing. Of these nearly 40% fall within 'Objective 1 regions', where development is considered to be lagging behind the rest of the Community. 63% of European fishermen are employed in the Objective 1 regions. The European fish catching sector is composed of many different sub-fleets. Fleet segments differ from one another in terms of their vessel numbers, physical capacity and value to the European economy.

The EC's Aquaculture Strategy under the Common Fisheries Policy (CFP) reform sets an ambitious target, to increase production and employment in aquaculture, creating up to 10,000 new jobs in the sector by 2008 - an increase of over 15%. Some experts believe that by 2020 Norway will be producing as much as 400,000 tonnes of cultured cod, halibut and turbot each year; this would be twice as much as Norway's cod quota from the wild. While there are opportunities for further growth in the aquaculture sector there are also new concerns associated with the release of pollutants and the requirement for wild-caught feed-fish. According to one estimate, aquaculture will consume the entire world production of industrially-derived fish oil by 2006.

In September 2002, during the Johannesburg World Summit on Sustainable Development (WSSD), governments agreed to a restoration of stocks to levels that can produce the maximum sustainable yield by 2015. The EU 6th Environmental Action Programme, the FAO Reykjavik Declaration on 'Responsible Fisheries in the Marine Environment' and the OSPAR Bergen Declaration have also committed countries to halting current patterns of biodiversity decline by 2010 and encouraging an 'ecosystem approach' for the sustainable development of the oceans generally.

There are several European initiatives which aim to protect and restore the functioning of natural ecosystems. The EC's Biodiversity Strategy states that the Community should 'seek the conservation and, where relevant, restoration of ecosystems and populations of species in their natural surroundings'. Article 2 of the EC Habitats Directive (1992) requires measures to be taken to maintain or restore natural habitats and species of wild fauna and flora to a favourable conservation status. The EC Water Framework Directive (2000) requires measures to be taken to

protect and enhance the status of aquatic ecosystems, including estuarine and coastal waters. Article 2 of the OSPAR Convention requires Contracting Parties to 'protect the maritime area against the adverse effects of human activities so as to safeguard human health and to conserve marine ecosystems and when practicable, restore marine areas which have been adversely affected'.

There are many other important regulations, instruments and agreements relevant to fisheries management. Notable among these are the UN agreement on the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (United Nations, 1995), the International Plan of Action for the Management of Fishing Capacity (FAO, 1999), International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (FAO, 2001), the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS) and the UN Fish stocks Agreement (UNFA).

Fishery management relies heavily on scientific evidence; research makes a significant contribution to the translation of the CFP, and other policy drivers, into practical effect. Fisheries research is funded for the principal purpose of providing scientific evidence and advice to fisheries managers. The total combined annual fisheries research budget of Europe amounts to approximately €160 million and represents a very significant body of scientific knowledge (MARIFISH 2005).

Recent revisions to the CFP, as set out in the new basic regulations adopted in December 2002 (Council Regulation 2371/2002), imply a substantial challenge for fisheries research. Research and science will have a crucial role in the development of necessary tools for the operational and practical implementation of fisheries management, and to fulfil the overall objective of the CFP to secure sustainable fisheries within an ecosystem approach.

Challenges include a need for broader and more ecosystem based fisheries advice; there is a need for high precision in short term forecasting and Total Allowable Catch (TAC) advice; science is needed for the development of longer-term management plans; and finally there is a need for closer links with socio-economics research. In order to meet these challenges research will need to be well coordinated and as efficient as possible, especially in light of constrained levels of funding available for fisheries research.

The need to adopt an ecosystem based approach for fisheries management is a priority, as indicated by the now developing European Marine Strategy which aims to give additional protection to the European marine environment. There are significant challenges here for fisheries science - understanding the impact of fishing on the marine environment, assisting in the development of alternative management measures, and how to monitor recovery, through the development of appropriate indicators. To meet these challenges the Marine Strategy specifically calls for coordinated programmes of science of the kind proposed under FEUFAR.

4.2.1 Institutional context

In September 2002, during the Johannesburg World Summit on Sustainable Development, the head fisheries Ministries approved a resolution addressing three major issues (eliminate illegal, unreported and unregulated fishing; application of the ecosystem approach; facilitate the use of marine protected areas) to result in 2015 in a restoration of stocks to levels that can produce the maximum sustainable yield with the aim of achieving these goals for depleted stocks.

The Common Fisheries Policy of the EU in its late reform (2003) and the proposal for a Marine Environment Strategy (2005) incorporated these concerns to comply with global policy objectives, which would probably be intensified after the implementation of the Maritime Policy under the Green Paper in preparation by the EC.

4.2.2 Environmental context

Both fisheries and aquaculture rely upon renewable and natural resources and are in this respect competing with other uses of the marine resources and space. In the recent proposal by the EC for a Marine Environment Strategy, fisheries are considered as one of the major threats to the marine environment. The main strategic component from a biological and environmental perspective is to comply with the impact of climate (including long term evolution) and environmental drivers on the living resources, and the ecosystem response to fishing.

Competition with other uses of the environment, such as oil and gas extraction and commercial shipping do have an impact on the living resources and may reduce the available habitat for fishing and aquaculture. Effects such as noise and potential harmful substances from these activities can interfere with fish recruitment. Similarly eutrophication from agriculture production on land and pollutions from urban areas can have an effect on the marine ecosystem, and consequently on the fisheries and aquaculture sectors.

Fisheries and aquaculture food systems management are changing, driven by complex environmental, technological and policy factors. Environmental regulations have altered the conditions for the fishing and aquaculture industries and increased public awareness will generate more consumer pressure in many areas including food safety and animal welfare.

4.2.3 Sectoral context

To get more food from the oceans, a better use of natural resources is required, which must include i.a. allowing over-fished stocks to recover, avoiding wastage, making renewed efforts in better management of fisheries and accompanying aquaculture growth. After a century of geographical expansion followed by technical intensification, the effective management of fisheries needs to enter a new era. In this respect, aquaculture activities follow the same trends and are already facing the same challenges, e.g. the focus on sustainability, environmental impact and food safety in a global market.

This implies for fisheries and aquaculture the challenge to develop capacity for supporting research and management, allocating specific exploitation rights (particularly in the context of coastal zone management for aquaculture and small scale fisheries), improving monitoring control and surveillance, and improving reporting on inputs and outputs.

