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Community research

Project Synopses



*Synopsis of selected R&D project
in the field of fisheries
and aquaculture*



QUALITY OF LIFE AND MANAGEMENT
OF LIVING RESOURCES



European Commission
Community research

***Synopsis of selected R & D
projects in the field of fisheries
and aquaculture***



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FOREWORD

In the reform of the common fisheries policy (CFP) adopted in December 2002, emphasis was put on the improvement of the scientific basis for the advice needed by the EU for fisheries management. Today, more than ever before, when so many fish stocks are heavily exploited, decisions on fisheries management need a solid basis in science. The relevance and effectiveness of measures taken under the CFP depend to a large extent on the quality and timeliness of the scientific advice on which they are based. The European Commission also recognises the importance of aquaculture in the framework of the reform and the necessity to develop a strategy for the sustainable development of this sector supported by EU-wide research. Finally, assuring the quality and safety of the seafood supply in response to consumer needs while enhancing the competitiveness of the European seafood industry is also a priority for the Fisheries DG.

Research activities carried out under the fifth framework programme in the field of fisheries concerned three key actions of the thematic programme 'Quality of life' (QoL): 'Food, nutrition and health', 'Control of infectious diseases' and 'Sustainable agriculture, fisheries and forestry, and integrated development of rural areas including mountain areas'. Special attention was given to quality monitoring and traceability throughout the food chain, to the development of strategies to identify and control infectious diseases, to the improvement of the scientific basis for fisheries management, to the improvement of aquatic production, to the integration of environmental requirements, and to the investigation of the economic dimension of sustainable fishing and aquaculture.

This synopsis summarises 112 projects of high scientific quality demonstrating the excellent response from the scientific community to the research priorities defined in the different calls for proposals. Strong collaboration has been established among the different research groups and cluster-type projects have been launched, promoting valuable cooperation and exchanges among project leaders in several fields of research such as interaction between the environment and fisheries and fishmeal and oil replacement in aquaculture feeds.

I hope that this document will be a useful guide, not only to researchers involved in fisheries research in Europe, but also to public authorities and other stakeholders involved in the fisheries, aquaculture and food technologies sectors.

Jörgen Holmquist
Director-General
Directorate-General for Fisheries
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INTRODUCTION

Research projects of direct interest for the Fisheries DG in the fifth framework programme (FP5) concern three key actions (KAs) of the thematic programme ‘Quality of life’ (QoL): KA1 ‘Food, nutrition and health’; KA2 ‘Control of infectious diseases’; and KA5 ‘Sustainable agriculture, fisheries and forestry, and integrated development of rural areas including mountain areas’. A limited number of projects were also funded under the horizontal domain ‘Support to research infrastructure’ (six projects funded).

Most of the selected projects (85 or 88 %) concerned KA5.

The objective of this document is to present a general overview of all research projects funded under the QoL programme in the field of fisheries, aquaculture and food processing. The analysis is limited to pure research projects: shared-cost projects, concerted actions, thematic networks, and combined projects (research and demonstration). Each project description includes: background, objectives, and expected research and achievements, as well as information on the partnership and the duration of the project. Web sites are also indicated when available.

The projects are classified by area and sub-area of research as defined in the original work programme (see detailed repartition in the index of projects by area). Projects funded under the horizontal domain ‘Support to research infrastructure’, area ‘Facilities for aquaculture and fishery research’, are also considered.

The proposed classification intends to give a clear picture of the situation and to provide research institutions and policy-makers and other stakeholders with information on how the QoL work programme was covered regarding research in the field of fisheries, aquaculture and food processing. The global figures are indicated in the following table.

Table 1: Number of QoL projects selected by area and by instrument in the field of fisheries, aquaculture, and seafood quality and safety

	KA1		KA2		KA5		Support to infrastructure	Total
	Area 1: Technology and raw materials	Area 2: Food safety	Area 1: Development of vaccines	Area 2: Control of infectious diseases	Area 1: New and sustainable systems of production (fisheries and aquaculture)	Area 4: Support for common policies		
SC	6	2	5	7	63	11	6	100
CA	1			1	7	1		10
TN					1	1		2
CO						1		1
Sub-total	7	2	5	8	71	14		
Total	9		13		85		6	113

NB: SC (shared-cost), CA (concerted action), TN (thematic network), CO (combined projects, research and demonstration).

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<http://europa.eu.int/>
<http://www.cordis.lu/en/home.html>

INDEX OF PROJECTS BY AREA

KA1: FOOD, NUTRITION AND HEALTH

Area 1: Development of safe and flexible and new and/or improved manufacturing processes and technologies

Sub-area 1.1: Novel and improved biological raw materials for high-quality food

- QLK1-2000-01017 Utilisation and stabilisation of by-products from cod species
- QLK1-2000-01575 Improved quality of smoked salmon for the European consumer
- QLK1-2002-02433 Seaweed antioxidants as novel ingredients for better health and food quality

Sub-area 1.2: Advanced and optimised food technologies, packaging systems and process control

- QLK1-2001-01788 Radio-frequency heating technology for minimally processed fish products

Sub-area 1.3: Quality monitoring and traceability throughout the food chain

- QLK1-2000-00164 Traceability of fish products
- QLK1-2000-00476 Development of molecular genetic methods for the identification and quantification of fish and seafood
- QLK1-2001-01643 A new method for the objective measurement of the quality of seafoods

Area 2: Development of tests to detect and processes to eliminate infectious and toxic agents throughout the food chain

Sub-area 2.1: Improved understanding and control of contamination conditions arising among the entire food chain from primary producer to consumer

- QLK1-1999-00634 Virus-safe seafood
- QLK1-2001-01437 Sources, consumer exposure and risks of organotin contamination in seafood

KA2: CONTROL OF INFECTIOUS DISEASES

Area 1: Development of improved or novel mono-component, multi-component and combined vaccines

- QLK2-1999-00799 Intraperitoneal immunopathological reactions following vaccination of farmed fish — Studies of basic immune mechanisms
- QLK2-2000-01049 Pathophysiology and prevention of *Lactococcus garvieae* and *Streptococcus iniae* infections in rainbow trout
- QLK2-2001-00838 Development of a pathogen epitope prediction programme, and evaluating its usefulness in designing fish vaccines
- QLK2-2001-01288 Oral vaccination of fish with plant-derived protein vaccines
- QLK2-2001-01691 Antiviral innate immunity in cultured aquatic species

Area 2: Strategies to identify and control infectious diseases

Sub-area 2.1: Comprehensive approaches for treatment and protection

- QLK2-2000-01076 Stimulation of fish larval defence mechanisms against infectious diseases
- QLK2-2000-01631 The genetic basis of *Gyrodactylus salaris* resistance in Atlantic salmon (*Salmo salar*)

Sub-area 2.2: Antimicrobial drug resistance and changes in virulence

QLK2-2000-00809 Sea lice resistance to chemotherapeutants: diagnosis, mechanisms, dynamics and control

Sub-area 2.3: Diagnostic tests for humans and animals

QLK2-2000-00844 Infectious salmon anaemia — Development and standardisation of diagnostic methods and aspects of the epidemiology of ISA

QLK2-2001-00722 Diagnosis, epidemiology and control of an enteric myxosporosis of commercial Mediterranean fish

QLK2-2001-00970 Diagnoses, pathogeneses and epidemiologies of salmonid alphavirus diseases

Sub-area 2.4: Risk assessment and transmission

QLK2-2002-01546 Appraisal of the zoo-sanitary risks associated with trade and transfer of fish eggs and sperm

KA5: SUSTAINABLE AGRICULTURE, FISHERIES AND FORESTRY, AND INTEGRATED DEVELOPMENT OF RURAL AREAS INCLUDING MOUNTAIN AREAS

Area 1: New and sustainable systems of production, including breeding methods and exploitation in agriculture, fisheries and aquaculture, taking into account profitability, the sustainable management of resources, product quality and employment as well as animal health and welfare

Sub-area 2.1: Interactions between environment, fisheries and aquaculture

1. Interactions between environment and fisheries

Q5RS-2000-30183 Linking hydrographic frontal activity to ecosystem dynamics in the North Sea and Skagerrak: importance to fish stock recruitment

Q5RS-2000-30864 Interactions between the marine environment, predators, and prey: implications for sustainable sand eel fisheries

Q5RS-2000-31141 Management of silver eel: human impact on downstream migrating silver eel in the River Meuse

Q5CA-2000-31387 Reducing the conflict between cormorants and fisheries on a pan-European scale

Q5RS-2001-00839 Effects of changes in fishery discarding rates on seabird communities

Q5RS-2001-00993 Costing the impact of demersal fishing on marine ecosystem processes and biodiversity

Q5RS-2001-01685 European fisheries ecosystem plan

Q5RS-2001-01836 Estimation of the reproduction capacity of European eel

Q5RS-2002-00787 Response of benthic communities and sediment to different regimens of fishing disturbance in European coastal waters

Q5RS-2002-00799 The effect of turbidity and hypoxia on the behaviour of coastal marine fishes

Q5RS-2002-00813 Cod spatial dynamics and vertical movements in European waters and implication in fisheries management

- Q5RS-2002-00856 Managing fisheries to conserve groundfish and benthic invertebrate species diversity
- Q5RS-2002-00891 Assessment of biomass export from marine protected areas and its impacts on fisheries in the western Mediterranean Sea

2. Interactions between environment and aquaculture

- Q5RS-2000-30305 Biofiltration and aquaculture: an evaluation of substrate deployment performance within mariculture developments
- Q5RS-2000-30778 Rapid and ultrasensitive fluorescent test for the tracking of toxic algae in the marine environment
- Q5RS-2000-31151 Aquaculture and coastal economic and social sustainability
- Q5RS-2000-31334 Species diversification and improvement of aquatic production in seaweed purifying effluents from integrated fish farms and from other waste sources
- Q5RS-2000-31779 Development of monitoring guidelines and modelling tools for environmental effects from Mediterranean aquaculture
- Q5RS-2001-01185 Impact of aquaculture on the immune response genes of natural salmonid populations: spatial and temporal genetic signatures and potential fitness consequences
- Q5RS-2001-02456 Effect of nutrient release from Mediterranean fish farms on benthic vegetation in coastal ecosystems
- Q5RS-2002-00730 Sustainable management of interactions between aquaculture and wild salmonid fish

Sub-area 2.2: Scientific basis for fisheries management

- QLK5-1999-01157 Genetic identification of fish by species-specific DNA markers for use in stock biomass assessments and detection of commercial fraud
- QLK5-1999-01222 Population structure, reproductive strategies and demography of redfish (genus *Sebastes*) in the Irminger Sea and adjacent waters (ICES V, XII and XIV; NAFO 1)
- QLK5-1999-01253 Combining geostatistical and Bayesian methods to improve the scientific basis for the management of Atlantic mackerel fisheries
- QLK5-1999-01272 European decapod fisheries: assessment and management
- QLK5-1999-01438 A multidisciplinary approach using genetic markers and biological tags in horse mackerel (*Trachurus trachurus*) stock structure analysis
- QLK5-1999-01546 A coordinated approach towards the development of a scientific basis for management of wild Atlantic salmon in the north-east Atlantic
- QLK5-1999-01567 Sexual identification and development in the swordfish — Improved determination tools for more efficient stock assessment and implementation of control measures

QLK5-1999-01609	Development of structurally detailed, statistically testable models of marine populations
QLK5-1999-01617	Demonstration of maternal effects of Atlantic cod: combining the use of unique mesocosm and novel molecular techniques
Q5RS-2001-00953	The role of sub-stock structure in the maintenance of cod metapopulations
Q5RS-2001-01370	Conservation of diversity in an exploited species: spatio-temporal variation in the genetics of herring (<i>Clupea harengus</i>) in the North Sea and adjacent areas
Q5RS-2001-01998	Sharing responsibilities in fisheries management
Q5RS-2001-02038	Combining acoustic and trawl data for estimating fish abundance
Q5RS-2001-02054	Species identification methods from acoustic multi-frequency information
Q5RS-2002-00818	Sardine dynamics and stock structure in the north-east Atlantic
Q5RS-2002-00935	Research on effective cod stock recovery measures
Q5CA-2002-00962	Cephalopod stocks in European waters: review, analysis, assessment and sustainable management
Q5RS-2002-01056	A multidisciplinary approach to the identification of herring (<i>Clupea harengus</i> L.) stock components west of the British Isles using biological tags and genetic markers
Q5RS-2002-01216	Association of physical and biological processes acting on recruitment and post-recruitment stages of anchovy
Q5RS-2002-01328	Development of a predictive model of cod-end selectivity
Q5CA-2002-01353	Mutualisation of fisheries and aquaculture European research institutes
Q5RS-2002-01603	An assessment of mortality in fish escaping from trawl cod-ends and its use in fisheries management
Q5RS-2002-01610	Integrated approach to the biological basis of age estimation in commercially important fish species
Q5CA-2002-01693	European advice system evaluation
Q5RS-2002-01782	Policy and knowledge in fisheries management — The North Sea cod case
Q5RS-2002-01824	Framework for the evaluation of management strategies
Q5RS-2002-01825	Reproduction and stock evaluation for recovery
Q5CA-2002-01891	Towards accreditation and certification of age determination of aquatic resources
<i>Sub-area 2.3: Improvement of aquatic production</i>	
1. Aquaculture genetics	
Q5RS-2000-30360	Cloning and functional analysis of fish peroxisome proliferator-activated receptors: the transcriptional control of lipid metabolism in farmed fish species
Q5RS-2000-31365	Improving production efficiency of sea bass farming by developing methodologies to eliminate environmental androgenesis

- Q5RS-2001-00994 Protein and growth efficiency in salmonid selection
- Q5RS-2001-01701 Tools for the genetic improvement of sea bass — Construction and preliminary application of a medium-density linkage and synteny map
- Q5RS-2001-01797 Bridging genomes: an integrated genomic approach towards genetic improvement of aquacultured fish species
- Q5RS-2001-02211 A functional genomic approach to measuring stress in fish aquaculture
- Q5RS-2002-00784 Towards the development of technologies for cryopreservation of fish oocytes
- Q5RS-2002-01302 Genetic implications in the production of rotifers in commercial finfish hatcheries
2. Aquaculture general
- Q5RS-2000-30058 Researching alternatives to fish oil in aquaculture
- Q5RS-2000-30068 Perspectives of plant protein use in aquaculture
- Q5CA-2000-30105 European network for the dissemination of aquaculture RTD information
- Q5RS-2000-30271 Feed for aquatic animals that contains cultivated marine micro-organisms as alternatives to fish oil
- Q5RS-2000-31457 Improved procedures for flatfish larval rearing through the use of probiotic bacteria
- Q5RS-2000-31629 Environmental, nutritional and neuroendocrine regulation of skin coloration in the red porgy (*Pagrus pagrus*): towards the development of natural hue in cultured populations
- Q5RS-2000-31656 Gastrointestinal functions and food intake regulation in salmonids: impact of dietary vegetable lipids
- Q5CA-2001-00989 Dietary self-selection in fish: a geometrical approach for optimising aquaculture production
- Q5RS-2001-01233 Optimisation of rearing conditions in sea bass for eliminated lordosis and improved musculoskeletal growth
- Q5RS-2001-01465 Calcium, the backbone of fish culture: importance in skeletal formation, reproduction and normal physiology
- Q5TN-2002-00628 Fish oil and meal replacement
- Q5RS-2002-01192 Arrested development: the molecular and endocrine basis of flatfish metamorphosis
- Q5RS-2002-01355 Reproduction of the bluefin tuna in captivity — Feasibility study for the domestication of *Thunnus thynnus*
- Q5RS-2002-01801 Photoperiod control of puberty in farmed fish: development of new techniques and research into underlying physiological mechanisms

Area 4: Support for common policies — Development of methods of control, surveillance and protection including protection of land and prevention of soil erosion — Pre-legislative research designed to provide a scientific basis for Community legislation

Sub-area 4.3: Monitoring and enforcement of the CFP

QLK5-1999-01295	Technical efficiency in EU fisheries: implications for monitoring and management through effort controls
Q5RS-2001-01697	Establishing traceability for cod (<i>Gadus morhua</i>): determining location of spawning and harvest
Q5RS-2001-02266	Improving fisheries monitoring through integrating passive and active satellite-based technologies
Q5CO-2002-01335	Development and testing of an objective mesh gauge

Sub-area 4.4: Social and economic basis of the CFP

QLK5-1999-01271	Value of exclusion zones as a fisheries management tool in Europe: a strategic evaluation and the development of an analytical framework
QLK5-1999-01273	Multiple objectives in the management of EU fisheries
QLK5-1999-01346	Margins along the European seafood value chain — Impact of the salmon industry on market structures
QLK5-1999-01405	Fishery regulation and the economic responses of fishermen: perceptions and compliance
Q5CA-2001-01502	Economic assessment of European fisheries
Q5RS-2001-01533	Bioeconomic modelling of Mediterranean fisheries
Q5RS-2001-01535	Modelling fishermen's behaviour under new regulatory regimes
Q5RS-2001-02277	Élaboration et application d'un modèle calculable d'équilibre général à l'analyse de la contribution des activités halieutiques au développement régional
Q5RS-2002-01291	Technical developments and tactical adaptations of important EU fleets
Q5TN-2002-01560	Les femmes dans la pêche et les cultures marines en Europe

SUPPORT FOR RESEARCH INFRASTRUCTURES

Area 5: Facilities for aquaculture and fishing research

QLRI-CT-2000-00216	Development of a network to support an open access, online, fish technology knowledge base
QLRI-CT-2001-00007	European network supporting infrastructures for arctic charr culture and conservation
QLRI-CT-2001-00025	Database trawl surveys
QLRI-CT-2002-02755	Genetic catalogue, biological reference collections and online database of European marine fishes
QLRI-CT-2002-02773	Fish aggregating devices as instrumented observatories of pelagic ecosystems
QLRI-CT-2002-02819	Development of a European resource on the origins of pathogens of aquaculture

KA1: FOOD, NUTRITION AND HEALTH



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Area 1: Development of safe and flexible and new and/or improved manufacturing processes and technologies

Sub-area 1.1: Novel and improved biological raw materials for high-quality food

**Utilisation and stabilisation of by-products from cod species
FISHERY BY-PRODUCTS**

Contract number: QLK1-2000-01017/
QLRT-2001-02829
Contract type: Shared-cost project
Starting date: 1.12.2000
Duration: 36 months
Scientific Officer: Sigurdur Bogason
Project web site:
<http://kibt.chembio.ntnu.no/fishbyprod/>

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Utilisation and stabilisation of by-products from cod species

BACKGROUND

By-products from cod species will be studied with the aim of increasing their utilisation to produce value added food ingredients. Work will focus on fat and protein fractions (liver, viscera, heads, skins and cut-offs). Increasing the proportion of fish catch used for human consumption will increase profitability, reduce waste and reduce pressure on overfishing. The project will aim to develop systems to sort, handle and store by-products on board vessels, find safe and effective preservation methods and develop well-functioning logistics. Chemical composition of the by-products will be characterised regarding species, seasonal and habitat variation. Processing methods to extract biomolecules with application in food, feed and pharmaceuticals will be studied and optimised. Finally, the market for these compounds will be assessed.

OBJECTIVES

The main objective of this work is to increase the utilisation of by-products from cod and carp species to produce value added food ingredients. This project will focus on the following species of Gadidae/cod: cod (*Gadus morhua*), saithe (*Gadus virens*), haddock (*Melanogrammus aeglefinus*), tusk (*Brosme brosme*), ling (*Molva molva*).

This will be done by technology development on board vessels to produce, handle and store by-products. The technology development will be such as to ensure that the by-products are in a condition suitable for subsequent production of value added isolates for food, pharmaceutical and other purposes. The work will focus on the fat and protein fractions mainly from the liver, viscera, heads, skin and cut-offs from cod species and carp.

Scientific and technological objectives:

1. To develop value added food ingredients from by-products from cod and carp species.
2. To develop systems to recognise and separate different fractions.
3. To characterise the chemical composition of different by-products.
4. To develop suitable methods for preserving the different fractions.
5. To develop methods to extract the interesting fractions/biomolecules.
6. Where appropriate, to develop the capacity to do all of the above on board vessels to optimise the quantity and quality of high value added by-products.
7. To review the market potential for the selected by-products.

EXPECTED RESULTS AND ACHIEVEMENTS

1. High value added products from by-products.
2. Characterisation of the chemical composition of the selected by-products including variations on the basis of season, habitat, individual and species.
3. Development of an overview of new applications for the components from by-products in foods, healthcare products, pharmaceuticals and cosmetics.
4. Increased knowledge about the market potential for the selected by-products by contact with potential industrial users.
5. Evaluation of which by-product operation can be done practically on board the vessel and which can be done onshore — logistics.
6. Find suitable equipment and machinery for handling the by-products.
7. Build knowledge about the physical behaviour of the selected by-products.
8. Build knowledge about new technology for extraction and preservation by evaluating different processes with special focus on product stability, practicable and economic factors.

Application of the knowledge gained in this project has three distinct phases:

1. Gaining more scientific knowledge about the chemical composition and the stability of the by-products, especially the protein and lipid fractions with a view to extending the utilisation of the by-products. The project will look at extending the utility of fish collagen and gelatine as a substitute for mammalian collagen and gelatine. The project will also look at methods to extract and take care of the nutritionally valuable fish lipids.
2. The knowledge gained in phase 1 will be used to find safe and effective preservation and storage methods.
3. Further research will look at an extended range of by-products, which the research in phase 1 has shown is there in commercial quantities.

**Improved quality of smoked salmon for the European consumer
EUROSALMON**

Contract number:	QLK1-2000-01575	Coordinator:	Gudmundur Örn Arnason
Contract type:	Shared-cost project		Technological Institute of Iceland
Starting date:	1.12.2000		Matra
Duration:	36 months		Keldnaholt
Scientific Officer:	Sigurður Bogason		IS-112 Reykjavík
Project web site:	www.mmedia.is/matra/eurosalmon		Tel. (354) 570 71 00
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Improved quality of smoked salmon for the European consumer

BACKGROUND

Over 80 % of the world's production of farmed Atlantic salmon is farmed in Europe. About 40 % of this quantity, or above 250 000 tonnes, is smoked. Recently, concerns have been expressed by smoked-salmon producers regarding the flesh quality and suitability for smoking of salmon that is farmed today. The main purpose of the project is to establish the necessary technical base to solve the main quality problems related to smoked-salmon products. This will be done by multidisciplinary research activities carried out in a continuous chain from farming to the consumer using physical, chemical and sensory measurements. To understand the origin of these phenomena, an experimental design is proposed to identify influential factors such as feed/feeding and salting and smoking processes on the quality of the final product, and to adapt the results to consumers' expectations in five different market segments in Europe.

OBJECTIVES

The main objective of the project is to improve the quality of smoked salmon by enabling the European industry to deliver salmon with adapted quality to the different market segments in Europe. Furthermore, the aim of the project is to establish the necessary technical base to solve the main quality problems, i.e. fat leakage in processing and colour fading during storage, related to smoked-salmon products.

This will be achieved by the following:

1. Mapping differences between preferences and deliveries by:
 - mapping the preference/habit of consumption of smoked salmon in selected EU countries;
 - mapping sensorial, chemical and physical characteristics of smoked salmon in selected EU countries.
2. Tailoring smoked salmon according to consumer preferences by:
 - investigating the effects of chilled storage prior to smoking, final product salt content and smoking temperature during smoking on the predicted quality characteristics for different raw materials;
 - understanding the mechanisms behind fat leakage to be able to control it;
 - understanding the mechanisms behind colour fading to be able to control it.

EXPECTED RESULTS AND ACHIEVEMENTS

The project will increase the competitiveness of the European salmon production and smoking industry by enabling it to deliver products to the European markets that satisfy the consumers' preferences.

A better understanding of the mechanism behind fat leakage and colour fading will make it easier to control the quality of smoked salmon; hence, fewer incidences where unequal quality causes significant losses can be expected.

Products that are of consistent quality will result in increased competitiveness as well as improved image of the product and producer.

The extension of possible markets for small and medium-sized enterprises (SMEs) within Europe could be achieved with the dissemination of results through an established user group. The information will enable farmers and SME processors to tune the attributes of their products more efficiently to different market requirements.

**Seaweed antioxidants as novel ingredients for better health and food quality
SEAHEALTH**

Contract number:	QLK1-2002-02433	Coordinator	Patricia Burtin
Contract type:	Shared-cost project		Centre d'Étude et de Valorisation des Algues
Starting date:	1.1.2003		Presqu'Île de Pen Lan
Duration:	36 months		F-22610 Pleubian
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Seaweed antioxidants as novel ingredients for better health and food quality

BACKGROUND

The main objectives of the Seahealth project are to develop a new generation of algal antioxidant ingredient and functional foods, and to demonstrate the benefits for human health in prevention of atherosclerosis and cancer. Analysing consumer appreciation and sensory perception of these novel functional foods linked to the marketing investigation constitutes an important task of the project as well as socioeconomic aspects and relevant gender specifications. It is intended to develop communication strategies in order to inform consumers about the health effects and specific benefits of algal ingredient products.

OBJECTIVES

The Seahealth project aims at studying the role of algal antioxidant substances as novel food ingredients:

1. for cancer and atherosclerosis prevention;
2. for food quality enhancement.

The objectives are to develop an optimised procedure at laboratory and pilot scale for extraction and isolation of antioxidant substances, to demonstrate the antioxidant potential of the extracts by *in vitro* and *in vivo* tests, and to evaluate their role in cancer and atherosclerosis prevention and also as novel ingredients for food quality preservation. This project also aims at developing new food products and at setting up a strategy to improve the consumers' acceptability of such extracts or food products.

EXPECTED RESULTS AND ACHIEVEMENTS

1. To provide an optimised manufacturing protocol of antioxidant substances (carotenoids, polyphenols, tocopherols) contained in selected brown algae at both laboratory and pilot scale (details on algae pretreatment, extraction/purification processing, and packaging conditions to warranting antioxidant potential).
2. To characterise the antioxidant substances in terms of structure and content in order to improve knowledge about the diversity of antioxidant substances extracted from brown algae.
3. To provide a detailed report on the *in vitro* antioxidant potential of the seaweed extracts.
4. To provide a detailed report on the extracts' antioxidant activity by estimating safe and effective use levels (*in vivo* study on rats) and bioavailability (*in vivo* studies on animals and humans).
5. To provide a documented report on the potential role of these antioxidant substances in preventing cancer and atherosclerosis diseases (*in vitro* and *in vivo* studies on animals) in order to obtain a better understanding of the structure/function relationships and to identify the principal components responsible for beneficial health effects.
6. To evaluate the usefulness of the extracts as antioxidants in the food industry by formulation of some functional foods (beverages, milk products and snacks).
7. To study the effects of processing conditions, matrix composition and storage conditions on antioxidants' availability and stability.
8. To improve consumer acceptance of and preference for these novel functional foods by defining the best formulations in some beverages, milk products, such as yoghurt, and snacks.
9. To provide details on the seaweed ingredients: features, potential applications, storage conditions, and consumers' perception of comparative advantages over functional ingredients from other sources in order to speed up their acceptance by scientists, manufacturers and consumers and favour a rapid commercial exploitation of the results.

10. To provide points to consider for an efficient exploitation and dissemination plan to facilitate communication between researchers from various backgrounds (nutrition technology, behavioural sciences, e.g. psychology, sociology and marketing sciences), the food industry, consumers and food distributors.
11. To provide a strategic plan to promote employment and relationships between the research world and industry with regard to the project results and the enormous potential of the growing use of algal antioxidant additives in the consumption of foods.
12. To ensure efficient technical and financial coordination during the whole duration of the project in order to secure a successful outcome, while promoting the role of women scientists in European research as coordinator or task leader.

*Sub-area 1.2: Advanced and optimised food technologies,
packaging systems and process control*

**Radio-frequency heating technology for minimally processed fish products
RF-FISH**

Contract number:	QLK1-2001-01788	Coordinator	Thomas Pfeiffer
Contract type:	Shared-cost project		Fraunhofer-Institut für Verfahrenstechnik und Verpackung
Starting date:	1.1.2002		Giggenhauser Straße 35
Duration:	36 months		D-85354 Freising
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Radio-frequency heating technology for minimally processed fish products

BACKGROUND

The proposed project will investigate radio-frequency heating of foods in flexible vacuum pouches during water immersion and its application to minimal processing of convenience cook/chill or cook/freeze fish products. The rapid volume heating of the process is expected to reduce overcooking of the heat-sensitive fish flesh and to result in better product quality while maintaining product safety and shelf life. Application of the process is expected in fish processing as well as in large food service companies; the processed products will go to the retail market and to food services. The proposed project covers process adaptation and optimisation, investigation of safety and microbiological process validation, validation of achieved product quality, and estimation of processing cost and of potential convenience fish product markets. Expected project results will enable the industrial implementation of the process and will help to judge the potential and economy of the novel process for producing high-quality prepared fish meals.

OBJECTIVES

1. Explore the potential of a combination of radio-frequency heating (RF heating) with water immersion for production of minimally processed cook/chill or cook/freeze convenience fish dishes. It is intended to use a mild thermal treatment with temperatures < 100 °C, which requires subsequent chilling or freezing for safe storage and distribution.
2. Investigate and optimise the process with respect to heating uniformity, rapidity and reproducibility, and develop a temperature–time treatment that will retain most of the desired fish quality while achieving safe reduction of potential hazardous micro-organisms.
3. Adopt and develop methods and predictive models for process validation and demonstrate experimentally microbiological safety of the heating process.
4. Verify quality achievements with respect to texture, cook-out, taste, colour, and shelf life of heated products and compare with conventionally autoclave or hot water-bath processed products.
5. Estimate the economic feasibility of the process and investigate markets and the distribution system for minimally processed fish products.

EXPECTED RESULTS AND ACHIEVEMENTS

1. Demonstration of microbiological safety and product quality achievement of the novel RF heating process for minimally processed fish products.
2. Availability of experimental tools and predictive models to optimise the process, to perform microbiological validation, to implement the process on an industrial scale, and to adopt the process for other prepared foods or for temperature–time regimes with short-time sterilisation.
3. Estimation of the economic feasibility and competitiveness of the process for both the fish/food processor as well as the manufacturers of process equipment and packaging material.

Sub-area 1.3: Quality monitoring and traceability throughout the food chain

**Traceability of fish products
TRACEFISH**

Contract number:	QLK1-2000-00164	Coordinator	Petter Olsen
Contract type:	Concerted action		Norwegian Institute of Fisheries and Aquaculture Ltd
Starting date:	1.12.2000		Centre of Industrial Processing
Duration:	24 months		Muninbakken 9–13
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Traceability of fish products

BACKGROUND

The overall objective of this concerted action is to go some way towards establishing a broad consensus for what traceability data should be recorded and transmitted for fish products, and how these data should be coded. To accomplish this, we will establish a forum where representatives of various parts of the fish/product industries and research institutes can meet to discuss traceability related issues. This forum will be implemented in the form of four conferences over two years with presentations, discussions and work groups. Representatives of other food chains will make presentations that will form a basis for discussion and a reference point in the fish/product chains. Suppliers and buyers of fish products will present their often conflicting views, systems and requirements. Researchers will share relevant results, especially relating to what data elements influence health, safety, shelf life and yield, and how these may be quantified.

OBJECTIVES

1. To provide a forum for discussing traceability-related industry issues in the fishing industry.
2. To facilitate the transfer of traceability-related ideas and technology from other food industries to the fish/product industry.
3. To produce a document that recommends what data typically should be recorded and disseminated for farmed fish and for captured fish.
4. To produce a document that recommends how these data should be coded and transmitted/shared electronically.
5. To result in implementation projects based on the common ground represented by the documents.

EXPECTED RESULTS AND ACHIEVEMENTS

1. Four international conferences with focus on all the different aspects of traceability for fish products.
2. One voluntary industry standard establishing consensus with respect to what data should be recorded and made available in the chain for captured fish, from vessel to consumer.
3. One voluntary industry standard establishing consensus with respect to what data should be recorded and made available in the chain for farmed fish, from fish farm to consumer.
4. One voluntary industry standard establishing consensus with respect to how the data should be coded and transmitted or made available electronically.

**Development of molecular genetic methods for the identification
and quantification of fish and seafood
DNAIQ**

Contract number: QLK1-2000-00476
Contract type: Shared-cost project
Starting date: 1.2.2001
Duration: 36 months
Scientific Officer: Sigurdur Bogason
Project web site: Not yet available

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Development of molecular genetic methods for the identification and quantification of fish and seafood

BACKGROUND

So far, it is not possible to quantify reliably the constituents of fish or other seafood products. The methods used today rely on the quantification of substances which are highly susceptible to processing conditions. Due to its stability, the quantification of DNA is a very promising attempt to overcome this problem. Practicable, fast and easy-to-use methods for quantification are in the interest of consumers and industry to prevent fraud and mislabelling. The technical progress in DNA quantification offers the opportunity to develop methods applicable in routine analysis. The excellent access to the European market and to fisheries with long experience in DNA analytical and state-of-the-art equipment will provide the fundament to achieve protocols and procedures for high-throughput identification of fish and seafood and a sensitive, reliable technique to quantify species in fish and seafood products.

OBJECTIVES

1. Improvement of DNA-based fish and seafood identification.
2. Development of reliable as well as sensitive quantification techniques for fish and seafood products. In recent years, the growing interest in quantitative applications for the PCR has favoured the development of a large number of assay procedures suitable for this purpose. We will focus on two methodological approaches for quantitative polymerase chain reaction (PCR) based on the use of fluorogenic probes. The remarkable technical and analytical progress made can now be exploited to gain routine analytical procedures.
3. Evaluation of the developed techniques, protocols and procedures for identification and quantification by collaborative studies of the participants.
4. Evaluation of the techniques developed in routine practice by end-users.

