FEUFAR

THE FUTURE OF EUROPEAN FISHERIES AND AQUACULTURE RESEARCH

An overview:
- The project
- The methods used
- The material produced

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www.cefas.co.uk

Ifremer

www.ifremer.fr

futuribles

www.futuribles.fr

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6th Framework Programme of the EU

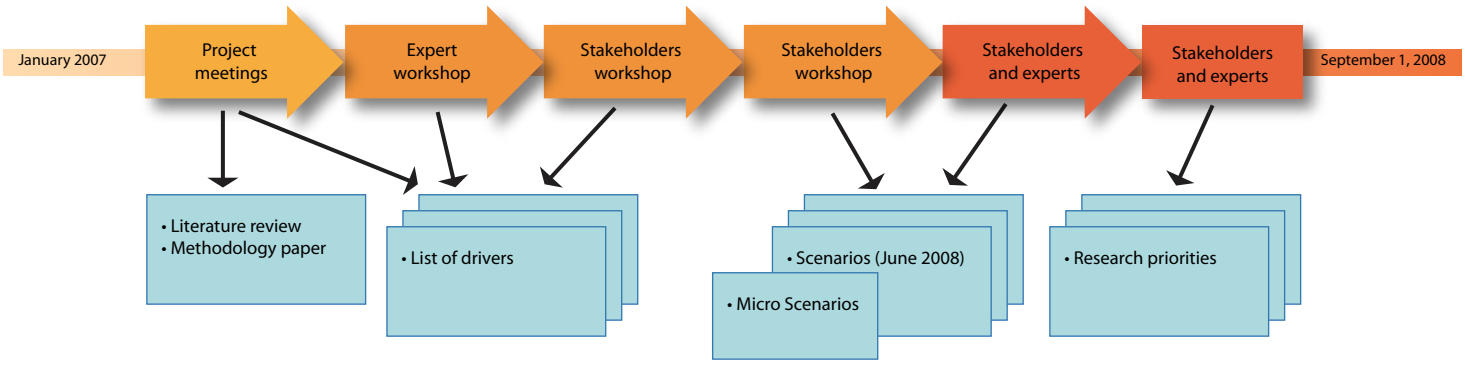
SIXTH FRAMEWORK
PROGRAMME

The Future of Fisheries and Aquaculture Research

The project

The FEUFAR project (the Future of Fisheries and Aquaculture Research)) was implemented between January 2007 and August 2008 by a consortium consisting of experts from Wageningen IMARES, CEFAS, Ifremer, Futuribles, Fiskeriforskning, HCMR and the Marine Board-ESF. The aim of the project was to develop a research agenda defining the research required in the medium term (10 years) to enable a sustainable exploitation and farming of aquatic resources. We developed a set of publications outlining the key challenges and opportunities for fisheries and aquaculture and the research needed to meet the challenges or exploit the opportunities.

This leaflet gives you an overview of the project, the method used and the material produced. A large group of stakeholders and experts was involved in this process, resulting in the research priorities presented in this leaflet.



How did we work?

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 and aquaculture. We looked at how these factors evolved over the past 20 years and how they might develop in the future.

We organised workshops with stakeholders from the fishing and aquaculture industry and their representative organisations, environmental NGOs and consumer organisations. We also organised workshops with experts from the fisheries and aquaculture science community, as well as joint stakeholder and expert workshops.

As a starting point the project team made an analysis of previous foresight studies in fisheries and aquaculture world wide.

Methodology

The methodology of the foresight process consists of six logical steps.

Step 1: Defining the system

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

- "world context" gathers factors that are beyond the system boundaries, yet still have an impact on fisheries and aquaculture.
- "production" encompasses characteristics of fisheries and aquaculture production.
- "seafood markets and economics" reflects aspects of prices and trade.
- "ecosystem" reflects environmental components.
- "social dynamic" presents society and fisheries communities.
- "regulation" describes policies and management measures.
- "research" addresses fisheries and aquaculture research and the broader research context.

Step 2: Drivers

For each of the system parts the key variables are determined. In the figure below you will find those variables that are found to be key to the future development. These are the so called 'drivers' of the system. After these drivers were indentified, each of the drivers was documented. That means that for each driver we determined the most important indicators and how this driver has evolved over the past 20 years.