4.2.4 Socio-economical context

Fisheries and aquaculture are concerned with challenges on both macro-economic and micro-economic level including investments in vessels and other facilities, their profitability, linked to both to internal (e.g. fish stock status) and external (e.g. oil price) factors, limited flexibility, and – on the micro economic scale - fishermen responses to different management measures. In recent years, the social aspects of policy implementation necessitated a further integration of analysis, next to encompassing a biological and economical assessment to also consider social and societal aspects. Hence the governance of fisheries and aquaculture management to focus on an integration of the ecological, economical and societal aspects, with specific attention for:

- acceptance of new governance and management rules;
- increased involvement of stakeholders in the management process.

The linkage between development of the natural system (generally degradation), economical/social impact and pursuing political pressure is a key governance issue to address in order to obtain ecological, economical and societal sustainability, particularly in the coastal areas. Progress is still to be made in order to understand and predict the response of both natural systems and human behaviour to management decisions, i.e. the knowledge based approach.

The challenges that lie within European fisheries and aquaculture production systems are no longer only manifested through the provision of safe and healthy food. They are also strongly influenced by an increasing number of environmental and societal goals. A broad interdisciplinary approach, indicating a wider scope of implications throughout society, is therefore essential if we are to fully understand what can be achieved and how.

4.2.5 Research context

There is a need for a substantial scientific effort to develop and manage aquaculture and fisheries activities within the framework of sustainable exploitation. In order to address this research domains have to cut across science themes, including modelling, socio-economics, molecular biology, sustained monitoring and provision of scientific advice. One of the major challenges marine research institutions are facing is the provision of insight into ongoing developments and state of the ecosystem and provide the basis for innovative solutions. This is of particular relevance when stakeholder confidence in existing assessment and management models is declining. There is a need to focus on methods and models, which include fleet interactions, geographical differences, as well as the impact of the environment on fish stocks and the impact by fisheries on the ecosystem.

New approaches and models are also required to communicate complex insights effectively to the increasing number of stakeholders involved in the decision-making process (e.g. by the development of efficient partnerships between public research and research by the industry). This addresses in particular:

- social and economy sciences which enter in a new paradigm where they have to deal together with the same object rather than looking at it separately;
- ecosystem based management, which considers all parameters impacting on the system, including human activities affecting the ecosystem, in a particular geographical area.

Through a broader understanding of the different driving forces within food systems this project will aim to deliver a research agenda which can provide additional clarity in these complex matters. The ultimate aim is to create a self-evolving scientific agenda that will be progressively more equipped to take on major future challenges through research, training and education, on the improvement of aquaculture systems, in trying to make them productive, yet environmentally clean and sustainable. This FEUFAR report aims to provide policymakers with tools to establish a more equitable balance of food security within European societies.

4.3 Relevance of this study for Policy Development

This report provides a prospective research agenda for fisheries and aquaculture, contributing to the implementation of a future Maritime Policy and to further strengthen the European Marine Research Area through a better anticipation of research needs, taking both a scientific, policy and sectoral context into consideration. In particular in the **fisheries** primary sector:

Balancing the capacity of fisheries with natural stock renewal

Declining yields, shrinking stock biomass and uncertain profitability are characteristics to incorporate in any commercial fisheries analysis. In those that are unmanaged or managed as de facto open-access fisheries, the race for fish tends to create a fishing capacity that is larger than needed to viably produce a sustainable yield. Overcapacity and capacity management have become key issues in fisheries management. Overcapacity and over fishing are really symptoms of the same underlying management problem – the absence of well-defined property (or user) rights. Although this situation might change in the future the improvement of monitoring control and surveillance, as well as fisheries data collection and reporting will remain of importance.

Evolution in management and governance

Fisheries management is largely based on annual fish stock assessments. Multi-annual assessments, incorporating both biological and socio-economical considerations, will provide a medium to long-term planning horizon to the decision making process. Within the context of marine fisheries management, this includes:

- the more explicit recognition of access rights in both artisanal/small-scale and industrial fisheries so as to reinforce management input and output controls;
- the management of fleet capacity and the clarification of the role of industry subsidies which may distort production arrangements;
- the strengthening of monitoring, control and surveillance as a means of ensuring effective implementation of agreed management measures.

In addition, increasingly stakeholders' input is being used in the management cycle. In the development of European fisheries management new analytical tools (including fleet interactions, impact on the environment by fisheries and vice versa) will enable communication of complex insights effectively to the increasing number of stakeholders involved in the decision-making process. Article 10 of the UN Fish Stocks Agreement includes the obligation for states to "agree on decision-making procedures which facilitate the adoption of conservation and management measures in a timely and effective manner". In this context, decision-making procedures will involve a variety of inputs such as research and development with broad participation of stakeholders in specialized instruments (i.e. Regional Advisory Councils).

Curbing environmental degradation and innovative use of biological resources

EU fish stocks have been declining for years. Reducing fishing effort has been the main measure for recovery of over-fished stocks. However, because of the cost and difficulty of reducing fishing capacity to a harvest level compatible with stock recovery, these actions have often been insufficient and slow while the catching efficiency and the real fishing effort of the sector increased. To this end, technical measures and such instruments as season closures, mutual moratoria, Total Allowable Catch (TAC) and quotas have been main tools for fisheries management and stock rebuilding but the effects vary based on the stocks and geographic areas in question. It is obvious that recovery plans will have significant costs both in the form of recovery expenses as well as socio-economic repercussions to the stakeholders involved.

The reformed CFP now provides for the progressive implementation of an ecosystem approach to fisheries encompassing anthropogenic impacts other than fisheries. Two examples illustrate this component:

- in the estuaries water quality impairment and dredging have modified extensively the quality of nurseries and the recruitment capacity of the habitat. In the same context, anadromous species are under threat.
- global warming should impact on fish behaviour and migration patterns, displace nursery grounds, and change the food web features.

The major concern European **aquaculture** has to face lies embedded in the concept of sustainable development. In practice, this focuses on a better use of natural resources (including fishing for fish meal) and a better protection of consumer health, while preserving the competitiveness of the sector in a global and open economy.

Species composition

The focus on only a limited number of species at an industrial farming scale (oyster, mussel, salmonids, sea bass and sea bream) when the market demand is for a more diversified offer is a threat to aquaculture development and market share when competing with fisheries produce. The horizon for developing production of a new species is decreasing, now being in the range of 5 to 10 years.