EXPECTED RESULTS AND ACHIEVEMENTS

1. Collection of authentic organisms, and relevant fish and other seafood products.
2. DNA identification and quantification methods will be adopted for fish and seafood products.
3. The DNA database will be complemented with information relevant for fish and seafood products.
4. Primers and probes for fish and seafood identification; DNA-arrays-PCR-quantification exploiting the properties of competitive-, online-PCR and high pressure liquid chromatography (HPLC).
5. Ring trials among participants and end-users for harmonisation and maximum practicability.

**A new method for the objective measurement of the quality of seafoods
SEQUID**

Contract number: QLK1-2001-01643
Contract type: Shared-cost project
Starting date: 1.9.2001
Duration: 36 months
Scientific Officer: Sigurdur Bogason
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A new method for the objective measurement of the quality of seafoods

BACKGROUND

No satisfactory physical method exists for the objective measurement of the quality of seafood products. Thus concluded the project AIR3 CT94 2283. This project concerns a completely new physical method for seafood quality measurement. It arises from observations made in FAIR project CT97 3020. It is proposed to carry this work further with determination of quality as the main objective. The quality factors to be studied will be:

1. post-catching/slaughter deterioration of fresh fish;
2. changes due to frozen storage and to multiple freezing;
3. correlation with organoleptic variables, texture, and other quantifiable quality-related variables.

Prototype instruments will be built for validation in the field.

OBJECTIVES

To develop and validate a new rapid method and instrumentation for determination of the quality of seafood products. This objective will be achieved through several secondary objectives:

1. The acquisition of dielectric data of seafood products under the influence of various quality changes.

These dielectric data will comprise:

- the dielectric spectra of seafood materials over a frequency range from 100 MHz to 12 GHz;
- time domain dielectric responses to input electromagnetic pulses of well-defined characteristics of the materials under investigation.

The quality changes will be:

- spoilage of freshly harvested fish kept on ice at 0 °C;
 - changes in quality of frozen fish subjected to different thermal histories.
2. The analysis of the dielectric data obtained to provide calibration equations for use in hand-held and online instruments.
 3. Design and construction of a hand-held instrument.

EXPECTED RESULTS AND ACHIEVEMENTS

1. Performing an initial set of trials where results should demonstrate the feasibility of a method for each area of quality.
2. Completion of three prototype instruments for use in experiments where instruments have been recalibrated by the first set of results.
3. Completion of full quality trials.
4. Completion of full chill spoilage trials and end of project.

Area 2: Development of tests to detect and processes to eliminate infectious and toxic agents throughout the food chain

Sub-area 2.1: Improved understanding and control of contamination conditions arising among the entire food chain from primary producer to consumer

Virus-safe seafood VS SEAFOOD

Contract number: QLK1-1999-00634
Contract type: Shared-cost project
Starting date: 1.2.2000
Duration: 36 months
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Virus-safe seafood

BACKGROUND

The problem of shellfish contamination is currently under-diagnosed and under-managed, although significant epidemiological studies have linked viral illnesses to the consumption of contaminated shellfish meeting bacterial standards. Protecting the consumer will imply preventing action based on seafood specificity. Shellfish are a unique foodstuff because of the characteristics of the animal (filter-feeder) and the way they are eaten (slightly cooked, and even raw for oysters). These animals are grown in seawater, and hydric environment is the main source of contamination. They accumulate contaminants, among them human enteric viruses, which are able to persist for a long time in the animal. If viral hydric contamination occurs in harvesting areas, shellfish could be contaminated. As bacterial indicators have now been proved not to be correlated with viral presence, regulation set up to protect consumers is inefficient. Even if EU rules recommend depuration for bacterial-polluted shellfish, the efficiency of the depuration process to remove viruses still needs to be demonstrated. Efficient consumer protection must take into consideration the viral contamination of growing areas (sewage input and harvesting water quality) and the viral elimination during the depuration process. The food chain here is 'harvesting and depuration'. All these factors are taken into account in constructing and organising the project 'Virus-safe seafood'.

OBJECTIVES

The overall objective of the 'Virus-safe seafood' project is to provide, along the food chain, useful and rapid tools for the evaluation of human viral contamination of shellfish and innovative technology for their quality control and depuration. The final objective is to assure the safety of the food supply.

Expertise from fundamental research, R & D and shellfish producers is complementary to address the following objectives:

1. Determination of viral input and shellfish contamination: the main human enteric viruses implicated in diseases linked to shellfish consumption chosen for this study are: astrovirus (AV), calicivirus (CV), enterovirus (EV), hepatitis A virus (HAV), and rotavirus (RV). They will be searched to appreciate the role of the environment as a reservoir. The following techniques will be used:

- extraction/concentration of viral particles and purification of nucleic acids;
- commercial kit validation and evaluation for routine detection;
- detection by RT-PCR, hybridisation; quantification and standardisation of the protocols;
- molecular typing to determine the strains persisting in the environment.

These techniques will be applied to assess viral contamination of wastewaters, rivers, seawater and shellfish samples. Shellfish imported or sampled from harvesting areas will be analysed. The concentration of actual and potential indicators (*Escherichia coli* and F+RNA specific phages) will be compared with the presence of human enteric viruses and evaluated to propose a more valuable approach for shellfish safety.

2. Evaluation of the persistence of enteric viruses in the environment: virus-like particles (VLPs) of astrovirus, calicivirus and rotavirus will be constructed. This new technology resulting from molecular research will be used to:

- simulate and compare their behaviour in seawater;
- follow viral capsid degradation and thus obtain information on infectivity;

- evaluate the role of physical (temperature, salinity) and biological (bacterial flora) parameters on viral fate.
3. Optimisation of shellfish depuration: to assess the efficiency of the depuration process on viral contamination:
- VLP artificially contaminated shellfish will first be used;
 - different parameters will be evaluated to enhance depuration processes;
 - after VLP assay optimisation, the same depuration processes will be applied to naturally contaminated shellfish;
 - efficiency of depuration enteric viruses and indicators will then be evaluated.

EXPECTED RESULTS AND ACHIEVEMENTS

This information will define various tools to evaluate the accuracy of EC standards, reducing the risk caused by seafood consumption and providing a sustainable development of shellfish production:

1. understanding of pathogen distribution and designing 'viral risk months';
2. providing valuable information on viral risk for countries involved in shellfish trade;
3. improving shellfish safety by defining 'good depuration practices' and a 'warning system' in harvesting areas.

**Sources, consumer exposure and risks
of organotin contamination in seafood
OT-SAFE**

Contract number:	QLK1-2001-01437	Coordinator	Jan-Willem Wegener
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Sources, consumer exposure and risks of organotin contamination in seafood

BACKGROUND

The biocide tributyltin (TBT) is widely used in anti-fouling ship paint and accumulates through the marine food chain.

A recent literature survey revealed that in some European countries present levels of TBT in seafood exceed the tolerable daily intake for humans and may pose a risk to the consumer. However, the available data were very limited and for most EU countries no information was available. The main objective of OT-SAFE is to improve the quality of seafood in Europe and end the current uncertainty regarding TBT levels and the associated risks to consumers. An extensive database will be compiled on TBT levels in seafood at major EU fishing grounds and the possibilities to reduce the TBT content of seafood during kitchen preparation will be studied. A risk assessment will be carried out and maximum residue limits for TBT in seafood will be derived, taking import/export fluxes and consumption patterns into account. OT-SAFE will contribute positively to the ongoing discussion between scientists, government, industry and environmental pressure groups on the risks of TBT. If necessary, the results will help EU regulators to set seafood advisory guidelines.

OBJECTIVES

The objectives are to improve the quality of seafood and reduce the current uncertainty regarding its safety for consumers by:

1. building an EU-wide database on TBT in seafood at major European seafood farms and fishing grounds;
2. studying possibilities of TBT-level reduction in seafood during various different cooking procedures;
3. assessing whether there is a risk for consumers associated with the consumption of TBT-containing seafood sold on the European market.

If necessary, the final results of this study can be used to assist authorities in drawing up seafood advisory guidelines.

EXPECTED RESULTS AND ACHIEVEMENTS

The expected outputs of OT-SAFE are the completion of an evaluated database on TBT levels in seafood at major shellfish farms and fishing grounds across Europe, and a full evaluation of TBT degradation during kitchen preparation of seafood. The final outcome will be a thorough risk assessment of TBT in seafood for EU consumers. Irrespective of the results, OT-SAFE will reduce the current uncertainty regarding TBT levels in seafood in Europe and the associated risks to consumers.

KA2: CONTROL OF INFECTIOUS DISEASES



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Area 1: Development of improved or novel mono-component, multi-component and combined vaccines

**Intraperitoneal immunopathological reactions following vaccination of
farmed fish — Studies of basic immune mechanisms
EGC-VAC**

Contract number:	QLK2-1999-00799	Coordinator	Øystein Evensen
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Intraperitoneal immunopathological reactions following vaccination of farmed fish — Studies of basic immune mechanisms

BACKGROUND

The efficacy of disease prevention by vaccination of farmed fish against some of the major bacterial and viral diseases relies at present on the use of oil-adjuvanted vaccines. The main benefit is the induction of long-lasting protective immunity. The side effect of using adjuvanted vaccines is the formation of visible lesions at the injection site — the peritoneal cavity. This may on some occasions also result in downgrading of fish at slaughter or after processing, meaning a negative economic impact. The overall challenge in vaccine formulation for fish is to find the balance between inducing immune response and at the same time maintaining an acceptable level of adverse reactions.

OBJECTIVES

This project studies the immune mechanisms of granuloma formation in the peritoneal cavity of vaccinated farmed fish, warm-water (sea bass) and cold-water species (Atlantic salmon and rainbow trout), following the use of oil-adjuvanted vaccines containing *Aeromonas salmonicida*, *Vibrio anguillarum* or *Pasteurella piscicida*. The specific objectives are:

1. to elucidate the effect of single and combined bacterial components and vaccine formulations for the initiation, development and maintenance of intraperitoneal immune granulomas;
2. to investigate the key cellular mechanisms related to the development of vaccine granulomas both with regard to cell profile and cytokine profile.

EXPECTED RESULTS AND ACHIEVEMENTS

1. To identify the contribution of the individual vaccine components as regards induction and maintenance of immune granulomas at the injection site in commercial aquaculture fish species.
2. To obtain an overview of the kinetics of the inflammatory responses induced at the injection site following vaccination and their development over time.
3. To elucidate the underlying immune mechanisms with emphasis on pro-inflammatory cytokines and their complex interactions.

Results will be of importance for designing oil-adjuvanted vaccines, the aim being to optimise the side-effect profiles.

The data obtained can also be of value for the pharmaceutical companies in Europe involved in vaccine development for aquaculture fish species.

**Pathophysiology and prevention of *Lactococcus garvieae*
and *Streptococcus iniae* infections in rainbow trout
TROUT STREPTOCOCCOSES**

Contract number:	QLK2-2000-01049	Coordinator	Claudio Ghittino
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Pathophysiology and prevention of *Lactococcus garvieae* and *Streptococcus iniae* infections in rainbow trout

BACKGROUND

Streptococcal infections are nowadays considered the major cause of rainbow trout losses in several European and Mediterranean countries. Average mortality during the hot season may be over 50 % of the trout population. Due to the stormy character of these diseases, conventional treatments are not very effective. Besides being inadequate, massive use of antibiotics is expensive and environmentally unfriendly. In addition, a few gram-positive cocci have also been associated with human infections and are therefore a risk to public health. The definition of valid methods to prevent the onset of *Lactococcus garvieae* and *Streptococcus iniae* infections, through the generation of pathophysiological and immunological data, is therefore essential.

OBJECTIVES

The aim of the project is to generate information that will enable a more comprehensive understanding of streptococcal infections in fish. The pathophysiological events that lead to the onset of these diseases will be evaluated from two different aspects:

1. bacterial mechanisms of virulence, analysed through *in vivo*, *in vitro* and *ex vivo* models;
2. the host's response to the pathogens, analysed through the assessment of the cellular non-specific and specific immune functions.

These data will allow a better understanding of the pathophysiological and immunological events that precede the onset of these diseases and characterise their course, enabling a rational approach for designing specific vaccines and testing their efficacy in rainbow trout.

EXPECTED RESULTS AND ACHIEVEMENTS

The results expected from the project consist of:

1. the elucidation of the fundamental aspects of the agents' pathogenetic mechanisms;
2. the definition of the immune mechanisms which might allow fish to overcome *Lactococcus garvieae* and *Streptococcus iniae* infections;
3. the formulation of vaccines eliciting a specific immune response in rainbow trout.

The generation of basic data on *Lactococcus garvieae* and *Streptococcus iniae* infections will lay the basis for the future development of preventive tools.

The availability of efficient vaccines will improve aquaculture production in Europe, diminish the risk to public health and preserve the environment from the undesired impact of antibiotic residues.

**Development of a pathogen epitope prediction programme,
and evaluating its usefulness in designing fish vaccines
PEPTIDEX**

Contract number:	QLK2-2001-00838	<i>Scientific Coordinator:</i>	
Contract type:	Shared-cost project		Unni Grimholt
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Development of a pathogen epitope prediction programme, and evaluating its usefulness in designing fish vaccines

BACKGROUND

At present, no vaccines are available that successfully protect against viral infections in fish. Peptide-based vaccination is an approach that has been proven successful in warm-blooded vertebrates in particular relating to viral pathogens. In this project, we will generate sufficient knowledge to evaluate this technology in a cold-blooded vertebrate. The peptide-binding specificity for MHC class I alleles will be established providing the basis for peptide-binding assays, a pathogen epitope prediction programme, and a prototype viral peptide vaccine. By-products generated throughout the project will be immunological reagents and cellular model systems adapted to fish.

OBJECTIVES

The objective of the project is to develop a pathogen epitope prediction programme and to design a viral pathogen peptide vaccine. This will be accomplished by determining the interaction of the Atlantic salmon major histocompatibility complex (MHC) class I molecule with peptides derived from viral pathogens.

EXPECTED RESULTS AND ACHIEVEMENTS

The project will provide a broader understanding of the interactions between the immune system and viral pathogens. The approach of using peptide vaccines targeted at the animals' immunological content will be tested and evaluated as an approach for the future.

The project will develop reagents for use in immunological research in Atlantic salmon. A pathogen epitope prediction programme will enable easier detection of viral peptides exploitable for vaccine production. Additionally, a viral peptide vaccine will be developed and tested. If successful, it represents a new approach to developing vaccines against viral agents in fish and may be further developed into a commercial product available to the public.

**Oral vaccination of fish with plant-derived protein vaccines
FISHOV**

Contract number: QLK2-2001-01288
Contract type: Shared-cost project
Starting date: 1.1.2002
Duration: 36 months
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Oral vaccination of fish with plant-derived protein vaccines

BACKGROUND

In Europe and elsewhere, viral haemorrhagic septicaemia (VHS) and spring viraemia of carp (SVC) are two devastating viral diseases causing serious problems in farm-reared salmonids and carp, respectively. Several experimental vaccines comprising the G protein of the VHS virus (VHSV) resulted in the production of protective antibodies upon parental immunisation of rainbow trout and in protection in case of a DNA vaccine developed by one of the partners. Commercial vaccines are limited to some bacterial diseases and vaccination is mainly by labour-intensive injection or immersion methods. The major advantages of oral vaccines is that they will enable the farmer to immunise fish with a minimum of stress and handling at mass scale and from the moment that young fish are immune competent. Earlier fundamental research by one of the partners has shown the potency of oral vaccination. However, the procedures necessary to overcome digestion of the vaccine in the digestive tract are too expensive for commercial application.

OBJECTIVES

In Fishov, the complementary skills of seven research groups will be combined to develop a cost-effective oral vaccination method for the prevention of VHS and SVC. To this end, the specific objectives are:

1. production of viral G proteins of VHSV and SVCV in plants and evaluation of immunogenicity;
2. estimation of the most effective carrier molecule for gut delivery;
3. investigation of antigen processing in rainbow trout (*Oncorhynchus mykiss*) and carp (*Cyprinus carpio*) gut and subsequent immune responses;
4. production of the most promising vaccine in tubers and formulation in fish feed and evaluation of protection against VHS and SVC by challenging.

EXPECTED RESULTS AND ACHIEVEMENTS

The expected results will be:

1. production of viral G protein antigens and carrier complexes in potato tubers;
2. knowledge about antigen transport, uptake and immunogenicity in carp and rainbow trout;
3. detailed characterisation of antigen processing and aspects of immunity (systemic and mucosal immune responses, cell-mediated immunity) in trout and carp;
4. a method for the incorporation of plant-derived protein vaccines into fish feed;
5. knowledge about the relation between immunity and protection.

The results obtained in Fishov can lead to a safe and cost-effective innovative procedure for oral vaccination. Methodologies and findings will be published in peer-reviewed journals and our web site (www.fishov.org) and through presentations at international scientific meetings. The technology developed and tested on farm-reared fish can be extended much further and used for the development of edible vaccines for veterinary and human purposes. A marketing plan will assess further commercialisation of the technology.

**Antiviral innate immunity in cultured aquatic species
AVINSI**

Contract number: QLK2-2001-01691	Coordinator
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Antiviral innate immunity in cultured aquatic species

BACKGROUND

Viral infections are among the most destructive diseases that affect vertebrate and invertebrate species in aquaculture. Despite the impact that these diseases have on aquatic organisms, we know relatively little about what farmers can do to prevent and treat viral infections. The problems in controlling viral infections in aquaculture come mainly from the lack of commercial vaccines and specific therapeutic agents. Moreover, the use of currently available drugs in aquaculture is highly regulated in order to avoid risks to public safety and to prevent the development of resistant pathogen strains. Consequently, farmers are left with few resources other than the use of basic preventive measures. In the long term, alternative treatments using antiviral drugs may be developed in combination with the production of animals selected for disease resistance.

OBJECTIVES

Antiviral non-specific defence mechanisms (innate immunity) are important because they constitute the first line of defence in vertebrates, and the only one in invertebrates. The project aims to characterise antiviral innate immunity in fish, bivalves and crustaceans in order to provide new approaches for the control of viral infections in aquacultured species. Some molecules and genes involved in antiviral innate immunity will be defined and compared in different species. Selected antiviral effectors will be monitored by *in vitro* and *in vivo* assays to assess potential antiviral effects in different cellular and animal models. Furthermore, expression of the genes encoding selected molecules will be analysed in healthy and virus-infected individuals. Candidate molecules and genes will be supplied for further exploitation in aquaculture and to aid in the development of tools to control viral diseases of humans and other animals.

Five viral disease models will be studied in parallel in order to provide important information on complementary steps in defence mechanisms. The models involve specific pathogens: oyster herpesvirus 1/Pacific oyster (*Crassostrea gigas*), white spot syndrome virus (WSSV)/crabs (*Liocarcinus puber* and *Carcinus mediterraneus*), nodavirus/sea bream (*Sparus aurata*), koi herpesvirus (KHV)/common and ghost carp (*Cyprinus carpio*) and viral haemorrhagic septicaemia virus (VHSV)/rainbow trout (*Oncorhynchus mykiss*).

EXPECTED RESULTS AND ACHIEVEMENTS

The expected achievements of this research project are:

1. to characterise new genes and molecules involved in antiviral innate immunity in bivalves, crustaceans and fish;
2. to correlate functional data obtained in this project with genetic information already available through ongoing genomic projects in vertebrate and/or invertebrate species;
3. to assess the efficacy of candidate genes and molecules in the control of viral diseases of aquatic species.

In turn, the programme will be of benefit to the design of more potent vaccines in fish and antiviral therapeutic agents, and to the identification of new targets for preventive actions in different cultured aquatic species.

Area 2: Strategies to identify and control infectious diseases

Sub-area 2.1: Comprehensive approaches for treatment and protection

**Stimulation of fish larval defence mechanisms against infectious diseases
FISHAID**

Contract number: QLK2-2000-01076
Contract type: Shared-cost project
Starting date: 1.2.2001
Duration: 36 months
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Stimulation of fish larval defence mechanisms against infectious diseases

BACKGROUND

Production cycles, especially for Atlantic halibut and sea bass, are at present restricted by large larval mortality within hatcheries due to microbial infections. This problem is also experienced in the production of cod, wolffish and carp eggs and larvae and is encountered throughout the European aquaculture industry. As a consequence, it is imperative that a greater understanding of the ontogeny of the defence system within larval fish is developed.

OBJECTIVES

The project aim is to examine the immune defence (e.g. lymphocytes, macrophages, antibodies, complement proteins, pathogen-degrading enzymes) status during ontogenic development of different fish species (sea bass, Atlantic cod and halibut, spotted wolffish and carp). This will be achieved using immunological, immunocyto- and histochemical, enzyme histochemical, chromatographic and molecular biological techniques. The effects of immunotherapeutics on these fish larvae will be measured as survival after experimental challenges with pathogenic bacteria. In addition, the immune responses after immunotherapeutic treatments could be monitored as elevation of defence mechanisms and immune cell numbers during the treatments.

EXPECTED RESULTS AND ACHIEVEMENTS

By achieving the objective, the fish larval health, survival and welfare will be improved and this will contribute to a decrease in the economic losses of the European aquaculture industry.

Traditional techniques for delivering immunotherapeutics, such as intraperitoneal vaccination with an oil-based adjuvant, are far too traumatic, or even physically impossible, to be attempted on larval animals. The project will present new knowledge about immunotherapeutic strategies to modulate the immune defences of these commercial and potentially commercial species during the delicate larval stages. In addition, the outcome of this project, such as the development of strategies to prevent infectious diseases, may also be adaptable to other aquacultured fish species kept in the aquaculture industry.

**The genetic basis of *Gyrodactylus salaris* resistance
in Atlantic salmon (*Salmo salar*)
SALMOGYRO**

Contract number:	QLK2-2000-01631	Coordinator	Leslie Noble
Contract type:	Shared-cost project		University of Aberdeen
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Duration:	36 months		Tillydrone Avenue
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The genetic basis of *Gyrodactylus salaris* resistance in Atlantic salmon (*Salmo salar*)

BACKGROUND

Gyrodactylus salaris is a monogenean ectoparasite of fish that occurs in a number of European countries, and that has had devastating effects on Atlantic salmon stocks in rivers, most notably in Norway. The usual method of control in Norway is treatment of the affected rivers with the chemical rotenone. This is a very severe treatment, resulting in the death of all vertebrates in the river, and so is unsuitable for rivers with great biodiversity. It is also not feasible for use in the treatment of complicated river systems. Alternatives to this approach are therefore required. The current project is based on the results of challenge experiments using *G. salaris*, which have shown that salmon stocks from the Baltic area appear to be resistant to the parasite, while Atlantic salmon stocks are highly susceptible. This difference in resistance is thought to have a genetic basis. Examination of differences in fish response at the gene expression level, and isolation of resistance-associated DNA markers, will provide alternative approaches to the control of this dangerous fish pathogen.

OBJECTIVES

The main aim of the project is to gain an understanding of the interaction between *G. salaris* and its salmon host through investigation of the host immune response, the molecular basis for variation in host resistance to the parasite, and differences in genetic make-up of the parasite populations. Understanding the genetics of host resistance and parasite pathogenicity will be integrated and used to develop novel management options in relation to:

1. limiting the potential for inadvertent introductions of pathogenic strains of *G. salaris* into areas with susceptible salmon stocks;
2. genetically enhancing susceptible wild salmon stocks for increased resistance to *G. salaris* in rivers where inadvertent introductions take hold.

EXPECTED RESULTS AND ACHIEVEMENTS

1. Isolation of molecular markers or quantitative trait loci (QTLs) linked to resistance to *G. salaris* infection.
2. Development of molecular-marker-based selection methods that could be applied to introducing heritable resistance to parasites into wild salmon populations.
3. Isolation of markers for discrimination of *G. salaris* at the population level for use in the identification of pathogenic strains and epizootiology studies.
4. Elucidation of the immune response of salmon to *G. salaris* infection.
5. Elucidation of specific differences in host/parasite response that confer resistance to *G. salaris*.

The project aims to enhance animal welfare by increasing survival of salmon infected by *G. salaris*. Isolation of genetic markers linked to *G. salaris* resistance provides the potential for developing appropriate breeding programmes where the desired markers and associated genes can be increased in the population with the minimum loss in stock genetic diversity. Knowledge of the salmon immune response to *G. salaris* infection may provide information that can be used in the development of vaccines or immune enhancement. These may have limited use in the wild, but may reduce the potential of farmed fish to act as reservoirs for *G. salaris*. Knowledge of the salmon immune response to *G. salaris* will, in turn, provide insights into other fish/parasite interactions.

Improved control of *G. salaris* will protect the aquatic environment by preventing future loss of salmon populations and reducing the need for management approaches based on harmful chemicals such as rotenone, which eradicate *G. salaris* but also have a negative impact on the biodiversity of treated areas. Therefore, the management of the natural resources of salmon and the aquatic environment will be improved and sustainable fisheries will be protected through the control of this infectious disease.

The results of the project could potentially be used by legislators, fisheries managers and disease control authorities in planning and implementing methods for detection and prevention of disease, thus conserving at-risk populations of an already endangered species, the salmon.

Sub-area 2.2: Antimicrobial drug resistance and changes in virulence

**Sea lice resistance to chemotherapeutants: diagnosis, mechanisms,
dynamics and control
SEARCH**

Contract number: QLK2-2000-00809
Contract type: Shared-cost project
Starting date: 1.1.2001
Duration: 36 months
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Sea lice resistance to chemotherapeutants: diagnosis, mechanisms, dynamics and control

BACKGROUND

Throughout northern Europe, the salmon louse, *Lepeophtheirus salmonis*, seriously affects the marine phase of Atlantic salmon production. The development of sustainable methods of pest management has been unable to keep pace with the intensification of production, leading to excessive and very fragile reliance on very few chemotherapeutants, a situation that may promote development of resistance in the parasites.

Resistance against organophosphates has been demonstrated in sea lice in important salmon-producing countries, and resistance against pyrethroids and avermectins seems to be emerging. Most reports of clinical failures of control agents are, however, of an anecdotal nature. Unless they are verified as cases of resistance using validated diagnostic methods, control actions are difficult. Possible actions should be based on knowledge of the underlying mechanism in order to be effective. A thorough knowledge of the dispersion of the genetic material between salmon farms is vital for the assessment of the risk posed by resistance development in sea lice. The main objective of this project is, by a multidisciplinary effort involving scientists and aquaculture industry in Norway, the UK, Ireland and Canada, to develop strategies for identification and control of resistance development in sea lice.

OBJECTIVES

1. To develop biochemical and toxicological methods (bioassays) for early detection of reduced sensitivity to the pyrethroids cypermethrin and deltamethrin, the organophosphate azamethiphos, the avermectin emamectin and the chitin synthesis inhibitor teflubenzuron.
2. To study the underlying mechanisms using biochemical and molecular biology techniques.
3. To monitor sensitivity against the available chemotherapeutants in Norway, Scotland, Ireland and eastern Canada.
4. To study the dispersal of genetic material between individual farms under different control strategies by developing and applying microsatellite PCR methods.
5. To propose control strategies for handling resistance problems based on the knowledge generated through the project.

EXPECTED RESULTS AND ACHIEVEMENTS

The project is expected to result in:

1. validated protocols for the diagnosis of resistance in sea lice;
2. a thorough description of underlying mechanisms (e.g. altered detoxification, target site mutations);
3. an overview of the sensitivity towards the available control agents in Norway, Scotland, Ireland and eastern Canada;
4. a genetic population structure analysis on lice from adjacent salmon farms within fjords (Norway), in defined single-bay management schemes (Scotland and Ireland), and in a location with unusual hydrogeography (Canada).

The basic diagnostic protocols will be established in each of the participating countries, and will provide the industry and the authorities with knowledge-based tools to handle cases where resistance has developed. The project will help to establish strategies that minimise the risk of eroding the agent's effect, and with minimal consequences for the industry and the environment.

Sub-area 2.3: Diagnostic tests for humans and animals

**Infectious salmon anaemia — Development and standardisation
of diagnostic methods and aspects of the epidemiology of ISA
ISA**

Contract number:	QLK2-2000-00844	Coordinator	
Contract type:	Shared-cost project	Randolph Richards	
Starting date:	1.1.2002	University of Stirling	
Duration:	36 months	Institute of Aquaculture	
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Infectious salmon anaemia — Development and standardisation of diagnostic methods and aspects of the epidemiology of ISA

BACKGROUND

Infectious salmon anaemia (ISA) is a viral disease affecting farmed salmon. Since the first reports of this disease in Norway, ISA has occurred in many salmon-producing countries within the European Union and the Americas. Economic losses resulting from ISA can be severe. Rapid and reliable diagnostic methods are essential for the study of the epidemiology of ISA, and for the development of effective control measures. At present, there are no standardised detection procedures for the causative agent of ISA, an orthomyxovirus-like virus (ISAV). Cell culture isolation procedures have been developed for the detection of ISAV, together with molecular-based techniques including RT-PCR. However, the sensitivity and specificity of currently available diagnostic procedures are limited, and, consequently, the development of improved methods is urgently required.

OBJECTIVES

The objectives of this project are to develop and standardise rapid methods to detect infectious salmon anaemia virus. Both molecular and immunological probes will be developed. Methods studied will include real-time nucleic acid amplification (RT-PCR and NASBA), immunohistochemistry and serology. Antibodies against ISAV will be prepared using phage display technology. Once established and optimised, these methods will be used to investigate aspects of the epidemiology of ISA, including the role of wild fish as carriers, assessing the risk of vertical transmission, and to determine whether persistent infection with ISAV may occur.

EXPECTED RESULTS AND ACHIEVEMENTS

1. Optimised nucleic acid amplification procedures for the detection of ISAV (real-time RT-PCR; real-time NASBA).
2. *In situ* hybridisation test for ISAV.
3. Optimised immunohistochemical detection method for ISAV.
4. ELISA for detection of ISAV.
5. Standardisation of methods.
6. Anti-ISAV antibodies produced by phage display.
7. Assessment of the role played by wild fish and vertical transmission in transmission of ISA.

The results of this project will be used by veterinary diagnostic laboratory services throughout Europe, and will contribute to the control of ISA. The results are also applicable to the diagnosis of diseases caused by other pathogens of fishes, such as nodavirus, infectious pancreatic necrosis virus, and viral haemorrhagic septicaemia.

**Diagnosis, epidemiology and control of an enteric myxosporosis
of commercial Mediterranean fish
MYXFISHCONTROL**

Contract number:	QLK2-2001-00722	Coordinator	Pilar Alvarez-Pellitero
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Diagnosis, epidemiology and control of an enteric myxosporosis of commercial Mediterranean fish

BACKGROUND

Myxidium leei (Myxozoa) is an important pathogen of sparid fish cultured in the Mediterranean and causes high mortalities in netpens and in land-based mariculture systems, with a notable economic impact for Mediterranean mariculture. Despite the relevance of this myxidiosis, there are important gaps in the knowledge of the parasite life cycle, transmission, epidemiology, mechanisms of infection and immunology. Reliable, high-throughput diagnostic methods and efficacious control measures are currently unavailable.

OBJECTIVES

The overall objective of this project is to generate tools and knowledge which are useful for developing efficacious measures for the prevention and control of this enteric myxosporosis. The detailed objectives are:

1. to provide and validate a reliable PCR-based test for the specific diagnosis of the parasite, including non-lethal sampling methods for the fish;
2. to apply this PCR assay in field epidemiological studies involving diverse sparid systems in the different countries;
3. to use this PCR assay to evaluate the role of wild fish and invertebrates as reservoirs of the parasite;
4. to study the mechanisms involved in transmission, pathogenesis and infective process in sparid fish in the course of experimental infections;
5. to study relevant aspects of the innate and adaptive immune responses to the parasite, and evaluation of immunomodulation strategies for the prophylaxis of the infection.

EXPECTED RESULTS AND ACHIEVEMENTS

1. Validated PCR diagnostic tests and methods.
2. Data on the epidemiological situation of the disease in cultured and wild fish.
3. Data on the role of invertebrates as reservoirs or true alternate hosts.
4. *In situ* hybridisation methods for detecting all parasite stages.
5. Knowledge of parasite/host interaction, parasite development, and pathogenic mechanisms.
6. Knowledge of key factors involved in the immune response and determination of the existence of antibody response.
7. Evaluation of the adequacy of levamisole for disease prevention.

POTENTIAL APPLICATIONS

1. The PCR-based test for the specific diagnosis of *Myxidium leei* will be exploited by the partners, after an adequate agreement. It could be applied by the partners' laboratories, or by other licensed laboratories, including national and European reference laboratories. End-users will be fish farmers, veterinarians and diagnostic services on fish health. The use of this test will allow:
 - knowledge of the epidemiological status in the different countries, coastal areas and farms and evaluation of the risk of infection;

- control of the introduction and dispersion of the disease in national and international fish transactions.
2. Eventually, a protocol for the use of levamisole for disease prevention. Its exploitation will depend on the results obtained and the criteria of the laboratories involved, but the end-users would be fish farmers.
 3. The knowledge generated on the parasite epidemiology, life cycle, transmission, and pathogeny will facilitate the design of management recommendations for the prevention and control of this disease. Such recommendations will be disseminated among the entities involved, and some of them will be exposed in a final meeting with end-users and, eventually, by using a web site (to be developed).

**Diagnoses, pathogeneses and epidemiologies
of salmonid alphavirus diseases
SPD/SD DIAGNOSIS**

Contract number:	QLK2-2001-00970	Coordinator	Daniel Todd
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Diagnoses, pathogeneses and epidemiologies of salmonid alphavirus diseases

BACKGROUND

Salmon pancreas disease (SPD) of farmed Atlantic salmon and sleeping disease (SD) of farmed rainbow trout are emerging, economically important diseases, which have been reported in many European countries. The causal agents of SPD and SD have recently been characterised as closely related isolates of a novel alphavirus, the first to be reported in fish. Both diseases, which are associated with increased mortality and growth retardation, are thought to be significantly under-diagnosed because histology, the currently used method of diagnosis, is time consuming, labour intensive and requires input from an experienced pathologist. Sensitive, specific and convenient diagnostic tests, based on the detection of virus antigen and virus nucleic acid within tissue samples, are required to provide accurate information on the prevalence, severity and economic importance of these diseases. Such methods are also required to investigate the pathogeneses and epidemiologies of SPD and SD, providing information with which disease control strategies can be formulated.

