Cooperation in Fisheries,
Aquaculture and Seafood Processing

COFASP
ERA-net

Final results of a foresight analysis study

VIEW ON THE FUTURE RESEARCH

of European Fisheries, Aquaculture and Seafood Processing

ABOUT COFASP

COFASP is an ERA-NET. The objective of the ERA-NET scheme is to develop and strengthen the coordination of national and regional research programmes. COFASP was created to directly address actions envisaged within fisheries, aquaculture and seafood. It started in 2013 under the KBBE theme in FP7, and is part of the Europe 2020 strategy, which recognises bioeconomy as an important part of the strategy.

COFASP Partners

- DASTI - Danish Agency for Science, Technology and Innovation, Ministry of Science, Tehcnology and Innovation Denmark
- CNR - National Research Council Italy
- ICES - International Council for the Exploration of the Sea Denmark
- Tecnalia-AZTI Fundacion Azti/Azti Fundazioa Spain
- BMELV - Federal Ministry of Food, Agriculture and Consumer Protection Germany
- BLE - Federal Office for Agriculture and Food Germany
- DLO - Stichting Dienst Landbouwkundig Onderzoek, Wageningen University and Research Center Netherlands
- RANNIS - The icelandic Centre for Research Iceland
- Ifremer - French Research Institute for Exploitation of the Sea France
- UEFISCDI - Executive Agency for Higher Education, Research, Development and Innovation Funding Romania
- RCN - The Research Council of Norway Norway
- ANR - The French National Research Agency France
- DEFRA - The Secretary of State for Environment, Food and Rural Affairs United Kingdom
- Scottish Ministers - The Scottish Ministers Acting Though Marine Scotland United Kingdom
- IEO - Instituto Español de Oceanografia Spain
- HCMR - Hellenic Centre for Marine Research Greece
- GSRT - Geniki Grammatia Erevnas Kai Technologias, Ypourgio Paidias, Dia Viou Mathisis & Thriskevmaton Greece
- FCT - The Foundation for Science and Technology, Ministry of Education and Science Portugal
- Marine Institute - Marine Institute Ireland
- FGFRI - Game and Fisheries Research Finland
- DAFA - Danish AgriFish Agency, Ministry of Food, Agriculture and Fisheries of Denmark Denmark
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- MATIS - Matís ltd. Iceland
- ISPRA - The Institute for Environmental Protection and Research Italy
- GDAR - General Directorate for Agricultural Research and Policy Turkey

SEVENTH FRAMEWORK PROGRAMME

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Version 2.0

Author Luc van Hoof (EFARO, The Netherlands)
Josien Steenbergen (EFARO, The Netherlands)
Sarah Smith (IMARES-DLO, The Netherlands)

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EXECUTIVE SUMMARY

The COFASP foresight study was implemented between September 2013 and June 2014 by the European Fisheries and Aquaculture Research Organisation (EFARO) as part of Work Package 1 of the FP7 ERA-Net COFASP. The aim of the study was to develop a research agenda defining the research required in the medium term (15 years) to enable a sustainable exploitation and farming and retailing of aquatic resources.

There are many ways to develop a research agenda. Very often experts are consulted to provide their view on the future. We applied a foresight method using scenarios, building a step by step analysis of the most important factors influencing the future, in our case in fisheries, aquaculture and food processing. A large group of stakeholders was involved in this process. In three workshops we looked at how the factors might develop in the future and what research is needed to support these developments. These results have been reported 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 foresight process consisted of five logical steps. Starting point is the definition of the system and its subsystems after which for each of the subsystems the main drivers defining the future are described. Based on these drivers the scenarios are generated. The four constructed macro scenarios were the bases on which the research agenda was made.

Considering all areas that would need to be covered, the world of fisheries, aquaculture and seafood processing was divided into 7 areas or subsystems:

A. Policy: political objectives and legislation in a EU and national and regional context, including political and policy changes and interaction of different levels.
B. Economics/market: all aspects of the production distribution and consumption of goods and services. Demand vs supply.
C. Value chain: chain of activities to deliver a valuable product or service for the market.
D. Resource use: the use of marine resources and the competition between different users.
E. Society: societal trends, demographics, and developments, including values around the marine system.
F. Natural system: biological, physical, chemical environment of human marine activities. The natural system included all animals, interactions, and sediments.
G. Knowledge: information, understanding, facts, technology or skills acquired through research, or experience, or education (taking into account regional differences)

For each of the subsystems the so called 'drivers' were determined. Drivers are variables that are found to be key to the future development of the particular subsystem. For each driver we determined the most important indicators and how this driver has evolved over the past 20 years. Subsequently for each driver a set of different hypotheses, or a number of "possible futures", were developed.

The drivers and the hypothesis per driver were the bases for the construction of the micro scenarios: a scenario for an individual subsystem. Connecting the micro scenarios of the different subsystems resulted in the so called macro scenarios: possible futures for the entire system. Four scenarios were constructed, based on these scenarios the research priorities were developed.

MARINE SCIENCE IN GENERAL

Optimal use of the seas: what is the optimal sustainable use of our seas and oceans with increased possibilities of using available resources in novel ways and using novel ways to extract and use marine resources? This question has a bearing on the development of an overarching system of marine spatial planning (also see section on Governance).

Value of use of the seas: in order to strive for an optimal sustainable use of the seas it is important to be able to put a value to existing and potential future ecosystem goods and services. Related to this is the question of costing the impact of activities on the marine ecosystem and incorporate these costs into the production costs in the value chain. Together with non-economic values this analysis will provide a basis for a societal cost-benefit analysis of different activities, especially in a world with increased competition for marine resources, especially space. This in turn will provide important input into marine spatial planning.

ENVIRONMENT

Low impact products: a general challenge to all uses of the marine environment is to develop products and production techniques that not only reduce direct impact on the marine resources directly exploited, but are produced with the lowest possible impact on the marine ecosystem, including its associated carbon footprint.

Sustainable use strategies: combined with a strive for low impact products there is a need to devise holistic strategies at the level of Large Marine Ecosystems for sustainable production. This will include a definition of ecosystem and environmental boundaries, setting up strategies for marine resource use and prevention and mitigation measures.

This will require a methodology in which impacts of a multitude of activities can be determined at the appropriate ecosystem geographical and time scale. An example of such a methodology can be the **modelling and risk assessment** of disease and pathogen distribution in wild populations and aquaculture systems; develop prevention and treatment systems. Another example can be to devise a methodology that considers **species adaptation to ecosystem change** and the ecosystem impact considerations of the restoration of certain species.

FISHERIES

Monitoring and Management: for the appropriate management of the ecosystem it will remain necessary to develop long term integrated management plans for resource use. Especially in the field of fisheries this will require models that can reliably predict the dynamics of ecosystems and activities undertaken in the ecosystem. In addition, it will require user-friendly monitoring programs or techniques that result in reliable assessments of exploited marine resources/populations which clearly assess the impact of (alternative) fishery management programs on sustainable use of shared resources. The development and use of technology to improve monitoring and surveillance will be required in addition to continued improvements in monitoring and data collection.

Adaptation strategies: the fisheries sector is confronted with a multitude of challenges that will require an adaptation of prior used (fishing) strategies. As result of ***ecosystem change***, how can fishers adapt vessel types and equipment to make a fit with the new dynamic circumstances? In addition, how can fishing fleets respond to a ***societal call*** to develop low impact fishing methods, such as eco-friendly powered vessels, low impact fishing gears? And, in the light of ***market demand***, how can the entire harvest of vessels, including by-catch and discards, be appropriately managed and used?

Data use: in order to provide a basis for management of resources and the development of the industry's ma-

nagement and fishing strategy it is necessary to develop technology and methodology that will allow effective and accepted obtaining and using fishery-independent data and commercial data from industry, especially in small-scale fisheries.

Recreational Fisheries: a major challenge is the potential and role of developing recreational fisheries and other recreational uses of the sea, e.g. tourism. How do these activities relate to other commercial uses of marine space and resources and how does competition between alternative uses of resources develop?

AQUACULTURE

Market demand: noting consumer demand and production costs across all modes of aquaculture production, a main challenge remains to be the species that can be cost effectively produced and meet market demand. In this there are several challenges being posed to the sector; which species and production techniques can serve a high-value novel niche market? In case of multiple potential aquaculture species, how could a diversified production scheme look like? And how can aquaculture producers operate in a market characterized by multiple high-value products?

Organic aquaculture: related to market demand is the special case of organic aquaculture. Main questions related to this issue centre on developing the system, using the potentials for herbivore species, sources of feed, plant aquaculture, bivalves (shellfish). The main challenge is to lower the production costs relative to conventional methods.

Technology development: there is a continued demand for improved recirculation facilities and research into multi-trophic aquaculture/agriculture/hydroponics (i.e. both directions: sea-land and land-sea) and off-shore Multi Trophic Aquaculture. In order to devise these systems a better understanding of the potential of Multi Trophic Aquaculture systems is required. In addition, the potential health issues of IMTA components should be addressed as well as the identification of potential species, sources of feed, water treatment technology and increases in water/feed efficiency.

Species enhancement: as for the potential use and enhancement of species, starting point has to be addressing the issue of aquatic animal health and welfare. In addition, research into GM (genetically modified) feed use and fish genetic strains with low environmental risk will be addressed. Species adaptation to ecosystem change will have to be taken into account. Some aspects can be addressed through coordinated breeding programmes.

SEAFOOD PROCESSING

Towards more flexible production units: with a production sector with a more diverse (and more seasonal) production and an European market characterised by multiple market segments (high-value (no-bulk) products, next to bulk ingredients market) there will be a strive away from single-species production plants towards more small-scale and multi-purpose processing units. Research into developing these small-scale and multi-purpose processing units is required.

Maximise processing efficiency: there is an increased strive to fully use all of the harvested fish produce, be it from aquaculture or wild capture fisheries. On the one hand this implies maximisation of the filet yield. But, on the other hand, it also entails optimising the use for fish meal and oil coming from the remains from fish processing (from trimmings) and the use of all co-products for high value products for feed, food, pharmaceuticals and cosmetics.

New products and new production technologies: in addition to optimising the use of the fish harvest there is

also the need to develop production technologies for new resources such as seaweed and algae such as the production of biodegradable packaging (from seaweed). In addition, there is a need to overall reduce waste and environmental impacts in processing.

VALUE CHAIN

Increased sustainable efficiency: a generic challenge to the fisheries, aquaculture and seafood processing sectors lies in a search to increase efficiency of vessels and gears, of aquaculture production (e.g. feed conversion ratio, time to slaughter) and in seafood processing which at the same time reduces impact on the ecosystem and makes the most efficient use of harvested resources. The entire value chain will have to adapt to this principle of 'more with less', especially new technology/techniques in the processing sector will have to be developed to adjust to changes in raw materials (e.g. species, size).

Setting standards: a major concern is the development of methods to ensure that seafood products meet appropriate standards for health and safety. This includes both setting of health and safety standards as well as devising systems such as labelling, to communicate produce attributes. This will include the identification of threats to food safety along the supply chain, compared to thresholds for safe human consumption, and to develop programme/standards to prevent threats from entering the supply chain.

Information in the value chain: communication of attributes of produce along the value chain across the individual producers towards the final consumer is very important. One of the issues that needs to be addressed is: how can labelling and standardization be organized in the value chain towards a multitude of consumer groups and markets? Steps towards these can be taken by looking into best practice for certification and labelling and into the development of EIDs (electronic identification documents) providing relevant information along the value chain operators and final consumers.

GOVERNANCE

Control: a main issue is the establishment, in a dynamic world and a permanently changing ecosystem, of a framework for management to ensure resource use (including pollution) to stay within identified and agreed upon limits. This will include the question of which incentives could be used to ensure compliance of the industry and which technology could be further developed to support this (e.g. effort controls, VMS, CCTV).

Licence to produce: increasingly producers need to acquire a licence to produce: a public consent to the industry to exploit the marine environment. Obtaining this licence to produce pertains on the one hand the provisioning of (science based) information on primary production and across all steps in the production chain but, on the other hand, it would require insights in the public attitudes towards marine production and communication between producers, consumers and citizens.

Participation: with a growing complexity of the management challenge at Europe's seas and oceans there is an increased need for Marine Spatial Planning and Monitoring and Evaluation of the use of marine resources. The effective implementation of this calls for the development of a platform for stakeholders to increase participation/input in decision-making and evaluation processes.

ORGANIZATION OF RESEARCH AND FUNDING

The financing and organisation of research will over time depend on the relative priority given to (marine) research, the availability of funding from either public or private sources and the level at which science will be organised.

1 INTRODUCTION

The EU FP7 funded ERA-net COFASP has as main objective to strengthen cooperation and synergies between major European funding agencies that support research on sustainable exploitation of marine renewable resource with the aim of sustainable exploitation of marine living resources and to define the science, information and data necessary to underpin marine policy. In this it is closely related to the EU's agenda of Blue Growth which considers economic growth and employment prospects in the marine and maritime economy as to be of major importance to help Europe's economic recovery.

In COFASP the future research agenda in the marine living resource field, in particular in the fields of fisheries, aquaculture and seafood processing is an important topic. Also the way of implementation of that research agenda in terms of how it is being organised and financed is considered relevant. In order to arrive at a future research agenda the European Fisheries and Aquaculture Research Organisation (EFARO) implemented a Foresight study between September 2013 and June 2014 (van Hoof et al, 2013; 2014a,b). In a series of workshops together with stakeholders from the policy, research, NGO and industry we worked on a strategy for cooperation in research and innovation. The foresight process towards a research agenda in fisheries, aquaculture and seafood processing was based on a scenario building method (van Hoof, 2008a; van Hoof et al., 2008b; van Hoof and Steenbergen 2013).