Environment

Environmental constraints, such as resulting from global pressure on the coastal zones, and the shortage in available biological resources (e.g. fish oil), call for improvements in technology (e.g. extensive polyculture systems, offshore facilities and recirculation technology) and enhanced use of production input/factors (e.g. fry, food, vaccines). This development, however, in turn can affect both the perception of consumers of the sector as much as it can develop the scope for growth of the industry.

Requirements for quality control and traceability (including imports), the risks of epizooty (including those from trade of live animals), environmental constraints on genetic issues deriving from selective breeding programmes are increasing everywhere. The issue of fish meal based feed for carnivorous species may slow down the development of this industry.

Demand

The increasing demand, both globally and on the European market, for high quality and/or labelled products is still based on a perceived image of aquaculture and seafood produce as being natural and healthy products. Simultaneously, an increasing competition in the market, particularly from imports from low-cost countries, leads to a greater emphasis on costs of production (e.g. the cost of fossil energy, impact of mechanization) and macro economic indicators (life cycle of products, employment).

Shellfish specificities

Shellfish farming, relying directly upon natural resources, is subject to various risks (toxic algae, microbiology, pollutants), and hence directly has a bearing on the expectations of society in terms of safety and food quality; traditional activities should accommodate European standards, which lead to increased domestication (hatcheries, purification basins, genetic selection, etc) and higher requirements in terms of the microbiological quality of inshore waters.

Aquaculture interaction with industry and consumer

All these actions should be built on a total value chain approach, including aspects of live fish traits and the impact this will have on harvesting operations, processing and the quality of the final consumer product. Today's consumers and public call for better and clearer information to sustain their consumption.

In the **seafood processing** industry the main considerations centre on consumers' trust in safety, health benefits and quality of the seafood offered on the market. In order to maintain this, new concepts of transparency are required. Innovative consumer driven seafood production is necessary to satisfy the needs and expectations of the European consumers. Parts of the consumers are critical with regard to the environmental and animal welfare aspects of seafood production. The license to produce requires more and assured environmental and welfare care in sustainable fisheries management and aquaculture.

Health promoter

In the near future, seafood contribution to reducing the incidence of chronic disease will be of utmost importance. The production of functional seafood with high levels of Ω -fatty acids, fish proteins and other health-promoting nutrients is challenging for both fisheries and aquaculture. It has become clear that seafood consumption assists in the prevention of chronic nutrition related diseases and of certain forms of cancer. Understanding the impact of nutrients from seafood (amino acids, peptides and trace elements) on the health of consumers will have huge impact on the consumption profile of European consumers and therefore on the industry.

Consumer protection (toxicity, disease)

Food safety concerns require a particular attention to pathogenic infectious diseases, bio-toxins and toxic contamination. The level of the regulatory intensity will impact both on the production costs as on the costs of compliance as much as it will hinge on consumers acceptance.

New products

Product development based on consumer's perception, expectations, preferences and behaviour should be strengthened and must be consumer driven. Special attention should be focused on two categories of seafood consumers: younger people and the effects on their long-term health, and immediate health effects in elderly people.

Development of marketing processes

Both "slow" and "fast" food movements can be provided with tailored healthy seafood, and can lead to a higher value creation. These concepts will lead to more diversification and economic profit in seafood production and marketing. Any improvement in the European policy to improve the European seafood production will also have an impact on import of seafood from other parts in the world.

4.4 Implementation

Fisheries, aquaculture and their management are by their very nature an international issue as fish stocks are a common pool resource (be it present in capture fisheries, the environment in which aquaculture is taking place or as resource for aquaculture production) present across national boundaries. In addition, the fabric of fisheries and aquaculture policy is such that national policies are highly determined by the EU Common Fisheries Policy and such forums as the International Council for the Exploration of the Seas and the Regional Advisory Councils such as those for the North Sea, Pelagic, Baltic and Mediterranean. Hence this foresight was exercised at a European/international, rather than at a national level.

Noting the above, the consortium has chosen to fully incorporate stakeholder participation and dissemination of the results throughout the entire cycle of the project by embedding the consortium in two wider forums. An expert workshop, consisting of a broad selection of (representatives of) research institutes across Europe and from scientific networks such as the ESF Marine Board, EFARO and EAFE has been used to provide peer input to the process. In addition a stakeholder network, constituting representatives of industry (throughout the production and processing chain), (environmental) NGOs and consumer organisations have been involved.

In order to obtain an even more broad critical review of the findings the draft final report has been forwarded for comments to a range of organisations (i.a. Regional Advisory Councils, EAS, FEAP, EAFRO, EAFE, ESF-Marine Board, EATP, ACFA, CNPMSM, EBCD, European Anglers Alliance, European Consumers Organisation (BEUC), FEFAC, Greenpeace International, Hellenic Society for the Study & Protection Monk Seal, Invest in Fish South West, IUCN, MED AQUA, MED RAC, Medisamak, NFFO, Nireus Aquaculture, North Sea Women's Network, Office for preservation, diversification and development of Slovene Marine Fisheries, PEPMA, ICES, PFA, NVZ, TEST ACHATs and UNICOOPESCA, in order to receive feed back. Reactions are presented in annex 1.

Also the project has built on results and progress of other EU and national funded projects such as DEGREE (on reduction of impact of fishing gear on the environment), CAFÉ (on effort management in fisheries), CEVIS (on evaluation of fisheries management systems) PROTECT (on the subject matter of closed areas) and UNCOVER (on the subject of recovery plans). In the realm of Aquaculture the project will built on the results and progress of Priority 5 and 8 EU funded projects such as IMPACTFISH (Impact Assessment of the FP4 and FP5 Research Programmes on Fisheries,

Aquaculture and Seafood Processing Research Area and the Fishery Industry), the CONSENSUS initiative (a multi-stakeholder platform for building a protocol for sustainable aquaculture development), PROFET (identifying aquaculture industry needs in RTD), and PROFET POLICY (aimed at bringing RTD in fisheries and aquaculture to policy makers). Concerning innovative consumer driven seafood production, health attributes and development of new products FEUFAR built on the results and progress of the SEAFOODplus integrated project (aimed at reducing health problems and increasing well-being among European consumers by applying the benefits obtained through consumption of health promoting and safe seafood products of high eating quality).