OBJECTIVES

The primary aim of this project is to develop and evaluate tests for diagnosing infections caused by salmon pancreas disease virus (SPDV) in farmed Atlantic salmon and sleeping disease virus (SDV) in farmed rainbow trout. The tests include immunohistochemistry, cryostat section fluorescent antibody and tissue imprint fluorescent antibody, which depend on the detection of virus antigen, reverse transcription polymerase chain reaction for detecting virus nucleic acid, and an enzyme-linked immunosorbent assay for detecting serum antibody. Secondary aims are to improve the understanding of the pathogeneses of SPD and SD and to investigate epidemiological aspects of SPDV and SDV infections. Seven objectives, each associated with a separate work package (WP), have been identified. These are:

1. experimental reproductions of SPD and SD (WP1);
2. collection and characterisation of field samples (WP2);
3. production of recombinant SPDV/SDV proteins and virus-specific antibodies (WP3);
4. development of tests for detecting virus antigen, nucleic acid and virus-specific antibody (WP4);
5. comparative evaluation of diagnostic tests (WP5);
6. pathogeneses of SPD and SD (WP6);
7. epidemiological aspects of SPD and SD (WP7).

EXPECTED RESULTS AND ACHIEVEMENTS

1. The first sensitive, specific and convenient diagnostic tests for salmon pancreas disease of farmed Atlantic salmon and more convenient diagnostic tests for sleeping disease of farmed trout.
2. Improved understanding of the pathogeneses of salmon pancreas disease and sleeping disease.
3. Improved understanding of the epidemiologies of salmon pancreas disease and sleeping disease.
4. Information with which disease control strategies can be formulated.

Sub-area 2.4: Risk assessment and transmission

**Appraisal of the zoo-sanitary risks associated with trade
and transfer of fish eggs and sperm
FISHEGGTRADE**

Contract number:	QLK2-2002-01546	Coordinator	Paul J. Midtlyng
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Appraisal of the zoo-sanitary risks associated with trade and transfer of fish eggs and sperm

BACKGROUND

As the fish farming industry matures and becomes more competitive on an international level, there is a growing need to increase productivity by use of genetically improved stocks. In the resulting international trade, import requirements to prevent transfer of diseases are still mostly based on a 'zero-risk' approach, and there is generally a discrepancy between less stringent regulations being applied to movements inside States as opposed to stricter regulations applying to transfers across State borders. Knowing of the paucity and advanced age of scientific data forming the basis for current zoo-sanitary legislation in this field, a scientific appraisal of hazards and quantitative risks associated with the transfer of fish eggs and sperm has now become timely. A further motivation for the project is current work to revise European Community legislation on fish disease control.

OBJECTIVES

The aim of this concerted action is to scrutinise the scientific basis for current zoo-sanitary control requirements imposed upon the transfer and trade in seed stocks for international aquaculture, and to identify future research needs in this field. The quantification of risks for transferring certain infections when moving eyed eggs and fish sperm, and the potential of new techniques for improving the efficacy of disease risk management will be especially addressed.

During a series of project meetings, disease hazards associated with the transfer of fertilised eggs or gametes from cultured finfish, and scientific documentation relevant to risk assessment will be subjected to scientific scrutiny and in-depth discussions. Particular focus will be on the potential for 'true' vertical transfer (inside the egg) of studies allowing for a quantitative assessment of risks, and of studies on disease transfer risks with fish sperm. Pathogen survival and resistance to disinfection, and the quality of diagnostic tests for surveillance will also be addressed.

EXPECTED RESULTS AND ACHIEVEMENTS

In the outcome of the project, reports and scientific opinion documents will be produced, giving comprehensive and up-to-date background data for use in risk assessment and risk management procedures according to the sanitary and phytosanitary (SPS) agreement governing world trade. Scientific dissemination and publication based on the results of the project will be pursued.

Reports and scientific documents from this project will give comprehensive and up-to-date background data for use in risk assessment and risk management procedures according to the SPS agreement governing world trade. The reports from the project will also be utilised during the revision of current European Community legislation in this specific field, for the update of zoo-sanitary recommendations made by the Office International des Epizooties (OIE), and for the update on national and industrial rules and practices.

Through dissemination activities directed towards the international aquaculture industry and regulatory authorities, the project will contribute towards a commonly accepted risk perception, and stimulate the settlement of current disputes between European and non-European aquaculture trading partners.

**KA5: SUSTAINABLE AGRICULTURE,
FISHERIES AND FORESTRY, AND INTEGRATED
DEVELOPMENT OF RURAL AREAS
INCLUDING MOUNTAIN AREAS**



Q5RS-2000-30305 'Biofaqs'

Area 1: New and sustainable systems of production, including breeding methods and exploitation in agriculture, fisheries and aquaculture, taking into account profitability, the sustainable management of resources, product quality and employment as well as animal health and welfare

Sub-area 2.1: Interactions between environment, fisheries and aquaculture

1. Interactions between environment and fisheries

**Linking hydrographic frontal activity to ecosystem dynamics in the
North Sea and Skagerrak: importance to fish stock recruitment
LIFECO**

Contract number:	Q5RS-2000-30183	Coordinator	Helge Abildhauge Thomsen
Contract type:	Shared-cost project		Danish Institute for Fisheries Research
Starting date:	1.12.2000		Jægersborgvej 64–66
Duration:	36 months		DK-2800 Lyngby
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Linking hydrographic frontal activity to ecosystem dynamics in the North Sea and Skagerrak: importance to fish stock recruitment

BACKGROUND

One of the main objectives of the common fisheries policy is to consider environmental issues and interactions between fisheries and the ecosystem in fisheries management decisions. This so-called ecosystem approach is based on:

1. the identification of processes in, and influence on, the ecosystems which are critical in maintaining their characteristic structure and functioning, productivity and biological diversity;
2. taking into account the interaction among food-webs of the ecosystem;
3. protecting the chemical, physical and biological environment necessary to the well-being of these ecosystems.

The call for more in-depth ecosystem-oriented research is a consequence of the currently limited understanding of ecosystem functioning. Neither is it possible to explain the reasons for the gadoid outburst in the mid-1960s nor is the role of environment (circulation anomalies) in the recruitment failures of the North Sea herring stock fully understood. In other ecosystems, dramatic breakdowns of stocks (northern cod, west Greenland cod) have recently occurred, which were believed to be well monitored and managed. Managers and scientists are blamed for these developments, but also environmental effects may have contributed to the recruitment failures. The present interpretation of the processes involved in these stock collapses remains speculative as insufficient research effort was directed to the impact of environmental processes on stock development trends and available stock abundance indices.

The present project is a major step in this direction, taking a holistic approach to the understanding of a key element of the North Sea ecosystems: resolving the importance of the frontal regions, a key organising process in the marine environment, for recruitment success of important North Sea fish stocks. The fulfilment of this objective, when combined with spawning stock characteristics, will provide environmentally sensitive tools for the assessment, management and conservation of North Sea commercial fish stocks

OBJECTIVES

The key objective of this project is to resolve the importance of hydrographic fronts (h/U^3 and shelf break) and their variability for recruitment success of North Sea commercial fish stocks. Thereby, the proposed programme addresses the effects of a key hydrographic process on the dynamics of the ecosystem in a holistic manner rather than following a single-species approach. The approach proposed is mechanistic, resolving links and key processes, a strategy which is necessary to understand the effects of environmental warming on the ecosystem.

EXPECTED RESULTS AND ACHIEVEMENTS

First, we will resolve the influence of inter- and intra-annual climatic forcing on bottom-up processes, i.e. limited food resources for subsequent trophic levels in frontal and stratified regimes. This will involve the development and implementation of a nested small-scale physical/biological model incorporating organism behaviour and nutrient fluxes to simulate phytoplankton and zooplankton production and aggregation relative to frontal processes. This work step will allow us to simulate the horizontal and vertical distribution of potential prey items for larval and juvenile fish as well as the inter- and intra-annual variability of these items relative to frontal processes. Simulated fields developed by the model will then be validated with state-of-the-art field and remote

sensing techniques. Using this approach and time series of climatic forcing, the programme will develop a time series of frontal activity, as a proxy variable for larval fish prey availability, for testing of recruitment variability of fisheries stocks. The completion of this research task will also contribute significantly to the understanding of the dynamics of the North Sea ecosystem as it has recently been hypothesised that up to 40% of the North Sea's annual primary production occurs in these regions with climatic processes potentially modifying this dramatically.

**Interactions between the marine environment, predators, and prey:
implications for sustainable sand eel fisheries
IMPRESS**

Contract number:	Q5RS-2000-30864	Coordinator	J. van der Meer
Contract type:	Shared-cost project		Royal Netherlands Institute for Sea Research
Starting date:	1.12.2000		MEE Department
Duration:	42 months		PO Box 59
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Interactions between the marine environment, predators, and prey: implications for sustainable sand eel fisheries

BACKGROUND

The industrial sand eel fishery is the largest single fishery in the North Sea. Sand eels are a major food source for seabirds and cetaceans. Severe ecosystem effects of sand eel stock collapses have occurred, but the fishing industry contests the view that its activities negatively affect top-predators. Earlier studies have focused on the geographical overlap between feeding areas of seabirds and prey stock, but the relationship between stock size and prey availability to predators is poorly understood. As a result, current knowledge does not suffice to give fishery managers high-quality advice with respect to allowable levels of exploitation. In this project, predator–prey relationships in marine ecosystems will be studied in unprecedented detail using advanced technology. Threshold values of prey density will be established under which feeding is not feasible. Fishing techniques and exploitation strategies of industrial fisheries will be evaluated and discussed to assess the risks of overfishing.

OBJECTIVES

The main objective of the project is to assess the potential impact of sand eel fisheries on the higher levels of the food-web and to provide high-quality advice on allowable levels and strategies of human exploitation. To achieve this, prey selection and fine-scale temporal and spatial patterns in foraging strategies and feeding techniques of marine predators and in their foraging habitat requirements are described and compared with types (group) and habitats of sand eels targeted by industrial fisheries. Detailed information on the behaviour and rules which underpin the exploitation of sand eels by natural populations is fundamental for a better understanding of why certain predators are severely affected by low food stocks and others relatively little. The project aims at a combination of fundamental fieldwork, experimentation, the development and use of advanced technology to follow individual animals (innovation), individual-based modelling and oceanographic models on small space and timescales to look forwards and backwards in time under different climatic and prey availability scenarios.

EXPECTED RESULTS AND ACHIEVEMENTS

The project will determine the true relationship between hydrography, relevant sand eel population characteristics, i.e. the temporal and spatial patterns in abundance and age and size distributions, and the foraging performances of the groups of seabirds and marine mammals. This knowledge should enable exploitation strategies to be defined of the industrial sand eel fisheries that mitigate the impact on the top-predators of marine ecosystems.

The technological developments proposed under Impress, including the development of accurate, miniaturised compass-based loggers and GPS loggers to record the position and performance of individual seabirds at sea, will greatly enhance future possibilities to study top-predators in the marine ecosystems at sea and in unprecedented detail. The development and fine-tuning of such devices will form a major breakthrough in the potential for ecological research in the marine environment.

**Management of silver eel: human impact on downstream migrating
silver eel in the River Meuse
SILVER EEL**

Contract number: Q5RS-2000-31141
Contract type: Shared-cost project
Starting date: 1.4.2001
Duration: 24 months
Scientific Officer: Jacques Fuchs
Project web site: www.kema-water.com

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Management of silver eel: human impact on downstream migrating silver eel in the River Meuse

BACKGROUND

During the last two decades, a substantial decrease in the European eel (*Anguilla anguilla*) population has been observed in Europe, undoubtedly related to the decline of elver immigration. It is not clear which factor is crucial in the decline of the eel population: fisheries at different life stages of eel, hampering the immigration of glass eel or emigration of silver eel, mortality due to hydropower stations, water quality issues, parasites (e.g. *Anguillicola crassus*) or oceanic processes.

Impact on the downstream migrating silver eel in inland waters is caused by commercial fisheries and by mortality of eel passing the turbines of hydropower stations. Mortality rates for silver eels range from 13 to 50 % at individual hydropower stations. These human activities are widespread in many European rivers and might have detrimental effects on the population level of the European eel. Therefore, it is important to know to what extent damage to eel caused by hydropower stations is a threat to the population as well as the impact of withdrawal of eel by commercial fisheries. Which part of the silver eel population goes through the turbines has never been investigated. Until now, information on eel mortality by turbines has only been known of some individual hydropower stations in a limited number of rivers. No estimation has been made of the cumulative mortality caused by a series of hydropower stations. No comparison has been made between fisheries mortality and mortality caused by hydropower stations in a river system.

In this research project, we seek to find answers to mortality caused by commercial fisheries and hydropower stations in a large river system: the River Meuse (Maas). Commercial fishing of silver eel using various catch methods takes place on this river between the Belgian border and Diep in the Netherlands, a total length of 260 km. In the River Meuse, eight hydropower stations (six in the Belgian part of the river and two in the Dutch part) are currently in operation. For the Dutch part of the river, plans are being developed for three new stations. The governments of a number of countries (the Netherlands and Germany among others) require that the power station operators take expensive protection measures for fish. In view of the decline of the eel population, these requirements will increase.

Countermeasures to protect downstream migrating eels at hydropower stations are under research. One optional countermeasure is turbine management, i.e. to close down the turbines during the migrating periods of silver eel and to offer them a safe passage over the weirs. Closing down the turbines for longer migration periods, for example a number of months during the autumn, this being the main migration period for silver eel, means a substantial loss of electricity production for the electricity companies. Closing down the turbines during short periods at peak migration will be a better option. Until now, no practical tools have been available to assess the distinct periods of silver eel peak migration.

OBJECTIVES

The main goal of this research project is to contribute to a sustainable eel fishery and a sustainable production of electricity by hydropower in European waters. To achieve this goal, a research programme has been developed for the River Meuse area with the following objectives:

1. to monitor the catch of silver eels by professional fisherman in the River Meuse;
2. to monitor the cumulative mortality of downstream migrating silver eel passing two Dutch hydropower stations in the River Meuse on the basis of innovative telemetric methods;

3. to assess the impact of hydropower stations and fisheries on the eel population in the entire Meuse system;
4. to test an early-warning system for the prediction of the beginning of migration peaks of silver eel at the two Dutch hydropower stations, Linne and Lith, on the River Meuse;
5. to develop a turbine management system as a tool to protect silver eels passing turbines in order to improve the sustainable aspect of hydropower stations on the basis of the early-warning system;
6. to show the Migromat and NEDAP TRAIL systems at the Linne and Lith hydropower stations on the River Meuse to European and national authorities and power companies.

EXPECTED RESULTS AND ACHIEVEMENTS

To reach the goal, information will be provided for a management plan. The results of the investigations on mortality due to fisheries and hydropower stations will give an idea of the impact of these human activities on silver eel populations. On the basis of the level of this impact, the need for management measures for the fisheries and/or hydropower stations will be discussed. A valuable option for turbine management might be the closing-down of the turbines during short periods with peak migration forecasted on the basis of information from the Migromat system. The information provided will comprise the following elements:

1. withdrawal of silver eel by professional fisheries;
2. mortality of silver eel passing hydropower stations;
3. knowledge on the impact of fisheries and hydropower stations on silver eel;
4. development of an early-warning system for downstream migration by validation of the Migromat system.

**Reducing the conflict between cormorants and fisheries
on a pan-European scale
REDCAFE**

Contract number:	Q5CA-2000-31387	Coordinator	David Carss
Contract type:	Concerted action		Natural Environment Research Council
Starting date:	1.12.2000		Centre for Ecology and Hydrology
Duration:	24 months		Banchory Research Station
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Reducing the conflict between cormorants and fisheries on a pan-European scale

BACKGROUND

Two subspecies of the great cormorant (hereinafter 'cormorant') occur in Europe: the 'Atlantic' subspecies *Phalacrocorax carbo carbo* and the continental subspecies *P.c. sinensis*. Latest (1995) breeding estimates for *carbo* are of 40 000 pairs, mostly on the coasts of Norway, the UK, Ireland and northern France. The *sinensis* population (1995) is estimated to be over 150 000 pairs throughout the region, a dramatic increase since the 1960s. It is likely that the species is now more numerous across Europe than even before. The geographical range of these populations has also expanded with cormorants returning to some areas after a long absence and also moving into previously unoccupied areas. The reasons for such expansion is unclear, but possible causal factors include a 'non-limiting food supply' and protective legislation, particularly Directive 79/409/EEC on the conservation of wild birds. Cormorants are generalist fish-eating predators taking a wide variety of species in shallow coastal seas, running and standing freshwaters, and both traditional/extensive and intensive aquaculture systems. In almost all countries where cormorants are found, their increasing numbers and geographical spread have led to a growing number of conflicts with commercial fisheries and recreational angling interests.

OBJECTIVES

The overall objective of the project is to synthesise current cormorant/fisheries information and to identify and evaluate methods of reducing the current Europe-wide conflicts between conservationists and fisheries interests. The project will have five work packages, each with an overall objective as follows:

1. to synthesise available information on cormorant conflicts with fisheries, incorporating best estimates of associated financial losses;
2. to synthesise available information on aspects of cormorant ecology leading to these conflicts;
3. to produce a set of potential management tools, incorporating information on their efficacy and cost-effectiveness;
4. to develop and run a cormorant–fishery conflict resolution process based on a specific case study;
5. to disseminate information on cormorant conflicts with fisheries, relevant aspects of cormorant ecology, and strategies for conflict resolution at the local, national and European level.

The project will provide:

1. a synthesis of relevant information required as a precursor to conflict resolution;
2. an evaluation of potential management tools as a tool for cormorant/fisheries conflict resolution.

EXPECTED RESULTS AND ACHIEVEMENTS

The major milestones will be a cormorant/fisheries conflict workshop, cormorant ecology and potential management tools working group meetings and a case study workshop focusing on a specific case study. This work will establish a framework for improved communication and information transfer between stakeholders and other groups within the EU. The expected result will be the production of two reports detailing the findings of the project. These reports will also identify priorities for further, appropriate, cost-effective research.

**Effects of changes in fishery discarding rates on seabird communities
DISCBIRD**

Contract number: Q5RS-2001-00839
Contract type: Shared-cost project
Starting date: 1.2.2002
Duration: 42 months
Scientific Officer: Jacques Fuchs
Project web site:
[http://www.gla.ac.uk/ibls/DEEB/rwf/
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Effects of changes in fishery discarding rates on seabird communities

BACKGROUND

Huge quantities of demersal fish are discarded by fisheries. Scavenging seabirds eat many of these. This extra food may affect seabird community stability. The EU's CFP aims to manage fisheries in order to minimise damaging impacts on ecosystems, including top-predators. Knowledge of impacts of discarding rates on seabirds has been identified by the European Community (EC), the International Council for the Exploration of the Sea (ICES), and the Food and Agriculture Organisation (FAO) as a prerequisite. This study will provide such information. New state-of-the-art technologies (satellite tracking, geolocational data loggers, stable isotope and fatty acid biomarkers) will be used to quantify the importance of discards in seabird population ecology related to measures of breeding success. High-quality archived data on breeding ecology will be related to the best data sets on discarding rates. Results will inform policy on discard management.

OBJECTIVES

The main objective is to quantify the impact of change in fishery discarding rates on seabird communities in order better to inform fishery discard management. The study will determine whether winter at-sea distributions of selected scavenging seabird species are influenced by the distribution of fisheries generating many discards, and quantify how feeding on discards in winter affects seabird demography through influences on adult body condition, breeding and survival. Existing databases will be used to determine how changes in discarding rates in well-documented fisheries in the north-west North Sea and western Mediterranean over many years have influenced seabird diet, demographic parameters, and populations, and how changes in discarding rates are affecting the predatory impact of scavenging seabirds on smaller seabird species, and hence altering seabird community structure. The aim is to provide a better understanding of scavenging seabird ecology that can be used to inform policy.

EXPECTED RESULTS AND ACHIEVEMENTS

1. Mapped distribution of scavenging seabirds at sea in relation to discarding rates.
2. Measurement of the dependence of scavenging seabird population demography on discard availability.
3. Measurement of the effects of annual discard rates on scavenging seabird diet, body condition, breeding and population trend.
4. Measured impacts of scavenging seabirds on other bird populations as a result of diet switching.
5. Improved scientific basis for policy on discard management and seabird conservation.

**Costing the impact of demersal fishing on marine ecosystem processes
and biodiversity
COST-IMPACT**

Contract number: Q5RS-2001-00993
Contract type: Shared-cost project
Starting date: 1.12.2001
Duration: 36 months
Scientific Officer: Jacques Fuchs
Project web site: www.cost-impact.org

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Costing the impact of demersal fishing on marine ecosystem processes and biodiversity

BACKGROUND

The European Union currently faces potentially conflicting objectives of maintaining sustainable fisheries in European waters with all the economic benefits afforded to the Community through the fishing industry, while at the same time maintaining biodiversity and avoiding negative effects on the environment.

To date, the economic arguments for controlling fishing effort have focused on the costs of fishing per unit catch and maintenance of sustainable fish stocks for the future.

The current objectives of the EU are to control the environmental impact of fishing and to strike a balance between economic needs and protection of the environment.

OBJECTIVES

COST-Impact aims to put an economic valuation or costing on marine ecosystem resources or goods and services and indicate how this value is affected by fishing. This will provide fisheries and coastal zone managers with an effective tool to determine their policies.

The primary objectives are to provide advice to decision-makers on:

1. how demersal fishing impacts on the biodiversity of marine benthos and the associated goods and services, such as nutrient cycling, that they provide;
2. how these impacts influence other marine ecosystem processes;
3. what the likely values of marine ecosystem goods and services are and how these values are affected by fishing.

More specifically the objectives are:

1. collating existing data on the effects of demersal fishing;
2. experiments on goods and services provided by biodiversity;
3. modelling the effects of fishing on marine ecosystems;
4. modelling the costs/benefits of changes in fishing on the value of ecosystem services and natural capital.

EXPECTED RESULTS AND ACHIEVEMENTS

The project will help managers to integrate fishing policy with environment policy. COST-Impact will provide tools that help determine whether a balance can be achieved between the economic value of fisheries and the impacts of fishing on marine ecosystems and the economic value of the goods and services they provide.

With such knowledge, strategies can be developed for management of fisheries effort. Such strategies would balance the environmental impact on marine benthic biodiversity and the services the benthos provide for marine ecosystem functioning against the socioeconomic benefits of fishing.

More specifically, the expected results are:

1. an integrated European database;
2. empirical models of relationships between fishing and biodiversity;

3. empirical models of relationships between biodiversity and nutrient cycling, and ERSEM modelling of the impact of changes in fishing effort on marine ecosystem processes;
4. a bioeconomic model of the effects of changes in fishing on marine ecosystem processes, the economic value of the goods and services they provide and the value of the fisheries;
5. a management manual.

European fisheries ecosystem plan EFEP

Contract number:	Q5RS-2001-01685	Coordinator	Christopher L. J. Frid
Contract type:	Shared-cost project		University of Newcastle
Starting date:	1.1.2001		Dove Marine Laboratory
Duration:	36 months		Cullercoats, North Shields
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European fisheries ecosystem plan

BACKGROUND

The US National Marine Fisheries Service developed the concept of fisheries ecosystem plans (FEPs). The plans are designed to incorporate the principles and policies of ecosystem conservation into fisheries management. Specifically, an FEP provides a description and understanding of the basic environmental and human context in which a fishery is managed, they direct the use of that information for fisheries management and define strategies by which management objectives can be developed and implemented.

The European fisheries ecosystem plan (EFEP) will be achieved through the involvement of marine scientists, social scientists, economists and stakeholders (fishermen, fisheries managers, non-governmental organisations, etc.). The North Sea will be used as a case study; however, consideration will be given to the additional issues/regional differences that would influence the development of such plans for the northern/subarctic and Atlantic margin fisheries.

OBJECTIVES

The specific objectives of the project incorporated into work packages are:

1. to consult and develop links with stakeholders that have an interest in the North Sea (WP1);
2. to characterise the biological and physico-chemical environment of the North Sea which supports the fishery and to develop a conceptual model of the North Sea's key processes and food-web (WP2);
3. to rationalise the North Sea web into a 'significant web' which includes, amongst other criteria, habitats/species (as defined in EC legislation). A review of the metrics that have been used to measure the state/health of ecosystems and, potentially, develop new and/or modify existing ones (WP3);
4. to calculate total removals of harvest by-catch and incidental mortality in the North Sea (WP4);
5. to assess the degree of uncertainty in WP3 and WP4. A review of the input from stakeholders and develop a set of possible management regimes for later testing on the 'significant web model' (WP5);
6. to assess the evidence for ecosystem effects of fishing and match management responses that are acceptable to stakeholders and which are against them where they are significant (WP6);
7. to feed back results of management scenarios to stakeholders, elicit views and develop a draft FEP for the North Sea (WP7).

EXPECTED RESULTS AND ACHIEVEMENTS

The EFEP project will lead to a greatly increased understanding of the effect of fisheries on major components of the ecosystem and food-web dynamics. In addition, a set of tested management responses will be produced giving indications as to how to control the effect where significant. Policy-makers and managers will be informed of the results through the adoption of a project web site, a strict publication plan, academic- and policy-based conferences via the members of the EFEP Steering Committee, ICES meetings, dissemination through workshops and regular briefing/press releases.

Estimation of the reproduction capacity of European eel EELREP

Contract number: Q5RS-2001-01836
Contract type: Shared-cost project
Starting date: 1.11.2001
Duration: 36 months
Scientific Officer: Jacques Fuchs
Project web site:
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Estimation of the reproduction capacity of European eel

BACKGROUND

The ultimate goal is to stop the decline of the European eel population. The decline is probably multifactorial. We will determine the reproduction capacity of silver eels from different locations and the impact of parasites on their physical fitness. Furthermore, we aim to provide management tools allowing the formulation of reliable decisions for eel ecosystems and eel fisheries management. For this, we will estimate the capacity of yellow eel to transform into the downstream migratory silver eel ('silvering'). Finally, we aim to provide fundamental knowledge on the reproduction process, which is likely to be critical for the recruitment of the species.

1. The capacity of the silver eel to swim to the spawning grounds will be studied. Swimming performance, high-pressure resistance, and the effect of swimming and high pressure on maturation are the key factors in this project.
2. The development of a silvering index. This will allow for formulation of reliable decisions for eel ecosystems and eel fisheries management.
3. Maturation index. Silver eels are still in a prepubertal stage, the gonad development being heavily depressed. We will develop selection criteria for stimulated maturation, and new procedures for inducing sexual maturation either by long-term swimming/pressure or by hormonal treatments.

OBJECTIVES

The ultimate goal of the project is to stop the decline of the European eel population. For this purpose, we need to understand the underlying cause of the decline. In this project, we will determine the reproduction capacity of silver eels from different locations and the impact of diseases and PCBs on their physical fitness. Furthermore, we aim to provide management tools allowing the formulation of reliable decisions for eel ecosystems and eel fisheries management. For this, we will estimate the capacity of yellow eel to transform into the downstream migratory silver eel ('silvering'). Finally we aim to provide fundamental knowledge on the reproduction process, which is likely to be critical for the recruitment of the species. This knowledge might be used in future studies to develop a procedure for artificial reproduction.

The specific objectives are as follows:

1. To study the capacity of the silver eel to swim to the spawning grounds. The relation between swimming fitness, PCB levels and infection will be determined as well as the relation between pressure tolerance and infection.
2. To develop fundamental knowledge that can be used to estimate the silvering capacity. So far, little is known about morphological and physiological changes coupled to the transition from yellow to silver eel stage. Analysis of the various morphological and physiological parameters will lead to the establishment of a silvering index.
3. To develop fundamental knowledge on the maturation process. The role of hormonal and metabolic factors in the regulation of silvering and sexual maturation processes will be investigated.

The necessary activities within the programme are divided into six work packages (WPs):

1. silvering;
2. swimming performance;
3. pressure performance;

4. maturation performance;
5. genetic variability;
6. synthesis and recommendations.

EXPECTED RESULTS AND ACHIEVEMENTS

All activities in this project regarding the reproduction capacity of the European eel (sub)populations are focused on two lines of investigation: estimation of the capacity to reach the Sargasso Sea and understanding of the silvering and maturation process, including the potential disturbing effects of environmental factors.

The two lines will provide complementary knowledge and the tools to measure distinct eel populations with respect to the capacity to spawn and produce viable eggs and sperm. This knowledge is essential to set up a Europe-wide eel management system, which, in turn, is required to stop the decline of the European eel population. The project will also provide fundamental knowledge on the eel reproductive process, thereby contributing to the development of artificial eel reproduction technology. With the technology to produce viable eggs, aquaculture will no longer be dependent on the natural influx of glass eel, which will also help to stabilise the eel population.

The conclusions from the different tasks will be combined. Information on swimming endurance, high-pressure acclimation, ion regulation capacity, hormone responsiveness, genetic variability, and environmental conditions will be brought together in estimating the reproductive capacity of silver eels from different locations. Based on this information, recommendations will be made for European eel ecosystems and fisheries management. In addition, important information will be obtained for the development of eel artificial reproduction. All the work packages will start simultaneously, even WP6, since in each WP new techniques have to be developed, and applications must be made for the eel studies.

**Response of benthic communities and sediment to different
regimens of fishing disturbance in European coastal waters
RESPONSE**

Contract number: Q5RS-2002-00787
Contract type: Shared-cost project
Starting date: 1.10.2002
Duration: 36 months
Scientific Officer: Jacques Fuchs
Project web site:
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Response of benthic communities and sediment to different regimens of fishing disturbance in European coastal waters

BACKGROUND

Response is an integrated strategy to determine the response of the biotic environment structure and the changes of the particulate matter dynamic caused by the disturbance of fishing activity. This research is focused to provide new perspectives and management options to the CFP in order to achieve sustainable fisheries and protection of biodiversity, a widely recognised problem in moving towards ecosystem-based management in fisheries. The main objective is to obtain more knowledge on medium- and long-term effects to different regimens of fishing trawl perturbation on the seabed, analysing cessation of fishing activity and different levels of fishing effort. The study will be performed in real fishing grounds of European coastal waters. The objectives will be achieved by means of six multidisciplinary work packages, by estimation of changes in the sedimentological process, benthic and fish community, and secondary production of the lower trophic levels.

OBJECTIVES

The main objective of Response is to analyse the physical and biological response of the benthic ecosystem to different regimens of fishing disturbance in real fishing grounds. Response will address the following specific objectives:

1. to identify an appropriate studied area in each study area of the North Sea, Irish Sea and Mediterranean Sea;
2. to estimate the seasonal fishery and fishing effort;
3. to analyse the responses (community structure variability, diversity and abundance) of the benthic communities (macroinfauna, epifauna, fish) and sediment (resuspension, water turbidity) by considering cessation of fishing activity and different levels of trawl fishing effort;
4. to estimate the secondary production of lower trophic levels to contribute to coupling and to integrate biological (benthic communities) and physical (sedimentological) data.

This is a case study for biological and physical geology interactions. Special attention will be devoted to synthesis of results from different work and recommendations to the CFP to achieve an ecosystem well-being. The comparison of the results of the different geographical areas can provide information on different responses of benthic communities and sediments to the same kind of disturbance. The dissemination of the results obtained to scientists, decision-makers, user groups and the public at large is an important objective of the project.

EXPECTED RESULTS AND ACHIEVEMENTS

Response will provide additional information on the variability and resilience of marine ecosystems especially for marine communities relevant to fisheries. This information may help elucidate the potential effectiveness of using different time-limited closure periods on the impacts of fishing, providing unique data on organisms and sediments due to cessation of fishing activity and different levels of fishing effort, and on secondary production of different regimens of fishing disturbance. This investigation will be the mechanism that will permit us to minimise or to reduce fishing impact in order to allow recovery of the benthic ecosystems. Response will offer a valuable interface with stakeholders.

**The effect of turbidity and hypoxia on the behaviour
of coastal marine fishes
ETHOFISH**

Contract number:	Q5RS-2002-00799	Coordinator	
Contract type:	Shared-cost project	Paolo Domenici	
Starting date:	1.10.2002	Organismal Biology Group	
Duration:	36 months	International Marine Centre	
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The effect of turbidity and hypoxia on the behaviour of coastal marine fishes

BACKGROUND

Current knowledge of the behavioural and physiological processes that regulate the interaction between environmental variations (both man-made and natural) and the ecology of animals (i.e. their abundance and distribution) is limited. This knowledge is fundamental for understanding and predicting the effect of environmental disturbances on ecosystems, while its limitation is an obstacle to the development of specific environmental regulations. Turbidity and oxygen availability are two important environmental factors that are greatly affected by human activities along coasts. We will examine the effect of turbidity and oxygen availability on ecologically relevant behaviours such as habitat selection, predator–prey interactions and aggregation. We will use modern methods integrating laboratory and field studies. As a result, we will determine experimentally the thresholds beyond which turbidity and oxygen saturation alter fish behavioural and/or physiological processes. Experimental results will be incorporated into a conceptual model, including situation-specific sub-models of fish behaviour in response to hypoxia and turbidity.

OBJECTIVES

1. To assemble and further develop an integrative laboratory and field methodology, linking physical measurement with behaviour and physiological monitoring, for *in situ* evaluation of the effects of turbidity and hypoxia on fish behaviour.
2. To determine experimentally the thresholds above which turbidity, and below which oxygen saturation, alter fish behavioural and/or physiological processes.
3. To understand how habitat selection behaviour, an important determinant of biodiversity, is modulated by variation in turbidity and oxygen levels.
4. To determine the extent to which predator–prey interactions (focusing both on predator and prey) and the schooling behaviour of fish are affected by turbidity and/or hypoxia.
5. To integrate the results obtained into a conceptual and predictive model.