The scenarios that were developed provided the basis for the identification of issues and the key challenges in future, from an economic, ecological, societal and managerial (governance) perspective and identified the needs for research in capture fisheries, aquaculture and seafood processing. In addition, from the perspective of the different scenarios a reflection on the most appropriate research funding and organisation was developed. The basis of scenario building lies in developing hypotheses about possible futures (foresight) rather than making predictions. Scenarios, as a prime technique of future studies, have long been used as powerful tools to aid in decision making in the face of uncertainty. The idea behind them is to establish thinking about possible futures which can minimise surprises and broaden the span of managers' thinking about different possibilities (Mietzner and Reger, 2005). Good scenarios help us to understand how key drivers might interact and affect the future.

The foresight process in COFASP consisted of the following steps:

1 Define the system including the problem, boundaries, and horizon of the system and subsystems.
2 Identify key variables, so called drivers, and build different hypotheses for the future for each driver.
3 Create micro scenarios for each subsystem by assembling drivers hypotheses.
4 Outline possible future macro scenarios by assembling the micro scenarios.
5 Identify uncertainties, challenges and opportunities that research may answer in the macro scenarios.

In the next chapters a closer look at the method used is provided (chapter 2: methodology) after which the outputs of the different steps is written (chapter 3: output of the COFASP foresight exercise). In the end a research agenda for the future is extracted from the results of the output of the workshops (chapter 4: future research).

2 METHODOLOGY

2.1 STEPS OF THE SCENARIO METHOD

The aim of the COFASP Foresight Analysis workshops was for stakeholders to analyse the current situation and identify the system and drivers, to build micro scenarios and macro scenarios, to determine research needs within these macro scenarios and to determine how this research would have to be organized and funded.

2.1.1 DEFINING THE SYSTEM

The first step in the scenario analysis that was used in the foresight study is defining the system that needs to be analysed. This includes defining problem, boundaries, and horizon of the system. The problem relates to the main question we seek to address; in this case the development of a research agenda and institutional and financial setting of future research in the field of fisheries, aquaculture and seafood processing.

The boundaries of the system define which parts are considered to be within the system and which parts are considered to be derived from outside the system. One of the lines along which this distinction can be made is according to the influence the actors inside the system have on a particular part of the system. Outside the system are those elements over which the actors have no direct control. Within the system several subsystems need to be defined. Looking at the topic of the study it is for example logical to distinguish between (interdependent) subsystem of fisheries, one for aquaculture and one for seafood processing. In addition, subsystems for marine policy development, marine research and research funding seem logical parts. The number of subsystems should allow for a comprehensive description of the system and yet allow for a workable set of parts. Usually selecting between 6 and 9 subsystems allows for a proper analysis. Possible subsystems can relate for example to:

- The wider context: global warming, oil prices, world governance, risk management.
- Demand for fish and sea products (quantity and quality of material as food, and in terms of raw materials, pharmaceuticals).
- 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 (food web features, fish behaviour).
- Organization of research, including collaborative research.

Finally the horizon of the system needs to be determined. The most important element in this is to set the proper time horizon for the analysis. Taking the time period as too short will result in scenarios emulating to a large extent todays issues and 'business as usual' thinking. As the analysis aims at the future and seeks to stimulate creative thinking it is proposed to at least take a time frame of 10 years from now, perhaps even 20.

2.1.2 SELECTING DRIVERS

After the system has been defined and the subsystems are determined, the drivers of the system need to be determined. Each (sub)system can be described by a large array of variables. For each of the subsystems the key variables need to be determined. These are the variables that are found to be key to the future development. These are the so called 'drivers' of the system. Drivers are those variables that determine the future outlook of a (sub)system.

In order to allow for a comprehensive building of scenarios it is advised to have the number of drivers per system be restricted. Where some subsystems are covered by a rather limited number of drivers it is best to not have the number of drivers for a subsystem exceeding 10. Determining drivers is an iterative and interactive

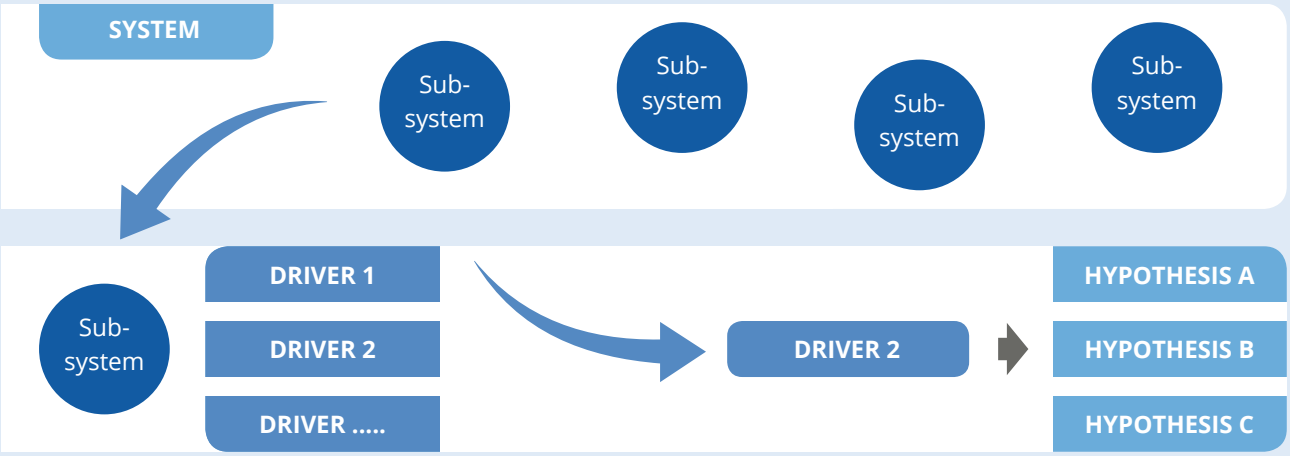

Figure 1: Building micro scenarios step 1

process in which during the workshops the drivers are being decided.

After the drivers have been selected they need to be described in detail. Each driver has to be documented in terms of indicators, past developments and for each driver a number of hypothesis on future development of this driver needs to be generated.

2.1.3 BUILDING MICRO SCENARIOS

After defining the system's boundaries and documenting the drivers of the system the next step in the process is to develop micro scenarios. A micro scenario is a scenario for a single subsystem based on a unique combination of hypotheses, including one hypothesis for each of the drivers of that subsystem. Hence based on the hypothesis developed for each of the drivers for each of the subsystems a set of micro scenarios are developed for each subsystem.

Each micro scenario consists of 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 driver. 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.

In figure 1 an example of building micro scenarios is given.

DRIVER	HYPOTHESIS	HYPOTHESIS	HYPOTHESIS	HYPOTHESIS
Driver 1	Hypothesis A	Hypothesis B	Hypothesis C	
Driver 2	Hypothesis X	Hypothesis Z		
Driver	Hypothesis μ	Hypothesis α	Hypothesis β	Hypothesis ξ

Table 1: Building micro scenarios step 2

DRIVER	HYPOTHESIS	HYPOTHESIS	HYPOTHESIS	HYPOTHESIS
Driver 1	Hypothesis A	Hypothesis B	Hypothesis C	
Driver 2	Hypothesis X	Hypothesis Z		
Driver	Hypothesis μ	Hypothesis α	Hypothesis β	Hypothesis ξ

Table 2: Building micro scenarios step 3: story lines

Story 1: Driver 1, hypothesis A, with Driver 2, hypothesis Z, Driver 3, hypothesis α is called:
Story 2: Driver 1, hypothesis C, with Driver 2, hypothesis Z, Driver 3, hypothesis μ is called:
Story n: Driver ..., hypothesis ..., with Driver ..., hypothesis ..., Driver ..., hypothesis ... is called:

2.1.4 BUILDING MACRO SCENARIOS

A macro scenario, or global scenario is a scenario for the system as a whole, based on a unique combination of micro scenarios, including a micro scenario for each subsystem (Table 3). This assembling is done with consistency which means that for every set of micro scenarios thus put together a scenario evolves that bears logic and is explainable.

2.1.5 FROM SCENARIOS TO RESEARCH AGENDA

Once the scenarios have been developed it can be determined what the main factors are that are driving the future of the system. For each of the scenarios (or 'worlds' or 'realities') the question can be raised: what research would be needed in this situation, who will find this research and how is research organised.

SUB-SYSTEM	MICRO SCENARIO	MICRO SCENARIO	MICRO SCENARIO	MICRO SCENARIO	MICRO SCENARIO
A	A1	A2	A3	A4	A5
B	B1	B2	B3	B4	B5
C	C1	C2	C3	C4	C5
D	D1	D2	D3	D4	D5
E	E1	E2	E3	E4	E5
F	F1	F2	F3	F4	F5
G	G1	G2	G3	G4	G5

Table 3: constructing macro scenarios

There should be consistency between the scenario's world view (hence aims, policies) and the related questions that are base for research and who will be funding the research. As mentioned above, the aim is to create scenarios that depict really opposing futures. The aims of this is that if a certain type of research is needed in several of the scenarios, most likely this type of research is indeed a future need. If a particular research need only surfaces in a single scenario it can be queried whether this is a relevant topic.

2.2 PARTICIPANTS

Both from aspects of available budget as from the perspective of facilitation of workshops there was a limit to the maximum number of people which could be invited to the workshops. Therefore, a focus was given to those organisations that are representative at the highest possible level. For some that meant the European level for others it would be more on a regional or perhaps even national basis.

Based on the suggestions made by the COFASP partners the facilitators of the scenario building process made a final selection of stakeholders to be invited. The participants of the workshop were representatives from relevant stakeholder groups involved in fisheries, aquaculture and seafood processing (Annex 1).

3 OUTPUT OF THE COFASP FORESIGHT PROCESS

3.1 SYSTEM

The COFASP Foresight Analysis process focuses on defining the future research agenda in the field of marine living resources, in particular in the fields of fisheries, aquaculture and seafood processing. **Fisheries, aquaculture and seafood processing** are therefore the system discussed. The time horizon of the **system** was set on approximately 20 years into the future, resulting in the year 2035. A time horizon of 20 years was preferred over a 10 year time horizon as this allowed to let go of present political issues. The general opinion was that the further into the future you go, the more uncertain you are of the issues of concern. This corresponds to the aim of the process; think out of the box with developing *possible* future scenarios instead of *desired* future scenarios.

Participants were asked to list all issues that would be of importance to the system fisheries, aquaculture and seafood processing. The lists were subsequently aggregated in **7 subsystems** that together comprised all issues related to the system (Table 4):

A. **Policy:** political objectives and legislation in a EU and national and regional context, including political and policy changes and interaction of different levels.
B. **Economics/market:** all aspects of the production distribution and consumption of goods and services. Demand vs supply.
C. **Value chain:** chain of activities to deliver a valuable product or service for the market.
D. **Resource use:** the use of marine resources and the competition between different users.
E. **Society:** societal trends, demographics, and developments, including values around the marine system.
F. **Natural system:** biological, physical, chemical environment of human marine activities. The natural system included all animals, interactions, and sediments.
G. **Knowledge:** information, understanding, facts, technology or skills acquired through research, or experience or education.

It was determined that fisheries, aquaculture and seafood processing would not be recorded in separate boxes as the determined subsystems applied to all three. Even though COFASP is not intended for the marine system alone, the subsystems do mainly focus on the marine system rather than on freshwater systems. Discussed was that fisheries, aquaculture and seafood processing are predominantly related to the ocean. However, for finfish aquaculture the freshwater system is dominant but, when looking at aquaculture in general (including shellfish culture), it is predominantly related to the marine system. Several more actors need to be taken into account when including the freshwater system and inland issues, overcomplicating the development of future scenarios. So, for practical reasons there was a concession not to incorporate the freshwater system into this scenario exercise as such. However, some of the chosen subsystems are generic enough to include some issues regarding aquaculture on land (e.g. breeding).

3.2 DRIVERS

The participants listed relevant drivers related to the different subsystem. In total 34 drivers were determined that were essential for the different subsystems. The suggested drivers were evaluated during a group discussion and finalized. Table 4 shows the chosen drivers per subsystem and the hypothesis per driver are described below.

A.	**POLICY**
A1	Big issues: food security, energy, fresh water
A2	Food safety
A3	Conservation of resources
A4	Multi-level governance
A5	Regionalisation
A6	Stakeholder influence
A7	Political continuity
A8	Employment
B.	**ECONOMICS/MARKET**
B1	Economic climate
B2	Economic signature
B3	Globalization – competition BRICS
B4	Trading conditions and opportunities
B5	Access to capital (for business)
C.	**VALUE CHAIN**
C1	Consumer demand (user)
C2	Certification standards and traceability
C3	Valorisation of raw material and co-products
C4	Production costs
C5	Product development and marketing
D.	**RESOURCE USE**
D1	Environmental health status
D2	Access, user rights and alternatives
D3	Wants and needs for resources
D4	Technological advancement
E.	**SOCIETY**
E1	Demographics
E2	Population wealth
E3	Media and education (marine literacy)
E4	Regional differences
F.	**NATURAL SYSTEM**
F1	Physical and chemical forcing
F2	Species 'demographics'
F3	Resilience of the ecosystem
G.	**KNOWLEDGE**
G1	Funding
G2	Motive for generating knowledge
G3	Reliability of knowledge
G4	Access and openness of knowledge (IP)
G5	Uptake of knowledge and innovation capacity

Table 4: The European fisheries, aquaculture and seafood processing system comprising 34 drivers under seven subsystems

3.2.1 POLICY (SUBSYSTEM A)

A1. BIG ISSUES: FOOD SECURITY, ENERGY, FRESH WATER

Definition
The future challenges in Europe will be found in the realms of food security, energy and freshwater. This driver concerns the policies that are being developed to address these big issues.