4.5 Foresight analysis

Aiming at scoping the future of fisheries and aquaculture in Europe and hence defining the research required to enable exploitation and farming of aquatic resources in the context of key challenges and risks for meeting sustainability requirements, the foresight exercise has a focus on future challenges for the exploitation and farming of aquatic resources, specifically on possible scenarios for meeting sustainability requirements (from international conventions) and results in the identification of areas in which additional research is required.

Following FAO (Bruinsma, 2003) the basis of any scenario exercise is a description of the current state of affairs and projections. These analyses and predictions have to render count of the geographical aspects, sectoral aspects and sustainability aspects. In this it has to be taken into account that next to deciding on which variables to include in the analysis (for example 1: demand variables 2: production variables 3: ecological variables) comparable data sets have to be available over the entirety of the several sub-areas included in the study. Effort has to be devoted to create a consistent set of historical and base year data based on which the scenarios can be developed.

Next the future has to be projected. Partially this can be enabled by so called “trend extrapolations”. On the one hand this will require a proper description of trends at all scales of analysis involved, on the other hand it will call for the availability of necessary data, be it qualitative or quantitative. In addition, and this being crucial to the exercise, a common understanding of the desired future state has to be elaborated. Following Goleman (2002) the scenario on the one hand enables for the anticipation of the future, on the other hand the making of the scenario is a process in which patterns and mechanisms are unfolded and projected into a future state.

Scenarios are imagined ‘futures’. They do not come singly, as a forecast would, but in sets of alternatives. Scenarios are not necessarily “visions” or “plans”, but they can help to guide strategy. They describe both optimistic and problematic futures. Each may concentrate on a different driver of change (e.g. sustainable development) or a different area of influence (e.g. fisheries or aquaculture development).

Good scenarios help us to understand how key drivers might interact and affect the future. Scenarios create representations of alternative worlds and can offer an inclusive and systematic way of thinking about what the future might look like. Scenarios go beyond a single best estimate, or a ‘high’ and ‘low’ projection both side of this, and encourage us to explore a number of different, logically-consistent pathways.

Scenarios describe the relevant world as it might be, far enough ahead to be beyond the scope of trend extrapolation, and after radical shifts in the social and cultural conditions which we unconsciously assume to be fixed. The wealth of recent experience suggests is that there is no single strategically best way to work with scenarios. However, well-designed scenarios do seem to share some common features:

- **DIY (do it yourself):** scenarios are best created by a panel - or at least commissioned and then explored and focused by a panel.

- **10 years distant, or longer:** scenarios are for the future that we cannot see, yet must still plan for. Their horizon is typically around ten years, though it may be as little as five, when change is fast or chaotic, and as much as fifty when strong and unambiguous drivers are operating.
- **Credible:** scenarios are not forecasts. They can usefully examine fairly extreme sets of consequences of the driving forces. However, it is important that those involved feel comfortable with each scenario - however surprising, they should be able to imagine living in such a world.
- **Internally consistent:** it follows that the social, political, economic, environmental, technical and cultural features of a scenario should hang together, as they would if a piece of consistent history had been written leading up to that state of affairs.
- **Focused:** the best scenarios dramatise a few key features or events which are of prime concern.
- **Plural:** some groups have experimented with a unique scenario. This is usually a mistake, because a single view of the future is too easy to confuse with a forecast. The practitioners' consensus is that two is a minimum and, in the time usually available, four is a maximum.
- **Striking and sometimes uncomfortable:** one of the prime objectives of scenario work is to startle managers, fire their interest and get them thoroughly involved and excited. Scenarios should never be boring.
- **Dramatised:** scenarios work best when they are dramatised in various ways - brought to life by scene-setting, stories, case-studies metaphors or encapsulated in memorable and vivid catch-phrases.
- **Altering plans and recommendations:** the acid test of good scenarios is that working with them changes the vision or plan that was proposed before the exercise. If one goes out by the same door that one went in, then the scenarios were probably too remote to have been useful.

5 Methodology

This methodology chapter describes a three-step process of bringing forward a new research agenda:

- A) Foresight state-of-the-art
- B) The foresight process
- C) From scenarios to a research agenda

5.1 Foresight state-of-the-art

The first step of the overall process has resulted in a state-of-the-art overview of fisheries and aquaculture foresight analyses world wide. The bibliographic overview of (potential) factors driving the system challenges and completes a factor list built by the consortium partners during their own foresight process.

This overview also helped later in the FEUFAR process by providing insights of past trends and future developments analysed in other foresight exercises. This, to a moderate extent, alleviated the documentation phase in the FEUFAR scenario-building process, by updating past development of some drivers.

The overview of other foresight studies performed world wide on fisheries and aquaculture was completed according to the template below, decided during the initiation meeting of the project:

FORESIGHT IN FISHERIES AND AQUACULTURE

- 1. Title – Report title**
- 2. Identifying short title**
- 3. Author(s)**
- 4. Source (book chapter, FAO Report, etc) and date**
- 5. Geographic scope**
- 6. Focus or disciplinary scope**
- 7. Stated objectives of the study and the target audience**
- 8. Time horizon**
- 9. Method employed for the analysis**
- 10. Consultee involvement**
- 11. Is there a list of drivers, and if so, what are the main ones? Is there a relationship with earlier work, e.g. climate change scenarios? And what is the structure of the scenarios – are they mutually exclusive?**
- 12. Is there any addressing of catastrophes/extreme events?**
- 13. Originality or USPs (unique selling points)**
- 14. Were original research or research drivers included**
- 15. What happened next – e.g. are there recommendations, and were any of them taken up?**

This literature review of foresight analyses was performed from month 1 to month 5 and was presented and discussed during the expert meeting in May 2007.

5.2 The foresight process

For the foresight process in FEUFAR, we built and used scenarios for identifying and assessing key opportunities and challenges. The scenario-building consisted of six steps:

1. **Define** the problem, boundaries, and horizon: initiation meeting
2. **Identify** key variables and their relationships
3. **Build** different hypotheses for each driver
4. **Explore** possible developments by assembling hypotheses (two steps)
5. **Outline** possible future scenarios and the paths to them
6. **Identify** the uncertainties, challenges and opportunities that research may answer

Generally, different stages of a scenario-building process are addressed during meetings scheduled for the purpose. However, because the FEUFAR project had limited resources, the number of project meetings was also limited. Therefore, a strong specificity of the process was that some stage validations among project partners were done through the project website and by e-mail, requesting each project partner to react to or to comment on the proposals at each stage.