EXPECTED RESULTS AND ACHIEVEMENTS

1. Improved laboratory and field methodology for measuring physical variables and fish behaviour.
2. The effects of hypoxia and turbidity on metabolic scope and activity pattern.
3. Field observations on habitat selection and activity patterns in relation to oxygen and turbidity.
4. An understanding of the effects of variations in turbidity and oxygen on predator–prey interactions, aggregation behaviour and habitat selection.
5. Implementation of results into a conceptual model.
6. Dissemination through a web site, scientific articles in peer-reviewed journals, and conferences.

**Cod spatial dynamics and vertical movements in European waters
and implication in fisheries management
CODYSSEY**

Contract number:	Q5RS-2002-00813	Coordinator	Kathrine Michalsen
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Cod spatial dynamics and vertical movements in European waters and implication in fisheries management

BACKGROUND

Fisheries managers face a number of management problems for European cod stocks, some of them generic, some of them specific. Most seriously, stock decline in the north-east Atlantic has alarmed fisheries managers everywhere. Firstly, the recent development of recovery plans for North Sea and Irish Sea cod stocks have highlighted the absence of high-quality basic biological information on which to build robust multiannual technical measures to conserve and rebuild stocks. Such information is particularly important in order to evaluate the utility of the closed areas that have already been applied to protect cod in the North Sea and to the west of Scotland. Similar problems are likely to be experienced in the Baltic Sea and Barents Sea. Secondly, assessment of stocks has become increasingly difficult as the quality of commercial catch statistics has declined. Attention is now shifting towards fisheries independent stock assessments, and greater emphasis needs to be placed on understanding the causes of variation in these assessments. Thirdly, the effect of climate change on stock distribution and spatial dynamics of cod may be considerable. In each of these problems, a lack of basic biological knowledge hampers the development of conservation policy. Behaviour is a crucial aspect to consider when determining the nature of 'basic biology' because behavioural decisions underlie habitat selection and therefore influence the distribution, abundance and survival of populations. By improving our understanding of the horizontal migrations and vertical movements of cod and the influence of environmental and biological factors on them, we can provide management-relevant information as to the availability, accessibility and vulnerability of cod to fishing activities.

The fundamental basis and innovation of the Codyssey project is in its use of the comparative approach. A key benefit of using a multi-ecosystem comparative approach is that a greater range of behaviour and environmental conditions will be observed than by looking at one ecosystem only, thus permitting the formulation of quantitative relationships between specific behavioural traits and ecological variables. In doing so, these relationships can then be used to formulate and test specific management hypotheses or scenarios. Our adoption of this approach has been prompted by recent findings that suggest cod behaviour is rather more variable than has been assumed. Such differences may be linked to genetic or environmental factors, and by simultaneously comparing the behaviour of geographically, and apparently genetically, separate stocks, the role of environment and stock identity can be separated.

OBJECTIVES

The principal aim of the proposed research is to improve understanding of the horizontal migrations and vertical movements of cod and the influence of environmental and biological factors on them in order to provide management-relevant information as to the horizontal availability, vertical accessibility and individual vulnerability of cod to fishing activities. The fulfilment of this objective will provide tools for the evaluation of stock assessment methodology, management and conservation of cod stocks in European waters and will be greatly relevant to future stock assessment and the management of cod stocks under the soon-to-be renegotiated common fisheries policy, and other fisheries management instruments. In order to achieve this aim, we will need to test the hypothesis that patterns of horizontal and vertical movement of individual cod vary systematically, and that the variation is the consequence of behavioural responses to environmental factors. The main objectives of the project are defined below.

1. To undertake a comprehensive data storage tagging programme to collect individual-level behavioural and environmental experience data from cod in four contrasting ecosystems: the North Sea, the Baltic Sea, the Barents Sea and Icelandic/Faroese waters.

2. To develop a geolocation database based on existing comprehensive hydrographic data sets.
3. To reconstruct horizontal movements of cod in relation to spawning/feeding grounds.
4. To identify key environmental forcings of horizontal movements of cod.
5. To simulate cod-population-level processes using behaviour-based models of spatial dynamics.
6. To describe patterns and mechanisms of vertical movement in relation to environmental parameters and develop predictive models of vertical distribution of cod.
7. To identify and validate signature microstructures in otoliths ('ethotyping') from recaptured fish and quantify their frequency distributions in populations in order to scale up individual-level behavioural results to population-scale behavioural phenomena.
8. To disseminate management-relevant information gained from the research as widely as possible through a variety of forums (e.g. ICES working groups).

EXPECTED RESULTS AND ACHIEVEMENTS

Achievement of these objectives will provide:

1. information on the timing, duration and scale of horizontal and vertical movements of cod;
2. definition of systematic changes in the horizontal availability and vertical accessibility of cod to fishing and acoustic survey gear, and recommendations for acoustic/fishing survey interpretation;
3. assessments of the potential and location of effective closed areas to conserve cod stocks;
4. understanding of the mechanisms of cod horizontal and vertical movements;
5. understanding of the links between the environment and cod behaviour;
6. improvement in our ability to predict the movements and spatial distribution of cod in response to changes in fishing effort or environmental parameters, and thus provide new biological inputs to models of assessment and management;
7. presentation of management-relevant information to fisheries managers through publications and appropriate forums, such as attendance of key project personnel at relevant ICES working and study groups, publication of project progress in the ICES newsletter, articles in the popular press (e.g. *International Fishing News*);
8. presentations of key results at ICES and other conferences, organisation of EU-wide workshops and mini-symposia;
9. dissemination of important scientific results in peer-review publications.

In addition, further benefits of the project will be:

1. identification of the limitations and applications of archival tag technology;
2. opportunity for collection of biological material for cod genetic programmes;
3. development of data analyses/technologies (e.g. feeding tags).

**Managing fisheries to conserve groundfish
and benthic invertebrate species diversity
MAFCONS**

Contract number:	Q5RS-2002-00856	Coordinator	John Lancaster
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Managing fisheries to conserve groundfish and benthic invertebrate species diversity

BACKGROUND

Fishing affects marine ecosystems beyond the effects on just the target species. Populations of non-target species, and species diversity have declined, contrary to the Rio Convention on Biological Diversity. The 1997 intermediate ministerial meeting determined that an ecosystem approach to management be developed, enabling marine ecosystems to be utilised in a manner consistent with sustainable development and the conservation of biological diversity. This project aims to develop a management protocol which, when added to the present ICES fisheries management advice process, would allow managers to predict the consequences of management policy on species diversity. A theoretical model underpinning the management protocol will be developed, taking account of the actual ecological impact on fishing activity. The data required to use and test the ecological model, and apply the model within the management protocol, will be collected.

OBJECTIVES

The project will develop a management protocol to predict the consequences of setting particular total allowable catches (TACs) on benthos and fish species diversity. Developing and testing the theoretical ecological model underpinning this management protocol are a major objective of the project. Such a model requires a sound understanding of how fishing activities affect marine ecosystems, so the relationship between 'effort statistics' and actual ecological impact will be explored. The data required to run the ecological models (e.g. local productivity), and to test the model results (fish/benthos species diversity), will be collected. Finally, fisheries management statistics will be examined to determine the relationship between fishing effort and catch so that the ecological model, based on effects of fishing effort, can be applied within a management framework dealing with 'catch limitation'. The management protocol will be tested using recent stock assessment data and management advice scenarios.

EXPECTED RESULTS AND ACHIEVEMENTS

The Mafcons project is concerned with providing fisheries managers with a 'tool' which should enable them to start to adopt a proactive ecosystem approach to fisheries management. This should be of economic benefit to all EU Member States with a stake in the North Sea fishing industry.

Mafcons will develop a management protocol that will allow managers to assess directly the consequences to fish and benthos species diversity of setting specific TACs, so enabling them to balance the needs of fishermen and the ecosystem. Ultimately, if successful, Mafcons will provide a 'blueprint' for future management, and the procedures, or protocols, developed during the project will become a routine part of the ICES/EC/fisheries ministers' management process.

It is important that the correct balance between the needs of the fishing industry and protection of the natural environment is maintained. Mafcons is designed to provide managers with the ability to maintain this balance.

The Community ecology science carried out to date in the North Sea has tended to be descriptive, with little attention paid to defining the underlying ecological theory and testing specific hypotheses. Mafcons should redress the balance, being theory oriented, with the emphasis on deriving and testing explicit hypotheses.

In addition to disseminating the work within the scientific literature, and through working documents to ICES, a Mafcons web site will be established. It is intended that a full description of the work being planned for Mafcons will be posted on the web site. All formal documentation (deliverables) and published papers will be available for downloading from the web site as portable document files.

**Assessment of biomass export from marine protected areas
and its impacts on fisheries in the western Mediterranean Sea
BIOMEX**

Contract number:	Q5RS-2002-00891	Coordinator	Serge Planes
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Assessment of biomass export from marine protected areas and its impacts on fisheries in the western Mediterranean Sea

BACKGROUND

The export role of marine protected areas (MPAs) has been emphasised as one of their major prospective benefits, but not a single study has been able to produce export estimates. Such export is a main economic output of MPAs as it represents a production that can be used without damaging the MPA itself. The main objective is to test and develop methods to estimate export of fish biomass from MPAs to surrounding areas. These methods and their results will be the basis for developing a common management strategy for European MPAs. Mediterranean coastal fisheries have decreased over the last 25 years with subsequent socioeconomic consequences on rural employment. Management of MPAs to optimise biomass export can certainly contribute to the development of coastal fisheries through production of larger and more numerous fish. Thus, local fisheries can maintain their activity using traditional fishing gear and subsequently produce high market value and quality fish.

OBJECTIVES

Biomex will investigate the efficiency of MPAs as sources of biomass and the consequent export that can be expected. In this project, we consider MPAs as a management tool for providing sustainable fisheries in areas open to fishing. Thus, the main objective is to assess export of fish biomass from MPAs to surrounding areas. Measures of efficiency of MPAs for biomass export will be based on a multidisciplinary approach that will include biological and fisheries aspects. The standardised methods we intend to deliver by the end of the project will be applicable to the management of existing MPAs, as well as to designing future ones. The final goals are to develop a common strategy, to estimate the biomass export from MPAs, to assess the impact of export in a fisheries economics perspective, and to make widely available the knowledge gained in this project.

Four specific objectives have been identified:

1. To estimate the export of adult fishes from MPAs. This component will involve methods for estimating 'spillover' resulting from random movements and the density-dependent process.
2. To estimate pelagic export resulting from the dispersal of eggs and larvae. As eggs and larvae are often pelagic (see exception for benthic egg strategy), we will investigate pelagic export, which has always been the most difficult part to quantify in recruitment studies.
3. To estimate the contribution of adult fish export to fisheries. To quantify the impact of MPAs on fisheries, we will carry out experimental fishing surveys at increasing distances from the MPA boundaries to assess gradients of catch per unit effort.
4. To translate our findings from the first three project components into management actions and recommendations for MPA policies in order to ensure the valorisation of these scientific results into actual achievements for a better management of marine coastal areas. This objective will be achieved through:
 - the organisation of workshops involving MPA managers and scientists;
 - the elaboration of scientifically sound recommendations for MPA policies.

EXPECTED RESULTS AND ACHIEVEMENTS

Biomass export will be assessed in several Mediterranean MPAs to provide comparative results. This project will also aim to homogenise surveys of MPAs in the western Mediterranean to allow directly comparable results and then transferring these methods to

MPA managers. The project uniquely will produce a set of comparable data across several MPAs that will be collected and analysed together in order to determine the effectiveness of the different MPAs with respect to their export value. Ultimately, we intend to identify physical and biological characteristics of MPAs that influence their inherent potential for export, and therefore define a strategic work plan to improve the design of MPAs when export is the desired goal.

We expect significant achievements in the following items:

1. tools to manage the project work (network, committees, web, training);
2. export estimate from fisheries survey;
3. export estimate from experimental fishing survey; export estimate from gradient of biomass from underwater visual survey;
4. export estimates for eggs and larvae.

2. Interactions between environment and aquaculture

**Biofiltration and aquaculture: an evaluation of substrate
deployment performance within mariculture developments
BIOFAQs**

Contract number:	Q5RS-2000-30305	Coordinator	Kenneth D. Black
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Biofiltration and aquaculture: an evaluation of substrate deployment performance within mariculture developments

BACKGROUND

The use of biofiltration as a way of optimising water quality in land-based intensive mariculture systems where water is recycled has become standard practice over the last few years. In recent years, however, a significant proportion of mariculture has been undertaken under intensive farming conditions in open cage culture in inshore coastal waters. At present, the farms are solely reliant on the local environment for waste dispersal. The accumulation of highly organic waste material on the seabed can have substantial effects on the biological composition of the seabed communities and, in severe cases, impact on the health and growth of target culture species with deleterious effects on the economic performance of the farm.

Biofaqs ('Biofiltration and aquaculture: an evaluation of substrate deployment performance with mariculture developments') is a new project supported by the European Commission, and includes partners from the United Kingdom, Israel, Slovenia and Greece. The objectives aim to demonstrate the effectiveness of biological filters ('biofilters') in reducing the environmental impact of intensive cage mariculture in inshore coastal waters of all the project partner States.

OBJECTIVES

This research project will demonstrate the effectiveness of reducing the environmental impacts of organic inputs from intensive mariculture by using biofilter deployments. The objectives relate principally to biofilter use over a pan-European scale that includes the inshore coastal waters of all the project partner States (i.e. will include fieldwork and experimental conditions relative to the Mediterranean and Red Sea interests of Israel). The project has three interrelated principal objectives:

1. To quantify the validity (effectiveness) of biofilter use in association with mariculture within both economic and environmental frameworks on a pan-European scale. As components of this, the project aims to:
 - review the current knowledge base relating to mariculture impacts on a pan-European scale;
 - appraise current and past biofilter initiatives both within and outside Europe and synthesise this previously disparate research;
 - examine existing biofilter designs to determine design principles that could be transferred from aquarium recirculation systems to open water deployments;
 - develop and/or advance quantitative impact assessment models and methodologies;
 - undertake test field deployments of biofilters in association with existing mariculture concerns over a range of mariculture types and impact levels;
 - examine the potential for combining additive mariculture concerns with the physical structure of the biofilters.
2. To optimise biofilter designs and placement protocols in line with geographical differences and validated model predictions. This objective will be assessed principally through mesocosm experimentation and will examine:
 - biofilter design and performance over a range of temporal scales, a range of environmentally relevant physico-chemical parameter variations and under differing organic loading rates;
 - energy and nutrient fluxes in order to estimate levels at which intervention (removal or cleaning) will be required;

- the dynamics and/or requirements for biofilter following;
 - the placement parameters of biofilter deployment in relation to the relative location organic input point source and prevalent hydrological influences.
3. To examine the environmental and regulatory options governing post-biofilter usage and to provide detailed economic analyses of biofilter use compared with existing practices. Within this objective, the project aims to:
- review the current regulatory status of mariculture impacts and mid-water substrate deployments in European waters and to ascertain the likely acceptance of biofilters within these regulatory frameworks;
 - evaluate the transferability of legal models within the European context;
 - develop an analytical tool within the framework of comparative legal analysis;
 - prepare pan-European cost–benefit analyses of biofilter deployment in association with mariculture development with specific reference to environmental value.

EXPECTED RESULTS AND ACHIEVEMENTS

Through the achievement of the specific objectives outlined above, the project will deliver:

1. a comprehensive trans-European assessment of the environmental benefits of biofilter deployment in association with mariculture concerns;
2. guidance on both the physical design of the artificial substrate complex intended as the biofilter as well as the size and location of the deployments in relation to estimated organic load profiles and the prevailing hydrological dynamics of the deployment site;
3. a socioeconomic cost–benefit analysis of biofilter deployment compared with non-deployment;
4. guidelines on the regulatory framework required for such deployments;
5. targets for future research priorities after the termination of the initial project within a determined framework of standardised research protocols;
6. a network of researchers and practitioners in the field through the mutual publishing of findings and the formal and informal exchange of data and results integral to the project via joint fieldwork programmes and annual workshops. The network will be extended with the project partners through close association with the Meramed programme and through selective invitations from representatives of the mariculture industry and statutory regulatory bodies to attend the final workshop;
7. dissemination of the findings of the project both within Europe and beyond, including academics, practitioners and policy-makers, through the publication of academic papers, trade press articles, notes and project reports;
8. the posting of project summaries on a project-specific Internet site;
9. presentations at conferences, workshops and industry meetings.

**Rapid and ultrasensitive fluorescent test for the tracking of toxic algae
in the marine environment
DETAL**

Contract number:	Q5RS-2000-30778	Coordinator	Hervé Moreau
Contract type:	Shared-cost project		Laboratoire Arago
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Rapid and ultrasensitive fluorescent test for the tracking of toxic algae in the marine environment

BACKGROUND

The occurrence of harmful algal blooms (HABs) has been known since antiquity, but, during recent years, these events have become an increasing problem in coastal marine waters, and particularly along European coasts. Monitoring for HABs is a requirement of EU Directive 91/492/EEC and most European countries have monitoring programmes to ban shellfish harvesting during harmful algal bloom events or when shellfish reach a specified level of toxicity that is potentially harmful to humans.

Planktonic toxic blooms can cause neurotoxic shellfish poisoning (NSP), paralytic shellfish poisoning (PSP), amnesic shellfish poisoning (ASP), ciguatera fish poisoning (CFP) or diarrhetic shellfish poisoning (DSP). New species of harmful algae are continuously detected, and more worrisome new toxins are being found and chemically characterised. Currently, PSP is the most widespread shellfish poisoning occurring all over the world, followed by DSP. These two toxic syndromes are of particular importance on European coasts. The other poisonings, ASP and NSP, have more restricted geographical occurrences, although there are now new reports of ASP from Scotland. CFP is localised in tropical waters only.

OBJECTIVES

DNA and RNA probes, cell-surface antibodies and other molecular and biochemical techniques have come into more widespread use for identification of a limited number of harmful algal species. Our final objectives corresponding to five work packages are:

1. to collect and cultivate harmful algae belonging to three selected genera: *Alexandrium* (dinoflagellate, PSP), *Pseudonitzschia* (diatom, ASP) and *Prymnesium* (haptophyte, fish kills);
2. to design and test oligonucleotide probes for the specific and sensitive detection of selected harmful algal species in the marine environment;
3. to prepare monoclonal antibodies specific to surface antigens of toxic algae for the specific and sensitive detection of selected harmful algal species in the marine environment;
4. to validate the specificity of the methodology on cultured and field material;
5. to transfer this technology to the different national harmful algal monitoring networks which represent the best-controlled sampling conditions existing to study the evolution of the populations of toxic algae.

EXPECTED RESULTS AND ACHIEVEMENTS

We will utilise state-of-the-art technology both in the use of molecular probes and antibodies for species/strain-level recognition. The probes will be incorporated into a format using a new solid phase cytometer, which uses a laser beam to scan a filter membrane onto which field samples have been concentrated, process signals from the probes, and record the number of micro-organisms. This proposed novel technology should allow for: a faster method of detection; an increased level of sensitivity in case of low cell concentration; and the identification of toxic or non-toxic strains within a species.

**Aquaculture and coastal economic and social sustainability
AQCESS**

Contract number: Q5RS-2000-31151
Contract type: Shared-cost project
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Duration: 36 months
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Aquaculture and coastal economic and social sustainability

BACKGROUND

The small-scale fisherman, the aquaculture firm, the tourist industry, the private landowner and local government all have particular concerns in the coastal zone and their activities and their futures are related in complex ways. Although they all depend on a sustained resource base in coastal zones, their interests are often in conflict since different values, goals and interests motivate them. Thus, there is a need for a collaborative process in addressing complexities of this nature and deriving a sustainable development of coastal areas. The Aqcess project offers a holistic approach integrating the dimensions of ecological, socioeconomic, community and institutional sustainability.

OBJECTIVES

The key objective is to define the sustainability of fisheries and aquaculture in biological and socioeconomic terms. The project is assessing the effects of interactions between environment, fisheries and aquaculture. It focuses, in particular, on the effects of aquaculture on local economies and employment, fishery performance, abundance of fish species and coastal biodiversity. The project aims to design and suggest tools and methods to assess the contribution of aquaculture and fisheries to the economic development of coastal areas and their socioeconomic interactions with other available economic activities. The project will review options and strategies for integrated utilisation of renewable marine resources in different rural regions. It will propose methods to obtain the participation of local actors in rural development processes and strategies, and tools for the transfer of experience, innovation and knowledge where they are needed.

To achieve these goals, the following objectives will be pursued:

1. analysis of labour market conditions in selected areas of five European countries where aquaculture and fisheries coexist in widely different social and biological environments;
2. analysis of the impact on the local economy of aquaculture and fisheries: social and economic circumstances of rural communities given the interaction between aquaculture and fisheries, fluctuations in profitability and demand for products, and changes in regulations and incentives;
3. analysis of the impact of aquaculture on spatial and temporal patterns of coastal fisheries and biodiversity; quantification of both positive and negative effects;
4. synthesis of results and evaluation of existing coastal resource management regimes in different European countries;
5. formulation of recommendations for sustainable coastal resource management.

EXPECTED RESULTS AND ACHIEVEMENTS

1. Describe and model the social and economic value of coastal fisheries and aquaculture in selected regions of the European Community.
2. Provide information on the diversification of the employment opportunities in these coastal areas.
3. Recommend policy and management initiatives for the enhancement of sustainable economic activity in coastal areas where fishing and aquaculture activities contribute significantly to local economies.
4. Recommend appropriate management policies aimed at reaching a balance between aquaculture and fisheries activities, taking into account the social and economic development of coastal areas and ensuring the reduction of any detrimental effects on the physical and biological environment.

5. Provide guidance to policy-makers for the design of local employment initiatives and explore the available opportunities for the participation of local people in the decision-making process.

**Species diversification and improvement of aquatic production in seaweed
purifying effluents from integrated fish farms and from other waste sources
SEAPURA**

Contract number:	Q5RS-2000-31334	Coordinator	Klaus Lüning
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Species diversification and improvement of aquatic production in seaweed purifying effluents from integrated fish farms and from other waste sources

BACKGROUND

Sustainable poly-aquaculture systems based on seaweeds (macroalgae) are tested, in which algal growth is integrated with fish farms, in conjunction with SMEs, so that the environmental impact and the costs of fish farms in Europe are reduced. The project is innovative in the following respects:

1. high-value seaweed species not used before in poly-aquaculture are grown as sources of cosmetics, pharmaceuticals and fine chemicals, and as fish feed;
2. seaweed production is improved by controlling day length to induce year-round growth, avoiding unwanted sporulation, seeding somatic cells, and the use of new tank and raceway designs;
3. health assays are developed for the farmed seaweeds, together with tests for the antibiotic activity of seaweeds against fish-pathogenic bacteria.

OBJECTIVES

1. Increase of seaweed species diversification in integrated poly-aquaculture systems (IPAS), based on the cultivation of new seaweed species of economic importance to reduce nutrient loads of intensive fish aquaculture in onshore systems, in conjunction with SMEs.
2. Improvement of seaweed production in IPAS by:
 - manipulating physiological processes controlling growth and reproduction;
 - seeding somatic seaweed cells on newly developed artificial substrates;
 - testing new culture systems with different hydrodynamics.
3. Development of reliable assays for health and physiological status of farmed seaweeds, and tests for possible antibiotic activity against fish-pathogenic bacteria.
4. Economic evaluation of IPAS including the value of the seaweed produced and the benefits of purifying aquacultural and domestic wastes.

EXPECTED RESULTS AND ACHIEVEMENTS

1. Completion of cultivation procedures of high-value seaweed species for purifying high-nutrient effluents from fish farms and testing farmed seaweed as an addition to fish feed, in conjunction with SMEs.
2. Completion of the development of techniques for improving seaweed culture for obtaining year-round growth, prevention of mass sporulation, seeding somatic cells, and using new tank designs.
3. Completing health assays for, and obtaining antibiotics from, farmed seaweeds.

**Development of monitoring guidelines and modelling tools
for environmental effects from Mediterranean aquaculture
MERAMED**

Contract number:	Q5RS-2000-31779	Coordinator	Jos Kögeler
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Development of monitoring guidelines and modelling tools for environmental effects from Mediterranean aquaculture

BACKGROUND

In the last decade, aquaculture of sea bass and gilthead sea bream has experienced a period of exponential growth in the Mediterranean region; however, little detailed information is available on the environmental impacts of this industry. In general, it has been assumed that these will, at least qualitatively, follow the pattern established in northern latitudes. Environmental assessment strategies, developed and proven in northern European cage farms, underpin effective regulations in those areas. However, the application of such strategies to Mediterranean coastal cage farms would be inappropriate without modification and adaptation to the ecological particularities of the Mediterranean Sea. In addition to differences in the species cultured, the climate, the current regime, and the level of eutrophication, differences in the composition and diversity of fauna and flora between the north Atlantic and the Mediterranean Sea must be addressed.

The development of an appropriate and effective impact assessment and monitoring system for cage farms is essential in order to ensure the sustainable development of aquaculture in Mediterranean coastal areas, while taking into consideration other aspects of integrated management of the coastal zone, including tourism, fishery and environmental protection.

OBJECTIVES

In order to address these various concerns, Meramed aims to develop and establish a model-based control system for the environmental monitoring of fish cage farms in the eastern Mediterranean. This will require the fulfilment of three major objectives:

1. to undertake a review of procedures used in the regulation and monitoring of marine fish cage farms in Norway, Scotland and elsewhere to be used as the basis for creating an appropriate set of protocols, monitoring systems and techniques for the control of such farms in Mediterranean conditions;
2. to carry out a field research programme to provide appropriate data on the environmental impact of marine fish cage farms in a range of conditions in the eastern Mediterranean;
3. to develop a predictive model to simulate the environmental response at Mediterranean Sea cage farms to differing cage stocking levels and feeding regimes. This will be designed as a management tool for both the industry and regulatory authorities.

Successful fulfilment of these objectives will result in the development of methods and strategies to assess the effects of the interaction between the environment and aquaculture by determining the influence of farm effluents on faunal distributions and on the interactions between wild and farmed organisms.

EXPECTED RESULTS AND ACHIEVEMENTS

A review will be made of the current regulations governing marine fish cage farms and of the environmental monitoring required at such farms operating in Norway, Scotland and elsewhere. The aspects of these regulations and requirements that are appropriate to marine fish cage farms in the Mediterranean will be identified and adapted to reflect the differing conditions. The best practices currently being used in regulating cage aquacultural operations in the other areas will then be used to suggest guidelines, control protocols and monitoring techniques suitable for regulating cage farms in the eastern Mediterranean.

Surveys will be undertaken at a series of cage farms in Greece that are representative of different environmental conditions and farming practices. Environmental conditions in the

water column and sediments will be measured in the vicinity of the cages and in control areas beyond the influence of the cages. Assessments will be made of the benthic infauna and epifauna and of wild fish populations in both the control and impact areas. Fish assemblages around cage farms and their effect on the flux of solid wastes will be evaluated. Detailed feed and production data from the farms over the years prior to the surveys will be collected. These various information sets will be analysed and collated to provide both an overview of the environmental impact of cage farms in the eastern Mediterranean and an appropriate data set to drive and validate a predictive model of cage farm effects.

This model will build on the experience already gained in modelling impacts at marine cage farms. Current models based on conditions in northern European tidal waters will be reconfigured and developed to ensure that model outputs truly reflect the complexity of Mediterranean conditions and are sufficiently sensitive to safeguard the interests and needs of both the industry and the regulatory authorities.

**Impact of aquaculture on the immune response genes
of natural salmonid populations: spatial and temporal genetic signatures
and potential fitness consequences
SALIMPACT**

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Impact of aquaculture on the immune response genes of natural salmonid populations: spatial and temporal genetic signatures and potential fitness consequences

BACKGROUND

Salimpact assesses the extent to which disease transmission from Atlantic salmon aquaculture affects genetic variation in natural populations of Atlantic salmon and brown trout. This is achieved by comparative analyses of loci that are critically involved in immune responses (i.e. major histocompatibility complex (MHC) genes) with selectively neutral microsatellite loci. Spatial and temporal genetic studies of affected and unaffected salmonid populations in two geographical regions will be complemented by field experiments testing for fitness differences among MHC genotypes. This allows assessments of potential fitness consequence of disease impacts on MHC variability in natural populations.

OBJECTIVES

The objective of Salimpact is to assess the extent to which disease transmission has, or has had, an impact on genetic variation in natural salmonid populations. Genetic signatures of impact of aquaculture will be identified by comparison of patterns of variability at selected and neutral markers. We have developed molecular tools to investigate genetic variation at loci that are critically involved in the immune response (i.e. major histocompatibility complex (MHC) genes) with variability at a number of selectively neutral markers (microsatellites). Both temporal and spatial cases, comprising affected (i.e. with documented history of impact) and unaffected Atlantic salmon and brown trout populations, will be identified and analysed. These studies will be complemented with field experiments which will assess the effect of mate choice and the fitness consequences of different MHC genotype frequencies in populations under semi-natural and natural conditions.

EXPECTED RESULTS AND ACHIEVEMENTS

1. Validated protocols and techniques for the detection of microsatellite markers from archived scales and extant fish populations.
2. Collection of DNA samples obtained from selected populations (affected and unaffected by aquaculture activities) over time and space and the field experiments.
3. Marker analyses of DNA samples and statistical evaluation of the results.
4. Identification and quantification of the effect of fish farming on fitness-related traits within natural populations.

**Effect of nutrient release from Mediterranean fish farms on benthic
vegetation in coastal ecosystems
MEDVEG**

Contract number:	Q5RS-2001-02456	Coordinator	
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Effect of nutrient release from Mediterranean fish farms on benthic vegetation in coastal ecosystems

BACKGROUND

The coastal ecosystem is an important resource throughout the Mediterranean for commercial as well as recreational purposes. Marine aquaculture production of fish is a rapidly increasing industry in the Mediterranean where aquaculture is relatively new. Consequently, it is important to elucidate the environmental impact of this production.

The information indicating that the coastal zones may not be able to sustain the pressure from human activity is rapidly growing. The Mediterranean is generally considered an oligotrophic ecosystem, but there are signs of nutrient enrichment in some areas. The number of reports on the flourishing of fast-growing macroalgae in the summer with many visitors on the beaches is increasing every year and investigations of seagrass beds along the east coast of Spain show that the distribution of seagrasses is declining, as the rate of recruitment is slower than mortality. The loss of seagrasses may have a significant impact on the coastal ecosystem due to increased erosion and loss of habitat for a variety of marine animals.

Aquaculture production contributes to the pressure on the coastal zones. Fish farms are often located in near-shore areas which are also suitable habitats for dense and coherent seagrass meadows due to the strong currents and coarse sediments at such locations. This can lead to conflicts of interest between efforts to protect and conserve seagrasses in coastal zones and exploitation of farming activities.

OBJECTIVES

The objective of this project is to examine the effects of nutrients released during fish farming on community dynamics of the benthic vegetation in coastal zones in the Mediterranean. We wish to obtain new and valuable insight into the following subjects:

1. fate of nutrients released from aquaculture production in the Mediterranean;
2. effects of aquaculture on seagrasses and associated benthic fauna;
3. shifts in coastal vegetation communities (from seagrass to macroalgae);
4. seagrasses and fauna as early-warning indicators of aquaculture impacts.

Nutrients are released from fish farms in dissolved and particulate forms, and both types of input may alter the benthic community significantly by enhancing the nutrient in the benthic compartment. In particular, the slow-growing seagrass *Posidonia oceanica*, which is the dominant seagrass in the Mediterranean, may be affected by a higher nutrient availability. Fast-growing species, such as smaller seagrasses or macroalgae, may take over the benthic community. Such a shift in vegetation will affect other trophic levels such as the associated benthic fauna. By understanding these shifts, we aim to identify early-warning indicators of aquaculture impacts.

EXPECTED RESULTS AND ACHIEVEMENTS

Due to the fact that the aquaculture industry is new in the Mediterranean, the amount of information on environmental impacts is relatively small. The use of the existing knowledge from Atlantic aquacultures is limited due to major differences between locations, for example the oligotrophic or ultra-oligotrophic conditions found in the Mediterranean and the presence of seagrasses in close proximity to aquaculture installations there. It is thus very important to acquire more knowledge on the environmental effects on regional scales as well as on the European level. The presence of seagrasses may prove to be a valuable tool for monitoring fish farming effects and for

planning new fish farm locations. The seagrasses are permanent plants, which may accumulate the effects during time and at the same time they are easy to monitor. In this project, we will utilise a number of methods to assess the effects of farming activities on seagrasses and the associated benthic fauna, which can be used by monitoring authorities. Supplementary to this, we will develop a dose/response model of the nutrient release and effects on primary producers in the surroundings. This model can be used during planning of new farms and, together with the fish farmer, to optimise the size of the farms and the composition of fish food, and thus contribute towards improved sustainability of the farming industry.

**Sustainable management of interactions between aquaculture
and wild salmonid fish
SUMBAWS**

Contract number:	Q5RS-2002-00730	Coordinators	Neil Hazon, Chris Todd
Contract type:	Shared-cost project		University of St Andrews
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Duration:	36 months		Gatty Marine Laboratory
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Sustainable management of interactions between aquaculture and wild salmonid fish

BACKGROUND

This multidisciplinary project addresses questions relating to:

1. the decline in wild salmonid populations in north-western Europe;
2. aspects of the migratory behaviour and physiological responses of juvenile salmonids, as they adapt to seawater and as they respond to the additional environmental challenge and stress of ectoparasitic sea lice infestation;
3. up-to-date appraisals and modelling of the socioeconomic importance, and interaction, of the aquaculture and game angling industries in peripheral rural regions of north-western Europe.

The research is necessarily multidisciplinary in approach and will engage academic and applied scientists, an SME consultancy and an industrial pharmaceutical company in focusing the various components on the overall objectives of quantifying the infestation levels which elicit significant physiological stress on the host fish, and an assessment of the possibilities of conserving and enhancing small definable stocks of salmonids in a sustainable context, but with minimum management intervention.