Indicators
Food production, energy production, availability of freshwater resources, existence of policies.

Past development (last 10 to 20 years)
Importation of food and energy; self-sufficient in freshwater resources. In the last years there was an effort to look for alternative sources of energy (renewable energies) and to increase the production of food through the common policies. Water Directives and Marine Strategy Framework Directive addressed the issues concerning the quality of water. In future the availability of fresh water resources will become a challenge. With a growing world population and an increase in wealth resulting in changes in consumption patterns, the availability of food in terms of quality and quantity is rapidly becoming an issue as well.

Hypotheses
1 We *will* persevere: efficient common policies; self-sufficient food production; self-sufficient energy production; self-sufficient freshwater.
2 We *will suffer*: absence of policies; not enough food production, need to import; not enough energy production, need to import; limited freshwater.
3 We *will fail*: failure of policies; serious shortage of food production, need to import; not enough energy production, energy dependence from external sources; limited freshwater access.

A2. FOOD SAFETY

Definition
Aspects of health and quality concerning seafood and seafood products. In particular, the associated risk to the health of consumers.

Indicators
Seafood product safety standards and compliance with such standards. Number and severity of seafood product related health incidents per capita and per kilo seafood products consumed (outcome/effectiveness of policy).

Past developments
Incidences of unsafe and unhealthy produce have occurred. The awareness of consumers concerning both the health aspects of seafood products and safety issues has increased. This has led to an increase in (centralised) seafood safety standards. Health aspects such as omega-3 fatty acids and selenium have resulted in an increased consumption of fish and fish products. This increased demand of healthy fish, also in relation to the increase in demand for food as described under driver A1, results in a possible shortage of available, safe produce.

Hypotheses
1. Frequent outbreaks of consumers getting ill due to unhealthy seafood are common; seafood product safety standards are inadequate or non-existent.
2. Despite existing food safety policies, incidences of disease outbreaks related to unhealthy seafood occur as policies are not fully effective at preventing health related incidents.
3. All new and existing food safety risks are identified and mitigated/controlled before they pose a threat to consumers. All actors in the value chain are able to comply with the policy without reducing the attractiveness of business.
4. Food safety risks are identified and the policy framework exists, but the costs of implementing/comply-

ing with the policy make production uneconomical or unattractive to businesses.

A3. CONSERVATION OF RESOURCES (MANAGEMENT OF RESOURCES)

Definition
The availability of biological, physical and mineral resources and the related management choices in using these resources.

Indicators
Measures of exploitation of living resources in relation to sustainability. Indicators of biodiversity and habitat status. The rate of extraction and remaining reserves of minerals. The use and management of physical phenomena such as wind energy, tidal wave energy, temperature differences.

Past Developments
Over past 20 years most fish stocks have declined but are now recovering. Rate of oil and gas production has peaked and is now declining. Aquaculture production increased rapidly but has stabilised. Biodiversity may have declined with ecosystems subject to increasing pressure.

Hypotheses
1. Maximise resource exploitation over short term. Scramble for use of marine resources and space.
2. Seas return to "natural" state minimising human impact. Conservation is a priority.
3. Aquaculture is prioritised for seafood production over capture fishery management.
4. Well managed system of marine planning balancing the needs of all users.

A4. MULTI-LEVEL GOVERNANCE

Definition
Interactions and objectives of various tiers of government, for example at international, regional, national and local levels which may be legally binding or voluntary.

Indicators
Number and effectiveness of binding and voluntary international agreements, commitments, and frameworks and the level at which policy is being organized, e.g. member state, regional, EU-level or international. A special area of interest is the international cooperation in Europe's seas and oceans between the EU and non-member states.

Past Developments
Increases in the number and scope of international agreements, commitments and frameworks, however progress towards achieving stated objectives has been variable. These agreements, commitments and frameworks have constrained policy options available at lower governance levels, which have aided efforts to address trans-boundary issues.

Hypotheses
1. Member states disengage from the EU and international treaties and retain the prerogative of policy making in the marine realm.
2. Europe is a key decision-maker in international agreements and frameworks, and is able to represent and defend their interests.
3. Europe withdraws from all international agreements and commitments such as the Kyoto agreement, OSPAR and Millennium goals.

A5. REGIONALISATION

Definition
Devolution of decision-making powers to regions or regional bodies.

Indicators
Number of regional bodies, delegation of decision-making powers, ability to meet stated objectives.

Past Developments
Highly centralised decision-making by EU institutions and

national governments. Creation of some regional bodies (e.g. regional advisory councils), however these generally lack decision-making powers.

Hypotheses

1. No regionalisation; decision-making is centralised.
2. Regional decision-making frameworks that achieve strategic European objectives.
3. Highly distributed decision-making with no coordination between bodies or common objectives.

A6. STAKEHOLDER INFLUENCE

Definition

The ability for direct and indirect stakeholders to have access to policy makers and affect policy development. Access may be leveraged in different ways and for different agendas.

Indicators

Number of public (open) consultations, impact assessment of policies, stakeholder campaigns, stakeholder notification.

Past developments

Stakeholder influence has increased dramatically and stakeholder consultation is a foundation of policy. Impact assessment is an integral part of policy making.

Hypotheses

1. Policy makers do not consult stakeholders.
2. Stakeholders are consulted but have no influence on policy making.
3. Stakeholders have taken control of policy content.

A7. POLITICAL CONTINUITY

Definition

The degree to which the political landscape (and the related balance of power or political environment) of a defined area (region, country, EU, world) is subject to major or significant change between successive administrations.

Indicators

Number/frequency of elections, length of service of parties/politicians/decision-makers, number and type of laws/decisions being passed, code of conduct for politicians and parties, number and circumstances of people removed from office, number of coups d'état.

Past developments

EU enlargement – accession of former eastern block, Improved democratic processes in many parts of the world. Increased accountability of politicians. Increased tendencies of populism and nationalism in politics. Prolonged economic crisis highly affects policy and policy making across Europe. This has a large influence on, for example, the perception of the need to implement sustainability in environmental policies. In addition, politicians are tempted to avoid unpopular (yet necessary) measures.

Hypotheses

1. Complete continuity at all levels (apathy, all parties think the same, control by Big Brother).
2. Instable political landscape at National level, EU takes over controls and applies top down policy making and implementation.
3. Constant disruptive change at all levels – EU and national - lack of confidence amongst population.

A8. EMPLOYMENT

Definition

The number of people having a job at a given time.

Indicators

Number of FTEs, percentage of the population employed, skill or competence level, employment demographics (i.e. rural), seasonal, national or EU censuses, by sector.

Past developments

Employment is one of the key priorities of governments and government policies. Careers have evolved from one job in one place to multiple jobs in different sectors and geographical areas. Increased opportunities to develop skills. Since 2008 employment rates in the EU have dropped significantly. The Blue Growth objective as formulated by the EU seeks to counter the current economic crises by stimulating economic activity and employment in Europe Seas and Oceans. Unemployment is increasing around Europe, in particular in southern countries and among young people; lower labour force in Europe.

Hypotheses

1. High unemployment rates; availability of appropriate and skilled labour does not match quantity and quality of available jobs.
2. High employment rates; availability of appropriate and skilled labour matches quantity and quality of available jobs.
3. Balanced employment rates; a labour market in flux in which changes in job requirements are met by a developing labour force.
4. Overheated labour market; vacancies in the marine sector fail to attract skilled labour.

3.2.2 B. ECONOMICS / MARKET (SUBSYSTEM B)

B1. ECONOMIC CLIMATE (STATE OF THE ECONOMY)

Definition

Economic climate refers to a general characterization of the overall mood of the global or regional economy, which captures the status of the stock market, the perception of the economy by consumers, and the availability of jobs and credit. Business decisions such as hiring, borrowing, lending, and investment in new initiatives are often strongly influenced by the overall economic climate.

Indicators

Indicators of the economic climate focus on consumer attitudes towards the economy, such as e.g. consumer confidence, consumer expenditure and consumption and, on the other hand, indicators for the climate for investment, such as interest rates and availability of capital and industry willingness to invest. In addition, a main indicator of the economic climate is formed by the signature of the (economic) policies prevailing in a certain period in a given nation, region or internationally (EU).

Past developments

The economic climate in general moves in conjuncture patterns in which periods of prosperity and growth are interspersed with periods of economic crisis and decline of level of economic activity. Over the past decades we have seen quite an extensive period of prosperity throughout the '90s and early '00s, followed by a prolonged economic and financial crisis.

Crises do not affect all EU member states equally. Also, not all EU MS subscribe to the same instruments to be put to work to counter a crisis.

The introduction of the Euro in the early '00s has, more than before, and in addition with the Schengen agreements on free movements of goods, people and capital, demonstrated the urgency of managing the European economy at the EU level. This has led the EU to seek to enforce the regulations concerning the national budget and public depth rates of the Member States. This in turn amplifies the differences in Europe between MS that promote strict adherence to these rules and countries opting for more lenient implementation and parallel to this different degrees to which countries in Europe are being affected by the crisis.

Hypotheses

1. Permanent Crisis: the current economic crisis in Europe, despite slight recovery, prolongs for extreme long periods. Growth rates as for example witnessed in the '90s and early '00s are no longer feasible.

Implementation of strict EU budget and public depth rules create an economic climate of decline.

2. Investors Paradise: all regulations favour industry to invest. Government income (through taxes and levies) increasingly is derived from consumers and tax levels on industry are reduced.
3. Top down rule: in order to avoid prolonged and deep economic crises the MS and EU decide to develop a central set of directives guiding Europe's economy. As crises are caused by 'bubbles' in the economy, borrowing of money, be it public or private, is strictly regulated.
4. Blue lagoon: sustainability concerns dominate the economic agenda. Economic growth is not measured solely in terms of income, consumer expenditure and jobs but is also discounted for by negative impacts on ecosystems, skewed distribution of wealth among people and indicators of population's physical and mental wellbeing.
5. Feed the world: as a consequence of the policy of free movement of people, goods and capital the movement of people within Europe and from outside Europe towards the more wealthy parts of the EU increases rapidly, leaving these regions to cope with a large influx of people needing food, houses, security and jobs.

B2. ECONOMIC SIGNATURE (POLICY-CHOICES)

Definition

Political ideology for structuring economies and determining economic strategies.

Indicators

Level of government regulation regarding markets and market actors, level of market-related taxes.

Past developments

Reduction in the intervention by the state in economic matters. De-regulation of economic systems, with occasional difficulties or adjustments required. Increase in free-trade/reduction of trade barriers.

Hypotheses

1. Minimal government intervention or regulation of markets, low taxes (thus low government revenue from market activity); free-trade conditions.
2. High level of centralised government control or regulation of markets, high level of taxation (thus high government revenue from market activity).
3. "Fortress Europe" approach that encourages free trade within Europe, but discourages trade with third countries.
4. Abandonment of the European common market; return to nationalist markets and economic strategies.

B3. GLOBALIZATION – COMPETITION BRICS

Definition

This driver focusses on two main global processes: globalisation and the competition experienced worldwide by the new emerging economies. Globalisation can be defined as the process in which increasingly international integration is taking place. Part of this integration is manifested by opening up of economies and the transport of goods around the globe. This has facilitated the development of rapidly upcoming competitive economies, today referred to as the BRICS (comparable to the Asian Tigers of the 1980's): five major emerging national economies: Brazil, Russia, India, China and South Africa. The BRICS members are all large, fast-growing economies with significant influence on regional and global affairs; all five are G-20 members. As of 2013, the five BRICS countries represent almost 3 billion people, with a combined nominal GDP of US$14.8 trillion, and an estimated US$4 trillion in combined foreign reserves. Presently, South Africa holds the chair of the BRICS group. The BRICS have received both praise and criticism from numerous quarters.

Indicators

Indicators of globalisation (according to the IMF) and international competition can be found in four basic aspects: trade and transactions, capital and investment movements, migration and movement of people and the dissemination of knowledge. Further, environmental challenges such as climate change, cross-boundary water, air pollution, and over-fishing of the ocean are linked with globalization.

Past developments

Globalisation has over the past decades developed rapidly, not only as an autonomous process spurred by increased cheap ways of global communication, travel and transport but also as a result of direct stimulation of the development of the global economy and free trade as for example in the WTO. The movement of centres of production around the globe, and hence competition, is not a new phenomenon. However, the rapid growth of large economies such as the BRICS, is unprecedented. Especially the growth of China is perceived in a dual fashion: on the one hand as a supplier of cheap production, on the other hand as increasingly a major player in global competition which is expressed by increased competition for raw materials, minerals and energy but also increased competition for consumer goods.

Hypotheses

1. Europe's irrelevance: the shift in the global economy perseveres. The old economies are no longer at the centre of the global economy but resort to the periphery. The global competition has resulted in production structurally being moved to the southern hemisphere, leaving the old economies with no comparative advantage.
2. Seas of opportunities: with increased globalisation new markets are opened up, stimulating production and economic growth, resulting in an unprecedented global level of production and wealth.
3. Asian Union: confronted by increased competition from other parts of the world, major players in Asia team up to become a Union with internally free movements of people, goods and capital. To protect the union, movements from outside of people, goods and capital is strictly regulated, favouring the AU MS.

B4. TRADING CONDITIONS AND OPPORTUNITIES

Definition

The rules and principles according to which goods and services are bought and sold and the resulting demand for the goods and services and access to market.

Indicators

Level of freedom of trade – flow of goods and services between countries. Volumes exported and imported. Volume of sales and number of product/service inquiries. Share price index of the companies/concerns involved. Number and level/nature of sanctions and tariffs.

Past developments

Harmonisation of trading rules has come about. Establishment of WTO and various agreements signed and entered into (very important countries have joined, e.g. Russia + China). Bans/import restrictions are still imposed bilaterally.