5.2.1 Definitions

The project goal was to define the research required in the medium term (10 years) to allow exploitation and farming of aquatic resources (finfish and shellfish) in the context of key challenges and risks for meeting sustainability requirements. The project's target was to contribute to implementation of a future European Maritime Policy and to further strengthen the European Marine Research Area through better anticipation of research needs within fisheries and aquaculture. With this in mind, the boundaries of the foresight system were defined more precisely by the consortium partners during the initiation meeting.

Time: The time-frame was set to 2020. By looking 10–15 years into the future, the time-frame for the scenarios is deemed long enough for important changes to materialize, while not being so distant that the sense of realism and relevance is lost. We therefore asked how wild fisheries and aquaculture might look in 2020, to determine the most effective research priorities for the next 10 years to meet the different futures envisioned in the scenarios.

Geography: This was defined as the seas and oceans bordering Europe, including overseas European territories and long-distance fleets. The team decided, in discussion with the Commission, that the main focus should be on marine fisheries and mariculture. Therefore, although inland fisheries and freshwater aquaculture are mentioned in terms of common issues (global fish supply, feed demand, genomics, etc), inland freshwater ecosystems are not considered in the system.

Who to include: A broad array of input was secured through the involvement of experts and stakeholders from both fisheries and aquaculture. An expert committee was formed, consisting of representatives of the research community who could assist in providing feedback to the analyses made within the project. Stakeholders, representing industry and management areas on regional, European or international scale, as well as environmental and consumer interest, were invited to contribute to project workshops, to have interim findings presented, and to give feedback.

5.2.2 Identify key variables and their relationship

Here we clarify what is meant by variables, drivers and subsystems, and describe how we identified the key variables and the possible relationships between them.

Variables and subsystems

Definition: *Variables* or *drivers* are the parameters that describe or influence a system. They are always a mix of factors and actors acting on or affected by the factor. A trend itself is not a driver, but rather a hypothesis about the development of the particular driver.

The challenge in determining the set of drivers shaping the future of the system is to find the right number of key drivers for the topic being addressed in order to achieve a set of variables that does cover the entire system yet is still manageable, hence does not exceed around 50 drivers. Identifying the list of key drivers always starts with the question: what drivers influence the development of fisheries and of aquaculture towards 2020?

We considered drivers at several levels. Some drivers, termed *internal drivers*, describe the fisheries and aquaculture sector, for example fisheries production, fish demand, fisher demography, use of fishing technology, the number of boats in the fleet and fishery regulation. In addition, the development of fisheries and aquaculture is also influenced by *external drivers* such as climate change, that might influence the productivity of the ocean, and population growth or purchasing power development, influencing public demand for seafood.

The drivers describing the wild fishery and aquaculture and the ecosystem within which they operate were grouped into subsystems, the size of which was limited to a manageable number of 5–10 drivers each.

Definition: A *Subsystem* is a sub-section of the overall system, with a unique list of drivers. Together, different subsystems describe all relevant aspects of an area under investigation, in this case the European fisheries and aquaculture industries. Each sub-system has a direct logical link with the other sub-systems (for example climate change with ocean productivity within the subsystem “world context” has a relation with fish stock development).

The future of wild fisheries and aquaculture can be found in many different subsystems, and at the initiation of the project we considered the following subsystems to be likely:

Possible subsystems:

- Context: global warming, oil prices, world governance, risk management, etc
- Demand for fish and sea products (quantity and quality of material as food, and in terms of raw materials, pharmaceuticals, etc.)
- Fishery and aquaculture technical and technological processes (growing, catching, processing)
- Fishery and aquaculture activity and economics
- Fishery and aquaculture management and regulation
- Socio-economy of coastal regions
- Ecosystem: water quality and environmental features (foodweb features, fish behaviour)
- Organization of research, including collaborative research

Determining the key variables and subsystems

The drivers are the building blocks of the system. The team had an in-depth and lengthy discussion on the drivers we deemed relevant, in order to clarify overlap and differences among them. This was important for their functioning as building blocks for the scenarios, but also for managing the complicated tasks of driver description and documentation. With limited resources available, the team spent a lot of effort in keeping the extent of the system manageable. A system size of, say, 50 drivers was considered manageable during the time-frame of the project, but ending up with, say, 80 drivers, we risked not being able to describe the drivers in sufficient depth and detail.

Identification of drivers was performed in three steps. First we identified likely drivers. Second, we invited experts on fisheries and aquaculture to validate and refine our list. Finally, we completed and refined our list with the help of stakeholders. This three-step process is described below.

Team effort on drivers identification. A first list of drivers was assembled during the FEUFAR kick-off meeting held in early February 2007. This list, including a first attempt at assembling drivers into subsystems, was taken home by the partners to be completed (each partner indicating the missing drivers influencing fisheries and aquaculture). The team divided the drivers among them, with the aim of defining the drivers in 2–3 lines and listing indicators for each driver. The definition of each driver, meanings having been clarified to all, was agreed upon by the team by e-mail communication. Indicators for all drivers were also developed, to show how the drivers would differentiate future hypotheses: e.g. “labelling” drivers might mean the number of labels on seafood in Europe or worldwide, the evolution of stakeholders producing labels, and what issue is being labelled (origin, nutrient quality, fished/farmed, etc). Therefore, the definition and indicators for each driver at this early stage allowed new (clearer) wording of the variable and further system simplification. Such thorough discussion within the team paved the ground for the next steps, the validation of the drivers list by experts and stakeholders.

Expert meeting (21–23 May 2007). Experts in the realms of fisheries, aquaculture, socio-economics, marketing and consumer behaviour, management and marine science, were asked to discuss and prioritize the list of drivers drawn up by the project partners. The experts were researchers, acting as a peer group. To avoid the experts invited being coloured by the team’s perceptions, they were requested to build their own list of drivers from scratch, formulating their own groupings and building them into subsystems. After the initial brainstorming, the list of drivers list was discussed and improved upon. At the end of the workshop, this list was merged into the team’s list. Some new drivers were added to the team’s list, some were taken off the list, some were given new definitions or scope and some were placed into other subsystems.