OBJECTIVES

Using state-of-the-art cell biological and physiological techniques and socioeconomic modelling, recommendations on target lice burdens to allow the sustainable development of both industries will be achievable. For wild fishery managers, recommended levels will be those below which it can be assumed that sea lice are exerting no significant negative impact on local stocks. For the aquaculture industry, target infestation levels will be those below which significant impacts on the health of their stocks are minimal. Perhaps most importantly, however, by incorporating our data into mathematical models in a parallel programme, we will be able to recommend target levels for lice on farmed stocks which are sufficiently low as to minimise the possible impacts of farmed stocks on wild populations with regard to larval lice export and cross-infestation of wild fish. These latter farm levels are expected to be considerably lower than the minimal levels which elicit physiological stress effects on their own fish, and hence will have obvious economic consequences for the farming industry and social and economic implications for wild fishery interests.

EXPECTED RESULTS AND ACHIEVEMENTS

1. Identification of early migratory routes of salmonid smolts.
2. Assessment of species' susceptibility to sea lice infestation and the levels eliciting lethal and significant non-lethal stress.
3. Assessment of a prophylactic treatment protecting smolts from initial infestation by sea lice.
4. Socioeconomic appraisals of the aquaculture and wild game fishery industries, and their interaction, in rural areas of the EU.
5. Recommendations of the minimal levels of ectoparasitic lice infestation which are mutually beneficial to both industries and allow their sustainable development.



Q5RS-2002-00856 'Mafcons'

Sub-area 2.2: Scientific basis for fisheries management

**Genetic identification of fish by species-specific DNA markers for
use in stock biomass assessments and detection of commercial fraud
MARINEGGS**

Contract number:	QLK5-1999-01157	Coordinator	Eva García-Vazquez
Contract type:	Shared-cost project		Universidad de Oviedo
Starting date:	1.1.2000		Departamento de Biología Funcional
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Genetic identification of fish by species-specific DNA markers for use in stock biomass assessments and detection of commercial fraud

BACKGROUND

The main objective of the project is to improve a fisheries independent method of fish spawning stock biomass estimation by developing genetic-based methods for the accurate identification of the early stages of the eggs of 13 commercially important marine species: *Trachurus trachurus*, *T. mediterraneus*, *T. picturatus*, *Macroramphosus scolopax*, *Scomber scombrus*, *S. japonicus*, *Gadus morhua*, *Melanogrammus aeglefinus*, *Merlangius merlangus*, *Merluccius merluccius*, *M. senegalensis*, *Lepidorhombus whiffiagonis*, *L. boscii*. Probes will be developed for eight more species for commercial fraud identification. The species of each group show overlapped distributions and spawning period and their eggs can be confounded in plankton surveys. Protocols will be used in real surveys.

OBJECTIVES

1. To determine the most suitable method for preserving fish eggs to allow both visual sorting and DNA recovery.
2. To develop species-specific mtDNA and nDNA probes for: hake, Argentine hake, Austral hake, black hake, Chilean hake, Patagonian hake, Cape hake, Boston hake, megrim whiffiagonis, megrim boscii, cod, haddock, whiting, Atlantic mackerel, Spanish mackerel, Atlantic horse mackerel, Mediterranean horse mackerel, blue jack mackerel and snipe fish.
3. To develop PCR-based protocols for gene probe identification of fish eggs.
4. To assess the degree of improvement of the new PCR-based method for egg identification with respect to the visual method of egg identification.
5. To validate the method for the detection of commercial fraud in the European fish markets.

EXPECTED RESULTS AND ACHIEVEMENTS

1. Development of an egg preservation protocol.
2. Development of a protocol for routine DNA extraction from fixed eggs.
3. Development of species-specific markers for 21 commercially important fishes.
4. Development of an automated protocol for genetic identification of species using the new markers.
5. Assessment of the improvement achieved for egg identification using the new markers.
6. Validation of the new method for detection of commercial fraud in fish markets.

**Population structure, reproductive strategies and demography
of redfish (genus *Sebastes*) in the Irminger Sea and adjacent waters
(ICES V, XII and XIV; NAFO 1)
REDFISH**

Contract number:	QLK5-1999-01222	Coordinator	Hans-Joachim Rätz
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**Population structure, reproductive strategies and demography of redfish
(genus *Sebastes*) in the Irminger Sea and adjacent waters
(ICES V, XII and XIV; NAFO 1)**

BACKGROUND

The present project has been internationally developed to increase the fragmentary and preliminary biological knowledge about commercially exploited golden and deep-sea redfish stocks (*Sebastes marinus* L. and *S. mentella* Travin) in the Irminger Sea and adjacent waters within the framework of an agreed four-year research programme. The multidisciplinary intentions are designed to jointly investigate unsolved problems in the field of stock delimitation, reproductive strategies and demography as three separate work packages, respectively. A total of 16 scientists and six technicians from the Federal Research Centre for Fisheries (EU–Germany coordination), the Institute of Marine Research (EU–Spain), the Marine Research Institute (Iceland), the Institute of Marine Research (Norway) and the University of Bergen (Norway) will collaborate and contribute to the various analyses.

OBJECTIVES

Two commercially exploited redfish species occur in the Irminger Sea and adjacent waters, golden redfish (*Sebastes marinus*, Linnaeus, 1758) and deep-sea redfish (*Sebastes mentella*, Travin, 1951) which are currently treated as three management units straddling over European, Faeroese, Icelandic and Greenlandic exclusive economic zones (EEZs) as well as international waters. They are defined as golden redfish and deep-sea redfish on the continental slopes and oceanic redfish distributed over the pelagic Irminger Sea waters. The pelagic occurrences of redfish below 500 m and the ‘giants’ of the Reykjanes Ridge remained unidentified. The first work package investigates the genetic relation across these redfish, while the second work package deals with the reproductive strategy of the viviparous redfish species in terms of fecundity and seasonal cycles by sex. The third work package focuses on the dynamic demography of the redfish stocks including scientific and commercial fleet data.

EXPECTED RESULTS AND ACHIEVEMENTS

The project will provide essential information on stock identification and genetic relations between the redfish occurrences, and improve the basis for assessing their biomass production. Thus, the results are expected to contribute significantly to international management regimes and achieve sustainable exploitation.

**Combining geostatistical and Bayesian methods to improve
the scientific basis for the management of Atlantic mackerel fisheries
GBMAF**

Contract number:	QLK5-1999-01253	Coordinator	Sevket Durucan
Contract type:	Shared-cost project		Imperial College London
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Combining geostatistical and Bayesian methods to improve the scientific basis for the management of Atlantic mackerel fisheries

BACKGROUND

Atlantic mackerel fisheries are economically important in EU waters. A major tool for the assessment of these stocks, which forms the main scientific basis for the fishery management, is a triennial survey of pelagic mackerel eggs. From these surveys, absolute estimates of spawner abundance are obtained. However, recent research has suggested that there may be large biases in survey estimates of abundance due partly to incomplete survey coverage of the spatial and temporal extent of pelagic eggs in the spawning season. It is also unclear whether the estimation methods applied account adequately for uncertainties in the estimates of spawner abundance and whether the current management approach is sufficiently robust to address these uncertainties.

The pelagic egg survey is to date the only fisheries independent data source available for the mackerel and horse mackerel stocks. The calculated egg abundance is entered into a stock assessment model that applies an age-structured population estimation method, VPA. This project aims to combine geostatistical and Bayesian estimation methods to reduce bias in estimates of egg abundance and to better account for uncertainties in these estimates.

OBJECTIVES

The main objectives of the project are:

1. to combine geostatistical and Bayesian statistical methods to improve the scientific basis for the management of Atlantic mackerel stocks;
2. to apply Bayesian decision theory to evaluate the potential consequences for fishery management of applying both total allowable catch (TAC) and spatial controls, and to assess the information-gathering requirements of these controls.

The fundamental research carried out in this project deals with the sequential survey data on pelagic egg densities and aims to improve the estimates of egg production from this data and better account for uncertainty. Research does not directly seek to improve the stock biomass estimation methods and does not consider parameters such as fecundity and sex ratio. However, an improved estimate of egg production will have a positive impact on the output of models currently used to estimate stock abundance. Based on this principle, this project also aims at quantifying the impact of improved egg production estimates on the stock biomass estimates obtained through conventional modelling techniques which use the egg abundance estimates as one of the input parameters.

Geostatistical and Bayesian estimation methods are being combined to reduce bias in estimates of egg abundance and to better account for uncertainties in these estimates. Furthermore, Bayesian decision analysis methods will be applied to identify fishery control measures and information-gathering and estimation methods that will ensure that the management methods applied are adequately robust to deal with the uncertainties and conform to the recently adopted precautionary guidelines for fishery management in the CFP. The project also aims to use the uncertainty calculation methodology developed to design an 'optimal' egg survey design.

EXPECTED RESULTS AND ACHIEVEMENTS

The expected achievements of the project are:

1. development of a mathematical Bayesian framework for geostatistical analysis of sequential spatial data on pelagic egg densities to improve estimates of egg production

and better account for uncertainty; incorporate environmental/bathymetric data to improve estimates;

2. development of Bayesian Monte Carlo integration methods to estimate annual spawner abundance from geostatistical analysis of sequential data for pelagic egg densities;
3. development of a method for optimising egg survey designs which, for given levels of total annual pelagic egg survey effort, will minimise bias and variance in spawner biomass estimates provided by a geostatistical estimator;
4. assessment of the potential biological consequences of some alternative management options for the western and horse mackerel fisheries that involve different abundance surveying and harvest control methods;
5. identification of the optimal resource abundance survey and estimation approaches for each combination of methods for controlling fishing mortality;
6. comparison of the risks of over-depletion and robustness with uncertainties in stock size of the western and horse mackerel fisheries under different methods of controlling fishing mortality with the quality of information available to different methods for gathering information;
7. identification of how alternative management strategies can potentially be applied to improve sustainability of the western and horse mackerel fisheries.

**European decapod fisheries: assessment and management
EDFAM**

Contract number:	QLK5-1999-01272	Coordinator	Oliver Tully
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European decapod fisheries: assessment and management

BACKGROUND

The overall aim of the EDFAM concerted action is to provide a framework for future data requirements, assessment and management of European decapod crustaceans. EDFAM will also discuss the optimum management structures and policies that connect the structure and dynamics of these resources, the fishing process and the socioeconomic framework within which they are exploited. These actions are warranted given the low level of assessment work and consequent poorly defined management policies for the majority of these species and the importance of these resources to artisanal and offshore fisheries in Europe. Although some stock monitoring programmes exist in many countries and assessment is carried out at the ICES WG level, this applies to the minority of species. Assessment procedures need to be reviewed. Also, there is significant new knowledge worldwide in relation to assessment and management models to allow EDFAM to incorporate new developments and to apply them to the management of European crustacean fisheries.

OBJECTIVES

The objectives and actions of the project are to:

1. review existing assessment data collection programmes for European decapod crustaceans;
2. review the biology and fisheries for each of the commercially exploited species in Europe;
3. produce a web-hosted metadatabase for European crustacean fisheries (ECFM) that will host all available metadata on these fisheries including biological, economic and social metadata (www.edfam.net);
4. review current stock assessment methodologies. This will include the models used, methods of parameter estimation, assumptions and robustness of the assessments;
5. host a conference on the assessment and management of crustaceans that will also explore new developments in source sink dynamics and metapopulation concepts;
6. explore the capacity for standardised assessment data collection for decapods and develop a database template for such a standardised protocol;
7. review the systems for management of crustacean fisheries in Europe. Issues discussed will include institutional arrangements, national policies, delegation of management, property rights, management scale and distribution of the fish resources.

EXPECTED RESULTS AND ACHIEVEMENTS

EDFAM is expected to identify gaps in knowledge of European decapod stocks and to make definite recommendations through:

1. a synthesis of new approaches to assessment. This is important as it will define future data and research requirements;
2. identification of the optimum management structures. This is important for future national and European legislation and the common fisheries policy.

The findings of the project will be disseminated to industry and to fisheries laboratories in Europe involved in research and assessment of decapod resources.

**A multidisciplinary approach using genetic markers and biological tags
in horse mackerel (*Trachurus trachurus*) stock structure analysis
HOMSIR**

Contract number: QLK5-1999-01438
Contract type: Shared-cost project
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A multidisciplinary approach using genetic markers and biological tags in horse mackerel (*Trachurus trachurus*) stock structure analysis

BACKGROUND

The aim of this project is to assess the stock structure of the horse mackerel (*Trachurus trachurus*), which is an important target species in many north-east Atlantic and Mediterranean fisheries. The project will provide information which is currently lacking for an effective definition of horse mackerel stock boundaries, and will evaluate the status of the horse mackerel populations. The overall objective will be achieved by integrating the results from several techniques such as genetic markers, other biological tags such as morphometric studies and the use of parasites, physical tagging and life history traits (growth, reproduction and distribution). The genetic stock assessment will be performed by means of five different genetic approaches comprising the analysis of allozymes, the mitochondrial DNA and the microsatellite DNA. The proposed research will therefore set up an improved multidisciplinary tool for fish stock identification, and an exhaustive knowledge of horse mackerel stock structure, in order to allow enhanced management of horse mackerel resources in EU waters in the short, medium and long term.

OBJECTIVES

The project aims by means of the development and validation of methods to establish the geographical limits and the genetic structure of the horse mackerel stocks in the north-east Atlantic and Mediterranean. A combination of various techniques that cover the use of biological tags (molecular genetic markers, parasites, morphometry), physical tagging and life history traits (growth, reproduction and distribution) will be applied to obtain the information requirements for the stock identification. A better understanding of the horse mackerel stock structure will allow the establishment of management policies that take into account the genetic integrity on a medium- and long-term basis.

To obtain this, a number of sub-objectives will be developed:

1. identify, by using different molecular genetic markers, populations and stocks from the Mediterranean Sea and north-east Atlantic that maintain and sustain the Castle–Hardy–Weinberg equilibrium;
2. indirect quantitative estimation of gene flow among the stocks, to evidence the population fragmentation;
3. characterisation of the genetic diversity of the horse mackerel along its entire area of distribution;
4. assessment of the summary statistics of levels of infection in terms of prevalence, mean intensity and/or abundance of metazoan infection in different horse mackerel samples;
5. interpretation of the results in terms of host population biology (migration routes, feeding and spawning areas, recruitment grounds, etc.) after the comparison of infestation levels in intra- and inter-sampling areas;
6. application of the geometric morphometrics on the horse mackerel body and otoliths, as a tool for the identification of intraspecific variation;
7. isolate body and otolith shape differences among areas, by applying multivariate statistical techniques;
8. evaluation of the viability of the application of internal and external tags in the horse mackerel;
9. examination of the different population parameters — growth rate, maturity ogive, fecundity, age structure, distribution and abundance — to identify horse mackerel production units;

10. assessment of the effects of the extrinsic factors (environmental conditions, fishing pressure), space and time, in the population parameters observed;
11. analysis of the relationship between the genetic characterisation and the production units — consequences for the management in relation to preserving the genetic integrity.

EXPECTED RESULTS AND ACHIEVEMENTS

The project will provide:

1. genetic markers to identify horse mackerel stocks;
2. the selection of tag parasites;
3. results based on morphometric analysis;
4. conclusions on the viability of physical tagging and the characterisation of production parameters by area;
5. the integration of all the information to delineate the boundaries of stocks.

The results produced will be scientific data allowing an improved formulation of managerial advice for the CFP, in order to plan sustainable exploitation of the horse mackerel, as well as a developed and validated multi-method approach to assess fish stock structure.

**A coordinated approach towards the development of a scientific basis
for management of wild Atlantic salmon in the north-east Atlantic
SALMODEL**

Contract number: QLK5-1999-01546
Contract type: Shared-cost project
Starting date: 1.2.2000
Duration: 36 months
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A coordinated approach towards the development of a scientific basis for management of wild Atlantic salmon in the north-east Atlantic

BACKGROUND

The project seeks to advance the scientific basis upon which advice is given to managers of local, national and international salmon fisheries, compatible with the precautionary approach, as adopted by all signatories (including the EU) to the North Atlantic Salmon Conservation Organisation 1998 Accord on Salmon Management. Specifically, experts in salmon biology and in fishery modelling will carry out a concerted action to improve our ability to set salmon conservation limits, addressing transportability and dynamic change issues, and taking account of underlying stock structure. Work will also be carried out to develop more reliable estimates of pre-fishery abundance (PFA) for north-east Atlantic salmon stocks and to develop predictive PFA estimates that can be used to advise on catch options.

OBJECTIVES

The overall objectives of Salmodel are to improve our ability to set salmon conservation limits (CLs), addressing transportability and dynamic change issues, also taking into account underlying stock structure, and to examine methods of estimating pre-fishery abundance for north-east Atlantic salmon stocks and to determine whether and how PFA estimates can be used to give catch advice.

A number of specific tasks were set up to address these objectives, as follows:

1. to examine and agree definitions and principles involved in the use of biological reference points in salmon management;
2. to review the quality of relevant data existing in national laboratories/databases and determine whether additions/improvements are necessary;
3. to review and evaluate progress in individual countries towards setting river-specific or regional conservation limits;
4. to review and evaluate progress on establishing national and international conservation limits and their use in developing ICES advice for the management of fisheries;
5. to examine methods for interpreting stock-recruitment data upon which conservation limits can be based; to explore the use of new data sets (e.g. catch time series) and to investigate the effects of dynamic change in both the stock and the habitat;
6. to evaluate currently available habitat assessment methods in order to assess our ability to transport stock/recruitment relationships between rivers and to examine uncertainty inherent to these extrapolations; to evaluate new technologies (e.g. GIS) that may assist this process;
7. to review the model currently being used to estimate pre-fishery abundance at an international level, and investigate means for independent validation of the PFA estimates; to examine the sensitivity of the PFA model to variability in input parameters;
8. to review the options for developing PFA forecast models and to determine the most appropriate stock groupings for use in international management;
9. to examine the role of risk assessment and to investigate the uncertainties in the use of the above models for management advice; to determine the biological and fishery implications of these uncertainties;
10. to evaluate alternative management approaches and consider management risks compared with the approach currently being developed;
11. to provide recommendations for further collaborative R & D in these areas, to trigger new bids for shared-cost project funding (particularly in model development).

EXPECTED RESULTS AND ACHIEVEMENTS

Development of scientific assessment methods to the stage where they can confidently be used for advice on the management of salmon fisheries.

More specifically, the following results are expected:

1. decisions on whether present interim assessment methods will support development, or whether alternative approaches should be adopted;
2. satisfactory method of setting and transporting conservation limits;
3. reliable estimates of salmon pre-fishery abundance in the north-east Atlantic.

**Sexual identification and development in the swordfish —
Improved determination tools for more efficient stock assessment
and implementation of control measures
SIDS**

Contract number: QLK5-1999-01567
Contract type: Shared-cost project
Starting date: 1.3.2000
Duration: 32 months
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[http://www.uni-duesseldorf.de/WWW/
MathNat/Zoophys/bridges/swordfish.htm](http://www.uni-duesseldorf.de/WWW/MathNat/Zoophys/bridges/swordfish.htm)

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Sexual identification and development in the swordfish — Improved determination tools for more efficient stock assessment and implementation of control measures

BACKGROUND

In the large, economically important, Mediterranean and Atlantic marine fishery for the swordfish (*Xiphias gladius*), the determination of both sex and gonadal maturity of fishes at capture are important requisites for the controlled regulation of the fishery. This fishery accounts for a yearly financial turnover of well over EUR 300 million within the combined fisheries of the EU. In many cases, the sex and the gonadal maturity of the swordfish cannot be determined due to the lack of external sexual dimorphisms between the sexes or due to the fact that much of the catch is 'gutted' at sea thereby making determinations on the landing of the catch obsolete. This type of data can then only be ascertained by the use of scientists 'on board' to examine the catch, an undertaking which may be both costly and time consuming under harsh conditions. In search of a more efficient and cost-effective assessment method of these two parameters, an enzyme-linked immunosorbent assay (ELISA) mediated muscle biopsy (EMMB) will be developed to establish the levels of the sex hormones together with the lipoprotein vitellogenin for the swordfish and standardised using morphological and histological techniques.

OBJECTIVES

The objective of the project is to sample swordfish populations from the eastern, central and western Mediterranean Sea and develop methods to determine steroid hormone concentrations and vitellogenin concentrations in plasma and tissue of these fish over a seasonal reproductive cycle. These will then be used to determine sex and sexual maturity and compared with histological studies made at the same time. Using this study as a calibration, a muscle biopsy test will be evolved for standard determination of sex and maturity from single muscle samples. This will be tested by simulated market conditions and 'double blind' experiments under field conditions.

The objectives will be carried out over two fishing seasons, with the second season serving as market testing. In the first season, the main objectives are to determine the stability of the sampling methods and to develop the necessary methods for determining steroids and vitellogenin in swordfish plasma and muscle.

EXPECTED RESULTS AND ACHIEVEMENTS

From the first fishing season, over 400 fish were examined throughout 118 fishing days. Steroid stability was proven and vitellogenin was isolated from female fish and antibodies for an ELISA test have now been prepared. From early results, it appears that some large male swordfish have levels of vitellogenin in their plasma and these have been correlated with the presence of the female hormone estradiol. Further examination of the gonads of at least eight male specimens from the central Mediterranean confirm the presence of oocytes in the testis. This may be the first evidence of 'endocrine disruption' in a top pelagic predator within the Mediterranean basin and requires further study.

From the second fishing season (2001), 184 fish were sampled in Italy (62 males and 122 females), 184 fish were sampled in Greece (86 males and 98 females) and 335 fish (mostly sex unknown) were sampled in Spain. The histological analysis of testes led to the identification of a high percentage of intersex (25 %) showing the presence of isolated or grouped oocytes inside the testicular tissue of Spanish, Greek and Italian fish. The results from the steroid determinations were unsatisfactory and cannot be used for sex determination on a regular basis. Vitellogenin has, however, proved to be an excellent marker for sex and in a discrimination window from May until August with a lower jaw-fork length > 140 cm, all females could be determined using this molecular marker.

The earlier evidence of endocrine disruption shown in the first fishing season has been confirmed from fish taken in the second fishing season.

One of the main problems for the fishery is the large percentage (> 70 %) of immature fish which are caught which have not reproduced previously as shown by histological and molecular markers.

**Development of structurally detailed, statistically testable models
of marine populations
DST2**

Contract number:	QLK5-1999-01609	Coordinator	
Contract type:	Shared-cost project	Gunnar Stefansson	
Starting date:	1.1.2000	Marine Research Institute of Iceland	
Duration:	48 months	Modelling Division	
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Development of structurally detailed, statistically testable models of marine populations

BACKGROUND

Fish stock assessment is the basis for fisheries management advice. Data and models currently used for fish stock assessment in the north-east Atlantic area provide estimates of abundances of fish and exploitation rates, and estimates of precautionary limits for these quantities. Multispecies effects and dynamic growth are usually omitted as are spatial variation and fish migration. In some cases, specialised models (e.g. multispecies virtual population analysis — MSVPA) have been used to quantify some of these relationships and are believed to provide better fundamental descriptions of the stocks in question but, as the various models are rarely statistical, it has been difficult to make formal evaluations about the extent to which they are supported by the data or the improvements they may offer in practical terms.

OBJECTIVES

The overall goal of the project is to decide on the level of complexity to use in modelling fish stocks for management advice. The first objective is to collect relevant data into data warehouses and provide objective means of analysing these through libraries of computer programs. The next objective is to validate present estimates of the stock sizes and exploitation histories for key fish stocks, using statistical models that include descriptions of growth, migration and predation. This will be followed by an evaluation to find out whether, when and how increased complexity in models enhances management advice on: (i) closed area restrictions; (ii) state of stocks and catch forecasts; (iii) small-scale effects such as local depletion of forage species. Finally, perceptions of limit reference points for safe exploitation of resources, taking spatial and multispecies concerns into account, will be evaluated and validated.

EXPECTED RESULTS AND ACHIEVEMENTS

Construction of models that are empirically justifiable in that they contain an amount of detail in their structure which is appropriate to the data which are available. The intention is to develop fisheries science as far as the information will support such development. This can be used as support for decisions about the most appropriate level of complexity to be used in modelling fish stocks for supporting annual management decisions, and also in formulating long-term strategic advice.

**Demonstration of maternal effects of Atlantic cod: combining
the use of unique mesocosm and novel molecular techniques
MACOM**

Contract number:	QLK5-1999-01617	Coordinator	Terje Svaasand
Contract type:	Shared-cost project		Institute of Marine Research
Starting date:	1.1.2000		Department of Aquaculture
Duration:	36 months		Division of Genetics and Ecology
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Demonstration of maternal effects of Atlantic cod: combining the use of unique mesocosm and novel molecular techniques

BACKGROUND

Atlantic cod is a major target species for the European fishing fleet. All European cod stocks are under heavy fishing pressure or overexploited. An effect of overexploitation is a reduction in the average age and size, with an increasing proportion of recruit spawners in the stock. The basis for this project is to follow offspring from selected families of cod reared under identical and semi-natural conditions from hatching, through the larval and juvenile stages, and until sexual maturity, and compare their viability through these stages. Viability comparisons will be made between and within recruit female spawners and repeat female spawners. The investigation will improve our understanding of the relative importance of individual genetic variation compared with maternal effects on the growth and survival of cod and the results will be incorporated into management models to study how to improve fishery management strategies.

OBJECTIVES

The main objectives are:

1. to examine the viability of offspring from recruit female spawners compared with offspring from repeat female spawners of Atlantic cod;
2. to examine variations in viability between the offspring of individual pairs of cod;
3. to analyse the demographic structure (age, sex, and maturity structure) of selected European cod stocks by means of historical data sets;
4. to evaluate the possible effects on cod recruitment and implications for fishery management based on the results of objectives 1, 2 and 3.

EXPECTED RESULTS AND ACHIEVEMENTS

The expected result of this project will improve the understanding of the relative importance of individual genetic variation compared with maternal effects on the growth and survival of cod. The experimental results will be compared with a study of the demographic structure of selected European cod stocks to investigate how the spawning stock composition affects recruitment. The results will be incorporated into management models to study how to improve fishery management strategies.

**The role of sub-stock structure in the maintenance of cod metapopulations
METACOD**

Contract number: Q5RS-2001-00953
Contract type: Shared-cost project
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Duration: 48 months
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The role of sub-stock structure in the maintenance of cod metapopulations

BACKGROUND

The geographical management units (stocks) of most commercially exploited fish species almost certainly do not represent single spawning stocks, but complex aggregations, or metapopulations, comprising many distinct sub-stocks. The number of sub-stocks comprising a stock has been referred to as the 'stock-richness'.

The stocks of many commercial fish species in the north Atlantic are considered to be overexploited, but groundfish, and especially cod, appear to be in a particularly depleted state. A recurrent feature of the decline in cod stocks (and those of many other species) has been the collapse of the spatial distribution of fish into decreasingly small areas of the original stock regions, implying loss of stock-richness. From theoretical considerations, erosion of stock-richness should decrease the genetic diversity and reproductive potential of the stock as a whole. Indeed, where moratoriums on exploitation have been effectively implemented, recovery of depleted stocks appears to have proceeded more slowly than might be expected on the basis of historical reproductive rates. If the depleted stocks have been damaged in this way by overexploitation, then the lesson to be learned is that fisheries management measures should be concerned not only with maintaining stock biomass within safe biological limits, but also with conserving stock-richness.

OBJECTIVES

The overall objective of this project is to develop the conceptual and mathematical basis for advising on how fisheries management measures might be framed to conserve or restore not only stock biomass, but also sub-stock diversity. The case studies will be the cod stocks off Iceland and the west and north of Scotland. The aim is to establish the extent of genetic sub-structure in these stocks, how it is maintained, and the extent to which overall population dynamics are dependent on the sub-stocks. To achieve this, it is necessary to reach the sub-objectives of establishing the genetic, behavioural and oceanographic basis for the richness of the cod stocks, and the variations in productivity between sub-stocks, and to compile all the strands of evidence for sub-stock diversity in these cod stocks into a conceptual and mathematical model of the overall population dynamics incorporating sub-stock dynamics.

EXPECTED RESULTS AND ACHIEVEMENTS

Improved understanding of the metapopulation structure of cod stocks and how vulnerable the populations are to disruption of the metastructure. The development of a conceptual and mathematical model as the basis for advising on management measures aiming at conserving or restoring both stock biomass and sub-stock diversity.

**Conservation of diversity in an exploited species:
spatio-temporal variation in the genetics of herring
(*Clupea harengus*) in the North Sea and adjacent areas
HERGEN**

Contract number:	Q5RS-2001-01370	Coordinator	
Contract type:	Shared-cost project	Dorte Bekkevold	
Starting date:	1.1.2002	Danish Institute for Fisheries Research	
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Conservation of diversity in an exploited species: spatio-temporal variation in the genetics of herring (*Clupea harengus*) in the North Sea and adjacent areas

BACKGROUND

Herring populations have previously been distinguished by stocks based on tag returns, differences in spawning times and other life history characteristics. The characteristics of individual stocks suggest a complex population structure, but most previous genetic studies have failed to reveal significant differences among populations. This could reflect the use of markers with relatively low polymorphism and unsuitable sampling from lack of attention to ecological and life history detail, rather than genuine genetic homogeneity among populations. The objective of this study is to apply high-resolution microsatellite DNA analysis in order to estimate the genetic structure of herring spawning populations in the North Sea, Skagerrak, Kattegat, western Baltic and west of Scotland. Furthermore, the aim is to estimate the proportions that these spawning populations contribute to feeding aggregations of mixed origin targeted by commercial fisheries. This will be achieved by integrating genetic data with knowledge of the ecology and demography of herring, regional and temporal differences in spawning and migration, and oceanography.

OBJECTIVES

The project's overall goal is to provide guidelines for the conservation and management of the biodiversity of Atlantic herring in the North Sea and adjoining waters by identifying its genetic population structure, and by quantifying relative stock contributions to the fishery.

Within the project there are six major objectives:

1. Estimation of genetic differentiation among spawning aggregations. The partners will determine the degree to which the different spawning populations of Atlantic herring in the North Sea, Skagerrak, Kattegat, western Baltic and west of Scotland can be distinguished genetically.
2. Determination of temporal stability of population differentiation. The degree of short- and long-term temporal variation in the genetic composition of the spawning aggregations will be determined by (i) taking annual samples from spawning aggregations found on the same or geographically related locations and by (ii) comparing the allozyme and mtDNA data with results from surveys in the early 1980s (allozymes) and early 1990s (allozymes and mtDNA).
3. Determination of composition of mixed-feeding aggregations. Using advanced statistical techniques (e.g. mixed stock analysis (MSA) and assignment tests, etc.), the proportions of fish from the various regional spawning components that contribute to mixed aggregations found on common feeding grounds in areas targeted by major fisheries in the North Sea and Skagerrak/Kattegat will be determined.
4. Determination of temporal (seasonal and annual) variability in contributions to mixed aggregations. The partners will examine seasonal and annual variation in stock contributions to mixed fisheries by comparing contribution estimates from repeat samples in two regions.
5. Proposal for incorporation of findings into management of herring stocks. The most appropriate management units and data collection requirements to monitor selected populations will be recommended, taking into account genetic diversity and practical management issues.
6. Dissemination of results and guidelines. The information will be disseminated in at least three ways:
 - annual and final reports to the EU;

- scientific papers at conferences and in peer-reviewed journals;
- contributions to ICES annual meetings and working groups.

EXPECTED RESULTS AND ACHIEVEMENTS

1. Identification of the spatial genetic structure of Atlantic herring in the west of Scotland, North Sea, Kattegat, Skagerrak and western Baltic.
2. Provision of estimates quantifying temporal variation in genetic structure of up to 20 years.
3. Delivery of quantified population proportions and confidence intervals for commercial fish catches in the targeted geographic regions.
4. Assessment of the extent and dynamics of temporal variation in stock contributions to mixed aggregations.
5. Delivery of reports on management units, methodology and data requirements to ICES annual meetings and the Herring Assessment Working Group.
6. Delivery of reports and publication of studies in the scientific literature.

**Sharing responsibilities in fisheries management
RESPONSIBLE**

Contract number:	Q5RS-2001-01998	Coordinator	Luc van Hoof
Contract type:	Shared-cost project		LEI
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Sharing responsibilities in fisheries management

BACKGROUND

The research provides different alternatives for division of responsibilities resulting from the CFP's conservation and structural policy and in the fisheries management of five EU countries and in Norway. These alternatives will be based upon an evaluation of the current division of responsibilities, whereby the perceptions of different stakeholders will be taken into account. The process towards more stakeholder involvement will be explored and external pressures upon responsibility chains will be assessed.

OBJECTIVES

The research aims to contribute to good governance in fisheries management by:

1. evaluating the division of responsibilities within the CFP and in the fisheries management of Denmark, France, the Netherlands, Spain, the United Kingdom and Norway;
2. investigating decentralisation and delegation of responsibilities.

The work will start with an elaboration of a framework for institutional analysis, based on the institutional framework that has been used in the OECD study 'Towards sustainable fisheries'. The completed common framework will then be used to describe the division of responsibilities within the CFP and in the fisheries management of Denmark, France, the Netherlands, Spain, the United Kingdom and Norway. Developments in these responsibility structures will also be described.

EXPECTED RESULTS AND ACHIEVEMENTS

Comparison of these responsibility divisions between the countries mentioned above should give more insight into nation-specific (e.g. socio-cultural) circumstances and this will contribute to the evaluation of current divisions of responsibilities. Identifying the perceptions of stakeholders in the fisheries management in these countries about the responsibility chains will be another component of this evaluation.

If the outcome of this evaluation justifies changes, alternative divisions of responsibilities will be suggested. A process towards these alternatives will be explored and external pressures upon responsibility chains will be assessed. This includes external pressures arising from technological developments and from the markets.