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

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

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

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

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

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

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

Hypotheses (2020)

1. Alien attacks: Aquaculture growth tries to offset the reduced production from wild fisheries. introductions of many species (finfish and shellfish) result in increased invasions of alien species, with a c oncomitant negative impact on wild stocks. Oysters are so numerous that they become pests, filtering phytoplankton production to the detriment of other commercial stocks. Ballast -water transport increases due to the opening of new routes (e.g the Northwest Passage). Invasive species increase in number, phylum and quantity. There are some positive effects as commercial harvesting becomes possible on "new stocks", but generally ecosystems are badly disturbed and do not stabilize by 2020. Huge "ecological therapy" exercise needed to restore sustainability.

2. Green pieces in a black (red?) puzzle: Intentional introduction of species has succeeded at several locations along the European coast; farmers are able to contain the introductions. However, some other i ntentional introductions fail; coastal waters result in a patchwork of productive aquaculture and fisheries and unproductive ecosystems where fishing and/or cultivation are not possible as a consequence of the unexpected "new" species. There is no stable equilibrium between different areas and economic sustainability cannot be attained. Unintentional introductions remain a risk as regulations on ballasts, transfers, etc. are not efficient.

3. Sea is a kitchen garden: Intentional introduction of species has succeeded around Europe; objectives of "restocking" and high density cultivation are achieved. In that way, "new" local and sedentary stocks are highly productive: scallops, clams, lobsters and crabs, seaweeds. Effects on ecosystems are monitored and contr olled by means of "artificialized" environments (e.g. artificial reefs). Shipping regulations prevent dissemination of larvae by ballast water.

Step 3: Hypothesis

Also for each driver a set of *different hypotheses,* or a number of "possible futures" were elaborated. In the example to the left you find the hypotheses for the driver "Invasive Species" described as follows:

"Invasive species are introduced artificially by man. Species (plants and animals) can be introduced in an ecosystem, intentionally (for cultivation, for aquarium) or unintentionally (nonvisible but associated with voluntary introduced species) or transported from a distant area within ballasts or cargo. They become invasive when favourable conditions allow them to replace one or more "native species". Results on fish production are sometimes positive, often negative.

A: World context			
Drivers	*Hypothesis*		
A1 Climate change	Main IPCC trend	Faster warming	Fast mitigation:
A2 International agreements	New protectionism from both sides	Free trade in fishing	Johannesburg ++ / Automatic Ship Identification Systems
A3 Food security in the world, inc. demography	Fish against meat	High fish supply	Fish supply a major part of food security

Step 4: Micro-scenarios

For each subsystem you can write a story matching one hypothesis of each of its drivers. This story is called a micro-scenario: a possible development of that subsystem. In the table to the left you see the titles of the different micro-scenarios for each of the 7 subsystems.

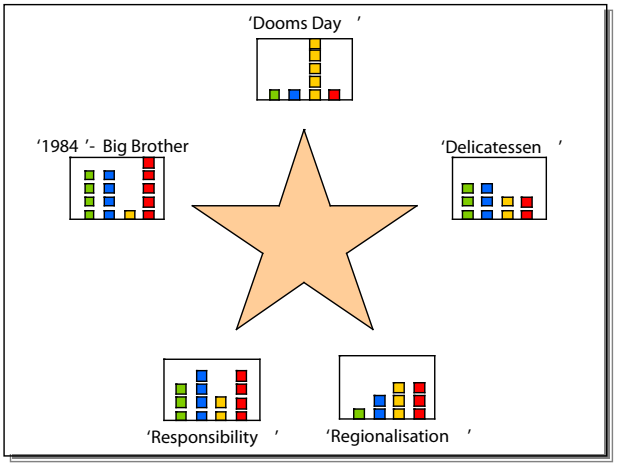
Subsystem	Micro-scenarios					
A World Context	Free trade and Production Specialities	Short-Term Economy	Protection-ism for Food	World Gover-nance		
B Regulation	Industry Responsi-bility	Integrated Europe	Local Solutions for Local Problems			
C EU Seafood markets and econom-ics	Responsible World	Innovative World	Shopping World	Expensive Fish	Ready Made Fish Meals	
D Social dynamics	Urban Ecology	Green Indus-trialization	Tourist Rather than Fisher	Fishers Know Better	We Need Produc-tion from the Sea	
E Ecosystems	Starts Bad but Gets Better	Global Meltdown	Local Solutions for Global Problems	Supergreen		
F Production	Free Market	The EU Promotes Aquaculture	Healthy and Diversified Products	Fisheries bounce back and natural food is the order of the day	Fishing Feeds Poor People and Aqua-culture	Big Fish is a Luxury
G Research policies	Pop Idol	European Drive to Technology Transfer	Funding Nemo	C'est la Vie	Public Money Rules Research	