Hypotheses

1. Harmonised, international system adhered to - level playing field for all traders in the world.
2. Breakdown in adherence to international agreements – each block/country protecting own interests.
3. No demand/significantly reduced demand for products and services.
4. Demand outstrips supply.
5. Increase in the black market.

3.2.2.1 B5. ACCESS TO CAPITAL

Definition

Access to capital to value chain – working capital.

Sources of capital:

- Internal (participants in the value chain)
- Private
- Public

Indicators

Interest rate, geographical distribution of money, willingness of banks to fund investments, share of debt and equity capital in companies.

Past developments

Finance market has become global. Bank crises made it difficult for SMEs to find capital. Shift from European/western financial markets to global (incl. Asia).

Private funds become more visible and want influence in the companies. Private/pension funds more proactive also in infrastructure. Crowd funding is on the increase.

Hypotheses

1. Collapse of major currencies / new "currencies" developing (Bitcoins/Barter systems, etc.) leading to uncontrolled interest rates.
2. Barter (non-monetary systems) economy: vertical integration through cooperation/cooperative organizations. less interference by established money monitoring/regulation systems, more individual BtB and C2C interactions, e.g. facilitated through web/apps. Increasing Cooperative/crowd funding/increased micro-finance/small/grey money lending market.
3. Monetary, controlled economy: total guided economy, regulation (e.g. restrictions on money transfer in the world) interest rates, high/increased public money/owned funding schemes (e.g. Chinese system).
4. Monetary, total free economy, multi-national companies rule the world (difficult to collect VAT from within one company).
5. Black market (illegal activities leading to illegal money market).

3.2.3 VALUE CHAIN (SUBSYSTEM C)

C1. CONSUMER DEMAND

Definition

The demand for a specific product; the demanded quantity of a specific product or the number of people who want a specific product.

Indicators

Demand for a specific product, sale volume.

Past developments

Historical demand for seafood products: both total and per capita demand increased after each world war in Europe. Relative per capita demand remains high but relative total is being overpassed by other regions (e.g. Asia). Increased dependency on fish from non-European countries. General increase in demand in non-edible sea products.

Hypotheses

1. Demand for sea produce reduces (high prices, healthy issues, poorer European population, other competing products).
2. Demand for sea produce increases (increasing population, healthy issues, richer middle class, etc.).
3. There is a shift in demand for sea produce towards the BRICS.
4. There is an increasing mismatch between produce wanted by consumers and produce available on the market.

C2. CERTIFICATION, STANDARDS AND TRACEABILITY

Definition

Public or private benchmarks used to define and differentiate products, processes and cycles. These may be within the value chain or towards society. They either need to be audited over a time period or comply with internationally accepted guidelines.

Indicators
Number of standards, number of certification bodies, public recognition of labels, demand for labelled products.

Past developments
Compliance with e.g. ISO and traceability have become mandatory. Consumers may be overwhelmed by number of options but recognise certain labels. Organic became and remains a niche market. Retailers looking for sustainability or responsibility. EU is developing organic and eco labels for aquaculture. EU Regulation of labelling of fisheries and aquaculture products continues to evolve. ENGOs have had a big impact on labelling.

Hypotheses
1. Number of B2C benchmarks is dramatically reduced; labelling is not a priority.
2. There is a single globally recognised benchmark (e.g. ASC, MSC); labelled produce becomes the standard.
3. There are only National or Regional labels; labels not widely recognised and no unification in certification procedures.
4. Too many labels have led to consumer mistrust and confusion.
5. Labels have become an attractive commercial market. Labels are developed to cater for market sub-segments. Costs of certification force individual producers to go "label-shopping" leading to less reliable labels and increased amount of labels on the market.

C3. VALORISATION OF RAW MATERIAL AND CO-PRODUCTS

Definition
Capacity of making an efficient use of raw material and to create added value to raw material and co-products.

Indicators
% of waste, earnings related to raw material cost, amount of new products from raw material.

Past developments
Valorisation was not a concern in the last years and companies were focused in the conception and improvement of their traditional products. With the introduction of eco-efficiency and the increase of production costs this became more important in recent years.

Hypotheses
1. No improvement: % of waste rises, no increase of earnings related to raw material cost, no new products.
2. Little improvement: % of waste reduces, no major increase of earnings related to raw material cost, no new products.
3. Major improvement: % of waste reduces, major increase of earnings related to raw material cost, a number of new products.
4. Valorisation heaven: due to the development of a wide range of new products wastes are reduces to zero earning related to raw materials.
5. Valorisation havoc: earnings from new products and use of raw material competes with traditional fish produce consumption less edible fish produce available for consumers.

C4. PRODUCTION COSTS

Definition
All the costs involved to convert the raw material into the marketable product.

Indicators
Availability, supply and costs of: raw materials, energy, fuel, transport, labour, overheads, packaging, equipment (including depreciation).

Past developments
Production costs in EU have increased, production has moved to cheaper parts of the world (but now starting slowly to return). Costs of transporting goods around the world has become cheaper - easier to transport larger

volumes around the world. Increasing cost of oil and fuel. Profit margins for producers are smaller (retailer taking the markup).

Hypotheses

1. Machine-based society dealing with all production.
2. Completely hand-based production.
3. Global reversal in the world – labour becomes cheaper in the EU and more expensive in Asia.
4. Energy costs get even more expensive.
5. Cheaper and alternative energy available.
6. Costs and logistics associated with treatment of waste lead to increased production costs.

C5. PRODUCT DEVELOPMENT AND MARKETING

Definition

"Product" includes tangible/material products but also includes intangibles/services. Development efficiency and effectiveness to reach your goal. Marketing is the activity of creating a market for your product.

Indicators

Number of new products developed, product lifecycle duration, number of ads for a specific product, market penetration, market differentiation, price differentiation.
Utilization of "big data" in business intelligence and in society.

Past developments

Top-down developments, based on established business intelligence. Focus on brand/brand value.
Product development typically done in separate organizations. Shift from traditional consumption to ready to eat/ready to cook, shift towards easy food and healthy food. The move from fish produce to fishy product.

Hypotheses

1. Bottom-up driven (consumer driven market) development processes, Collective intelligence, crowd sourcing. Individual improvements/developments (software/3D printing) "product"/services will be systems/facilitation services – building an "ecosystem" that self-regulates, evolves. Collective undefined needs, intrinsic control of development. Higher involvement/engagement from users/consumers.
2. Centralistic, controlled multinational companies influence politics and lead to top-down, extrinsic controlled developments. Research seen as a service for the industries/community development. Using big-data for providing in-depth information of market.
3. Niche market development. Consumer preferences (such as ready to eat, sustainable, healthy,) trigger seafood processes to develop specific market segments targeted products.
4. Bulk market. Shortage of natural resources forces processes to produce marine natural proteins in bulk. Aquaculture specializes in a few specific species, mass produced.

3.2.4 RESOURCE USE (SUBSYSTEM D)

D1. ENVIRONMENTAL HEALTH STATUS

Definition

The status of the marine ecosystem in terms of biodiversity and productivity.

Indicators

Indicator species, spawning stock biomass (SSB), presence of all life stages, biodiversity, non-indigenous species, food webs (presence of tiers), eutrophication, seafloor integrity, hydrographical conditions, contaminants, marine litter.

Past developments

Increased exploitation has caused an increased pressure on the environmental system, resulting in overfishing, the decline of certain species and/or an unbalanced presence of different life stages and damaging of the seaf-

loor. Biodiversity and the food webs have been adversely affected, resulting in a skewed distribution in species. Due to globalization, distribution of non-indigenous species has increased. Marine litter has increased over the last decades. Regulations concerning the marine environment have only been developed as recent as over the past 40 years.

Hypotheses

1. Excellent environmental health status: best status we can possibly have: good regime shifts: fishing + aquaculture continues.
2. Poor environmental health status due to: high pollution + low biodiversity (and extinctions).
3. Environmental health status pushed to high salinity (excessive and uncontrolled land use activities).
4. Virgin state of environmental health status (no marine use or exploitation at all).

D2. ACCESS, USER RIGHTS AND ALTERNATIVES

Definition

This driver refers to the way the use of marine resources is being regulated. It relates to the regulation of access and the regulation of use. Access and use can be regulated in many different ways ranging from licenses and permits to input controls, output controls and access charges.

Indicators

Licenses and permits required to use or access a certain marine resource.

Regulations concerning the use or access of certain marine resource.

Controls on output and inputs for the process of using certain marine resources.

Past developments

In general 2 main schools of thought can be distinguished in the use of marine (renewable) resources: the ownership school and the tradability school. The first relates to the question whether natural resources can be owned by a private entity or at all times is a common good to which only use-rights can be adhered. The second discourse relates to the tradability of use rights of marine resources. The latter is especially vivid in the use of fish.

Regulating our seas and oceans only developed recently. Grotius already formulated in 1609 his *mare liberum* (the principle that the sea was international territory and all nations were free to use it for seafaring trade - the disputation was directed towards the Portuguese *Mare clausum* policy and their claim of monopoly on the East Indian Trade). By the end of the 18th century, it was understood that states had sovereignty over their territorial sea. The maximum breadth of the territorial sea was generally considered to be three miles - the distance that a shore-based cannon could reach and that a coastal state could therefore control. In 1994 the 1982 agreed Law of the Sea treaty came into force, covering setting limits, navigation, archipelagic status and transit regimes, exclusive economic zones (EEZs), continental shelf jurisdiction, deep seabed mining, the exploitation regime, protection of the marine environment, scientific research, and settlement of disputes.

Today the sea is regulated in a multileveled governance setting were simultaneously regulations are made at the national level (wind farms), EU level (fisheries) and the international level (shipping). Still huge differences can be found between the regulation of the territorial waters (EEZ) and the high seas.

Hypotheses

1. Rule the seas: in order to safeguard the seas of being over-exploited a global legal setting comes into forces that regulates access and use of all marine resources. This framework is based on a sustainable use of resources.
2. Says who?: within the confines of national sovereignty access and use of resources is strictly regulated,

yet outside the EEZ no legal framework is put into place, leading exploitation to shift towards the unregulated high seas.
3. Incentives: licences and permits are used to have industry incorporate the externalities of production into the cost price of produce and products.
4. Free zones: following free trade zones on land and the flag state principal, globally areas develop where the local authorities allow unlicensed use of marine resources.

D3. WANTS AND NEEDS FOR RESOURCES

Definition

This driver refers to the will to use resources from the Sea either to satisfy a basic need (e.g. water, food), or any other motive (energy, health, leisure). Different resources can have a different trend, e.g. relative wants and needs for aquaculture versus wild fish, preferences for fish from a given fishing gear (selective gears versus non-selective gears).

Indicators

Volume of extractions (catches of species, production from aquaculture, sand extraction, oil extraction, etc.).
Percentage of (marine, littoral) space used.
Energy consumption (including horsepower) / emissions in marine related activities.

Past developments

Both total and per capita wants and needs increased after each world war in Europe. Diversification of resources subject to wants and needs. Increased competition between different uses. Wants and needs moved from basic needs to secondary needs (e.g. towards ecological/ethical products, leisure products, etc.).

Hypotheses

1. Blue growth: resource use increases, maximisation of resource utility.
2. Sustainable growth: economic growth is made subject to sustainability considerations and resource use is optimized in the light of ecosystem considerations.
3. Competitive growth: there are wants and needs for more different resources such as beach, fishing, and wind mills, which can create competition.
4. Precious resource use: a specific resource is preferred and the other resources are prohibited.

D4. TECHNOLOGICAL ADVANCEMENT

Definition

Incremental improvement in the known methods of production and the development of new innovative technology that allows access, extraction and value adding of marine resources in a more efficient manner.

Indicators

Number of emerging technologies, cross utilisation of technologies, number of new or more efficiently exploited resources.

Past developments

Massive technological advances over the past 50 years have allowed access, extraction and value adding of marine resources, e.g. ability to track and catch fish, aquaculture production in sea and on land, new aquaculture species, processing at sea and on land. Developments in other marine and maritime sectors.

Hypotheses

1. High tech world: technological fixes for all problems (robot world).
2. Cheap world: high level use of commonly available technologies leading to low cost production.
3. Intellectual Property right and other barriers limit technology advancement.
4. No money no honey: due to severely reduced investment in technology advancement, innovation has come to a full stop.

3.2.5 SOCIETY (SUBSYSTEM E)

E1. DEMOGRAPHICS

Definition
Population distribution and trends such as age distribution, wealth, global population distribution.

Indicators
Size, trend and distribution (e.g. spatial, age).

Past developments (last 10 to 20 years): what, how and who?
Population growth in Europe is stagnated in contrary to Asian countries (China, India); European population is getting older; population tends to move to coastal and urbanized zones.

Hypotheses
1. A growing world: huge population growth worldwide (especially in emerging countries). Wealth and related demand for produce increases in the BRICS. Population living in coastal areas. Majority of people in Europe are old. Restriction to immigration in the EU.
2. A stable world: population stabilizes, population spreads evenly across the globe. Trend from growth scenario to equal sharing of wealth.
3. An unstable world: unequal distribution of wealth in the world. Europe loses its wealth to the BRICS. Unequal distribution of wealth within Europe. Skewed population distribution, both in place and in age. Massive growth in especially emerging economies.

E2. POPULATION WEALTH

Definition
How much money people have and what is their purchasing power (also mental/spiritual wealth taken into account).

Indicators
Ability to purchase products beyond basic needs, physical mobility, capital + investments, surplus wealth/disposable income (donations to charity >>> number of charitable trusts/interests); (good physical and mental health status).

Past developments
Increasing wealth in emerging countries, increasing wealth gaps, monetary crises/speculation/experimentation, static/negative wage increases >>> affecting purchasing power in different parts of the world.