The key results and outputs are:

1. completed common framework of analysis;
2. interim report containing division of responsibilities;
3. interim report containing comparison and evaluation of responsibility structures;
4. interim report containing conditions for devolved management and, if justified, alternatives for division of responsibilities.

**Combining acoustic and trawl data for estimating fish abundance
CATEFA**

Contract number: Q5RS-2001-02038
Contract type: Shared-cost project
Starting date: 1.11.2001
Duration: 36 months
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www.cefas.co.uk/Fishbehaviour/cafeta.htm

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Combining acoustic and trawl data for estimating fish abundance

BACKGROUND

The principal, fisheries independent data source for the stock assessment of commercial groundfish in European waters is the standard bottom trawl surveys. It is now possible, and often routine, to collect simultaneously acoustic data during these surveys. However, these two sources of information are used separately. Combination of these two methodologies would be one of the most cost-effective ways of improving these surveys.

Data sets will be selected to encompass existing situations with a focus on the international bottom trawl surveys. For each data set, the relationships between acoustic and trawl data will be analysed, modelled and used to provide combined indices of abundance. Intrinsic model performance will be evaluated as will the performance of the derived indices in comparison with existing assessment indices. The findings will be used to define possible survey design improvements.

OBJECTIVES

The overall aim of this project is to develop and apply appropriate combination methodologies for the use of both acoustic and trawl data from bottom trawl surveys. Bottom trawl surveys are the most important, fisheries independent data source used in the stock assessment of commercial groundfish in European waters. The inclusion of simultaneously collected acoustic survey data, with their more resolved sampling structure, could improve the precision and accuracy of these surveys at little extra cost.

Within this overall aim, the project has four main objectives:

1. to determine the relationships between the acoustic and trawl data;
2. to develop mathematical models to calculate combined stock abundance indices;
3. to test the performance of these new indices within the stock assessment process;
4. to provide and test improved survey designs, which allow optimum collection of both types of data.

EXPECTED RESULTS AND ACHIEVEMENTS

Common quality-controlled data sets will be built. Relationships between acoustic and trawl data will allow the selection of a combination of data from which we wish to compute a combined index of abundance. Four different methodologies will be used: geostatistics, generalised additive/linear modelling, fuzzy logic modelling and artificial neural networks. In each case, the results will be models of interrelationships, derived combined indices and tests of performance in terms of robustness and internal consistency. Reports on field trials of some survey design improvements are expected.

**Species identification methods from acoustic multi-frequency information
SIMFAMI**

Contract number:	Q5RS-2001-02054	Coordinator	Egil Ona
Contract type:	Shared-cost project		Institute of Marine Research
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Species identification methods from acoustic multi-frequency information

BACKGROUND

Acoustic methods are used extensively within fisheries research for estimating the abundance and distribution of fish. The major problem for estimating indices of abundance from such surveys is the correct allocation of observed echoes to species. The current solution to this problem employs trawl samples to provide 'ground truth', but this is opportunistic and punctual, giving direct information for only a few kilometres. The information is then extrapolated to the surrounding area, often in an ad hoc manner.

Simfami aims to apply modern multi-frequency acoustic techniques, in addition to the single-frequency methods available, to establish methods for acoustic identification of echo traces that are applicable to routine survey procedures. Multi-frequency techniques alone have been shown to be successful for acoustic species identification, particularly for distinguishing fish with a swim bladder (e.g. herring) from those without (mackerel). Ultimately, the project will improve acoustic surveys, allow the techniques to be used efficiently for mackerel assessment, and enable the techniques to be carried out on platforms other than research vessels.

OBJECTIVES

The overall goal of the project is to enhance fisheries management through improved fish stock survey methodology by improved identification of fish species using acoustic methods. The project will apply modern multi-frequency fisheries acoustic techniques, in addition to the single-frequency methods available previously, to establish methods for acoustic species identification of echo traces that are applicable to routine survey procedures. The project will:

1. construct an echogram library;
2. apply single-frequency extraction/identification methods on multi-frequency data;
3. develop multi-frequency algorithms for the differentiation of fish from plankton and for the identification of fish (with and without swim bladders);
4. combine these techniques in a generic algorithm for plankton and fish stock identification.

EXPECTED RESULTS AND ACHIEVEMENTS

1. Construction of an echogram library.
2. Selection of single-frequency shape and environmental recognition criteria.
3. Construction of a database of object characteristics by species.
4. Development of algorithms for separating plankton and fish.
5. Development of algorithms for identifying fish species without swim bladders.
6. Development of algorithms for identifying fish species with swim bladders.
7. Development of generic algorithms for generic fish group, species and plankton identification.

**Sardine dynamics and stock structure in the north-east Atlantic
SARDYN**

Contract number:	Q5RS-2002-00818	Coordinator	Yorgos Stratoudakis
Contract type:	Shared-cost project		Instituto de Investigação das Pescas e do Mar
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Sardine dynamics and stock structure in the north-east Atlantic

BACKGROUND

This project will provide a comprehensive study of the life history and structural dynamics of the sardine (*Sardina pilchardus*) in Atlantic European waters with an emphasis on the aspects required for improvement of the assessment and management of this species. The study will lead to the modification/extension of existing assessment models or to the development of a new model based on biologically defensible definitions of the stock boundaries and a better understanding of the sardine dynamics within the stock area of distribution. A multidisciplinary team will study the stock structure of sardine in the north-east Atlantic, describe the sardine dynamics in relation to the environment and integrate the results into models that can be used to enhance the quality of management advice.

OBJECTIVES

The principal objective of this project is to improve the basis for management advice provided for sardine (*Sardina pilchardus*) in Atlantic European waters. This will be achieved by undertaking a comprehensive analysis of the factors influencing the spatial structure of sardine recruitment, growth, movements, reproduction and mortality. Survey design, assessment models and management strategies will be reviewed and extended to incorporate biologically defensible definitions of the stock boundaries and internal dynamics. A multidisciplinary team will study sardine stock structure in the north-east Atlantic, describe the spatial dynamics of sardine in relation to environmental variability, and integrate the results into models that can be used to enhance the quality of management advice.

EXPECTED RESULTS AND ACHIEVEMENTS

This study will identify appropriate stock boundaries for sardine in Atlantic European waters, describe sardine dynamics, and develop assessment methods that capture key biological aspects of the stock. The milestones are: adequate execution of planned sampling; thorough compilation of historical data; successful application of complementary stock identification analyses; adequate delimitation of spawning areas; identification of crucial periods/areas for sardine dynamics; appropriate model development.

Research on effective cod stock recovery measures
RECOVERY

Contract number:	Q5RS-2002-00935	Coordinator	Bob van Marlen
Contract type:	Shared-cost project		Netherlands Institute for Fisheries
Starting date:	1.11.2002		Research
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Research on effective cod stock recovery measures

BACKGROUND

The cod and hake stocks in some European waters are at critical survival levels. Cod represented in 1999 a total of 24% (in weight) of the landings of fish for human consumption in the North Sea fishing ports. These fisheries involve thousands of direct employees in the fishing industry. The biodiversity action plan furthermore demands that fish stocks are conserved and sustainably used. The European Commission issued an emergency plan for North Sea cod in 2001 and has also developed a longer-term rebuilding plan for cod and hake. The Commission's strategies on rebuilding cod stocks include actions such as catch limits, closing fishing areas and setting annual time limits for fishing. In addition, the EU common fisheries policy has a range of technical measures that relate to the technical specifications of fishing gear to be developed. Selectivity is usually based on the size of the fish in relation to a specific cod-end mesh size. However, this is problematic in the mixed fisheries of the North Sea and the Irish Sea where differences in minimum landing size and fish morphology exist. This situation can be greatly assisted by improving the species selectivity in gear and also by using behavioural differences.

OBJECTIVES

The main objective is to develop novel species-selective gear prototypes for the mixed-species demersal trawl fisheries (otter trawling, *Nephrops* trawling and beam trawling) in the North Sea and the Irish Sea, where cod is an important catch component. Sub-objectives are: design new selective gear using scale models and behavioural observations; conduct sea trials on newly developed species-selective gear modifications on the three principal gear types; consult representatives of the fishing industry and fisheries management during the design and development of the new selective gear.

EXPECTED RESULTS AND ACHIEVEMENTS

The main expected achievement will be effective and acceptable new designs of species-selective otter trawls, *Nephrops* trawls, and beam trawls. The development of these gear types is intended to reduce the fishing mortality rate on cod of all ages/sizes, to enhance the recovery of the cod stock and at the same time permit the continued exploitation of other species taken in the same fisheries as cod.

**Cephalopod stocks in European waters:
review, analysis, assessment and sustainable management
CEPHSTOCK**

Contract number:	Q5CA-2002-00962	Coordinator	Graham J. Pierce
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Duration:	36 months		Tillydrone Avenue
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Cephalopod stocks in European waters: review, analysis, assessment and sustainable management

BACKGROUND

Cephalopods constitute increasingly important fishery resources in European waters, with total landings of between 40 000 and 50 000 tonnes/year since 1993. Cephalopods have the potential to substitute for overexploited finfish stocks as a source of both protein and revenue. Cephalopods are not quota species under the common fisheries policy and their population dynamics remain relatively poorly known.

The European Commission has funded several large-scale R & D projects on cephalopod biology and fisheries, as well as a number of smaller-scale data collection projects. There remains, however, a need for further analysis, synthesis and dissemination of previous results on cephalopod fishery biology. The social and economic importance of cephalopod fisheries needs to be described to allow the consequence of changing fishery patterns and management regimes to be explored.

Because cephalopods are short-lived, semelparous and difficult to age, and stock-recruitment relationships have not been determined, traditional methods of stock assessment have generally been thought to be unsuitable. Another problem is that few European countries collect detailed data on cephalopod fisheries. To make real advances in stock assessment, there is a need to ensure that cephalopod fisheries are well described and adequate fishery data are collected. In particular, biological and management reference points need to be identified and specified for the various stocks.

OBJECTIVES

A major aim of the concerted action is to facilitate publication and wider dissemination of existing data and results, and to assemble definitive comparative reviews synthesising information on the status of all major fished cephalopod stocks in European waters, in a common format. The concerted action forum will also provide a mechanism for generating new R & D proposals focused on perceived gaps in knowledge, and opportunities for training of young scientists. The CA aims to review current knowledge and issues in cephalopod fisheries science, to assemble, organise, analyse and synthesise data from ongoing national projects, previous and new European-Commission-funded R & D projects, and to recommend future actions for scientists and cephalopod fishery managers in European waters.

EXPECTED RESULTS AND ACHIEVEMENTS

Reports on current stock status for all exploited cephalopod species in European waters. Reports on fishery data collection and current cephalopod fishery management practice in all participating European countries. Review paper on the socioeconomic value of European cephalopod fisheries. Review papers on cephalopod biology and ecology relevant to their sustainable exploitation. Review paper on management options for currently unregulated cephalopod fisheries. Review of cephalopod aquaculture. Recommendations for improving data collection on fished cephalopods. A common database and GIS for cephalopod fisheries. A feasibility study of the commercial development of the GIS as a tool for managers and for provision of data products to fishermen.

**A multidisciplinary approach to the identification of herring
(*Clupea harengus* L.) stock components west of the British Isles using
biological tags and genetic markers
WESTHER**

Contract number: Q5RS-2002-01056
Contract type: Shared-cost project
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Duration: 36 months
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Project web site: www.fisheries.de/clupea/westher/about/about.html

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A multidisciplinary approach to the identification of herring (*Clupea harengus* L.) stock components west of the British Isles using biological tags and genetic markers

BACKGROUND

Herring are important in EU commercial fisheries. They are highly migratory and it is not uncommon for them to be caught in management areas outside their area of origin. Assessment of stocks under these circumstances is problematic. We aim to describe the interrelationships of herring stocks to the west of the British Isles through a combination of traditional and novel biological tools and multivariate statistical techniques, to provide a framework for discriminating between stocks. Our research, therefore, aims to provide an unambiguous classification of herring in the catch, such that they can be assigned to their areas of origin. This will provide the basis for a sound assessment for the management and the conservation of biodiversity.

OBJECTIVES

Westher's goal is to describe the structure of herring stocks in west European waters, distributed from the Celtic Sea to the north-west of Scotland. This goal can be split into four objectives:

1. Estimation of genetic and phenotypic differentiation between spawning aggregations: analysis of ripe-and-running herring from the major spawning grounds in the area to determine the number of stock components present, to provide the stock structure reference collection against which non-spawners will be assessed.
2. Determination of stock origins and life history of juveniles: comparisons of the genetic and developmental attributes of juveniles from nursery and overwintering grounds with the spawning reference collections, to enable an estimation of natal stock and subsequent spawning stock affiliation to be made.
3. Determination of composition of feeding aggregations: comparisons of non-spawning stock feeding aggregations fished commercially with the spawning reference collections, to see if feeding aggregations are stock specific or not. In the case of the latter, the proportions of each stock component fished within a particular area could be determined.
4. Improved guidelines for the conservation and management of biodiversity and stock preservation by incorporation of the findings into the assessment processes for western herring.

The project aims to provide information, currently lacking, for an effective separation or aggregation of herring stocks in west European waters and clear association of spawning and nursery areas with adult stocks. This will be achieved through integrating several techniques, both innovative and established, each of which will be applied to individual herring collected at different stages of the life cycle. We will optimise the determination of stock structure of herring in west European waters creating a unified database of individual herring characteristics using the following techniques: body morphometry, otolith morphometry, meristic analysis (pyloric caeca counts), microsatellite DNA analysis of tissue, fish parasite assemblages, parasite genetics, otolith microstructure, and otolith core microchemistry. This approach, combining a suite of complementary identification techniques that cover multiple aspects and stages of herring life history and biology on the same individuals, will allow apparent discrepancies implied by individual methods to be resolved and improve confidence in the results of the stock identification. The combined use of these methods over the three years of the project, targeting sampling at both adults and juveniles, will allow the population structure to be described, providing a basis for the management guidelines that will be delivered to the ICES Herring Assessment Working Group (HAWG).

EXPECTED RESULTS AND ACHIEVEMENTS

Westher aims to characterise herring in west European waters so that they can be assigned to their area of origin, wherever they were caught. It will provide a sound basis for understanding the life history of herring in west European waters. The results of the project will be used to provide guidelines for the conservation and management of biodiversity through input to the ICES Herring Assessment Working Group (HAWG) and ultimately to management of these stocks. A number of the members of the consortium are members of HAWG and this will ensure that the project results are applied quickly to the assessment and available to the fishery managers.

More specifically, the following results are expected:

1. collection of all herring samples through involved partners;
2. completion of data collection from morphometrics, meristics, parasites, genetics, otolith microstructure and otolith microchemistry work packages;
3. completion of testing, and finalisation, of multivariate statistical procedures;
4. delivery of results to ICES HAWG.

**Association of physical and biological processes acting
on recruitment and post-recruitment stages of anchovy
ANREC**

Contract number:	Q5RS-2002-01216	Coordinator	Argyris Kallianiotis
Contract type:	Shared-cost project		Fisheries Research Institute
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Association of physical and biological processes acting on recruitment and post-recruitment stages of anchovy

BACKGROUND

Environmental conditions are closely linked to the year abundance fluctuations in fish populations. These physico-chemical processes, concurrently with biological processes, act upon the recruitment and post-recruitment of small pelagic fishes such as sardines and anchovies. This project will be carried out over a period of three years and fieldwork surveys will be undertaken for two years in order to:

1. understand the major sub-processes within the recruitment and post-recruitment processes as well as physical and biologically induced changes which affect them;
2. improve prediction of the effects of such changes on an anchovy stock;
3. address more efficiently the management of anchovy stocks.

OBJECTIVES

Environmental conditions and oceanographic features in relation to the location and the timing of spawning of fish species can greatly affect the management of fishery by influencing both the variation in stock size and the complexity of the population structure. The main objectives of ANREC are to advance the understanding of the recruitment of small pelagic fishes (anchovy) in relation to physical and biological forcing and to improve the capability of predicting the effects of environmental and biological variability and change on such recruitment. To achieve these objectives, the project includes multilevel sampling in three ontogenetic stages of anchovy (larvae, juveniles, adults) and the online and remote monitoring of the events. The scientific innovation will be realised from a multidisciplinary study of several key parameters, such as the environmental impact on anchovy recruitment and the importance of the post-recruitment processes. The area for this project has been selected for its oceanographic complexity and its importance as a spawning and nursery ground for anchovy.

EXPECTED RESULTS AND ACHIEVEMENTS

By studying the Thracian anchovy stock, we intend:

1. to provide new insights into the major sub-processes within the recruitment and post-recruitment processes and the physical and biologically induced changes which affect them;
2. to improve the capability in predicting the results of these changes on this anchovy stock;
3. to evaluate the effects of these changes on the anchovy fishery in the area;
4. to provide the decision-makers with inputs necessary for the management of the species;
5. to propose management plans based on all the above.

**Development of a predictive model of cod-end selectivity
PREMECS II**

Contract number:	Q5RS-2002-01328	Coordinator	Daniel Priour
Contract type:	Shared-cost project		Institut Français de Recherche pour l'Exploitation de la Mer
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Development of a predictive model of cod-end selectivity

BACKGROUND

This project will develop further a predictive model of cod-end selection so that the selectivity of commercially used cod-ends fished in commercial conditions can be predicted.

The influence of (i) netting materials made from thicker and stiffer twines, (ii) the dynamic effects of the interaction of sea state, fishing vessel, trawl gear and cod-end, and (iii) fish morphology and fish escape behaviour will be investigated and included in the model.

An individual-based model of cod-end selection will also be developed. This model will be more complex and make better use of the behavioural information that is available.

OBJECTIVES

The overall objective of this project is to develop further a predictive selectivity model so that it can predict the selectivity of commercially used cod-ends fished in commercial conditions. Briefly, the influence of (i) netting materials made from thicker and stiffer twines, (ii) the dynamic effects of the interaction of sea state, fishing vessel, trawl gear, and cod-end, and (iii) fish morphology and fish escape behaviour will be investigated and included in the model.

EXPECTED RESULTS AND ACHIEVEMENTS

1. Methodology for the measurement of mesh opening stiffness and twine elasticity of netting used on the commercial fleet.
2. Models of catch in the cod-end, of the dynamic of the trawl and of the dynamic of the cod-end.
3. Measurement of selectivity, fish geometry and fish behaviour in the cod-end during sea trials.
4. Models of selectivity process in the cod-end and comparison with results of sea trials.

Mutualisation of fisheries and aquaculture European research institutes MUTFISHARE

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Mutualisation of fisheries and aquaculture European research institutes

BACKGROUND

The concerted action aims at contributing to a European research area on fisheries and aquaculture and supporting the common fisheries policy. The main objectives are to enable the coordination and integration of research in these fields in the Community. This action will allow the different directors of fisheries research organisations from the European Union to develop coordinated and joint effort on key biological issues and parameters for fisheries and aquaculture management.

OBJECTIVES

The common fisheries policy applies to the European fish populations and their fishermen for managing the European exclusive economic zone. This common framework, with the same objective to reach sustainability of fish populations and their ecosystems, could be strong enough to build the base of scientific research programmes which are well integrated and coordinated to give the best scientific advice. The analysis of the fourth and fifth programmes showed clearly that the way to answer European calls does not allow that objective to be achieved.

On some topics, there are duplications or redundancies, even if all the proposals are excellent on the basis of scientific criteria. On the other hand, on some other topics which are crucial for the future of the CFP, there are no answers. For example, on the marine protected areas in relation to the environmental impact of fisheries, there is no EU research effort, although the society demand needs to develop our scientific knowledge in relation to the evolution of the CFP which is described in the 'Green Paper on the future CFP'.

For these reasons, it is urgent to move 'towards a European research area' to establish 'a common system of scientific and technical reference' to build a common research programme. This strategic EU plan will be the foundation for cooperative research which will be based on national programmes of research institutes.

The directors of the main European institutes of research in fisheries and aquaculture propose this concerted action as a first step towards integrating and increasing cooperation between their institutes in order to achieve the sustainable development of fisheries and aquaculture in Europe.

During the last meeting of the directors of fisheries research organisations, it was decided to increase the cooperation between the main fisheries research organisations and to answer the fifth programme through a concerted action to focus on some research subjects:

1. to avoid duplication in research;
2. to create synergy between the different institutions;
3. to create critical masses of research for different institutions.

In order to contribute to building a European research area on fisheries and aquaculture to support the common fisheries policy and to develop coordinated and integrated research, it is proposed to develop some of the objectives of research detailed previously.

EXPECTED RESULTS AND ACHIEVEMENTS

Three types of outputs will be produced by this concerted action:

1. Technical exchanges of knowledge and standardisation of methods of research on the following subjects:

- fisheries and genetic approaches of population dynamics;
 - identification of rare species;
 - new improvements in acoustic methods;
 - selectivity and impact of fishing gear.
2. Increased cooperation on subjects where critical masses of research do not exist in the different EU countries:
- environmental interactions with fisheries;
 - environmental protected areas;
 - research of indicators for ecosystems management.
3. Take strategical decisions with the common board of directors:
- exchange of boats and equipment;
 - evolution of the EU fisheries research fleet;
 - evolution of fisheries management;
 - aquaculture research strategy.

The dissemination of the outputs of the different workshops will be large as they will be available on the network's Internet site. Some important reports (annual meeting) will be published for distribution to scientists, national administrations, and EU directorates.

Exchanges of students and searches will be developed to increase cooperation between the institutions. A consequence of the concerted action will be a jointly developed project with or without the support of the new instruments of the sixth framework programme.

**An assessment of mortality in fish escaping from trawl cod-ends
and its use in fisheries management
SURVIVAL**

Contract number:	Q5RS-2002-01603	Michael Breen
Contract type:	Shared-cost project	Fisheries Research Services Marine
Starting date:	1.10.2002	Laboratory
Duration:	36 months	PO Box 101
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An assessment of mortality in fish escaping from trawl cod-ends and its use in fisheries management

BACKGROUND

Regulations on selectivity in fishing gear have been a widely used and trusted means of managing fisheries. In the last decade, we were convinced that a proper mesh size and grid system gave a sound and selective strategy for gadoid species. However, according to ICES, the spawning stock biomass of several important gadoid fisheries is alarmingly low. It is clear that changing regulations towards improved selection in fishing gear is of little value if the fish do not survive the selectivity devices. It has recently been demonstrated that previous investigations in this field may be fundamentally flawed with respect to their sampling techniques. As such, there are currently no reliable estimates of escape mortality for fish escaping from towed fishing gear.

OBJECTIVES

This project will provide the technology for accurate survival estimates that may be used as standards in future survival experiments. Furthermore, it will give an estimate of the seasonal variation in survival estimates and a method for inclusion of these estimates in stock assessment models for haddock (*Melanogrammus aeglefinus*) and cod (*Gadus morhua*). This project will provide knowledge on survival in high-intensity fisheries and in fish escaping at the surface in side-trawling fisheries.

The first challenge is the development of a new cod-end cover to ensure that the problems concerning low flow around the cod-end and high flow in the cover can be eliminated. This will be technically achieved by a new cover design that is already under development. The flow around the cod-end will be undisturbed and the rear end of the cover will provide a static environment for the safe collection of captive fish. Full-scale testing of the cover and operational procedures will be carried out during the first sea trials.

The next objective is to determine if escape mortality is influenced by the fishing intensity in the area, i.e. if repeated encounters with a selection device will impair the probability of survival. Currently, there are no estimates of selectivity or survival of fish escaping from a trawl in the surface position. Surface selection is profound in side-trawlers where the cod-end is floating alongside the ship after haul back.

The estimates of survival will be incorporated into current virtual population analysis (VPA) models and tested in simulations.

EXPECTED RESULTS AND ACHIEVEMENTS

New selection technology must be used in the North Sea in order to decrease the unwanted by-catch of undersized fish and increase the population growth of demersal fish species. This development must be linked to studies of unaccounted mortality caused by the new fishing gear. This project will give rise to improved technology for estimating trawl escape survival and thereby lead to higher precision in future estimates of unaccounted mortality in trawl fisheries. Furthermore, it will provide a better tool for estimating parameters connected to sustainable fisheries.

**Integrated approach to the biological basis of age estimation
in commercially important fish species
IBACS**

Contract number:	Q5RS-2002-01610	Coordinator	Beatriz Morales-Nin
Contract type:	Shared-cost project		Institut Mediterrani d'Estudis Avançats
Starting date:	1.11.2002		Grup d'Ictiologia
Duration:	36 months		Miquel Marqués, 21
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Integrated approach to the biological basis of age estimation in commercially important fish species

BACKGROUND

Our objective is to develop a fuller understanding of the environmental influences on otolith growth, leading to a new protocol for estimating fish age. Focusing primarily on gadiform otoliths, we will use known-age material to develop artificial neural network models of age. Otolith growth models will be integrated with results from new laboratory and field investigations to improve the objective basis for interpreting seasonal and non-seasonal growth structures. We will work on hake, cod, haddock and whiting, representing a large proportion of the European fisheries in both value and volume. As such, this project will improve the confidence and reliability of the scientific data used to underpin management of sustainable fisheries.

OBJECTIVES

This project is a cooperative venture to improve our understanding of the biological basis of age estimation for commercial fish species. Our objective is to integrate modelling, and laboratory and field observations to provide an objective basis for interpreting the macrostructures of otoliths used for the estimation of fish age. We will take a multidisciplinary approach, including mathematical modelling, geochemical analysis of oxygen isotope ratios, experimentation and collection of biological and environmental data, to develop generic models of otolith formation. We will establish a new age estimation protocol, and enable training through a web site and DVD accessible by fisheries laboratories and fishermen's organisations.

To achieve a generic understanding of the formation of calcified tissues, we will progress from model development, through new field and laboratory investigations, to the production of a new protocol for age estimation supported by interactive training media. We will begin by developing models of otolith growth and shape. We will evaluate historical collections of otoliths and other calcified tissues, creating a database of this material to model seasonal influences on the formation of these structures. The models will draw on a critical literature review and identify gaps in the data to be filled by new investigations. Field-caught fish will be marked in the otoliths and fitted with data logging electronic tags. Additional observations on field samples will include marginal analysis and measurement of otolith oxygen isotope ratios. The effects of temperature and food availability will be investigated through experiments in controlled laboratory conditions to study the formation of otolith macrostructures. Together, the laboratory and field-caught fish will be used to test model predictions about seasonality and temperature effects. Because the field and laboratory experiments will be directed at closely related species, we will have a strong data platform for a generic model and age estimation protocol. A new protocol for age estimation will be produced, based on refined models using all available data. Neural network models will be used to classify known and unknown age material to help elucidate the steps necessary in the new protocol. Example images, showing the biological interpretation of features, will be assembled and distributed. The efficiency of the new protocol will be tested through a scheduled age estimation exercise.

EXPECTED RESULTS AND ACHIEVEMENTS

We expect to complete and deliver our primary model by the end of the first year. Field observations and laboratory experiments will deliver data for model refinement throughout the first two years of the project. The final year will be dedicated to integrating the new data to refine the model, testing the predictions with artificial neural networks, and delivering an accessible new protocol for fish age estimation. We expect our results to enable more precise and accurate fish age data.

European advice system evaluation EASE

Contract number:	Q5CA-2002-01693	Coordinator	
Contract type:	Concerted action	P. Sparre	
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Duration:	36 months	Jægersborgvej 64–66	
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European advice system evaluation

BACKGROUND

Routine work from data collection to the yearly updating of fish stock assessments absorbs a very significant amount of the available human and budgetary resources. Assessment methods used in most cases require a large amount of detailed data, collected in a standard way. The existing procedures imply an almost complete reassessment each year, especially for the more sensitive stocks. Nevertheless, the relationship between the amount of 'energy' devoted to each specific task or action (e.g. ageing fish or reassessing completely each year the status of a stock) and the quality of final scientific advice delivered to managers is rarely considered. The added value of the existing machinery compared with a less data and/or time-consuming procedure is not known.

It would be unwise to disrupt the present ongoing data collection and/or annual reassessment processes before the consequences of any changes are properly appreciated. However, the stress on the present processes and lack of clarity as to their cost-effectiveness indicate the need to improve procedures.

Until now, scientific research devoted to the methodology of 'classical' assessment (including data collection) methods has been limited. At present, even basic expertise in sampling techniques is lacking in many Member States. Due to insufficient communication between groups of scientists, some potentially useful techniques are ignored in some areas, while they are the only ones considered for other fisheries (e.g. length-based techniques or surplus production models). Existing methods are, however, far from being systematically used and combined. An overall framework would make it possible to establish links between scientific teams working on similar issues, to put within the proper context the 'partial' problems addressed until now, to promote awareness about existing methods, and to identify existing gaps not covered by any existing method and not addressed by any existing research programme.

OBJECTIVES

The overall objective of the concerted action is to set up the basis for more appropriate data collection and analysis programmes in order to support existing and emerging fisheries management issues. The main objectives of the concerted action are as follows:

1. To understand the current balance between resources devoted to data collection and value of these data in the provision of advice. This requires the evaluation of the range of advice requested on fisheries management and the data needs to perform the science to support it. Of particular importance are the so-called basic data, i.e. routinely collected data to support existing fisheries management since these are used in almost all analyses. However, consideration will be given to other types of necessary data.
2. To quantify the quality of the scientific outputs derived from the data inputs. Since much advice is qualitative and relies on expert judgment, this objective will be limited to quantifying the reliability of routine annual stock assessments upon which advice is formulated.
3. To identify alternative uses of data and alternative analytical methods which could support present fisheries management needs as well as those which could address new and emerging issues.
4. To analyse ways of redeploying existing resources in order to support a modern fisheries management system.

EXPECTED RESULTS AND ACHIEVEMENTS

The proposed concerted action will directly address problems related to competitiveness with direct implications for the sustainable production of renewable resources providing better objective information in support of fishing systems and of policy orientations of the common fisheries policy.

The action will not only take into account the existing procedures for delivering scientific advice as required by the implementation of the existing CFP, but it will also consider emerging requests for other management approaches, giving, among other things, more importance to environmental questions.

The concerted action is devoted to the issues of collection and interpretation of data resources and management, and more specifically to the efficiency and accuracy of such assessment. It will offer a strong basis for rationalising the collection of data essential for the common fisheries policy, and will suggest methods to improve the reliability and usefulness of the scientific advice concerning fisheries management. The results obtained will make it possible to improve the implementation of the existing regulations, and to facilitate the anticipated revision of these regulations.

**Policy and knowledge in fisheries management —
The North Sea cod case
PKFM**

Contract number:	Q5RS-2002-01782	Coordinator	Poul Degnbol
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Policy and knowledge in fisheries management — The North Sea cod case

BACKGROUND

European fisheries management has, as described in the Commission's Green Paper on the future of the common fisheries policy, not delivered sustainable exploitation of fisheries resources and will need to be changed to do so. This has happened despite a long tradition of knowledge-based management and a detailed regulatory system. Against this background, it is pertinent to consider and analyse the factors that have contributed to the failure of the management system. The interaction between knowledge and policy decisions is a crucial link in the European management system. The pressures on the scientific advisory process include requirements, within a total allowable catch (TAC) system based on annual predictions, to produce very accurate predictions of catch rates in a situation where unknown variables or variables known with low precision carry substantial weight in the prediction. The advisory process itself is also under political and economic pressure caused by losses of legitimacy among users, which are related to their lack of involvement, and increasing costs to produce the advice when better precision is required. This project will investigate how these aspects of the institutional set-up of the management system have contributed to the shortcomings and negative developments in relation to North Sea cod.

OBJECTIVES

The overall objectives of the project are to identify and understand specific shortcomings in the European fisheries policy and its implementation, which have contributed to the problems evident in several European fisheries, and to devise means for their rectification. The project will focus on the knowledge production and decision-making within the fisheries management system, the interrelationships between these processes and the role played by stakeholders. Fisheries for North Sea cod will be adopted as a case study.

EXPECTED RESULTS AND ACHIEVEMENTS

The project milestones are the output of an initial documentary study of North Sea cod management, project seminars to track and communicate the progress of work and external project products. The products of the project will be a policy brief summarising results and presenting proposals for improvement, and papers in the international scientific journals presenting the research results.

Framework for the evaluation of management strategies FEMS

Contract number:	Q5RS-2002-01824	Coordinator	João Gil Pereira
Contract type:	Shared-cost project		Universidade dos Açores
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Framework for the evaluation of management strategies

BACKGROUND

Develop a simulation framework to evaluate management strategies that are consistent with the precautionary approach whilst maintaining the viability of the fishing industry. Thereby provide advice to managers on the response of fish stocks to exploitation and management.

Understand the impact of processes related to environmental fluctuations, complex stock dynamics and fisheries interactions on management. Quantify the benefits of including such processes in current stock assessment management procedures and, where appropriate, develop alternative assessment management strategies.

Conduct comparison of management strategies across life history strategies and assessment and management bodies.

OBJECTIVES

Initially simulation models (referred to as base cases) will be developed for the study of stocks (demersal and large pelagics) consistent with current dynamics assumptions and management procedures as used by the International Council for the Exploration of the Sea (ICES) and the International Commission for the Conservation of Atlantic Tuna (ICCAT).

These base cases will then be modified to include more realism in order to test the robustness of current procedures. The North Sea cod and north Atlantic albacore base cases will be modified to include environmental factors that have been shown to influence biological processes (recruitment and spatial distribution and migration pattern). The east Atlantic and Mediterranean bluefin tuna and North Sea plaice base cases will be modified to include complex dynamics (long-term fluctuations in carrying capacity and density dependence in biological processes). The North Sea flatfish and tropical tuna base cases will be modified to include multispecies. Simulations will be performed to evaluate a variety of management options consistent with the precautionary approach. This will be done to evaluate current practice and to develop new strategies that reflect a variety of management objectives. Where appropriate, generic conclusions will be drawn from a comparison across stocks and management procedures.