During the *Stakeholder workshop* of June 2007 (see below), this process was repeated once more which resulted again in changes, be it minor, to the drivers and the grouping over subsystems.

Experts were asked whether they would wish, later in the project, to contribute to the documentation of the drivers and the development of the hypotheses. The meeting was also used to present, question, add to, and discuss the literature review performed under Work package 1.

Stakeholder workshop (25–27 June 2007). The stakeholders were asked to determine the drivers most likely influencing the system. They were asked to start with a blank sheet, so that their representation of the system drivers could be compared with that of the project team and the experts. The two representations of the system were discussed and compared, and by the end of the workshop, the final set of drivers and subsystems was agreed upon, taking the stakeholders’ vision of the system into account.

The system definition was then elaborated into an internal working document. Each driver being described and discussed, and for each driver, several hypotheses were developed. The drivers and the hypotheses are found in report 3: System and Drivers; trends and developments.

Relationship among variables, and system simplification

A rational method known widely as *structural analysis* can be used to study the relationships among drivers by quoting the influence of each driver on the others. The analysis leads to an influence–dependence graph of the drivers of the system, enabling one to retain only the most influential drivers in the system for the study. The most dependent ones are results, so can be described in the resulting scenarios and may be disregarded as drivers. However, the method is time-consuming in terms of meetings. Consequently, a fast-track method was used to decide by

reasoning and argument which would be the most influential drivers (present and potential), and to retain only those that were most important.

Once all drivers identified by the team had been defined, the system (drivers and subsystems) was reworked:

- to ensure that drivers covered complementary topics (and do not overlap);
- if needed, to propose reformulation of certain drivers;
- to propose system simplification, deleting drivers, to end up with some 50 drivers:
 - drivers that were roughly the same were reformulated to encompass the essence of both,
 - drivers were deleted when they were a consequence of other drivers
 - drivers having only a secondary influence were deleted;
- to make a new proposal for the subsystem assembly;
- to show the logical links among subsystems.

5.2.3 Build different hypotheses variable by variable

This stage lasted from July to November 2007. In order to build future hypotheses for 2020 for each driver, we had to understand the dynamics of each individual driver. Therefore, for each driver, we had to answer several questions in order to build our hypotheses about the future:

- 1) How did that driver develop over the past 20 years or so, and why?
 - a. which indicators can we use to trace this development over time?
 - b. what data and time-series are available to prove our point, and how dependable are they?
 - c. what drove this development?
 - d. which actors influenced the driver, and who was affected by it?
- 2) What is the trend in development or its logical extrapolation? This trend in development was taken as a first hypothesis.
- 3) Are there potential breakpoints that could block or change the trend in development? Such potential breakpoints can be thresholds, e.g. market saturation, threshold triggering cascade effects (such as regarding climate change), and the minimum biomass for fish stock renewal ability. However, the possible influences may also include innovation, local circumstances or a “weak signal” that could be generalised (a very local way of managing or regulating fishing; a traceability device used for high tech purposes such as defence or research that may have mass market application). Another influence could be a change in the (game of) actors, such as new alliances or new stakeholder(s) influencing the driver. Taking into account a host of possible influences allowed the construction of hypotheses other than the trend extrapolation.

The foresight literature review (Work Package 1) and the methodology followed during stage two of the scenario process (describing the system) were used to facilitate understanding of the documentation needed in this hypothesis-building process:

- drivers documented in the literature review (WP1) were updated (i.e. rethinking the hypotheses);
- the effort put into understanding and defining the drivers and their possible indicators during the previous stage of the process allowed the team to focus directly on the documentation of past development and to draft hypotheses (step 3 and following, in the template below) during this stage.

Documenting the drivers

For each driver, the team set out to document the driver according to the template below:

1. Definition
2. Indicators
3. Past evolution
4. Hypotheses (future): hypotheses are argued (threshold, actors, etc) and given a **name**
5. Actors identified
6. Source

Author signature / revision number

Documentation for the drivers was developed between July and September 2007 and shared among participants. Each template was completed and placed on the project website as soon as it had been written, so that all project members could access it. A first draft was available to the team on the project site by 1 October 2007. Therefore, everyone was able to comment on the documentation and hypotheses for the driver templates written by other project partners during October, allowing all inputs to be commented upon by everyone.

It was considered crucial that the hypothesis be named and that its describer signed it as author. Then, each author took into account comments from the rest of the team and personally edited the second draft. Note that an hypothesis is a *possible* vision of the driver in 2020, not a *desirable* vision. The different hypotheses for a single driver are generally not compatible, but mutually exclusive.

The project team’s version of the templates and hypotheses for each driver were finalised by mid October 2007, and hypothesis tables were then prepared subsystem by subsystem, in time for the late October 2007 meeting of the group. At that meeting, all drivers and their hypotheses were discussed in full again, and comments were again taken up by the author of each before final acceptance of each driver. In early December 2007, given their importance, all drivers were thoroughly edited (grammar and content) by two team members, and the document “Trends and Developments” was made available on the website before Christmas 2007. This stand alone document provides a thorough overview and back ground to the most important factors influencing the future of fisheries and aquaculture.

5.2.4 Explore possible developments by assembling hypotheses (two steps)

Most of the creative part of this two-step process, i.e. assembling hypotheses to build scenarios, was carried out during formal meetings, and the time between meetings was dedicated to writing up the scenarios. The global process can be summarized as follows:

Micro-scenarios subsystem by subsystem, to Global (macro)scenarios

Subsystem X

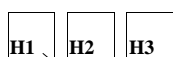
Key variable scenarios

Hypotheses

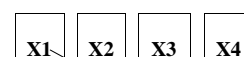
Subsystem

Micro-

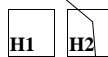
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X



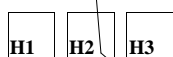
B



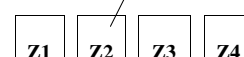
Y



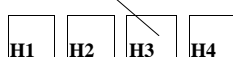
C



Z



D



Combined hypothesis exploration:
microscenario X1, X2....