Hypotheses
1. Society becomes more egalitarian – wealth becomes more evenly distributed.
2. Gap between rich and poor gets even wider (intra EU).
3. Richer emerging countries contra poorer EU.
4. Things get so bad, society enters civil disruption.
5. Everyone gets richer!!!!

E3. MEDIA AND EDUCATION (MARINE LITERACY)

Definition
This driver refers to the marine knowledge existing in the population and in the media. Different population strata may have a different degree of marine literacy.

Indicators
Number of news (articles, papers, blogs…) related to marine environment and their impact ("likes", website visits…), surveys of marine knowledge in the population by strata, marine topics included in curricula (primary and secondary education, university…).

Past developments
Traditional knowledge on the sea (transmission in the family) has decreased. However, general public is more aware of envi-ronmental issues including the sea. Different degrees of influence of the media and on the media by different stakeholders (pro-fishing vs pro-environment).

Hypotheses

1. Low marine literacy; nobody cares for the sea.
2. Biased marine literacy; activist groups dominate the media; public opinion is pushed towards the activist agenda. The media has little influence on the attitude and opinion of the population.
3. Balanced marine literacy; on average people are aware of the issues playing a role in the marine world. Media portrays balanced views on the different aspects and opinions of the way the sea should and could be used.
4. High marine literacy; population is aware of the marine environment. Seas and oceans have become part of the regular curricula. Activist opinions no longer play a dominant role in agenda setting.

E4. REGIONAL DIFFERENCES

Definition

The different cultures, traditions, languages, beliefs, governance and legislative frameworks between and within countries.

Indicators

Multilingualism, ethnicity, autonomous governments, recognised country groupings (Baltic states, Balkans, Med), inter-regional cooperation, conflict(s).

Past developments

It can be argued that Europe is strong as a result of its regional differences. But these can also result in increased polarity such as a north-south divide. Trends of nationalism are increasing as is political will to favour regional (international) cooperation and development. Decentralisation of legislative framework. Devolution of government and attitudes to monarchies.

Hypotheses

1. High degree of differences between Europe's region and high competition between the regions. Political unification through Europe no longer exists. Cooperation in marine management is share impossible. Regional differences become more accentuated and more important than EU identity.
2. High degree of differences between Europe's region, yet an extensive willingness to cooperate despite the low degree of political unification through Europe.
3. High degree of national identity paired with a full integration of countries into regions; high degree of cooperation at the regional level in the light of European legislation.
4. Common and united Europe with a single European language (Esperanto). As a result of intra-European migration patterns a single European culture emerges.

3.2.6 NATURAL SYSTEM (SUBSYSTEM F)

F1. PHYSICAL AND CHEMICAL FORCING (INCLUDING TIPPING POINTS, EXTREME CONDITIONS)

Definition

The physical and chemical conditions that drive the abiotic environment of the ecosystem (climate, hydrography, nutrient levels).

Indicators

Temperature, salinity, pH, nutrients, hazardous substances, sea level.

Past developments

Increase in temperature, decline in strength of north Atlantic conveyor. Increasing nutrients (from human activity). Decreasing pH. Loss of Arctic ice. Overall increase in hazardous substances.

Hypotheses

1. Major variations to physical and chemical forces

cause substantial ecosystem changes providing new (positive) opportunities for ecosystem services.
2. Major variations to physical and chemical forces cause substantial ecosystem changes reducing ecosystem services.
3. No major change to physical-chemical forcing/ conditions.
4. Extreme weather conditions severely reduce opportunities to exploit the marine ecosystem.

F2. SPECIES DEMOGRAPHICS

Definition

The population, distribution, movement and interaction between all species that use the marine environment. This includes fish, invertebrates, plants, birds, mammals, plankton, microbes.

Indicators

Indices of population and population dynamics, biodiversity, epidemics, status of food webs and food chains.

Past developments

Methodology has changed from physically counting to various scanning techniques.
Increased understanding of interactions between species especially microbial communities, host pathogen interactions etc.
As a result of climate change size and composition of food webs have been severely altered.
Exploitation of marine species caused changes in the ecosystem.
After a height in fish exploitation and reduction in stock sizes, biomass currently is increasing.

Hypotheses

1. Composition of the food web is severely altered. Overall decline of commercial attractive species. Jellification of the ecosystem.
2. Increase in species composition as a result of new species entering the ecosystem as a result of climate change. Decrease in the more traditional species. Overall the goods and services level of the ecosystem is rather stable.
3. Invasive species stampede: shift in species composition as a result of invasive species dominating the ecosystem. Decrease in the more traditional species. Overall the goods and services level of the ecosystem declines rapidly.
4. Stable ecosystem composition; temporal fluxes in individual species are buffered over time.
5. Unstable ecosystem; as a result of changes to food webs the ecosystem develops towards tipping points.

F3. RESILIENCE OF THE ECOSYSTEM

Definition

The capacity of the natural system to remain in a relatively stable state, and to adapt to and to recover from changes caused by human and natural influences.

Indicators

Number of ecosystems recovered. Good environmental status: clean, healthy and productive.

Past developments

The existing policies did not incentivize the protection of the environment; there was a negative impact in the ecosystem in general; in the last years, conservation measures were introduced and in some cases the natural system shows signs of recovery. Yet as the exploitation rate of the numerous resources in the marine ecosystem increases the vulnerability of the marine environment increases and hence the resilience is negatively affected.

Hypotheses

1. Vulnerability: ecosystem resilience is low; impacts on the food webs cause severe alterations.

2. Punch bag: ecosystem resilience is medium; some impacts on the food webs are absorbed, others cause severe alterations.
3. Yoyo state: ecosystem resilience is relatively high as impacts on the food webs are fully absorbed, yet time to recovery is long and the ecosystem easily moves towards the irreversible tipping points.
4. Stability: ecosystem resilience is high; impacts on the food webs are fully absorbed.

3.2.7 KNOWLEDGE (SUBSYSTEM G)

G1. FUNDING

Definition
Availability of public or private capital for knowledge, technology, R&D and innovation.

Indicators
% GDP of public money, % GDP of private money.

Past developments
The % GDP slightly grew as funding and stabilized in the last 5 years.

Hypotheses
1. Public funding is cut in Europe, only private funding remains. Emerging countries are spending more money.
2. Public funding increases a lot, in Europe, private funding increases.
3. Europe is struggling to get 3% GDP, private funding remains the same.
4. No more public funding, only private fund.

G2. MOTIVE FOR GENERATING KNOWLEDGE

Definition
Reasons that individuals or organisations have to create new knowledge.

Indicators
Number of grant applications, number of students seeking further education or research opportunities, number of knowledge-acquisition awards, spending by the public and private sectors in research and development in relation to financial turnover.

Past developments
Public funding for research has declined. Private investment has decreased in some sectors but has increased in others (with possibly an overall decline). Investment norms and objectives (climate?) tend focus on short-term returns, as opposed to long-term research. Pressure on researchers to publish in academic peer-reviewed journals has increased.

Hypotheses
1. Demand for new knowledge, or ability to conduct research, decreases to the extent that generating new knowledge is unattractive.
2. Research capacity is focused on academic, "ivory tower" issues.
3. Research capacity is focused on problem-based, "real world" issues.
4. Funding and recognition of research increases, and motives for generating all types of knowledge are strengthened.

G3. RELIABILITY OF KNOWLEDGE

Definition
Reliability of knowledge refers to the trustworthiness of knowledge. It relates to the credibility, salience and legitimacy of knowledge: credibility reflecting the believability of the information, salience referring to the relevance of the information, and legitimacy as a measure of the acceptability of the information.

Indicators
Credibility, salience and legitimacy of the information.

Degree to which knowledge is being put the use. Number of disputes surrounding the use of certain information.

Past developments

Reliability of knowledge has always played a role. In science the peer review process seeks to guarantee this reliability. Increasingly it is recognised that scientific information is not the only source of knowledge useful in either innovation or policy development. Tacit or traditional, or users' knowledge increasingly finds its way to the (negotiation) table. Facts are no longer perceived as facts and saliency, credibility and legitimacy increasingly are important attributes of knowledge produced.

Science driven policy development makes way for evidence based policy development. Science as input in policy development increasingly meets criticism.

Hypotheses

1. I don't think so: regardless of the quality of knowledge produced, parties discredit the reliability of all knowledge not subscribing to their agenda.
2. Technopolis: knowledge is produced by the highest possible standards, fulfilling all kinds of peer review standards resulting in information being available that is beyond any reasonable doubt perceived as reliable. Science is reinstalled as the mother of all knowledge. All processes of innovation, technology development and policy development are firmly founded in science.
3. Mode II science: as problems tend to be complex and wicked which knowledge is being produced in a context-driven, problem-focused and interdisciplinary setting. It involves multidisciplinary teams brought together for short periods of time to work on specific problems in the real world, fully incorporating scientific and user knowledge.

G4. ACCESS AND OPENNESS OF KNOWLEDGE (IP)

Definition

The public availability and access to knowledge and technology.

Indicators

IP legislation, open access policies, public open databases, level of cooperation among stakeholders (R&D centres, companies, public administration).

Past developments

In the last years there was a trend to have more openness with public funded research. In the private industry there is a tendency to cooperate, but not sharing everything (open innovation). Laws of IP protection are strict but progress is made to adapt to the 21st century.

Hypotheses

1. Failure of open access policies, no cooperation among stakeholders, very strict IP legislation.
2. Complete access to knowledge, high cooperation among stakeholders, loose IP legislation.
3. Efficient open access policies, limited cooperation among stakeholders, strict IP legislation.

G5. UPTAKE OF KNOWLEDGE AND CAPACITY FOR INNOVATION

Definition

The level to which scientific and experience-based knowledge is packaged and communicated to different target users and how this process can lead to maximum innovation.

Indicators

Publications, citations, defined user groups and publications targeted for these specific groups of users, time from knowledge generation to application, routine expert as-

sessment of innovation potential, number of start-ups over a period.

Past developments

Focus still on dissemination (one way, often non-targeted) and often within our own "community". Recently we are better at targeting and understanding the need to show impact.

Hypotheses

1. Science leads to innovations, knowledge is appropriately disseminated, good cooperation throughout the process.
2. Innovation and science have no direct relationship, innovation is knowledge driven.

3.3 MICROSCENARIOS

The participants created micro scenarios by combining hypotheses per subsystem (table 6). Below a description is given for each micro scenario as developed by the workshop participants.

Table 5: Overview of hypothesis by subsystem

	MICRO-SCENARIOS				
SUBSYSTEM	**1**	**2**	**3**	**4**	**5**
A. POLICY	Don't worry be happy	Rabbit in the headlights	Command and control	Europe in splendid isolation	
B. ECONOMICS/ MARKET	Too much monkey business	Money, money, money	China Syndrome	Electric Stone Age	
C. VALUE CHAIN	You can't always get what you want	Corporate suit	Consumer's Choice	Bric - a - Brac	
D. RESOURCE USE	Too good to be true	We need to talk	Anarchy	United we fail/ OK for some	Brave new world; after war
E. SOCIETY	Imagine	Gated communities	Push and Pull		
F. NATURAL SYSTEM	Life in a changing world	Changes towards the collapse	Strangers in the night	Adam and Eve	
G. KNOWLEDGE	Nirvana	The Winner takes it all	Copycat	Knowledge a public good	

3.3.1 A. POLICY

DON'T WORRY BE HAPPY

This scenario is about a decentralised and participatory Europe. There is shared governance at all levels with orientation from the top and efficient implementation downstream. Regional decision-making frameworks are highly effective in achieving strategic European objectives. This stems for a large part from the fact that polices achieve a perfect local fit, also due to the fact that stakeholders are fully consulted and their views are taken into account. This system has a very stable basis over the years by developing effective common polices and rendering Europe a key player in the international arena. The system is solidly founded in a strive for gradual, incremental changes at all levels to engage citizens, and integrate diversity. Although policies at times can be stiff, all actors in the value chain are able to comply with the policy without reducing the attractiveness of business. There are sufficient raw materials for the needs of the population and the exploitation of marine resources by users is well managed. Hence, plenty of business opportunities arise. Employment rates are well balanced over regions and sectors.

RABBIT IN THE HEADLIGHTS

In this scenario the European experiment has failed. Member states disengage from the EU and international treaties and retain the prerogative of policy making in the marine realm. As a result decision making is scattered over different levels with no coordination between bodies or common objectives. Stakeholders are not included in the decision making process. Hence, there are constant disruptive changes at all levels – EU and national - and a lack of confidence amongst the population in policy making and the resulting policies. The main aim of marine policy making becomes the maximisation of resource exploitation over short term. The nations scramble for use of marine resources and space. Which results in serious shortage of food production (need to import), not enough energy production (energy dependence from external sources), limited fresh water access. Food safety risks are identified and the policy framework exists, but the costs of implementing/complying with the policy make production uneconomical or unattractive to businesses. There will be high unemployment rates and business investments are highly insecure.

COMMAND AND CONTROL

As a result of a highly instable political landscape at National level, the EU takes over controls and applies top down policy making and implementation. Rather than the top down scenario, in this scenario the EU takes full control with centralised command and control type legislation. The people will suffer because good policies exist but they bring many restrictions both in the form of limitations on business opportunities and also in a reduced availability of key essentials such as clean water, safe and sufficient food and nutrition and energy. Aquaculture is prioritized for seafood production as fisheries management is deemed to be too costly and too ineffective. Although at the central level Europe is a key decision maker and able to represent and defend interests, as the policy makers do not consult stakeholders, economic development and employment are unbalanced with variable rates in different regions and sectors. An united yet divided Europe emerges.