EXPECTED RESULTS AND ACHIEVEMENTS

1. Quantify the benefits of a variety of management strategies in terms of yield and probability of exceeding sustainable limits.
2. Develop alternative assessment/management strategies where appropriate.
3. Compare management strategies of ICES and ICCAT.
4. Contrast the responses of a variety of stocks (from data rich to data poor, from tropical to temperate species and from pelagic to demersal fish) to exploitation.
5. Provide flexible free software that can be used by fish biologists to address a wide range of stocks and management questions.
6. Review the relevant biological and bioeconomic models used in the formulation of fisheries advice.

FEMS will provide software and methodology that will be used by other current EU projects (e.g. PKFM, EASE, Bemmfish and BASER) to evaluate the consequences of improving our understanding of fishery systems.

**Reproduction and stock evaluation for recovery
RASER**

Contract number: Q5RS-2002-01825
Contract type: Shared-cost project
Starting date: 1.10.2002
Duration: 36 months
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Reproduction and stock evaluation for recovery

BACKGROUND

The traditional stock-recruitment models assume that spawning stock biomass (SSB) is proportional to reproductive potential, which implies that the survival chances of progeny do not change with age, condition or size of parents. However, the reproductive potential of a population is a measure of the capacity of the population to produce viable eggs and larvae in a given year. This concept goes beyond the simple estimation of spawning stock biomass. Recent studies indicate that, for a given population, larger individuals have different reproductive attributes than smaller fish. Moreover, a population comprising solely of smaller fish is seldom able to compensate for the loss of reproductive potential associated with the disappearance of the larger individuals due to fishing. As a response to this change in perception, it is now important to consider reproductive potential in relation to population demographics in cod and hake recovery plans. The current very low number of spawning fish strengthens this view. New and existing methods will be developed and evaluated to reduce the cost and improve the accuracy of estimating realised fecundity (number of eggs spawned), previous spawning activity and reproductive potential. The preferred methodology will be applied to samples of cod and northern hake collected across a large part of their distribution in European shelf-edge waters. These results will provide the first comprehensive data set on reproductive potential of these species in relation to biological reference points and stock demography.

OBJECTIVES

The overall objective is to measure the reproductive potential of cod and northern hake across their latitudinal range, applying enhanced methods developed during the project, to simulate complex stock dynamics using the revised biological reference points and fisheries interactions on management options for stock recovery.

The project will focus on three main objectives:

1. Development of a methodology to reduce costs of assessment and increase the precision in estimating realised fecundity.
2. Assessment of cod and northern hake reproductive potential across their latitudinal range.
3. Synopsis work packages:
 - evaluate the impact on assessment and management of cod and hake populations including models of more realistic variations in population reproductive potential for cod and hake;
 - assess the geographic variation in size and age at maturity, fecundity and spawning activity in relation to the observed variation in environmental conditions including fishing pressure;
 - incorporate new experimentally proven data on atretic and post-ovulatory follicle duration into previous ICES egg-production-based assessments to determine the potential bias in the assessment of realised fecundity and SSB.

EXPECTED RESULTS AND ACHIEVEMENTS

The main achievements will be to develop more cost-effective tools (automation through image analysis and less reliance on costly histology) for fecundity estimation, and accurate assessment of the dynamics of spawning and atretic follicle degradation for less uncertainty in egg-production-based stock assessment. Following from this, new information will be provided on the reproductive potential of cod and hake (data-poor species, ICES recruitment workshop 2001 and 2002) across their latitudinal range.

These data will be used to quantify the benefits of including such processes in current stock assessment procedures and developing alternative management strategies where appropriate.

An evaluation of the potential costs and benefits of incorporating fisheries independent methods (egg production over a daily period or annual basis) into assessment of spawning stock biomass will also be carried out.

**Towards accreditation and certification of age determination
of aquatic resources
TACADAR**

Contract number:	Q5CA-2002-01891	Coordinator	Erlend Moksness
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Towards accreditation and certification of age determination of aquatic resources

BACKGROUND

There is a discrepancy between sophisticated research into age determination and biomineralisation processes and the state of the art of routine age reading in fisheries assessment. While sclerochronological research in Europe has progressed tremendously throughout the past decades, routine age estimation has not adequately kept pace. Often, the quality of age data depends on skill and experience, and lacks, in most cases, standardisation, objective control and statistical evaluation. The quality of input data, such as the age data of fish populations, plays a vital role in the ability to manage fish resources. The need for reliable data is especially acute in times when stock levels are low and errors in predictions can have devastating effects on the resources. It is therefore important that age reading procedures in Europe are standardised and that quality assurance and quality control mechanisms for age reading are introduced.

OBJECTIVES

The concerted action aims to increase the adoption of procedures for age reading that include quality assurance and quality control mechanisms for the improvement of stock assessment and environmental management techniques. The overall objective is to increase the reliability of age estimation procedures in the European Community, compatible with the possibility of the future establishment of Europe-wide international fisheries laboratories. The ultimate objective is to stimulate the achievement of a higher level of quality within and integration between the partner institutes concerning fish age determination. Methods for age determination will be evaluated where more than one method is applied in the total data input for a stock assessment or an environmental management model.

EXPECTED RESULTS AND ACHIEVEMENTS

A strengthening, through a network of excellence, of the competitive position of European institutions involved in fish ageing, promoting institutional synergy and international cooperation. Improvement of dissemination of information on activities and results to the European institutes of fisheries science and fish ecology engaged in age determination activities. Development of a manual on quality assurance and standardised practices in age determination to be applied on the European level. This will involve statistical criteria as well as an evaluation of legal aspects of accreditation and certification and implications for the EU.



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Sub-area 2.3: Improvement of aquatic production

1. Aquaculture genetics

**Cloning and functional analysis of fish peroxisome
proliferator-activated receptors: the transcriptional
control of lipid metabolism in farmed fish species
fPPARs**

Contract number:	Q5RS-2000-30360	Coordinator	Grigorios Krey
Contract type:	Shared-cost project		National Agricultural Research Foundation
Starting date:	1.12.2000		Fisheries Research Institute
Duration:	36 months		GR-64007 Nea Peramos, Kavala
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Cloning and functional analysis of fish peroxisome proliferator-activated receptors: the transcriptional control of lipid metabolism in farmed fish species

BACKGROUND

Among the major problems encountered in intensive fish aquaculture, the accumulation of fat in the tissues of farmed fish and the dependency of the aquaculture industry on fish oils for high-quality feeds are issues of exceptional economic interest. The above problems can be efficiently addressed only by an increased understanding of the processes involved in lipid homeostasis in fish. In the work proposed herein, this is to be accomplished through the cloning and functional analysis of fish peroxisome proliferator-activated receptors (PPARs). PPARs are lipid-activable transcription factors that regulate both arms of lipid homeostasis in higher vertebrates. This study intends to provide the scientific background necessary for innovative solutions to the lipid metabolism-associated problems encountered in aquaculture and thus to contribute towards the sustainability of the industry.

OBJECTIVES

The specific objectives of this project are:

1. to clone and characterise the PPAR genes and cDNAs from four fish species of particular importance for the European aquaculture industry, i.e. sea bass (*Dicentrarchus labrax*), sea bream (*Sparus aurata*), Atlantic salmon (*Salmo salar*), and plaice (*Pleuronectes platessa*);
2. to study the functional properties of fish PPARs (fPPARs), i.e. their DNA and ligand binding properties, the PPAR-dependent transcriptional activation, and the expression pattern of PPARs in fish tissues; to establish species-specific and PPAR subtype-specific differences in the above-described properties; to identify potent subtype-specific ligands for the fPPARs;
3. to develop appropriate *in vitro* assays, i.e. cell and tissue culture systems, that will be used to clearly establish the role of PPARs in lipid metabolism in fish;
4. to examine *in vivo* the effect of induced PPAR expression and PPAR-dependent transcriptional activation on fat accumulation and lipid composition in fish tissues.

EXPECTED RESULTS AND ACHIEVEMENTS

During the first years of this project, it has been possible:

1. to clone and sequence the cDNAs and genes of the three PPAR subtypes from sea bass, sea bream, Atlantic salmon, and plaice. This represents the first report for the identification of three different PPAR subtypes in the above four species, and in fish in general;
2. to develop fish PPAR (fPPAR) subtype-specific antibodies, to be used in the study of the functional properties of the fPPARs;
3. to develop protocols for the primary culture of hepatocytes, adipocytes, and enterocytes from the fish species studied. These primary cell culture systems provide a valuable tool for the *in cellulo* study of the fPPAR properties.

The above achievements will allow, during the course of this project, the study of the properties of fPPARs both *in vitro* and *in vivo*. As regards the functional properties of the fPPARs, i.e. transcription activation properties, tissue distribution, and DNA and ligand binding properties, preliminary results support the hypothesis that these receptors have functions similar to those of their mammalian homologues and are therefore key regulators of lipid homeostasis in fish.

**Improving production efficiency of sea bass farming by developing
methodologies to eliminate environmental androgenesis
PROBASS**

Contract number:	Q5RS-2000-31365	Coordinator	Silvia Zanuy Doste
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Improving production efficiency of sea bass farming by developing methodologies to eliminate environmental androgenesis

BACKGROUND

Probass addresses the problem faced by sea bass aquaculture due to the fact that under culture conditions most of the fish (70–99 %) are males. Males grow slower than females and weigh up to 40 % less at harvest, which reduces their market value, or need to be longer, which increases production costs. Thus, a highly desirable goal for sea bass aquaculture is to develop methods to control sex differentiation to reduce unwanted males and increase females. Since environmental factors can influence sex ratios in fish, including the sea bass, Probass investigates hormonal, biochemical and molecular parameters to understand the regulation of sex differentiation, and aims to develop an environmental, hormone-free, feminisation protocol based on temperature and density manipulations. Female-dominant stocks will result in more efficient production and increased profitability of sea bass aquaculture.

OBJECTIVES

The overall objective of Probass is to understand the mechanisms regulating sex differentiation in cultured sea bass in order to develop methodologies to minimise the proportion of males in cultured stocks. This will result in an increase in production efficiency and profitability of the EU sea bass industry, since female-dominant stocks will reach market size earlier and produce more muscle mass.

There is accumulating evidence that sex differentiation in sea bass may be under the control of complex genetic and environmental interactions. Many factors of the brain–pituitary–gonad axis contribute to the development and differentiation of the gonads. These factors include sex determining genes, brain and pituitary hormones, growth factors, steroidogenic enzymes, sex steroids and sex-steroid receptors. The available information indicates that it is important to establish if there is a sexually dimorphic pattern of expression of the various factors implicated in the sex differentiation pathway, and to determine whether the environment can alter this pattern of expression.

Therefore, the first objective of Probass is to perform a temporal evaluation in sea bass during the period encompassing sex differentiation in order to understand which sex differentiation genes, brain and pituitary hormones, key steroidogenic enzymes, sex-steroid receptors, sex-steroid hormones or growth factors may be involved in the regulation of sex differentiation in males and females.

The underlying hypothesis of Probass is that environmental factors are influencing androgen/oestrogen production, with an excess of androgen leading to masculinisation. Whether a single or several environmental factors are involved is not known. Of the environmental parameters studied, temperature seems to be the best established parameter influencing sex differentiation in fish since temperature effects on phenotypic sex have been demonstrated, so far, in more than 24 species, including the sea bass. There is also evidence that density and relative size can influence sex differentiation.

The second objective of Probass is to manipulate the environment (temperature and density) during critical periods in early development in order to reduce or eliminate male dominance in cultured sea bass, and to determine which regulators of the sex determination pathway — sex differentiation genes, steroidogenic enzymes, steroid receptors, hormones or growth factors — are being influenced by those conditions. This understanding will facilitate the development of a practical procedure, easily employed by the EU aquaculture industry, to eliminate environmental androgenesis.

EXPECTED RESULTS AND ACHIEVEMENTS

1. Production of male- and female-dominant stocks by selective grading.
2. Study the brain–pituitary–gonadal axis during sex differentiation and understanding the role of key components on this axis in relation to age, size and sex.
3. Study of how and when temperature and density affect sex differentiation, and production of female-dominant stocks.
4. Development of a novel method based in the manipulation of these environmental factors and trials of this method in production facilities to test usefulness.

**Protein and growth efficiency in salmonid selection
PROGRESS**

Contract number:	Q5RS-2001-00994	Coordinator	Kari Ruohonen
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Protein and growth efficiency in salmonid selection

BACKGROUND

The overall goal is to establish a sufficient knowledge base for selection programmes aimed at improving protein growth. Three major objectives are identified: to provide reliable heritability estimates for protein growth, protein efficiency and meat quality; to develop predictive tools to recognise high-quality genotypes of these traits with the help of genetic correlations and growth curves for protein and lipid deposition; and to understand the biological correlates causing variation in these traits. Six work packages form a three-step work plan; rearing of fish according to a family-based genetic design; sampling and analysis of biological material (e.g. growth, feed intake, body composition, protein turnover, lipid deposition, muscle fibres); and genetic analyses and modelling on the basis of the biological assays. The results will be readily applicable to the improvement and re-evaluation of ongoing selection programmes.

OBJECTIVES

The overall goal is to establish a sufficient knowledge base to facilitate new selection programmes aimed at improving protein growth. Three major objectives are identified:

1. to provide reliable heritability estimates for protein growth, protein efficiency and meat quality;
2. to develop predictive tools to recognise the high-quality genotypes of these important traits with the help of genetic correlations and growth curve models for protein growth and lipid deposition;
3. to understand the biological correlates causing variation in these traits, genetic correlations and growth curves.

EXPECTED RESULTS AND ACHIEVEMENTS

1. The generation of families for the genetic set-up.
2. Provide a sufficient knowledge base of the heritabilities and genetic correlations of protein growth and efficiency as well as meat quality .
3. Predictive tools to recognise high-quality genotypes for these traits.

**Tools for the genetic improvement of sea bass — Construction and preliminary application of a medium-density linkage and synteny map
BASSMAP**

Contract number:	Q5RS-2001-01701	Coordinator	Filip Volckaert
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Tools for the genetic improvement of sea bass — Construction and preliminary application of a medium-density linkage and synteny map

BACKGROUND

The aquaculture of sea bass represents a growing industry on the coasts of the Mediterranean Sea and the south-eastern Atlantic Ocean. The current production of 40 000 tonnes (four times more than in 1990) employs directly and indirectly an estimated 20 000 people in mostly rural and underdeveloped regions. Growth over the past decade has been 15 % or more and predictions are that this rate will continue as markets are expanding. But there is a serious shortage of genetic information, both quantitative and molecular, to support the marine fish farm industry dependent on sea bass (and sea bream). At present, production is nearly completely based on wild-caught fish reproducing under often semi-controlled conditions in the hatchery. It is common practice to introduce wild broodstock into the hatchery. The 20 years of mass production of sea bass has not yet generated a single domesticated stock. This is, of course, a major difference to the situation in farm animals where only highly selected stock is available. For some time, the need to introduce genetic management in sea bass aquaculture has been recognised by the scientific community, and is now generally accepted by the aquaculture community.

There are several ways to improve the knowledge of the genetic base of this species for aquaculture such as a comparative strain testing programme to assess the levels of genetic variation in natural populations of sea bass. Alternatively, this can be done by initiating a classical selection scheme for economic traits, which has been adopted by several companies recently. However, any approach — assuming it will follow the development of other farmed species — will be heavily underpinned by molecular genetic techniques. The essential requirements will be a genetic map containing a large number of informative genetic markers for pedigree and linkage analysis and with landmark genes that will enable comparisons to be drawn between the more detailed maps being constructed for model genetic species. We believe that current conceptual and technological progress in the field makes it possible to generate in a relatively short period a linkage and synteny map of sea bass. This will be a first for a marine fish. It will result in a very useful tool for breeding sea bass, and it also sets a standard for other farmed fish and shellfish on the verge of genetic improvement.

OBJECTIVES

The main objective of the project is to prepare a medium-density linkage map of sea bass that includes both type 1 (functional coding sequences) and type 2 (non-functional sequences) markers in a single project so that it will be immediately available as a practical tool by the end of the project for the aquaculture industry. The practical application of the map will be enhanced by the availability of a partially characterised bacterial artificial chromosome (BAC) library. This can be used to isolate expressed sequence tags (ESTs) identified during the project but also as an open resource that will enable additional genes and markers to be readily identified and isolated as the scientific base of this species develops. The project will not only benefit the aquaculture industry, but also fisheries management and fundamental science.

The specific aims to reach the project goal are:

1. the breeding of F_1 , meiotic gynogenetic, single and double haploid (mitotic) crosses of sea bass reference families in preparation for mapping of type 1 and type 2 markers in order to generate a low-density genetic linkage and synteny map;
2. the provision of DNA from the reference sea bass families, normal diploid, haploids, meiotic and mitotic gynogenetics to other mapping projects in an attempt to reduce duplication and speed up the acquisition of additional markers and genes on the map;

3. the development of a partially characterised bacterial artificial chromosome (BAC) library (103 expressed sequence tags (ESTs) and 100+ markers identified to clones) for the long-term support of mapping and comparative genomic in this species;
4. the development and anchoring of a genetic linkage map using a mixed strategy including dominant (more than 200 amplified fragment length polymorphisms (AFLPs)) markers and more than 300 co-dominant short tandem repeat (STR) or DNA microsatellite markers;
5. the development of a synteny map on the basis of ESTs for comparative mapping purposes;
6. a pilot study based on the new medium-density genetic linkage map in the field of quantitative trait loci (QTL): mapping QTL, which links to at least 12 commercially important features of sea bass.

EXPECTED RESULTS AND ACHIEVEMENTS

The main achievement will include a publicly available linkage map, which will become a standard tool for a marker-assisted selection programme and evolutionary genetics in sea bass. A 10x coverage BAC library will be developed to be openly available as plated clones or as gridded filters for future work. The applicability of the constructed map will be demonstrated in a pilot project in a commercial environment targeting QTL.

With the recent rapid developments in technology, this project hopes to achieve in a single four-year project something that has not yet been achieved in other commercial farmed species such as salmon and trout with longer research histories. The tools developed, a medium-density map and a usable BAC library, will be needed to make rapid genetic progress in this species in the future. This project will go some way towards rebalancing the lack of genetic research effort in non-salmonid marine species, and will be the main basis for any large-scale aquacultural developments in the countries surrounding the Mediterranean.

**Bridging genomes: an integrated genomic approach towards genetic
improvement of aquacultured fish species
BRIDGE-MAP**

Contract number:	Q5RS-2001-01797	Coordinator	George Kotoulas
Contract type:	Shared-cost project		Institute of Marine Biology of Crete
Starting date:	1.11.2001		Department of Genetics and Molecular
Duration:	48 months		Biotechnology
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Bridging genomes: an integrated genomic approach towards genetic improvement of aquacultured fish species

BACKGROUND

The present project will use a combined approach of radiation hybrid, linkage and QTL mapping as well as creation of resources for genome research (BAC library, cDNA libraries, ESTs and database) to:

1. transfer genome information from model organisms to commercial species through the approach of comparative genomics;
2. bridge the gaps in maps by merging radiation hybrid maps and linkage maps;
3. bridge the distance between research and industry by accelerating the identification of DNA to phenotype relationships by a pilot application to a commercial selective breeding programme;
4. integrate evolutionary theory and modern technology to generate an applied endpoint;
5. integrate genome maps of various teleosts with data from higher vertebrates, thanks to the high potential of comparative mapping;
6. transfer technology and know-how from leading laboratories in genome analysis and mapping to more classical fish genetics laboratories.

OBJECTIVES

The project work plan is centred around the application of modern biotechnological methods to aquaculture. It is subdivided into eight main work packages, each of which is coordinated by the partner with the relevant expertise, and the completion of which will contribute to the attainment of the project objectives.

The work packages articulate with each other and can be subdivided into three main groups according to the nature of the methods used:

1. Molecular biotechnology, which includes methodologies for generating mapping panels for the linkage map (WP1) and radiation hybrid mapping (RH) (WP2), a highly automatable new method for physical mapping, genotyping the linkage map (WP3) and RH map (WP5), by use of high-throughput automated methods, and isolating STS markers for RH mapping (WP4).
2. Conventional genetic: the tools generated in WPs 1 to 5 will be used to screen sea bream (*Sparus aurata*) generated in a breeding programme on an SME fish farm. This will result in the transfer of molecular biotechnological methodologies to conventional genetics and the implementation of technology transfer from science to industry;
3. The final work package which will run simultaneously with the other project tasks, is the analysis of the extensive data which will be generated by the various work packages of the project. Bioinformatics will be essential for the handling and interpretation of the data and for their successful dissemination in order that the project can have a maximum impact in the fields of aquaculture research, fish genetics, and comparative mapping.

EXPECTED RESULTS AND ACHIEVEMENTS

Biotechnological and scientific expertise will be transferred from model organisms to commercial aquaculture species, for example the sea bream. An integrated map, merging physical and linkage maps, will be generated and applied to a selective breeding programme. This will be achieved by production of a radiation hybrid panel. Sea bream cDNA and BAC genomic libraries will be produced and coding genes with potentially commercial importance will be identified and mapped. A sea bream–zebra fish comparative map integrated with ‘gene rich’ vertebrate maps will shed light on the gene to phenotype relationship. This will be based on mapping of about 2000 genes and markers thanks to the creation of the radiation hybrid panel. Such a combined map of genes and polymorphic markers will directly link QTLs to chromosomal regions of known gene content through the comparative mapping approach. The project is expected to establish a reference genome information for marine perciformes species.

**A functional genomic approach to measuring stress in fish aquaculture
STRESSGENES**

Contract number: Q5RS-2001-02211
Contract type: Shared-cost project
Starting date: 1.11.2001
Duration: 36 months
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A functional genomic approach to measuring stress in fish aquaculture

BACKGROUND

The overall aim of this study is to identify in fish candidate genes associated with resistance to stress conditions and thus provide the physiological and genetic basis for new marker-assisted selection strategies. The recent development of genomic tools, particularly microarray technology, allows systematic gene expression analysis of biological material and provides an integrated overview of the global response at the level of gene expression. Such information is of major importance for identifying genes responsible for genetic variation in response to stress and for further development of a sufficient number of molecular markers, a critical requirement for marker-assisted selection schemes. The present study proposes, for the first time, to apply this new functional genomic approach to examine a complex physiological problem: analysis of the pattern of gene expression at the tissue level in response to exposure to a stressor. It is proposed to examine gene expression profiles in rainbow trout during exposure to a range of stressors typical of those encountered in the aquaculture environment. This should lead to characterisation of stress-responsive genes as potential candidate gene markers.

The rainbow trout has been selected as the focus of this project for several reasons: it is an important aquaculture species throughout Europe; there is a large body of physiological and genetic data available for this species; strains with divergent responsiveness to stress are available; all the partners have worked extensively on this species.

OBJECTIVES

The primary objective of this study is to develop whole animal gene expression profiles to identify candidate genes which are associated with resistance to various stressors in rainbow trout. Information obtained from genomic expression profiles of stressed fish is a necessary base for further development of a marker-assisted selection strategy.

The primary goal will be achieved by utilising DNA microarray technology together with whole animal physiology to address several subsidiary objectives:

1. the gene expression profiles of selected tissues will be determined in fish exposed to standardised stressors;
2. genes whose expression is linked to adaptation response to stress will be identified;
3. the difference in gene expression profiles between selected trout, which display a divergent trait (stress responsiveness, growth, salinity adaptation), will be used to identify potential candidate markers of genotypic variation in stress responsiveness.

EXPECTED RESULTS AND ACHIEVEMENTS

1. Construction of suppression subtractive hybridisation (subtracted) cDNA libraries derived from tissues collected from rainbow trout exposed to several stressors.
2. Preparation in microarrays, implementation of a bioinformatic management system, and the isolation of cDNA encoding for stress-regulation genes.
3. Use of selected families of rainbow trout to identify stress-regulated genes and to allow discrimination between stress-sensitive and stress-resistant individuals.

**Towards the development of technologies
for cryopreservation of fish oocytes
CRYOCYTE**

Contract number: Q5RS-2002-00784
Contract type: Shared-cost project
Starting date: 11.9.2002
Duration: 36 months
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Towards the development of technologies for cryopreservation of fish oocytes

BACKGROUND

The growth of intensive aquaculture requires efficient and effective methods to preserve gametes for higher flexibility in broodstock management, genetic improvement programmes and preservation of genetic diversity. While methods for cryopreservation of fish spermatozoa are well known, preserving maternally inherited important genetic factors has yet to be achieved. Methods for cryopreservation of yolk-laden fish embryos remain elusive so far, but immature or mature oocytes are a specific challenge. The objective is to develop technologies for cryopreservation of fish oocytes. Multidisciplinary studies will be performed on the oocyte envelope structure, on biological processes during oocyte maturation and hydration, on development of *in vitro* procedures for oocyte maturation, ovulation and fertilisation, and on molecular (nucleic acid and protein) markers for indicating oocyte viability prior to and after cryopreservation.

OBJECTIVES

The main objectives are to develop methods for cryopreservation of fish oocytes while ensuring their viability (e.g. maturation, fertilisation and embryonic development) after cryogenic storage and thawing. These aims will be achieved by innovative studies conducted on:

1. anticipated biological barriers for cryopreservation including the formation and structure of the vitelline envelope proteins and the process of oocyte hydration of pelagic eggs;
2. identification of specific biological markers to monitor oocyte viability after manipulation and/or cryopreservation;
3. development of oocyte *in vitro* incubation procedures to promote oocyte maturation, ovulation and fertilisation;
4. development of new cryopreservation technologies. Studies on two models (zebra fish and the gilthead sea bream) will highlight differences between marine and freshwater species and hydrating and non-hydrating oocytes. The results will improve fish production and increase its efficiency by genome banking of cultured and wild species.

EXPECTED RESULTS AND ACHIEVEMENTS

1. The primary end-product will be the development of procedures for successful cryopreservation of fish oocytes maintaining their developmental capabilities.
2. New and powerful tools for evaluating oocyte and egg characteristics as important diagnostic products for farmed fish and eco-toxicological studies. These will include stage-specific molecular markers (in the form of DNA micro- or macroarrays) and protein markers for fish oocytes and egg envelopes, biochemical assays to test the correct enzymatic cleavage of the yolk proteins, and markers to evaluate the buoyancy of pelagic eggs.
3. Methods for obtaining oocyte maturation and ovulation *in vitro* that will be extremely helpful in promoting fertilisation of naturally non-ovulating oocytes from farmed and wild fish species.
4. The formation of cryobanks for storage of preserved oocytes for genetic improvement programmes, for storage of important maternal genetic traits and easier transfer of genetic material between culture locations at reduced costs and reduced danger of disease transmission. It will provide a unique methodology and greatly contribute to improving the competitiveness of the European aquaculture industry.

**Genetic implications in the production of rotifers
in commercial finfish hatcheries
ROTIGEN**

Contract number:	Q5RS-2002-01302	Coordinator	
Contract type:	Shared-cost project	Patrick Sorgeloos	
Starting date:	1.10.2002	University of Ghent	
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Genetic implications in the production of rotifers in commercial finfish hatcheries

BACKGROUND

For first feeding of sea bream, turbot, cod, sole and halibut, the rotifer *Brachionus plicatilis* is the most common live food.

Success in rotifer production is still one of the major bottlenecks in the further industrialisation of the larviculture process. Mismanagement and bacterial contamination are parameters that cannot be neglected, while genetic reasons are getting no attention at all.

In natural conditions, rotifer populations have an alternating asexual and sexual reproduction cycle. When the environmental conditions become adverse, males are produced and sexual reproduction takes place. This ensures a recombination of the genome, as males coming from a female belonging to one clone can reproduce with a female from another clone.

The situation in commercial hatcheries is completely different. As parthenogenesis results in a faster increase in rotifer numbers and as rotifer males swim too fast for the fish larvae, farmers keep the conditions in the rotifer tanks in favour of parthenogenesis. This implies that there is little exchange of genetic material between the different clones present in the hatchery culture. Farmers exchange a relatively small number of rotifers to start a new culture so the new rotifer population suffers from a founder effect.

OBJECTIVES

1. A collection of isolated rotifer clones obtained from previous research and commercial cultures will be created. Several genetic identification techniques will be used. Protocols for sampling and preservation will be issued. The collection will be used to compose mixtures of clones for use in the project.
2. To determine the interclonal selection during rotifer culture, mixtures of clones will be cultured in three different culture methods. The data will provide evidence of the selection next to its rate. Harvesting and reinoculating the rotifer clones for three culture cycles will document the effect of its frequency on the selection.
3. The selective pressure of stable or variable culture conditions on the gene pool of the mixture, starting from disinfected parthenogenetic eggs, will be verified in monoxenic conditions using validated genetic markers. A comparison of the selection between stable and variable conditions will be made. Rotifers cultured under one set of stable conditions will be changed to two other conditions and followed.
4. The microbial flora in the culture systems may play an important role. The selection in cultures will be determined, starting from the five mixtures of disinfected parthenogenetic eggs with the addition of beneficial bacteria. Verification will be made under pilot-scale conditions. The adaptability of the rotifers will be followed.
5. Resting egg production of rotifer clones will be studied and the methodology of production and harvesting will be optimised.
6. A commercial hatchery and other hatcheries near the scientific partners will send samples to follow the genotypic diversity of the rotifers.

The results will be combined in a workshop for the industry.

EXPECTED RESULTS AND ACHIEVEMENTS

1. Mixtures of genetically identifiable rotifer clones.
2. A correlation between a rotifer culture method and the genetic clonal selection.
3. Abiotic and biotic conditions resulting in a low selection rate.

4. A bacterial mixture enhancing growth and survival of several rotifer clones.
5. A culture method with the addition of beneficial bacteria, and biotic conditions resulting in high production and low selection.
6. A production/harvest procedure giving high yields of resting eggs for use in aquaculture.
7. Data on clonal selection in rotifer populations in commercial cultures.
8. Dissemination of the results to the industry.

2. Aquaculture general

**Researching alternatives to fish oil in aquaculture
RAFOA**

Contract number:	Q5RS-2000-30058	Coordinator	Gordon Bell
Contract type:	Shared-cost project		University of Stirling
Starting date:	1.1.2001		Institute of Aquaculture
Duration:	48 months		Stirling FK9 4LA
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Researching alternatives to fish oil in aquaculture

BACKGROUND

The overall objective of the project is to research and develop vegetable oil alternatives to fish oils in aquafeeds for Atlantic salmon, rainbow trout, sea bream and sea bass, and to do so without compromising the health and welfare of the farmed fish, or the growth performance of the fish, or the processing characteristics and organoleptic properties of the final product, or the nutritional properties of the final product, especially its content of health-promoting nutrients. Achieving the objective will include substantially advancing the understanding of how the basic metabolism of fish responds and adapts to changes in dietary lipid composition.

OBJECTIVES

1. To feed Atlantic salmon, rainbow trout, sea bream and sea bass diets containing various blends of fish oil and vegetable oils, including linseed oil, grapeseed oil and olive oil, in two trials: first, with fish grown from at least six months before market size up to market size, this to define the best candidate oils and blends (dietary trial I); second, using oils and blends so defined, with fish grown from first feeding up to market size (dietary trial II).
2. To determine in these trials: feed intake, growth, utilisation of nutrients and energy; classes and fatty acid compositions of flesh lipids and, for salmon and trout, flesh carotenoids; levels and fatty acid compositions of serum lipoproteins; activities of lipoprotein and triacylglycerol lipases in liver, muscle and adipose tissue; activities of selected lipogenic enzymes in liver and muscle; rates of oxidation of polyunsaturated fatty acids (PUFAs) and other fatty acids in isolated hepatocytes and in muscle; activities of selected enzymes regulating fatty acid oxidation in liver and muscle; rates of conversion of C18 PUFAs to C20 and C22 PUFAs in isolated hepatocytes and *in vivo*.
3. To clone and characterise $\Delta 6$ and $\Delta 5$ fatty acid desaturases and to determine their expression, together with the expression of glucose-6-phosphate dehydrogenase and fatty acid synthetase.
4. To determine plasma levels of insulin, leptin, cortisol, prostaglandins E and F, and, in trout, voluntary feed intake.
5. To determine the potency of commercial vaccines to protect against commercially important disease organisms and the haemolytic capacity of the alternative complement pathway in serum.
6. To determine the organoleptic properties of cooked fillets for all species, and smoked fillets for salmon and trout, using taste panels in France, Norway, Spain and the UK; to assess sashimi products in Japan; to relate the results to non-subjective measurements based on electronic detection of volatile compounds in fillets.
7. To determine the stability during ice and frozen storage of flesh of all the species, and the quality and yield of flesh during processing of smoked salmon and trout.
8. To update understanding of fatty acid nutrition and metabolism in fish and to provide advice to the industry and the public on best practices for substituting fish oils with vegetable oils in fish feeds, without compromising the health and welfare of the fish, or the health-promoting benefits and acceptability of the final product to the consumer and producer.

EXPECTED RESULTS AND ACHIEVEMENTS

Detailed recommendations and guidelines to the aquaculture industry for substituting fish oils in aquafeeds for Atlantic salmon, rainbow trout, sea bream and sea bass with blends of sustainable vegetable oils, such recommendations and guidelines to be underpinned by advanced understanding of the nutritional biochemistry and physiology of lipids in fish.

**Perspectives of plant protein use in aquaculture
PEPPA**

Contract number:	Q5RS-2000-30068	Coordinator	J. Kaushik
Contract type:	Shared-cost project		Fish Nutrition Research Laboratory
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Duration:	36 months		F-64310 Saint-Pée-sur-Nivelle
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Perspectives of plant protein use in aquaculture

BACKGROUND

Studies will be undertaken with a freshwater and a marine teleost (rainbow trout and gilthead sea bream) in order to define the ideal protein amino acid profile for maximising muscle growth. Through adequation of amino acid balance, non-protein energy supply and reduction of anti-nutritional factors (ANFs), fishmeal-free (FMF) practical diets will be developed using plant protein sources. The consequences on digestion, absorption and nutrient utilisation leading to lower environmental load will be analysed. The metabolic and endocrine control of muscle growth, protein and fat synthesis will be studied both *in vivo* and *in vitro*. Long-term effects on voluntary feed intake, muscle quality, health and reproduction will be assessed. A socioeconomic analysis of the switch from the dependence of aquafeeds on marine resources to plant protein-based diets will be made.