Step 5: Macro-scenarios

Connecting in a logical way the micro scenarios of the different subsystems results in the so called macro-scenarios: possible futures for the entire system. To the left you find the construction of the scenario labelled "responsibility".

In total 5 different scenarios were chosen. Their main differences were found in terms of:

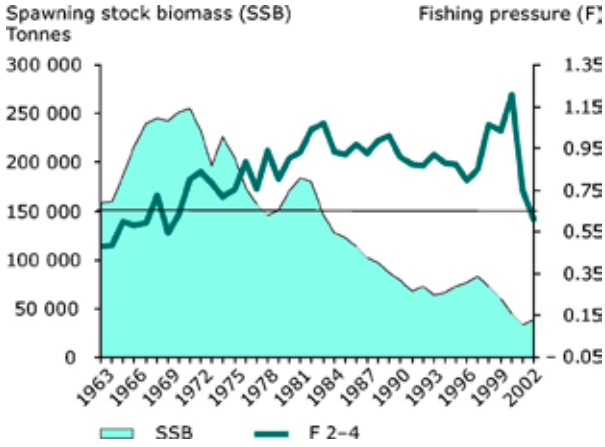
- the scale on which fisheries and aquaculture are managed (global or local) ■
- whether marine resources are to be used for production purposes or should be conserved for nature purposes ■
- whether we accept negative environmental impact or it should be avoided at all costs ■
- whether we operate under free market conditions or under strict (international) command and control ■



Step 6: Research priorities

Based on these scenarios the last step could be made: *Identify the uncertainties, challenges and opportunities that research may answer.*

Research Priorities for Cross-cutting Themes



Three *cross-cutting themes,* matters of interest for the system as a whole, were identified:

Data collection and analysis

Socio-economic data for fisheries, aquaculture, recreational fisheries and ecosystem goods and services are often not available. Next to collecting these data, there is a research issue on building a 'knowledge base' to improve understanding of how systems, from individual animals through population and ecosystem, and from individual economic agents through to socio-economic communities, work.

Risk management

Risks and uncertainties occur throughout fisheries and aquaculture. These occur at different scales and with different impact, for example the impact of climate change, invasive species, pathogens, harmful algae blooms, but also to uncertainty in stock assessments and policy impact. Risk analysis should be key component of (i) policy development and (ii) policy impact assessment .

Outreach

There is a need for communicating results of scientific research in a way and format fitting the target groups, e.g. promoting health benefits of sea food to consumers.

Research Priorities for Fisheries

Gear and operational technology

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

Management and governance

In order to address current management challenges it is needed to develop multi-annual and multispecies management models and approaches, taking trophic relationships and ecosystem health into consideration, and at the same time address uncertainty in a clearly understandable manner.

Resource exploitation

To address the growing demand for marine proteins the valorisation of currently *underused components* of the catch (both discards and waste of processing) is needed.

Basic research on populations of *lower trophic level resources* is needed to better understand their place and role in the ecosystem as well as addressing the fact that fisheries exploitation patterns are changing to these species.

Research Priorities for Aquaculture

New species

Research on new species, for the diversification of production based on regional characteristics and consumer's choice is desired. This should include research on species biology (e.g. reproduction, larval stages, fish health and welfare).

System technologies

Considering the high competition for the use of coastal areas the development of offshore technologies and on-land recirculation technologies is highly required. This should include research into renewable energy, life cycle analysis and the study of risk aspects.

Technologies for inshore aquaculture

Net cages represent around 99% of current production. Recirculated systems have potential but research is needed to improve technologies for fish growth in this type of systems.

Alternative feed

Research on alternative feed is needed to replace fish meal and fish oil and to develop strains able to grow on diets with lower protein content and lower omega 3 level.