EUROPE IN SPLENDID ISOLATION

Europe withdraws from all international agreements and commitments. International competition is too high, therefore Europe focusses on itself. Policies are efficient, as decision-making is centralised. Food safety risks are identified and controlled before they pose a threat to consumers. There is political continuity at all levels (all parties think the same). Stakeholders are consulted but have no influence on policy making. As Europe relies on itself, resource exploitation is maximised over a short term. We are scrambling for the use of marine resources and marine space. Throughout EU there is unbalanced employment, as they vary in different regions and sectors.

3.3.2 ECONOMICS / MARKET

TOO MUCH MONKEY BUSINESS

The current economic crisis in Europe, despite slight recovery, prolongs for extreme long periods. Growth rates as for example witnessed in the '90s and early '00s are no longer feasible. Implementation of strict EU budget and public depth rules create an economic climate of decline. As a result, Europe becomes increasingly irrelevant at the world stage: the shift in the global economy perseveres. The old economies are no longer at the centre of the global economy but resort to the periphery. The global competition has resulted in production structurally being moved to the southern hemisphere, leaving the old economies with no comparative advantage. To come to grips with this a high level of centralised government control and regulation of markets appear with high level of taxation (thus high government revenue from market activity). Each economic block in the world seeks to protect its own interests. All resulting in an increase in black markets and, for example, Illegal Unreported and Unregulated (IUU) fishing.

MONEY, MONEY, MONEY

European countries have become investors' Paradise and the sky is the limit. Economy of Europe and also in other parts of the world is flourishing. Growth rates similar to those in the 90ties, there are many opportunities for investors to start new business. All existing regulations favour industry to invest. Government income (through taxes and levies) increasingly is derived from consumers and tax levels on industry are reduced. This creates for business seas of opportunities: with increased globalisation new markets are opened up, stimulating production and economic growth, resulting in an unprecedented global level of production and wealth. There is a level playing field for all traders in the world and a total free monetary economy. As a result, multi-national companies rule the world.

CHINA SYNDROME

As a consequence of the unequal distribution of wealth in the world, movement of people within Europe and from outside Europe towards the more wealthy parts of the EU increases rapidly. Leaving these regions to cope with a large influx of people needing food, houses, security and jobs. This leads the European fortress to close its borders and restrict the free movement of goods, people and capital. The European 'common market' is abandoned leading to the return of the nationalist markets and economic strategies. In order to counter the loss of jobs and production opportunities countries resort to the (re)introduction of trade barriers and tariffs. National production needs to be protected at all costs as the global economy renders the unprotected to lose out. Demand outstrips supply and as a result black markets emerge.

ELECTRIC STONE AGE

Europe is in permanent economic crisis. Europe no longer has a central role in the global economy and is at a disadvantage compared to the new world economies in the southern hemisphere. Trade barriers and tariffs are (re)introduced as national production needs to be protected. Seafood has become increasingly expensive and the population has no interest due to the high prices. The demand for seafood products and services is therefore significantly reduced. The European 'common market' is abandoned, free-trade conditions apply and nationalist markets and economic strategies have returned.

3.3.3 C. VALUE CHAIN

YOU CAN'T ALWAYS GET WHAT YOU WANT

As a result of increase in population and an average increase in purchasing power of consumers, the demand for sea produce increases. Consumer preferences (such as ready to eat, sustainable, healthy) trigger seafood processors to develop specific market segments. Business centres on high segmentation of the market and more niche market development. In this high demand market the incentive to produce new products is high. This has

led to a valorisation heaven: due to the development of a wide range of new products wastes are reduced to zero. In this situation produce branding and labelling develop into an attractive instrument for the commercial market to cater for market sub segments. However, this strife for increased use of certification and labelling and the associated costs of certification force individual producers to go "label-shopping". Leading to less reliable labels and increased amount of labels on the market. At a certain point there are too many labels leading to consumer mistrust and confusion.

CORPORATE SUIT

In this scenario Europe's people lose consumer power to the new economies. As a result of high prices, a less wealthy European population and competing demand the seafood consumption in Europe diminishes. A shortage of natural resources forces processors to produce marine natural proteins in bulk with a shift to ingredients and non-food applications; due to this development of a wide range of new products wastes are reduced to zero. Aquaculture specializes in a few specific species, mass produced aiming at a similar market of ingredients and non-food applications. As consumers have a very limited choice of seafood produce effective demand reduces severely. Centralistic multinational companies are in control and highly influence European politics and policies. Their main goal is revenue generation. Production processes are therefore mainly machine-based for a high efficiency. Labels are used to attract customers, are therefore available in high numbers and less reliable. Earnings from new products and use of raw material compete with traditional fish produce consumption.

CONSUMER'S CHOICE

In this scenario consumers drive developments in the fish produce and seafood market. As a result of demographic developments (increasing population, healthy issues, richer middle class) demand for sea produce increases. The market responds to this increased demand by a consumer oriented product development in which manual based processing techniques and artisanal production attributes are key. "Appellation de Origine" as reflected by national and regional labels; these labels are not widely recognised and no unification in certification procedures emerges. No special attention is rendered to increase efficiency in the production processes and reduce waste.

BRIC-A-BRAC

There is a shift in demand for sea produce towards the BRICS. In addition, worldwide energy gets increasingly expensive. Only national and regional labels exist, which are not widely recognised. This results in the development of a bulk market in which improvement on waste reduction or new product developments does not pay off. Aquaculture specializes in a few specific species, mass produced.

3.3.4 RESOURCE USE

TOO GOOD TO BE TRUE

Hi-tech technological advancement in combination with responsible use of licensing and permits lead to sustainable growth and responsible exploitation of resources. There is an excellent environmental health status; fishing and aquaculture is optimized. Economic growth is made subject to sustainability considerations and resource use is optimized in the light of ecosystem considerations. Licences and permits are used to have industry incorporate the externalities of production into the cost price of produce and products.

WE NEED TO TALK

As a result of competing use of the marine environment and its resources, but mainly as a result of excessive and uncontrolled land use activities, the marine ecosystem is pushed towards high salinity and hence poor environmental health status. An effective system of licences and permits are used for marine activities to have industry incorporate the externalities of production into the

cost price of produce and products. Hence the price of seafood increases. Unfortunately land based activities, polluting the seas and oceans, are not included in this system. Competitive growth: there are wants and needs for more different resources such as beach, fishing, and wind mills, which create competition. On top of that is technology advancement to address these issues limited because of intellectual property right and other barriers.

ANARCHY

As a result of high levels of resource exploitation, high degrees of pollution and low biodiversity (and extinctions) the environmental status is low. One of the causes is the maximisation perspective on resource use; resource use increases maximisation of resource utility. Following free trade zones on land and the flag state principal, globally areas develop where the local authorities allow unlicensed use of marine resources. Due to reduced revenues investment in technology advancement is severely reduced and innovation has come to a full stop.

UNITED WE FAIL / OK FOR SOME

Despite a new global legal setting based on sustainable use of resources and regulation of access and use, which should facilitate sustainable growth, there is poor environmental status. The measures developed fail to counter the high levels of pollution and the resulting low biodiversity. Although this trend is slowly being changed, and policy measures do have a positive impact on reversing the poor environmental status, the recurring choice for Blue Growth continuously stresses a truly sustainable use of marine resources. Technological development stems from private initiatives. Since these technologies are IPR protected, these do not become widely available.

BRAVE NEW WORLD; AFTER THE WAR

After a period of no-use of the seas the environmental state of the seas has veered back to the pristine state. Resource use is highly managed with a dedicated system of licences and permits. Incentives incorporate environmental costs into the production cycle. All marine resources are considered to be precious. Only those resources that are highly needed and can be exploited sustainably are considered. Resources are exploited at the lowest possible costs, using quite high levels of freely available (but old) technologies. Low investment in more advanced exploitation technology.

3.3.5 E. SOCIETY

IMAGINE

Population size stabilizes because of wish (birth control), people enjoy living close to each other in large cities. People who wish to live in more remote areas have the possibilities of participate in community in general. In all aspects of life, people make considerate choices. Cultural identity is nurtured, people with high tolerance and respect for each other. Perceived social justice is high. Equal opportunities for all – no matter the skin colour, gender, age, religion. People have a strong sense of self-responsibility, well-educated with knowledge and awareness of the sea. Wealth is evenly distributed – within society and between countries. Well-developed welfare system - social safety net, rights for health, education, food, human rights in all societies. No strict borders - refugees are almost none existing, but migration is possible. Good cooperation at regional level underpinned by legislation.

GATED COMMUNITIES

Population in Europe is highly divided. People live in gated communities - separate world of communities – wealth is strongly polarized into the super-rich vs. the “rest”. Cities strongly divided into neighbourhoods. The superrich sit on the capital, and the labour force has no chance of moving up the social ladder. High social injustice leading to civil disruption. Short-term, and self-centred thinking is the order of the day. The European population is decreasing, but the global increase of population puts pressure on the borders of EU and the resources. Borders

between countries and societies are closed. EU identity is diminishing. No regional cooperation, high degree of differences between Europe's regions, with strong competition. No unification and thus no coordinated marine management. Low marine literacy – with no attention for environment or the sea.

PUSH AND PULL

A high degree of national identity and cooperation, with substantial EU decision making, yet with a strong national implementation of regulation. Many organisations transmit biased opinions through social media. Apart from traditional media, large corporation marketing and communications strategies, and civil society groups campaigning are key opinion forming channels. Increasingly business and civil society groups build linkages to mutually benefit, which is driving biased marine literacy in society. Gap between rich and poor gets wider within the EU. Forced by international competition for resources, and low cost production, intra EU labour standards and employee protection walls are gradually torn down. Leading to lower minimum wages for the masses, less security and social safety nets, lower public health care and education spending. Above that fewer well educated talented people are able to obtain well paid jobs because of relatively old population. The younger generation has problems to access private benefit schemes and are at the same time restricted by increased taxation.

3.3.6 F. NATURAL ECOSYSTEM

LIFE IN A CHANGING WORLD

Ecosystems may change due to major variations to the physical and chemical forces. There will be an increase in species composition as a result of climate change but a decline in 'traditional species'. Yet, the ecosystem services and benefits are positive. New species are part of the ecosystem. The ecosystems enter new states that are stable and resilient.

CHANGES TOWARDS THE COLLAPSE

Oceans move towards tipping points where there are changes in ocean currents and acidity may cause changed opportunities for living on the planet (such as regional ice age, reduced persistence for calcareous organisms). As a result of the absence of ecosystem resilience the food webs have collapsed, reducing goods and servers being available.

STRANGERS IN THE NIGHT

Due to human impact on the ecosystem (fisheries, increased transport) niches are created for new species and new species arrive in large quantities. These new species together construct a rather instable ecosystem community which easily through series of tipping points flips to new states. Ecosystems resilience over time is reduced leading to an increase of the yoyo state.

ADAM AND EVE

The state of total stability. A very resilient ecosystem under stable climatic conditions absorbs all impacts. No major change to physical-chemical forcing/conditions occurs. Temporal fluxes in individual species are buffered over time. And ecosystem resilience is high; impacts on the food webs are fully absorbed.

3.3.7 G. KNOWLEDGE

NIRVANA

Public funding increases a lot, in Europe private funding increases as well resulting in large budgets available for research. Research and innovation is highly recognized in society. Interdisciplinary groups are brought together for short periods of time to work on specific problems. Companies see the benefits of open access and cooperation. There is high prestige from private foundations to fund projects to solve needs that have no business opportunity build in. Knowledge produced at highest possible standards. There is an open access to knowledge

and high cooperation among stakeholders. Knowledge is well transferred and used in many aspects of life – non-professional use knowledge – and further developed in open-source communities. Community based knowledge (wiki-type) open source distribution. Research and innovation is rapidly developing and efficient in solving the "real world" problems. Education fosters and encourages a curiosity nature. IP legislation is lenient and science leads to rapid and diverse innovation.

THE WINNER TAKES IT ALL!

Scientists are focused and specialized. Research is only funded by private funding and research is focused on solving "real world" problems. Interdisciplinary groups are brought together for short periods of time to work on specific problems. Private funds prefer to secure their IP rights and have no cooperation with other stakeholders. No uptake/dissemination of knowledge in the community. Community only benefits from innovation through the products/services they buy. Loss of efficiency in society as there will be a lot of duplication within businesses.

COPYCAT

Demand for new knowledge and the ability to conduct research is low. Science is not recognized and scientists have low prestige in society; science careers are not encouraged in the education system. Scientific results are being disputed, parties discredited if it does not fit into agenda of the stakeholders. Strict IP legislation and failure of open access policies hide the research for other stakeholders to build on. No cooperation, and innovation is done by trying to copy science from others. Because of the very strict IP legislations reverse engineering is used to do so.

KNOWLEDGE; A PUBLIC GOOD

Fixing the main challenges of society is considered to be a public affair. Public funding for research is made available in sufficient quantities. Knowledge is open access.

3.4 MACROSCENARIOS

After finalizing the micro scenarios, the participants developed macro scenarios (New World scenarios) based on a unique combination of micro scenarios. During a plenary discussion the developed macro scenarios were presented and determined if the storyline was logic and if any adjustments, such as merges, were necessary. Ultimately this resulted in the 4 final macro scenarios:

1. EUtopia;
2. "It's not EU, it's me…";
3. Fortress Europe… Not so splendid isolation;
4. Europe takes the lead with a Moral High ground.

Below a description is given for each New World scenario.

3.4.1 EUTOPIA

After the prolonged crisis of the first decennia of the second millennium the world economy, and of Europa, has veered back and is flourishing. Growth rates similar to those of the late 1990s reoccur sparked by regulations favoring industry investments. Seas of opportunities are created in a globalized world offering new markets, stimulating production and economic growth, resulting in an unprecedented global level of production and wealth.

EU policies and national policies fully align in the strive for enabling prosperity. There is shared governance at all levels; strategic leadership is combined with efficient downstream implementation of policies at local levels. Stakeholders are consulted and their views are taken into account by decision-makers resulting in regional decision-making frameworks are highly effective in achieving strategic European objectives. This stable system develops effective common polices, rendering Europe a key player in the international arena.