Micro-scenarios X1, X2.... become the
hypothesis for the global system

Micro-scenarios

An expert workshop on micro-scenarios was held in late November 2007, and to prepare for this meeting, one member of the consortium developed the micro-scenarios for one of the subsystems as a demonstration of the process of construction. Then we allowed for half a day to construct micro-scenarios for each subsystem. To facilitate instruction and to guide the expert workshop in the creation of micro-scenarios, micro-scenarios were built by the team for 3 subsystems at a one-day meeting prior to the workshop (note that this, however, was only for exemplification purposes; these micro-scenarios were not used later in the process). Then, during the expert meeting, several groups worked in parallel to build micro-scenarios for the subsystems.

At the end of the micro-scenario workshop, an attempt was made to assess collectively what were the drivers or their hypotheses that allowed one to switch from one micro-scenario to another. These hypotheses are levers to move from one situation to another. Following that workshop, the project team did the writing of the micro-scenarios for each subsystem, with a short name being given to each micro-scenario. This writing was done before Christmas 2007 and placed on the project website for project partner reading and validation. This then allowed the tables to be prepared for the global (macro)scenario task scheduled for March 2008. The micro-scenarios were circulated to all workshop participants, and also made available at the project website.

Global (macro)scenarios

Global (macro)scenarios were constructed at a combined expert and stakeholder workshop in March 2008. Experts and stakeholders were asked to assemble hypotheses (in fact, micro-scenarios), with different logical consistence, to construct an image of the wild fishery and aquaculture system by 2020. They were also requested, after constructing this final image, to describe the path from 2008 to these different final visions, to develop a storyline for the development of the scenario. From a list of micro-scenarios, the experts and stakeholders sat together in five groups to develop the macro-scenarios. During the workshop the project team synthesised some 24 (micro)scenarios, and came up with a grouping of four, which during the following discussion was rationalised to a final list of five realistic scenarios. These formed the basis of the set of final scenarios used.

In this part of the project, it was considered vital that the number of scenarios did not exceed four or five, in order to present only the most divergent paths to the future and to allow readers to understand quickly the specific dynamics of each. One must remember here that the purpose of a scenario is not to depict exactly what the future will be (most likely, it will be an intermediate between scenarios), but to show, by comparing scenarios, the plan of action for different stakeholders, and to highlight different possible opportunities and challenges for fisheries and aquaculture. Therefore, the scenarios had to be slightly caricatured to clarify the issues in each storyline.

5.2.5 List possible futures and their paths

A first draft of the global (macro)scenarios was produced in April 2008 and placed on the website to allow the team to comment and to add detail before the final expert and stakeholder workshop, which had been scheduled for June 2008.

The scenarios describing the final images and the paths to the anticipated situations were presented to experts and stakeholders in June 2008. At that meeting, the participants were asked to discuss the scenarios during a workshop and to comment on whether they found alternative scenarios to be very different, on how much credibility they gave to the different scenarios and, very important, to say whether they could see alternative paths through some of the scenarios.

5.3 From scenario's to a research agenda

The final scenarios for fisheries and aquaculture are documented in the report from the final expert and stakeholder workshop. Identification of the challenges and opportunities for aquaculture and fisheries from the scenarios is the basis of the next step, to consolidate views on a research agenda, and permitted the project to move from Work Package 2 (WP2) to WP3. Therefore, Work Package 3 was initiated in June during the final expert and stakeholder workshop.

At the outset of the final expert and stakeholder workshop in June, experts and stakeholders were asked to derive from the scenarios the main challenges and opportunities for fisheries and aquaculture that might be met by future research.

Based on the final scenarios presented to them, the experts and stakeholders at the final expert and stakeholder workshop in June 2008 were asked to highlight the research required under each scenario, and to draft out a realistic research agenda based on each scenario (story line). Some scenarios obviously appeared more appealing than others. However, it was deemed as important for stakeholders to specify research to preclude moving towards (or alleviate) unsustainable scenarios as to promote sustainable scenarios. Therefore, all scenarios were crucial to the dialogue, especially in terms of identifying challenges and opportunities for fisheries and aquaculture and the accompanying research needs.. Specifically, the uncertainties around the consequences of specific strategies (parts of scenarios) on the business or the ecosystem led to new research topics being tabled.

To develop strategic options further, the workshop differentiated at the level of each scenario the links with both European and external context strategies. By confronting different options available to European actors illustrated within the scenarios in different contexts, we stressed the area of potential action for Europeans, what was their capability of meeting such challenges, and hence their strategic options.

Prioritized lists of research topics were developed during the process. However, priorities differed according to the criteria used: priorities to meet specific sustainability targets sometimes differed from stakeholder priorities. Another way we found to prioritize was to extract a list of common research topics from all scenarios. In elaborating the research needs, we also touched on the different roles and priorities of research institutes, universities and private research organizations in, e.g. biotechnology, processing and pharmaceuticals.

The need to organize and develop new tools was also part of the discussion, examples being relevant and accessible databases, mathematical models and experimental infrastructure. Also, suggestions were made for key solutions to improve the conditions for interdisciplinary research, research collaboration and research planning.

5.4 Methodological considerations

For the process of moving beyond scenarios towards research priorities we had several methodological issues to consider:

- how to allow new and interesting perspectives;
- whom to involve in the process;
- how to avoid pitfalls, such as stakeholders advancing their own personal interests in the process, or drowning new perspectives in discussing known topics that are still not solved?

The first question would be whether the scenarios, and their challenges and opportunities, were a sufficiently robust basis to recommend research priorities. In this respect, the scenarios needed to be

- consistent,

- believable, and
- well described in terms of actors and processes.

In the opinion of the team the scenarios fulfilled these requirements. An important argument for selecting a scenario approach for this project was that with scenarios it would be possible to prioritize entirely new areas of research. However, that will not happen automatically in a process like this, as there is a possibility that if today's stakeholders were to set an agenda, nothing new would transpire from the process. That itself, of course, is a good argument for making the scenario process a broad one. Involvement was therefore a key issue in the whole process. The team believes that solid foundations are laid through involvement, in terms of the perspectives shown and the legitimacy of the process and the results. In respect of the different perspectives and legitimacy, we sought to maintain a broad and representative (of many sectors) stakeholder representation throughout the process. Such a consideration was even more important for the final stage, where research priorities were discussed.

The primary stakeholders to be consulted in shaping a future research policy for fisheries and aquaculture would of course be the fisheries and aquaculture industries themselves, representing the entire value chain and its research community. We therefore asked the questions who would be the long-term stakeholders, and were they different from the stakeholders today? To ensure that potential future stakeholders were heard within the process, other stakeholders, such as consumer organizations and NGOs, some focusing on sustainability and environmental questions, were invited to participate in the overall process. Particular attention was also paid to the involvement of nations not represented in the project team itself, for instance Spain, Italy and Portugal, both of whom have a historical interest in the harvesting of marine resources and, lately, aquaculture.