Species enhancement

Research is needed for species enhancement by considering techniques such as selective breeding, hybrid, triploid and Genetically Modified Organism development in order to understand if and how production can be improved by these techniques.

Governance

Considering the high competition for the use of coastal areas research is needed on spatial planning. Research on the (reduction of) environmental impact of aquaculture activities is also needed

Non-food use

Developing aquaculture for non-food uses such as the production of pharmaceuticals and molecules for medicine and cosmetics, the elimination of pollution and the utilisation of species as pollution indicator is required.

Research Priorities for the Ecosystem Approach

Climate Change

The combined effect of human activities and climate change on stocks (distribution, behaviour, growth, food-webs), habitats (carrying capacity, hydrodynamics, oxygen depletion, food availability etc.) and the knock-on effects on higher predators (birds, mammals) need to be addressed. Research also needs to address how fisheries and aquaculture are affected and how adaptation is possible.

MPAs and habitat enhancement

Understanding the effect of Marine Protected Areas, their benefits and socio-economic implications (biodiversity, resilience of the ecosystem, 'spillover' effects, trophic cascades, effect of fishing effort displacement) is needed. Methods, tools, monitoring, siting methodologies need to be developed.

Coastal Zone Management

In Coastal Zone Management there is a need for tools for spatial planning. Matching particular activities to the most suitable locations requires appropriate methods for impact assessment (for example for the spatial interaction between fisheries and aquaculture).

Modelling ecosystems

It is important to understand ecosystem dynamics, including implications of aquaculture and fisheries for other ecosystem components. This will require multispecies and ecosystem modelling approaches (to establish indirect predator-prey effects, e.g. on other fish species, seabirds and mammals).

Research Priorities for Consumer preference and Market development

Consumer preferences

The starting point for market development is the consumer's demand for fish and fish products. Research is needed to better understand how consumer's preferences change, how buying behaviour is affected and how the European seafood industry can adapt to such changes.

Consumer health

Research should address the health effects of seafood and how health effects may promote seafood. Both the positive health effects and the combined effects of pollutants. In addition cheap and quick quality control technologies (freshness, pathogens or contaminant contents) should be developed.

Product development

For food and non-food product development research is needed into additional and new products as well as research in food processing to improve/maintain taste and texture. The development of new types of food for niche markets and also "from waste to taste"(new products from by-products) is important. In the non-food segment research should focus on functional and healthy food ingredients and bioprospecting: to bring out ingredients from both fish and non-fish marine resources, algae and plants for new and novel uses of compounds including ingredients for functional food and pharmaceuticals.

Traceability

Traceability is important for several purposes. Research is needed on traceability for assuring consumers, to document sustainable harvesting, origin, sources of input and days since catch, but also on the strategic use of traceability as a means of product differentiation. On the technical side, the further development of standards, procedures and systems is needed.

Labels

Concerning *certification, branding and labelling* research should focus on required information throughout the supply chain. Research is needed on effective labelling systems including information on health, fish welfare, origin, treatment and the development of standards.

Research Priorities for Socio-economics and Governance

Socio-economic analysis & impact assessment

There is a clear need for general socio-economic studies and impact assessments. This requires a data base both sound and available. This entails rather standard and continuous research into the economics of activities of harvesting marine resources (i.e. fishing, aquaculture, recreational fisheries) to maximise efficiency and production as well as into more specific issues.

Governance

Addressing governance issues has already become a standard feature in marine research. A major area of research is bringing together the triangle of stakeholders, management and scientific support to policy. Development of innovative, adaptive, context specific (regional) management tools and systems based on inclusion of stakeholders and geared at the creation and acceptance of shared knowledge is called for.

New management tools

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

What did we produce?

The 'final report' of this exercise consists of a series of reports, an index is provided here. In addition you can find accounts of the workshops on our web page.

For more information:

- you can download all the reports from the website *www.feufar.eu* go to 'project reports'. There you can also find the accounts of the workshops
- you can order a CD containing all the project reports. Send an email to *info@feufar.eu* with your request.
- you can contact the project team at *info@feufar.eu* for all your questions.

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Lay-out/paste-up: Oddvar Dahl, Nofima • Photos: Nofima (F. Gregersen/A. Iversen/S. Mennen/I. Jensen/O. Dahl), Cefas (J. Pinnegar), IMARES