As a result of a stabilization of the human population, hence a reduction in population growth, wealth is evenly distributed (within society and between countries). In this scenario the consumers drive developments in the fish produce and seafood market. The stable population with a richer middle class is focusing on health issues and the demand for seafood produce increases. The market responds to this increased demand by a consumer oriented product development in which artisanal production attributes are key. "Appellation d'Origine" as reflected by national and regional labels are striving and setting the market standard.

Although the ecosystems are in flux and remain highly dynamic and may change due to major variations to the physical and chemical forces, the ecosystems enter new states that are again stable and resilient. There is an increase in number species as a result of climate change but a decline in 'traditional species', yet, the net effect on ecosystem services and benefits are positive, resulting in even more productive ecosystems.

People have a strong sense of self-responsibility, well-educated with knowledge and awareness of the sea. There is a strong sense of belonging to ONE Europe, ONE world we have to explore and exploit carefully and sustainably. Geographical borders lose their significance, the natural boundaries of ecosystems become a leading principle leading to excellent cooperation at regional level. In fact it resembles a world nearly too good to be true: (Hi-tech) technological advancement in combination with rather strict yet effective management (responsible use of licensing and permits) lead to sustainable growth and responsible exploitation of resources. There is an excellent environmental health status as economic growth is made subject to sustainability considerations and resource use is optimized in the light of ecosystem considerations. Licenses and permits are used to have industry incorporate the externalities of production into the cost price of produce and products.

Fixing the main challenges for society is considered to be a public affair. Public funding for research is made available in sufficient quantities based on knowledge as being open access. In addition with a keen interest on innovation also private funding for research increases. As a result research and innovation develop rapidly and are effective in solving "real world" problems. Companies see the benefits of open access and cooperation and in addition there is high prestige from private foundations to fund projects to solve needs that have no business opportunity build in. Knowledge is well transferred and used in many aspects of life and further developed in open-source communities.

3.4.2 "IT'S NOT EU, IT'S ME..."

The European project has failed. There is a permanent economic crisis with decreasing economic activities in Europe and a nationalistic political system with a shift to reactive "crisis management" with no cooperation among EU countries. Nationalist markets and economic strategies are predominant. This results in the emergence of a bulk market in which improvement on waste reduction or new product developments does not pay off.

There will be high unemployment rates and business investments are highly insecure. As one consequence Europe will face a shortage in food production even with high subsides leading to a need for imports. With not enough energy production Europe is dependent on external sources. Businesses merge and get larger which gives them power to rule the markets (national and international). The population in Europe is highly divided and wealth is strongly polarized with no possibility to climb up the social ladder. Borders between countries and societies are closed.
Each state makes its own (marine) policies and has disengaged from international treaties. Stakeholders are not involved in the decision making process and there is a lack of confidence amongst the population in policy making.

No regional cooperation takes place and thus marine management is not coordinated. The high seas stay as areas of open access. Marine literacy is very low and the public does not have attention for environment or the sea.

Resource exploitation over the short term becomes the main aim. As a result of competing use of the marine environment and its resources, but mainly as a result of excessive and uncontrolled land use activities, the marine ecosystem is in a poor environmental health status with reduced resilience and instable ecosystem communities. Aquaculture specializes in a few specific species (salmon, shrimp, tilapia, catfish), mass produced. However, there is limited fresh water access.

Europe no longer has a central role in the global economy and is at a disadvantage. Trade barriers and tariffs are (re)introduced as countries feel that national production needs to be protected. This is forcing up the cost of seafood and decreasing its demand in Europe. At the same time the demand in other parts of the world (BRICS) is increasing. In Europe national labels are increasingly used. Demand for new knowledge and the ability to conduct research is low. Scientists have a low prestige and scientific results are disputed if they don´t fit into people´s agenda. There is no true innovation. There is strict IP and instead science is copied by reverse engineering.

3.4.3 FORTRESS EUROPE... NOT SO SPLENDID ISOLATION

Within the environment of increased global competition Europe is focusing on itself. It has political continuity, but maximal resource exploitation and use of marine space are at the top of the agenda.
The global distribution of wealth is heterogeneous and some European countries experience increased migration that threatens food, houses, security and jobs. Europe closes its borders and restricts free movement that has underpinned its previous guiding principles. With no common market, member states take back responsibilities for economic and other social strategies. National production and economies become the driving force where national labels are increasingly used, but this also leads to the emergence of black markets and parallel economies.

Trade barriers force up the cost of seafood and decreases its demand in Europe, but demand increases in other parts of the world (BRICS). This results in the emergence of a bulk market in which improvement on waste reduction or new product developments does not pay off. Global aquaculture specializes in a few specific species (salmon, shrimp, tilapia, catfish), mass produced, but growth of the sector in Europe remains very limited.

Europe is internalized in the face of the BRICS development, but nevertheless manages to have optimized use of the resources. Management takes place by means of licenses and environmental/ecosystem health is generally good.

While the EU maintains its power in terms of policy decision-making and legislation, there is a strong divergence between member states in implementation. Governments and companies use social and other media to form and influence societal opinions. Although marine literacy is generally high Europe's reduced competitiveness reinforces the wealth gap across the continent and within its member states.

Although ecosystem health is generally good, it becomes increasingly challenged due to increased human impact. These impacts allow new species to develop and this renders ecosystems more and more susceptible to the yoyo effect.

Research funding is almost exclusively by private funds and although scientists are focused and specialized to work on specific problems, the private funding sources demand higher IP rights and hence reduce cooperation, at least not with third countries. This sometimes leads to business inefficiency resulting from duplication and overlap of research outputs and inward focused knowledge management.

3.4.4 EUROPE TAKES THE LEAD WITH A MORAL HIGH GROUND

Wild fisheries are the last large scale human exploitation of wild stocks. However, harvesting on an industrial scale is no longer the standard. This future scenario envisages a sophisticated, well organized and well controlled recreational and artisanal/small-scale harvesting regime. The marketing of the produce is locally controlled and consumed. Depending on the amount produced, and if there is a surplus, depending on demand, Europe has a limited international trade in these products.
Persuaded by the public, the EU takes the lead on taking a stand and developing a policy on how to harvest marine animals in a sustainable and low impact way. Besides that consumers are very critical on ethical principles and all animals are considered to be sentient beings. There are tight limits within Europe on aquaculture in terms of species and areas where the production can take place. The insistence on having high ideals with respect to the careful and sustainable use of the environment leads to Europe becoming a high cost economy. Raising the bar has a price, but the consumer is willing to pay for it. Europe has the potential to export high quality niche produce with "appellation d'Origine".

In this niche production there is a focus on achieving greater efficiency, however it is still not cost efficient. The niche labels have high status and are in high demand. Production from these approved enterprises reinforces the moral high ground for the EU. This form of production is achievable by means of careful use of resources.

Public awareness about preserving the environment and carefully using the ecosystem services has led civil society groups consisting of both environmental groups and small scale fisheries groups to have a big influence on this. Together, they see the benefits of preserving the environment. At the same time the world is changing fast and the response to that is to play safe with its resources in the oceans. Hence a greener way of using resources and recognizing animal rights more strongly; the ecosystem can support that and benefit from it.

Knowledge is a public good and there is public access to ecosystem information. This is done in the form of a promise to make sure that the world knows about the marine ecosystem and animal welfare: their status and how things are developing. Research is genuinely in the public good and in turn is supported by national resources. The debate is all about the public good. This sets a big research agenda: new knowledge and methodologies for understanding exactly what quantities are available to be harvested and what the impact will be on the ecosystem. Research is carried out in an extensive collaborative way between the research world and the artisanal and recreational fishers. The development of high quality niche products will also be strongly supported by research.

3.5 RELEVANT RESEARCH TOPICS

The participants reviewed the macro scenarios and determined:

1. The FEEL of the scenario.
2. What is the situation in Aquaculture, Fisheries and Seafood processing in this scenario?
3. What are the challenges and problems this world is facing and specifically in Aquaculture, Fisheries and Seafood processing?
4. What science/research topics can be identified to help in this scenario?
5. How is the science organized in this scenario?

In ANNEX 2 a long list is given of the research needs and topics per New World scenario.

Based on the long list in ANNEX 2, a future research agenda was developed as is described below for the following themes: Marine science in general, Environment, Fisheries, Aquaculture, Seafood processing, Value chain, Governance and Organization of research and funding.

4 FUTURE RESEARCH

4.1 MARINE SCIENCE IN GENERAL

The use of Europe's seas and oceans will intensify. Partly as a result of an increase of traditional uses of the sea and an increased relocation of land-based uses towards the sea. Partly an increased use in a search for new ways to explore the richness of the seas and oceans. This leads to the following research topics.

Optimal use of the seas: what is the optimal sustainable use of our seas and oceans with increased possibilities of using available resources in novel ways and using novel ways to extract and use marine resources? This question has a bearing on the development of an overarching system of marine spatial planning (also see section on Governance).

Value of use of the seas: in order to strive for an optimal sustainable use of the seas it is important to be able to put a value to existing and potential future ecosystem goods and services. Related to this is the question of costing the impact of activities on the marine ecosystem and incorporate these costs into the production costs in the value chain. Together with non-economic values, this analysis will provide a basis for a societal cost-benefit analysis of different activities, especially in a world with increased competition for marine resources, especially space. This in turn will provide an important input into marine spatial planning.

4.2 ENVIRONMENT

In general continued basic research into the state and functioning of ecosystems is required. In addition, there are general challenges to be addressed in order to achieve sustainable use of Europe's seas and oceans.

Low impact products: a general challenge to all uses of the marine environment is to develop products and production techniques that not only reduce direct impact on the marine resources directly exploited, but are produced with the lowest possible impact on the marine ecosystem, including its associated carbon footprint.

Sustainable use strategies: combined with a strive for low impact products there is a need to devise holistic strategies at the level of Large Marine Ecosystems for sustainable production. This will include a definition of ecosystem and environmental boundaries, setting up strategies for marine resource use and prevention and mitigation measures.

This will require a methodology in which impacts of a multitude of activities can be determined at the appropriate ecosystem geographical and time scale. An example of such a methodology can be the **modelling and risk assessment** of disease and pathogen distribution in wild populations and aquaculture systems; develop prevention and treatment systems. Another example can be to devise a methodology that considers **species adaptation to ecosystem change** and the ecosystem impact considerations of the restoration of certain species.

4.3 FISHERIES

A challenge in the exploitation of fish stocks will be the balance between stock and ecosystem status and the exploitation of marine resources.

Monitoring and Management: for the appropriate management of the ecosystem it will remain necessary to develop long term integrated management plans for resource use. Especially in the field of fisheries this will require models that can reliably predict the dynamics of ecosystems and activities undertaken in the ecosystem. In addition, it will require user-friendly monitoring programs or techniques that result in reliable assessments of exploited marine resources/populations which clearly assess the impact of (alternative) fishery management programs on sustainable use of shared resources. The development and use of technology to improve monitoring and surveil-

lance will be required in addition to continued improvements in monitoring and data collection.

Adaptation strategies: the fisheries sector is confronted with a multitude of challenges that will require an adaptation of prior used (fishing) strategies. As result of ecosystem change, how can fishers adapt vessel types and equipment to make a fit with the new dynamic circumstances? In addition, how can fishing fleets respond to a societal call to develop low impact fishing methods, such as eco-friendly powered vessels, low impact fishing gears? And, in the light of market demand, how can the entire harvest of vessels, including by-catch and discards, be appropriately managed and used?

Data use: in order to provide a basis for management of resources and the development of the industry's fishing and management strategy it is necessary to develop technology and methodology that will allow effective and accepted obtaining and using fishery-independent data and commercial data from industry, especially in small-scale fisheries.

Recreational Fisheries: a major challenge is the potential and role of developing recreational fisheries and other recreational uses of the sea (e.g. tourism). How do these activities relate to other commercial uses of marine space and resources and how does competition between alternative uses of resources develop?

4.4 AQUACULTURE

The role of aquaculture will remain important over the next decades. Challenges to the sector are found in the production system and its effect on the wider environment and in using the potential of new modes of production.

Market demand: noting consumer demand and production costs across all modes of aquaculture production, a main challenge remains to be the species that can be cost effectively produced and meet market demand. In this there are several challenges being posed to the sector; which species and production techniques can serve a high-value novel niche market? In case of multiple potential aquaculture species, how could a diversified production scheme look like? And how can aquaculture producers operate in a market characterized by multiple high-value products?

Organic aquaculture: related to market demand is the special case of organic aquaculture. Main questions related to this issue centre on developing the system, using the potentials for herbivore species, sources of feed, plant aquaculture, bivalves (shellfish). The main challenge is to lower the production costs relative to conventional methods.

Technology development: there is a continued demand for improved recirculation facilities and research into multi-trophic aquaculture/agriculture/hydroponics (i.e. both directions: sea-land and land-sea) and off-shore Multi Trophic Aquaculture. In order to devise these systems, a better understanding of the potential of Multi Trophic Aquaculture systems is required. In addition, the potential health issues of IMTA components should be addressed, as well as the identification of potential species, sources of feed, water treatment technology and increases in water/feed efficiency.

Species enhancement: as for the potential use and enhancement of species, starting point has to be addressing the issue of aquatic animal health and welfare. In addition, research into GM (genetically modified) feed use and fish genetic strains with low environmental risk will be addressed. Species adaptation to ecosystem change will have to be taken into account. Some aspects can be addressed through coordinated breeding programmes.

4.5 SEAFOOD PROCESSING

The main challenge in the seafood processing industry

was found in addressing an increased need to more rapidly adjust to changes in production and demand.