It was also considered important that the team advanced the need for careful prioritization of research tasks. As new perspectives were advanced, we were prepared for the stakeholders potentially to move into a form of "prioritization mode", perhaps causing new perspectives to be drowned in conflicts of interest among existing topics. This was, we believe, alleviated by insisting that the stakeholders asked themselves "what are the *interesting* perspectives?", in order for them to be able to discuss the original thoughts being advanced. This was important for making them explore the *possible*, as well as the desirable and likely, futures.

In trying to develop research priorities, the team looked at whether they should represent a consensus among stakeholders. Indeed, was that possible? In addition, we discussed how to handle different or opposing interests among participants. Ultimately, the project team found this to be less of a problem than anticipated, possibly because in shaping the process, we took the dynamics of the different actors into account. The process of developing the research priorities was therefore handled in a very structured manner:

- Experts and stakeholders together were divided into mixed groups, each group working with a single scenario. They were asked to come up with the most relevant or important research tasks, in their opinion, to be deduced from the scenario in question, which included funding of research and research organisation.
- They were also asked to draft research tasks aimed at following a desired course of development, and (as important) the tasks needed to preclude unwanted developments following from the particular scenario.
- From a long-list of tasks, re-arranged groups of the same representatives at the meeting were then asked to prioritize among the tasks.
- Finally and very importantly, they were asked to argue the case for their priorities in front of the whole workshop, including the contract team. In this manner, every argument in favour of a research topic had to be aired in front of a group, and no one person was able to advance his/her own personal agenda.

Input from different stakeholders was provided to the project team in written form, including from stakeholders not able to join the workshop, as a form of wish list for future research, but this input was used only as a reminder that the topics in question had been taken into account in the discussion. It was considered important that no topic would form part of the research agenda other than as a result of discussions in workshop groups. The research agenda, divided into five areas of research, was finalized on the last day of the final workshop by the project team, and circulated among workshop participants for comment.

5.5 A time-line of the foresight process

In this final part of our methodology chapter, we provide a brief summary of the steps and the progress in the foresight process.

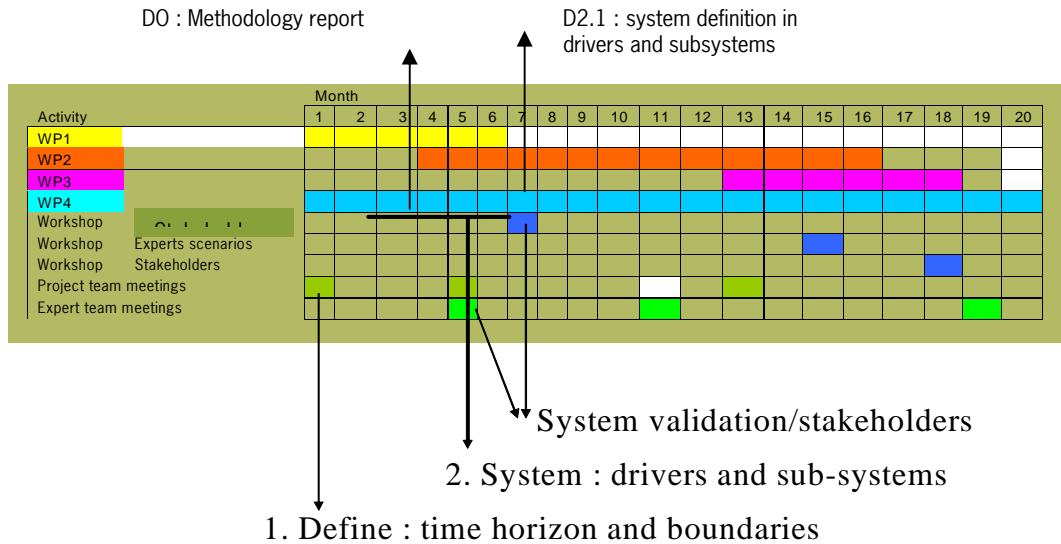
5.5.1 Stages 1 and 2, describing the system

Stage 1: one of the objectives of the start-up meeting in Heraklion (Crete) from 5 to 7 February 2007 was to define the boundaries of the system.

Stage 2: defining drivers and subsystems lasted from month 2 to month 6, and ended with the stakeholder workshop in month 6.

A more detailed overview of stage 2 is listed below:

- At the initiation meeting of the project in early February 2007, a first list of drivers was drafted and assembled roughly into subsystems.
- The subsystem/driver table was sent to partners for additions, comments and rethinking, and returned for finalization shortly thereafter.
- A short template asking for a definition and indicators was circulated to team members in late February, and driver documentation tasks were split among the team. The completed template with definitions and indicators was delivered by 15 March.
- A synthesis of the driver system was then circulated among the team during early April.
- This synthesis was commented upon and questioned by the team, so that the whole consortium could agree on a description of the drivers during early May.
- A short methodology report and plan was made available on the project website for experts and stakeholders in mid-March.
- An Expert meeting was held from 21 to 23 May in Brussels, to discuss the literature review and the driver system.
- The Stakeholder workshop of 25–27 June, held in the Netherlands, compared the description of the system through the drivers within the system outlined by the project team, and fresh input was made as appropriate.
- System definition ended in late June, and the report was available in July 2007.



5.5.2 Stages 3 – 6 : hypotheses and scenarios

The system was defined (in terms of drivers and subsystems) during late June, and a template (with definition and indicators already documented for most) for the driver documentation was sent to partners during early July 2007.

Documentation of the drivers was finalized through to the late October team meeting, and it was carefully reviewed, edited and made available on the website in mid-December 2007.

During the October team meeting the project team finalized the hypotheses. The expert meeting and the project meeting in early November 2007 was dedicated to building micro-scenarios subsystem by subsystem.

The drafting of micro-scenarios was shared among partners and made available on the project website before Christmas 2007.

A first draft of global (macro)scenarios was drafted and made available on the project website for team/partner validation, comment or addition in April 2008.

The global (macro)scenarios, ratified by the team, were then discussed with experts and stakeholders during June 2008.