Towards more flexible production units: with a production sector with a more diverse (and more seasonal) production and an European market characterised by multiple market segments (high-value (non-bulk) products, next to bulk ingredients market) there will be a strive away from single-species production plants towards more small-scale and multi-purpose processing units. Research into developing these small-scale and multi-purpose processing units is required.

Maximise processing efficiency: there is an increased strive to fully use all of the harvested fish produce, be it from aquaculture or wild capture fisheries. On the one hand this implies maximisation of the filet yield. On the other hand, it also entails optimising the use for fish meal and oil coming from the remains from fish processing (from trimmings) and the use of all co-products for high value products for feed, food, pharmaceuticals and cosmetics.

New products and new production technologies: in addition to optimising the use of the fish harvest there is also the need to develop production technologies for new resources such as seaweed and algae such as the production of biodegradable packaging (from seaweed). In addition, there is a need to overall reduce waste and environmental impacts in processing.

4.6 VALUE CHAIN

The main challenge in the value chain can be found in achieving integration over the distinct links on the production chain form primary production to consumption.

Increased sustainable efficiency: a generic challenge to the fisheries, aquaculture and seafood processing sectors lies in a search to increase efficiency of vessels and gears, of aquaculture production (e.g. feed conversion ratio, time to slaughter) and in seafood processing which at the same time reduces impact on the ecosystem and makes the most efficient use of harvested resources. The entire value chain will have to adapt to this principle of 'more with less', especially new technology/techniques in the processing sector will have to be developed to adjust to changes in raw materials (e.g. species, size).

Setting standards: a major concern is the development of methods to ensure that seafood products meet appropriate standards for health and safety. This includes both setting of health and safety standards as well as devising systems such as labelling, to communicate produce attributes. This will include the identification of threats to food safety along the supply chain, compared to thresholds for safe human consumption, and to develop programme/standards to prevent threats from entering the supply chain.

Information in the value chain: communication of attributes of produce along the value chain across the individual producers towards the final consumer is very important. One of the issues that needs to be addressed is: how can labelling and standardization be organized in the value chain towards a multitude of consumer groups and markets? Steps towards these can be taken by looking into Best practice for certification and labelling and into the development of EIDs (electronic identification documents) providing relevant information along the value chain operators and final consumers.

4.7 GOVERNANCE

The main challenge in governance is devising a governance set up that addresses the major challenges put to society in such a way that all relevant actors in the production process and value chain participate in the management of marine resources.

Control: a main issue is the establishment, in a dynamic world and a permanently changing ecosystem, of a frame-

work for management to ensure resource use (including pollution) to stay within identified and agreed upon limits. This will include the question of which incentives could be used to ensure compliance of the industry and which technology could be further developed to support this (e.g. effort controls, VMS, CCTV).

Licence to produce: increasingly producers need to acquire a licence to produce: a public consent to the industry to exploit the marine environment. Obtaining this licence to produce pertains on the one hand the provisioning of (science based) information on primary production and across all steps in the production chain. On the other hand it would require insights in the public attitudes towards marine production and communication between producers, consumers and citizens.

Participation: with a growing complexity of the management challenge at Europe's seas and oceans there is an increased need for Marine Spatial Planning and Monitoring and Evaluation of the use of marine resources. The effective implementation of this calls for the development of a platform for stakeholders to increase participation/input in decision-making and evaluation processes.

4.8 ORGANISATION OF RESEARCH AND FUNDING

The financing and organisation of research will over time depend on the relative priority given to (marine) research, the availability of funding from either public or private sources and the organisational level at which science will be organised. Below some tendencies are presented.

Research can be organised at three levels: at the level of the individual Member State, at the central EU level and at the regional level. With increased regionalisation towards the regional seas this regional level is expected to become of more importance, for example through the development of regional research financing structures such as ERA-nets.

In line with this development it seems logic that increasingly investments in major research infrastructures are not financed at the Member State level but at a more central level, such as the regional sea level. In addition to this, transfer and extension of knowledge can be organised at a more central level in dedicated centres of transfer of excellence.

Always a balance has to be struck between public and private funding of research and ways in which the two can cooperate. Noting the need for data sharing and making commercial data more widely available for research a cooperation between science and producer organisations, with clear mandates tools to share performance data and market intelligence, should be developed.

New to this way of financing is the possible development of micro-financing (private and public opportunities): local initiatives to address local problems. This form of addressing problems will allow for high levels of local participation and addressing the problems identified by local residents.

In addition, a balance should be struck between short-term oriented research programs focussing on market and applied science (e.g. development of high-value products/niche markets) and more long term research programs focussing on a shared understanding of long-term ecosystem dynamics.

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WP1: Foresight analysis. Workshop 4.

ANNEX 1 WORKSHOP PARTICIPANTS

LAST NAME	FIRST NAME	ORGANISATION	COUNTRY
Bernal	Miguel	General Fisheries Commission for the Mediterranean (GFCM)	Italy
Casey	John	STECF	United Kingdom
Clink	Sally	Baltic Sea Regional Advisory Council	Denmark
Cook	Robin	EFARO	United Kingdom
Costas	Benjamin	Oceano XXI	Portugal
Derichs	Camiel	Marine Stewardship Council / Regional Director Europe	Netherlands
Domingues	Carla	Oceano XXI	Portugal
Doring	Ralf	STECF	Germany
Duguid	Lorna	North Sea Regional Advisory Council	United Kingdom
Edvardsen	Torgeir	SINTEF Fisheries and Aquaculture / European fisheries technology platform	Norway
Eripret	Mariella	CNC-Euroshell project	France
Kellermann	Adi	ICES	Denmark
Lane	Alistair	European Aquaculture Society (EAS)	France
Lisbjerg	Dennis	DTU Aqua / COFASP	Denmark
Luis Filipe	Castro	Oceano XXI	Portugal
Lund	Jorgen	North Atlantic Seafood Forum	Norway
Marino	Giovanna	ISPRA	Italy
Miller	Katie	Client Earth	United Kingdom
Motos	Lorenzo	AZTI Tecnalia	Spain
Ni Cheallachain	Cliona	AquaTT	Ireland
Nool	Floris	North Atlantic Seafood Forum	Netherlands
Ohms	Verena	Pelagic RAC	Netherlands
Punzo	Elisa	CNR ISMAR	Italy
Johne	Berit	JPI Oceans	Spain
Scarcella	Giuseppe	STECF	Italy
Valdimarsson	Grimur	Ministry of Industries & Innovation Iceland	Iceland
Van der Heijden	Paul	North Atlantic Seafood Forum	Netherlands
Van Doren	Davy	Mature development BV	Netherlands
Veitch	Liane	Client Earth	United Kingdom

ANNEX 2 LONGLIST RESEACH NEEDS AND TOPICS

The present Annex is a long list of all research needs and topics, and research organization and funding described by the workshop participants for the 4 New World scenarios. Those mentioned for the New World scenario Fortress Europe are in red; those mentioned for the Moral High Ground are in green; those for It's not EU, it's me... are in blue and those for EUtopia in yellow. In the latter scenario research topics are specified per area; aquaculture (A), fisheries (F) and seafood processing (P).

MARINE SCIENCE IN GENERAL

- Biotechnology – search for new materials, elements, by-products from plants, substitutes for animal products.
- Devise market mechanisms to pay for the high cost of protecting the ecosystem.
- Put value on eco-services (A, F).

ENVIRONMENT

- Basic research on the state and functioning of ecosystems.
- Development of low impact products.
- Set up monitoring, investigate environmental boundaries, develop prevention, mitigation, and sustainable-use strategies.
- Model and assess risk of disease and pathogen distribution in wild populations and aquaculture systems; develop prevention and treatment systems.

FISHERIES

- What is the impact of fishery management programs on sustainable use of shared resources? & What monitoring programs or techniques could result in reliable assessments of exploited marine populations? & What models could reliably predict the dynamic of ecosystems?
- In the light of changing ecosystems, how could fishery adapt appropriately (e.g. vessel types / equipment)?
- In the light of decreased supply, how could by-catch and discards be appropriately managed?
- Use of technology to improve monitoring and surveillance.
- Developing recreational fisheries and other recreational uses of the sea e.g. tourism.
- Low impact fishing methods, improvement of efficiency in the small scale fleet.
- Multi-annual planning with contingency measures (F). & Appropriate % of stocks that can be removed (F). & Develop user-friendly stock reference models - ecosystem & precautionary approach (F) & Continued improvements in monitoring and data collection (F).
- Develop eco-friendly powered vessels (AFP).
- Species adaptation to ecosystem change (AF)& Restoring certain species(AF).
- How to get/use commercial data from vessels (F) & Technology to obtain fishery-independent data (F).

AQUACULTURE

- Which species, that could serve a high-value novel niche market, could be produced in aquaculture? & In case of multiple potential aquaculture species, how could a diversified production scheme look like? & How could a market characterized by multiple high-value products be labelled and standardized appropriately?
- Research in organic aquaculture, primary producers, potentials for herbivore species, Plant aquaculture, bivalves (shellfish), to lower costs relative to conventional methods.
- Genetic strains with low environmental risk.
- Improved recirculation facilities & Research into multi-trophic aquaculture /agriculture/hydroponics (i.e. both directions: sea-land and land-sea) and offshore MTA &.
- Research into aquatic animal health and welfare.

- Identify new species, sources of feed, water treatment technology; increase water/feed efficiency.
- Understand better the system (IMTA) (A) & Address potential health issues of IMTA components.
- Species adaptation to ecosystem change (AF).
- Restoring certain species (AF) - Restoration of key species.
- Coordinated breeding programmes.
- GM – feed ingredients – closed containment (greenhouse) production of DHA-enriched seed crops.
- Live feed replacement solved!

SEAFOOD PROCESSING

- In a market characterised by multiple high-value (non bulk) products, what could be the role of small-scale and multi-purpose processing units? & In case such small-scale and multi-purpose processing units could prove valuable, how should they look like?
- In the light of decreased supply, how could by-catch and discards be appropriately managed?
- Technological research for multi-use facilities because catch is more likely to be locally caught and change seasonally.
- Potentials for fish meal and oil coming from the remains from fish processing (from trimmings).
- Technical improvements to reduce waste and environmental impacts.
- Maximise filet yield & Use of all co-products for high value products for feed, food, pharmaceuticals, cosmetics.
- Biodegradable packaging (from seaweed) – fish boxes - polystyrene finished & Seaweed processing.
- Recycling of water.

VALUE CHAIN

- Investigate the potential for value added for niche fish products.
- Methods to ensure that seafood products meet appropriate standards for health and safety (both local and imported.)
- Marketing strategy for new products (diversification of demand).
- Increase domestic production to meet demand over long term (addressed in other variables).
- Identify threats to food safety along supply chain, compare to thresholds for safe human consumption, develop programme/standards to prevent threats from entering supply chain.
- Increase efficiency of vessels and gears, of value chain, and of aquaculture production (e.g. feed conversion ratio, time to slaughter).
- New technology/techniques in processing sector to changes in raw materials (e.g. species, size) and in aquaculture production.
- New distribution channels to ensure products widely accessible.

INFORMATION IN THE VALUE CHAIN

- How should labelling and standardization be organized in the presence of multiple high-value, non-bulk, products?
- Best practice for certification and labelling.
- EIDs (electronic identification docs) to provide info to value chain operators.

GOVERNANCE

- In order to maintain a fishery environment, what incentives could be implemented to guarantee compliance of sustainable fishery objectives?
- Uses of the sea: coastal monitoring, Marine Spatial Planning.
- Develop appropriate management tools for small scale fleets (eg effort controls, VMS, CCTV...).
- Improve marketing of low impact products (including aquaculture products).

- Controlling fisheries access in national waters (e.g. new control technology).
- Framework for management to ensure resource use (including pollution) stay within identified boundaries.
- Investigate public/industry attitudes toward science, develop programme to better communicate value of science and scientific knowledge; (re)integrate science into school system & Develop balanced forum for stakeholders to increase participation/input in decision-making.
- Provide science based fact to licence production (IMTA) (A).

ORGANISATION OF RESEARCH AND FUNDING

- Due to limited public funding, increased attention for public-private partnerships and industry-university collaborations & Short-term oriented research programs focussing on market and applied science (e.g. development of high-value products/niche markets)& Research programs based on shared understanding of a need for long-term stock/resource protection.
- Research is genuinely in the public good and in turn is supported by national and regional resources.
- Public/private partnerships & Engagement of stakeholders.
- The development of high quality niche products will also be strongly supported by research.
- Ultimate goal – increase food security and self-sufficiency (supported by all research streams).
- Funding needs.
- To set up new governance structures and institutions at domestic level.
- National public funding (private investment will not suffice).
- Micro-financing (private and public opportunities): local initiatives to address local problems.
- (Re-)establish communication and regional cooperation with other countries to avoid duplication and increase knowledge sharing.
- EU: Key strategic, policy support, measurement; monitoring, etc.
- National: In line with the main 'pillars', with elasticity for national priorities.
- Regional: Takes on high importance.
- Transfer and extension are always built in, and organised at EU/Regional/Member State/local level, through dedicated centres of transfer excellence.
- Producer organisations clear mandates & tools – to reduce competition and share performance data and market intelligence.
- 'Mega' research vessels: multi-national & multi-disciplinary (F).

ANNEX 3 WORKSHOP FOTO'S

Participants at work during the workshops:

Participants presenting the macro-scenarios to the COFASP partners after the fourth workshop in June 2014.

Cooperation in Fisheries,
Aquaculture and Seafood Processing

COFASP
ERA-net

Bredgade 40
DK-1260 Copenhagen K
Denmark

P: +45 3544 6200
F: +45 3544 6201
E: management@cofasp.eu
I: www.cofasp.eu

SEVENTH FRAMEWORK PROGRAMME

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