OBJECTIVES

1. To define the ideal amino acid profile for maximum muscle protein growth.
2. To evaluate the interrelationships between amino acid supply and protein, carbohydrate and lipid metabolism.
3. To assess the effects of amino acid profiles and of plant protein use on digestive and metabolic processes affecting muscle protein growth and adiposity.
4. To develop 'fishmeal-free' or low-fishmeal diets based on mixtures of plant proteins; to assess the effects of such plant protein diets on metabolic and endocrine potential affecting muscle growth, protein accretion and adiposity.
5. To analyse the consequences of long-term feeding on flesh quality, fish health, immune response, reproductive performance and quality of gametes.
6. To provide scientific objective data for feed manufacturers.
7. To provide guidelines based on analysis of the ethical, economic and social issues.

EXPECTED RESULTS AND ACHIEVEMENTS

1. Identification of the most suitable amino acid profile that can promote maximum protein growth.
2. In-depth knowledge on nutritional, metabolic and endocrine factors that govern protein growth and adiposity and their molecular basis.
3. Development of practical low/fishmeal-free diets that promote muscle growth, flesh quality, reproductive performance and affluent water quality.
4. Social and economic analysis of a possible shift from fishmeal to plant protein-based feeds in European aquaculture.

**European network for the dissemination
of aquaculture RTD information
AQUAFLOW**

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European network for the dissemination of aquaculture RTD information

BACKGROUND

AquaFlow is a European network providing information on the results and progress of EU-funded and national research and technological development programmes to aquaculture producers across Europe. After a very successful first three years (as FAIR-CT97-3837) that saw the development of an effective network capable of disseminating information in 14 languages throughout 17 European countries, AquaFlow now operates in 16 languages and in 19 countries. An estimated 145 000 end-users have access to AquaFlow summaries and other services.

Enhancing contacts between the research and production sectors at both horizontal (between producers) and vertical (between scientists and producers) levels is key for improved information exchange and the successful transfer of innovative technology. Such actions are vital in maintaining the competitiveness of both sectors in Europe.

OBJECTIVES

AquaFlow has one principal goal — an increase and improvement in the exchange of information and interactions leading to a wider enhanced application of research results at an industrial level.

The objectives are:

1. to consolidate AquaFlow as a successful international network bridging the gap between the aquaculture industry and the research community;
2. to provide a more diversified range of information through the production and publication of technical leaflets based on European, regional and national RTD programmes, addressing more specifically SMEs' needs and interests;
3. to expand the network by further developing the national AquaFlow teams already active in 17 European countries and involving two acceding countries, the Czech Republic and Poland;
4. to further enhance horizontal (between SMEs) and vertical (between SMEs and scientists) contacts at an international level;
5. to provide decision-makers, administrations, researchers, and producer representatives with concise and up-to-date overview documents, reflecting the industry as a whole;
6. to enhance the use of electronic media and electronic means of communication (e-mail, Internet) for the transfer of information and to set up an intranet.

EXPECTED RESULTS AND ACHIEVEMENTS

The collection, classification and dissemination of information in 16 languages, originating from European-funded aquaculture projects, will provide a unique overview of aquaculture RTD throughout Europe and an efficient platform for diffusion of that information. Several databases will be created, supplying information for Internet-based services. European aquaculture SMEs will give their views on the suitability of AquaFlow as a dissemination tool, which will be a basis for its long-term development.

**Feed for aquatic animals that contains cultivated marine
micro-organisms as alternatives to fish oil
PUFAFEED**

Contract number:	Q5RS-2000-30271	Coordinator	Lolke Sijtsma
Contract type:	Shared-cost project		Agrotechnological Research Institute
Starting date:	1.12.2000		Bornsesteeg 59
Duration:	36 months		PO Box 17
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Feed for aquatic animals that contains cultivated marine micro-organisms as alternatives to fish oil

BACKGROUND

At present, aquaculture consumes nearly 50 % of the available quantities of fish oil and the requirements are increasing. However, the world's fish oil production is decreasing and toxins that are difficult to monitor can be present. Alternatively, marine micro-organisms that are high in long-chain polyunsaturated fatty acid (LCPUFA) content may be added to feeds. However, the availability of such micro-organisms (algae, marine fungi) is limited. Therefore, there is a strong and increasing demand for high-quality, stable and affordable raw material for fish feed production. The lack of it may even hinder the growth of the fish farming industry in Europe within the short term. This project is aimed at the production of PUFA-rich micro-organisms, as an alternative resource to fish oil, in feed for the aquaculture industry. This approach offers several advantages: it reduces the requirements for fish oils; toxin-free feeds will be produced; and feed of constant quality will be available throughout the year.

OBJECTIVES

The overall objective of the PUFAfeed project is the development of alternative feed resources to fishmeal and fish oil employing heterotrophic and mixotrophic micro-organisms in order to supply the aquaculture industry with feed of constant and good quality that is free of toxins or genetically modified materials. In addition, feed based on a combination of heterotrophic (growth in the dark with a suitable carbon source) and autotrophic (growth in light) produced micro-organisms will be developed. PUFAfeed aims at the evaluation of single cell oils (SCOs), obtained from micro-organisms which include microalgae and diatoms, that are rich in the polyunsaturated fatty acids docosahexaenoic acid (DHA) and/or eicosapentaenoic acid (EPA) as alternative/complementary feed ingredients for fish oils. Within the project, fundamental aspects of lipid accumulation in algae will be elucidated and the technologies to produce microbial biomass and novel feeds, based on this biomass, will be developed. Furthermore, the performance of these feeds and the economic feasibility of the integrated process will be established in order to provide a cost-effective alternative to or complementary solution for fish oil use in feeds for aquaculture.

The project involves several disciplines which are all aimed at the complete integrated process of biomass production under controlled conditions, processing, packaging and storage and the application of the final product within the aquaculture industry. Results with newly developed feed will be evaluated and compared with conventional fish-oil-based feeds.

EXPECTED RESULTS AND ACHIEVEMENTS

It is expected that the achievements of this project will include the following:

1. An efficient process for the production of microbial biomass containing long-chain polyunsaturated fatty acids (LCPUFAs) such as DHA. For EPA (or EPA/DHA) production, a novel process will be developed. So far, most EPA originates from autotrophic microalgae. In order to improve the availability of EPA-containing biomass, reduce the costs and have material of constant quality throughout the year, heterotrophic or mixotrophic production will be established. Physiological tools as well as the naturally present variability between strains will be used to improve the yields of the selected strains.
2. Production of feeds for aquaculture that are based on untreated or processed microbial biomass. At the end of the project, the performance of microbial biomass or microbial oils in starter feeds for salmon and sea bream or enrichment feeds will have been determined.
3. Based on the results obtained in feeding trials with respect to, for example, growth, survival and stress tolerance of the fish larvae as well as on economic data of the production costs, the economic evaluation of the whole integrated process will be established.

**Improved procedures for flatfish larval rearing through the use
of probiotic bacteria
PROBE**

Contract number:	Q5RS-2000-31457	Coordinator	
Contract type:	Shared-cost project	Thomas Henry Birkbeck	
Starting date:	1.12.2000	University of Glasgow	
Duration:	36 months	Institute of Biomedical and Life Sciences	
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Improved procedures for flatfish larval rearing through the use of probiotic bacteria

BACKGROUND

Strategies to control bacterial growth (particularly the growth of unwanted bacteria) in intensive rearing of marine fish larvae have frequently resorted to the prophylactic use of antibiotics, with the attendant problems which arrive when antibiotic resistance develops in bacteria. This problem is not limited to the larval culture system as resistance can often be transferred to micro-organisms in other environments. Subsequently, such resistance may spread to bacteria causing disease in humans.

The aim of the project is to reduce the reliance on antibiotics by developing methods that can positively regulate the microbial flora of flatfish by other means and to provide a new and systematic approach to improving the rearing conditions of larval turbot by using biological, non-antibiotic-dependent measures of disease control. The results will be transferable to other larval rearing systems in aquaculture.

OBJECTIVES

The objective of this project is to identify promising bacteria that can be used to regulate the bacterial microflora during rearing of larval turbot and thereby improve larval survival and health.

1. Development will take place in the laboratory to test the effectiveness of this approach.
2. Large numbers of bacterial isolates from a range of sources will be provided which are suitable for use as probiotics in larval flatfish. These will be screened using *in vitro* tests to identify those suitable for use as probiotics. Promising candidates as probiotics will be tested for their effects on larvae and in disease control during larval rearing on a small scale.
3. Methods for delivery of such bacteria to larvae will be optimised and the most promising candidate probiotics will finally be tested on an industrial scale.

It is intended to transfer the science-based knowledge and understanding of bacterial interactions with marine fish larvae to practical use in industrial-scale production sites for turbot and other species of fish.

EXPECTED RESULTS AND ACHIEVEMENTS

The project is expected to identify a large number of bacteria that could potentially be used in aquaculture to improve larval rearing. The mechanisms by which bacteria cause losses in larval turbot rearing as well as the mechanisms which potential probiotics inhibit their actions will be determined and this fundamental knowledge will be important for developing future strategy in this area. The route by which probiotic bacteria need to be delivered to larval rearing systems for optimum protective effect will be determined and this requires study of their stability, efficiency of delivery via water or live food prey organisms, levels required in the rearing system and frequency of application. The methods investigated in laboratory-scale trials will be chosen so that they can be applied to commercial-scale rearing in due course.

The expected benefits to the industry should include:

1. improved health, disease resistance and welfare of fish;
2. enhanced survival and better reproducibility between batches of fish;
3. reduced use of antibiotics and, consequently, reduced environmental impact;
4. rapid transfer of laboratory findings to commercial-scale culture;
5. allowing the industry to become more competitive and potentially lead to significant expansion and economic growth of the flatfish aquaculture industry;
6. application of the work to other larval rearing systems;
7. increased food safety through minimising the use of antibiotics in the food chain.

**Environmental, nutritional and neuroendocrine regulation
of skin coloration in the red porgy (*Pagrus pagrus*):
towards the development of natural hue in cultured populations
COLORED**

Contract number:	Q5RS-2000-31629	Coordinator	Michael Pavlidis
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Environmental, nutritional and neuroendocrine regulation of skin coloration in the red porgy (*Pagrus pagrus*): towards the development of natural hue in cultured populations

BACKGROUND

The red porgy, *Pagrus pagrus*, is one of the most popular sparids in the Mediterranean region and the Atlantic coast, characterised by high price value, highly appreciated flesh and good market perspectives. Initial commercial trials have already been performed in several Mediterranean fish farms. Intensively reared fish show good adaptability to culture conditions, a high growth rate, and present no serious disease problems. Therefore, red porgy has been considered a prime species for diversification of aquaculture production. However, the main problem for moving towards commercial production is the discoloration of skin observed in cultured fish. Red porgies fed formulated feeds exhibit a dark colour at the back and sides, unlike wild specimens which have a pink and silver colour on the dorsolateral surface of the body with scattered blue spots. The overall aim of the project is to resolve this market-related problem towards the generation of a natural hue in cultured populations, through a better understanding of the different environmental, nutritional and neuroendocrine mechanisms regulating skin coloration.

OBJECTIVES

1. To gain basic knowledge on the coloration pattern of red porgy through the identification of basic differences in skin colour pattern between wild and cultured fish.
2. To identify the nutritional and neuro-physiological basis of colour change.
3. To develop the most appropriate husbandry conditions towards the development of natural hue.
4. To estimate the cost-effectiveness of the developed product and appreciate the effects of colour on the buyer's evaluation of red porgy as a viable product for commercial aquaculture.

Partners from academia, research institutes, aquaculture producers' associations and marine fish farmers are joined to address the following:

1. Investigation into the basic coloration pattern of red porgy. The objectives are to explore the natural coloration pattern of red porgy (wild fish) and to set the coloration standards that the cultured red porgy should fulfil.
2. Understanding of the physiological basis of colour change in culture conditions. The aims are:
 - to determine the physiological basis of colour change in culture conditions;
 - to define the nature (central/peripheral, neural/hormonal) of colour change;
 - to define the neural mechanisms that underline the control of skin coloration.
3. Manipulation of husbandry conditions towards the development of natural skin colour. The aims are:
 - to determine the role of environmental and rearing-related factors (light, background colour, handling, and stocking density) on colour change;
 - to evaluate the relationship between pigmentation and stress;
 - to identify the appropriate husbandry conditions for the development of natural hue.
4. Nutritional impact on skin colour. The aims are to gain knowledge on the role of nutrition and to develop a feeding scheme towards natural coloration of cultured fish.

The outcome of the project's results will be applied to the installations of an end-user to validate the developed methodology and feeding scheme at an industrial scale (end-user — fish farm). In addition, analysis of the acceptability of the developed product (red porgy) in its different forms (including size and colour) within the traditional and developing markets for European aquaculture produce will be performed. This will also assist the assessment of the industrial applications of the project's results.

EXPECTED RESULTS AND ACHIEVEMENTS

Through a multidisciplinary approach, the project will contribute to a better understanding of the mechanisms regulating pigmentation in fish. The application of modern techniques in the study of brain circuits controlling skin colour will enhance our understanding of the hypothalamic regulatory system and of the nervous system in fish, the mechanisms governing biological, ethological and behavioural (chromatic adaptation) processes and their interrelationship. The project also includes in its scope the development of an appropriate food and the definition of a feeding strategy for this species. The identification of the appropriate culture conditions for the development of natural hue will lead to an improved and integrated culture strategy for a new species for aquaculture. Finally, red porgy may be used as a model species for solving discoloration problems observed in several other commercially important marine species.

**Gastrointestinal functions and food intake regulation in salmonids:
impact of dietary vegetable lipids
GUTINTEGRITY**

Contract number:	Q5RS-2000-31656	Coordinator	Björn Thrandur Björnsson
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Gastrointestinal functions and food intake regulation in salmonids: impact of dietary vegetable lipids

BACKGROUND

Sustainable and ethical aquaculture is of great future economic importance for many rural areas of the European Community, providing a healthy food source to the Community. To achieve this, the industry needs to lessen its dependence on fishmeal and fish oil as the basis for fish feed. Vegetable lipids may be a major source of alternative energy for cultured fish, but current knowledge on their effects on the gastrointestinal tract of fish is insufficient to give recommendations on content and composition in fish feed.

OBJECTIVES

The gastrointestinal tract has a number of vital functions. In fish as in other vertebrates, it is the site of food digestion and nutrient uptake, imparts postprandial information for the regulation of food intake, is a regulatory site for ion and water balance, and acts as a barrier against infections. Changes in diet composition may affect any of these functions, and thus the nutritional and osmoregulatory balance, hunger and satiation level, disease resistance and health. The maintained integrity of the gastrointestinal tract, irrespective of diet composition, is therefore of major production concern during finfish aquaculture, as well as an important issue of animal welfare.

The overall goal of the project is to provide a strong factual basis for the quantitative and qualitative incorporation of vegetable lipids into feed for salmonids, a group of commercially important European aquaculture species, without compromising the growth, health and welfare of the animals.

EXPECTED RESULTS AND ACHIEVEMENTS

1. Understanding how vegetable lipids affect the gastrointestinal tract, especially absorption processes, nutrient uptake mechanisms, barrier function, indigenous microbiota and disease resistance.
2. Understanding how vegetable lipids affect food intake, how this is mediated through signals by gut peptides and hormones, and how fish are able to discern between lipid sources.
3. Understanding how the health of the fish, i.e. performance during development, growth, welfare and ability to recover, is affected by disturbance of the intestinal integrity.

**Dietary self-selection in fish: a geometrical approach
for optimising aquaculture production
SELFISH**

Contract number: Q5CA-2001-00989
Contract type: Concerted action
Starting date: 1.10.2001
Duration: 36 months
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Dietary self-selection in fish: a geometrical approach for optimising aquaculture production

BACKGROUND

Despite abundant reports on fish nutrition, dietary self-selection is little explored. To date, to compose diet mixtures, theoretical formulations have to be practically evaluated in long and costly feed trials. However, fish show considerable 'nutritional wisdom' to select nutritionally balanced diets from suboptimal feeds. Better knowledge of macronutrient self-selection in fish has important economic, welfare and environmental benefits. The geometric analysis of dietary selection represents a major innovation, providing new concepts for fish nutrition. The partners involved in this concerted action have made significant contributions to this field and are currently developing research programmes at a national level. The harmonisation of their research activities and the communal discussion of data sets will improve the performance and relevance of the national projects, integrating the data analysis and designing new experimental programmes.

OBJECTIVES

The main objective is to harmonise individual research activities to take advantage of recent theoretical and experimental advances in fish nutrition to assess:

1. whether and how fish regulate their macronutrient intake, finding targets in the nutritional space (three macronutrients' axes) and verify that fish defend them;
2. how they balance overingesting some nutrients against underreating others when provided with suboptimal diets of animal and plant origin;
3. how they regulate food selection, growth and body composition post-ingestively;
4. how such points of regulation change with the age of the fish, season and rearing conditions.

Such data will allow manufacturers to formulate feeds that better reflect the needs and regulatory responses of fish. As a result, feeding performance and flesh composition will be optimised, fish welfare improved, and nitrogenous and other waste products minimised, providing considerable benefits to the aquaculture industry and its consumers.

EXPECTED RESULTS AND ACHIEVEMENTS

The geometric analysis of dietary self-selection will provide:

1. improved performance and relevance of existing national research programmes;
2. a geometric framework of dietary selection in farmed fish;
3. advanced self-feeding methods for food selection;
4. knowledge of macronutrient preferences of fish with different feeding habits;
5. new concepts for aquaculture and feed industries;
6. formulation of a major research and development programme with added European value.

**Optimisation of rearing conditions in sea bass for eliminated
lordosis and improved musculoskeletal growth
ORCIS**

Contract number:	Q5RS-2001-01233	Coordinator	Neil Stickland
Contract type:	Shared-cost project		University of London
Starting date:	1.11.2001		The Royal Veterinary College
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Optimisation of rearing conditions in sea bass for eliminated lordosis and improved musculoskeletal growth

BACKGROUND

Lordosis is a significant problem in the aquaculture of several species, including sea bass. The development of skeletal abnormalities in reared fish exerts disadvantageous influences upon fish biological performance, welfare, market image and acceptability by the consumers, and therefore on fish commercial value and on the productivity and efficiency of the aquaculture industry.

Sea bass (*Dicentrarchus labrax* L.) is one of the two main species of the Mediterranean marine aquaculture and its farming is extending to other parts of Europe (FEAP 2000, web site). It is an extremely popular fish not only in the Mediterranean but also on the Atlantic coast, while the market demands for it have increased in other European countries as a result of market diversification during the last few years.

When intensive aquaculture of sea bass first started, up to 70 % of fish presented serious vertebral lordosis (requiring sorting and discarding) due to inadequate knowledge on the biological and technological mechanisms of swim bladder inflation. The application of adequate rearing conditions solved the problem of lordosis induction by swim bladder non-inflation. However, lordosis continued to develop in reared sea bass with functional swim bladders reaching frequencies of 25–70 %. Other studies have implicated a range of possible factors that might influence lordosis induction in fish with functional swim bladders. These factors include dietary deficiencies, notochordal distortions during early development, pollutants, myopathies, and high swimming activity due to high velocity of water currents.

OBJECTIVES

The overall objective of this project is to apply a multidisciplinary scientific investigation of the influence of environmental and nutritional factors on the incidence of lordosis and on the development and function of the musculoskeletal system. This will be achieved through an integrated approach where an understanding of the underlying science will be addressed in consort with the aquaculture industry.

The specific objectives of the project are as follows:

1. To assess the influence of rearing temperature, nutrition (mainly vitamins C and E and selenium), and current velocities and their interactions on the incidence of lordosis. This will be achieved by rearing eggs and larvae at two different temperatures (15 and 20 °C) up to 18–20 mm total length (TL). The juveniles will then be reared at different swimming speed currents up to about 1 g. In parallel studies, juveniles will be fed differing levels of selenium, vitamin E and vitamin C for different swimming speed groups.
2. To assess, for the same factors and same groups of fish, the influence on musculoskeletal development and growth at tissue, cell, protein and molecular level, as an informed basis for reducing the problem of lordosis and for optimising musculoskeletal growth.
3. To provide a tool for standardised assessment of quality in a commercial environment, which will take into account not only the presence or absence of skeletal deformities, but also the real effects of their different expression intensities on both biological performance and product final image.

EXPECTED RESULTS AND ACHIEVEMENTS

The results will help in the understanding of the reasons for vertebral deformities including lordosis and will indicate the optimum rearing conditions for its elimination and for

improved musculoskeletal growth. The findings of this project will lead to benefits for the consumer, producer and animal, namely:

1. for the consumer — optimisation of production will lead to improved product quality;
2. for the producer — by optimising production and improving product quality, the competitiveness of European aquaculture will be increased;
3. for the animal — the well-being of cultured stocks will be improved.

Although the species to be investigated is the sea bass, it is expected that the principles derived will be applicable to other species.

**Calcium, the backbone of fish culture: importance in skeletal
formation, reproduction and normal physiology
FISHCAL**

Contract number:	Q5RS-2001-01465	Coordinator	Adelino V. M. Canário
Contract type:	Shared-cost project		University of Algarve
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Calcium, the backbone of fish culture: importance in skeletal formation, reproduction and normal physiology

BACKGROUND

Despite improved methodologies for farming of marine fish species, the viability of eggs and larvae is still, in most cases, no more than 20–30 %. This is a consequence of high mortalities and/or a high incidence of larvae with skeletal deformities (dystrophies). Often dystrophies are not immediately apparent leading to a wasteful use of food, energy, space and human resources until dystrophic fish are graded and removed. Skeletal deformities arise as a consequence of abnormal calcification of cartilaginous tissue and there is evidence that hypercalcaemic factors may be involved. Therefore, the elucidation of the processes controlling ossification in fish larvae is of extreme importance in order to devise culture methodologies that minimise abnormal development. Calcium is also important in a range of other physiological processes of practical importance to aquaculture, such as during reproduction when high concentrations of calcium need to be available for vitellogenesis and for growth, which requires both bone remodelling and ossification. Surprisingly, there is relatively little information available on how calcium requirements vary in teleost fish during their life cycle or the physiological mechanisms employed to raise plasma calcium levels. The aim of this project is to determine how calcium homeostasis and availability are maintained during critical stages of the life cycle of the teleost fish *Sparus aurata*, an important marine aquaculture species in south European countries.

Whilst hypocalcaemic factors, such as stanniocalcin and calcitonin, have been identified and characterised in fish, until now there has been no recognised hypercalcaemic factor. However, the project partners have cloned and identified a gene in sea bream for a potential hypercalcaemic factor, parathyroid hormone-related protein (PTHrP), and shown that teleost PTHrP does elevate internal calcium. This discovery indicates that raising circulating calcium levels is an important physiological function, but the mechanisms by which this is achieved are currently unknown.

OBJECTIVES

The first objective of the project is to identify the relative importance of dietary, endogenous and environmental sources of calcium during critical phases of development, growth and reproduction of sea bream during a normal production cycle in the fish farm.

The second objective is to determine, experimentally, the roles of the parathyroid hormone-related protein (PTHrP) in whole animal calcium homeostasis. Tissues sensitive to changes in calcium availability, including gut, kidney and gills, will be identified by *in vitro* and *in vivo* techniques. This will be carried out at stages in which calcium requirements are high, namely during skeletal development, reproduction and growth. A multidisciplinary approach will be used including molecular techniques to produce recombinant homologous PTHrP for *in vivo* treatments and production of specific antisera. These will be used to establish specific assays for PTHrP in tissues and plasma.

The third objective will be to study the molecular mechanisms that underpin bone formation in fish and the way in which PTHrP regulates this process. This will involve the identification of factors *in vivo* that may influence its expression.

Overall, these objectives will provide new information on calcium physiology in sea bream hitherto unavailable. This will allow the identification of causal factors in abnormal bone development in larvae, the mechanism by which calcium is incorporated into vitellogenin, the general requirements of calcium for normally growing fish and the function of PTHrP in these processes.

EXPECTED RESULTS AND ACHIEVEMENTS

The Fishcal project will start by generating new specific tools based on the genomic information available, which will be used as reagents and assay methods in the experiments to be carried out. Then a series of studies will follow to evaluate calcium requirements and the source of calcium in rapidly growing fish and in larvae undergoing skeletal development. The way in which calcium homeostasis is maintained in changing conditions of calcium availability, and the role of PTHrP, its receptor and of the calcium-sensing receptor in this process will be elucidated. A similar approach will be taken to study calcium homeostasis during vitellogenesis when high loads of calcium are required for gamete development and maturation. In a third phase, the molecular mechanisms, which underpin bone formation in fish, will be studied. This will involve the identification of genes activated during initiation of endochondral bone formation and characterisation of their response to the presence of PTHrP. Factors which regulate the PTHrP gene expression, and thus ossification, will be identified by studying the promoter region of the PTHrP gene.

The overall achievement of the project will be to provide new information on calcium physiology in sea bream hitherto unavailable. This will allow the identification of causal factors in abnormal bone development in larvae, the mechanism by which calcium is incorporated into vitellogenin, the general requirements of calcium for normally growing fish and the function of PTHrP in these processes.

Fish oil and meal replacement FORM

Contract number: Q5TN-2002-00628
Contract type: Thematic network project
Starting date: 1.11.2002
Duration: 48 months
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Fish oil and meal replacement

BACKGROUND

A thematic network on fish oil and meal replacement based on five existing EU-funded programmes (PEPPA, Gutintegrity, PUFAfeed, FPPARS and RAFOA) will be formed. All five projects focus research on and evaluate the consequences of the expected shortage in fish oil and meal. Based on existing knowledge, healthy and productive fish farming still greatly depends on these feed ingredients. Four network meetings will be organised, and new research results will continuously be added together with new information and informed comments on an Internet site. While all projects represent important activities, there is a marked imbalance between effort on fish oil and meal replacement. None of the projects considers food safety or consumer health as a consequence of changed fillet composition stemming from changes in feed resources. There are no considerations of genetically modified feed resources, which may soon dominate the alternative feed resource market. The five projects are keen to widen the knowledge pool, by informed discussions with other authorities and stakeholders in the field of farmed fish, fish feed producers and bodies concerned with health and safety.

OBJECTIVES

1. To optimise scientific networking, management, coordination, monitoring and exchange of information on a volunteer basis by utilising and expanding the existing activities of the ongoing EU-funded projects PEPPA, Gutintegrity, PUFAfeed, FPPARS and RAFOA.
2. To utilise, at modest cost, existing knowledge in the partners' scientific institutions in the aforementioned EU-funded projects so as to strengthen and expand scientific discussions and information exchange relevant to fish oil and meal replacement.
3. To relate findings emerging from existing programmes to the wider field of farmed fish quality and safety by information exchange and informed discussion between participants in existing programmes and experts from the feed- and fish-producing industries, producer and consumer organisations, and health and safety authorities.

EXPECTED RESULTS AND ACHIEVEMENTS

1. Establish a thematic network — FORM — to enhance interactions between the scientific partners and the feed industry, producers and consumer organisations.
2. Organise four network meetings, one per annum:
 - alternative feed resources — influences on feed consumption, protein and lipid metabolism, physiological changes and product quality;
 - alternative feed resources — with special focus on genetically modified ingredients and/or ingredients derived from genetically modified plants or micro-organisms versus genetic modification of farmed fish species;
 - aquaculture and food safety — with special focus on dioxins and other potential hazardous contaminants;
 - aquaculture and healthy eating — with special focus on tailoring the farmed product to consumer needs.
3. Provide the public with up-to-date factual information and informed comments on current and developing issues on farmed fish quality and safety through a planned web site.

**Arrested development: the molecular and endocrine basis
of flatfish metamorphosis
ARRDE**

Contract number:	Q5RS-2002-01192	Coordinator	Björn Thrandur Björnsson
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Arrested development: the molecular and endocrine basis of flatfish metamorphosis

BACKGROUND

Flatfish species such as halibut, turbot and sole form a major focus of the diversification of the European aquaculture industry. However, production has been severely hampered by biological problems in larval rearing.

Metamorphosis of flatfish involves major and easily recognised changes in body form, which convert a bilaterally symmetric pelagic larva into a benthic juvenile with both eyes on the same, pigmented, side of the body. In addition to the tissue remodelling and differentiation that produces these dramatic transformations, metamorphosis also involves myriad biochemical and physiological alterations mediated through differential gene expression and endocrine systems.

Despite juvenile quality being determined during larval metamorphosis, the knowledge of flatfish metamorphosis is still rudimentary, especially in terms of the molecular and endocrine basis. As normal metamorphosis is a prerequisite for post-larval development, growth and survival of the fish, it is literally vital, in nature as in hatcheries, for this transition to proceed correctly.

Arrested development during metamorphosis arises at a high frequency in the aquaculture of Atlantic halibut, sole and turbot. The high percentage of juveniles exhibiting these abnormalities limits the cost-effectiveness of the juvenile production industry. At the same time, the juvenile rearing phase represents the bottleneck in an industry with huge potential for growth. If this problem can be overcome, existing facilities could reliably multiply their juvenile production rates with marginally added running costs, such as heat, water, feed, and infrastructure.

OBJECTIVES

The overall project objective is to determine the biological basis for arrested metamorphosis and find ways of alleviating the problem.

This will be achieved by addressing key questions concerning the morphological endocrine and molecular basis of metamorphosis in a model species. The information will form the basis for improved cost-effective rearing techniques for the production of marine flatfish juveniles, and thereby strengthen European marine flatfish aquaculture, an industry of great potential and importance for rural coastal areas.

The specific objectives of the project are:

1. to elucidate the morphological and molecular transformations that constitute metamorphosis;
2. to elucidate the complex interaction between age, growth rate, size and metamorphic stage;
3. to determine the endocrine mechanisms which regulate metamorphosis;
4. to determine the underlying cause(s) of arrested development during metamorphosis;
5. to suggest rearing practices that will alleviate the problem.

EXPECTED RESULTS AND ACHIEVEMENTS

1. Characterisation of morphological and biochemical changes associated with halibut metamorphosis through studies of morphology and histology, and the analysis of known markers of metamorphosis.

2. Characterisation through construction of a gene microarray of gene expression profiles during metamorphosis. Subtractive hybridisation and construction and screening of a gene microarray will be used to provide information on the timing, order and regulation of the various tissue transformations that occur during normal metamorphosis.
3. Elucidation of the endocrine regulation of metamorphosis. Known or potential regulators of metamorphosis (thyroid hormones and deiodinase enzymes, prolactin, growth hormone, cortisol and IGF-I) will be determined in halibut larvae at different stages, using whole body measurements and hormone gene expression (*in situ* hybridisation, gene arrays, Q-PCR). Furthermore, the potential responsiveness of specific tissues to hormones will be assessed by measurements of receptor gene expression. The roles of individual hormones will be further examined through *in vivo* treatment studies.
4. Determination of the basis for arrested metamorphosis. This will be made by carefully comparing normally and abnormally metamorphosing larvae using the above approaches.
5. Elucidation of functional relationships between nutritional supplements (iodine, selenium), endocrinology and rate and success of metamorphosis to establish 'functional feeds' for metamorphosing larvae.

**Reproduction of the bluefin tuna in captivity — Feasibility study for
the domestication of *Thunnus thynnus*
REPRO-DOTT**

Contract number:	Q5RS-2002-01355	Coordinator	Antonio García Gómez
Contract type:	Shared-cost project		Centro Oceanográfico de Murcia
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Duration:	36 months		Ctra. de la Azohía s/n
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**Reproduction of the bluefin tuna in captivity —
Feasibility study for the domestication of *Thunnus thynnus***

BACKGROUND

The present project draws on the exceptional opportunity to combine forces of an international group of scientists and commercial ‘growing-out’ facilities for bluefin tuna (BFT) to provide an in-depth study of the reproduction of BFT in captivity, thereby providing a strategic feasibility study for the domestication of this species. Controlled reproduction is a crucial step on the road to domesticating a wild species. We have to study the hormonal regulation on gonadal development, maturation of gametes, spawning and fecundity, and finally develop suitable methods to control the reproduction of the BFT. The availability of captive broodstock will allow us to increase the knowledge on the input of reproductive cues to recruitment determinism in the wild, hence allowing better management of the resource in a global sense.

OBJECTIVES

Four main objectives can be identified:

1. in order to develop an aquaculture farming technology for bluefin tuna (BFT), it is of utmost importance to improve our knowledge of the reproductive biology of the species in captivity and compare this with wild populations;
2. a second major objective of this project is to assess the capability of BFT broodstock to mature and spawn in captivity;
3. we then have to assess the feasibility to obtain viable eggs from BFT breeders and bring them to hatching;
4. we need to develop handling techniques for routine operations in BFT aquaculture, including the use of adequate transport systems for live fish, testing of appropriate anaesthetics, and removal of tissue samples by non-invasive methods for monitoring maturation.

EXPECTED RESULTS AND ACHIEVEMENTS

The progress of the project will be clearly marked by the milestones, such as: development of handling techniques and the completion of wild and caged fish sampling programmes for sex and maturity; successful broodstock maintenance; natural spawning and induced spawning success; determination of reproductive hormonal control; and successful hatching of eggs. The long-term results will determine the global strategy to be followed for the successful and sustainable aquaculture of BFT.

**Photoperiod control of puberty in farmed fish: development of new techniques and research into underlying physiological mechanisms
PUBERTIMING**

Contract number: Q5RS-2002-01801
Contract type: Shared-cost project
Starting date: 1.10.2002
Duration: 36 months
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Project web site:
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Photoperiod control of puberty in farmed fish: development of new techniques and research into underlying physiological mechanisms

BACKGROUND

Early male puberty is a significant economic problem in the farming of several fish species in Europe. It is therefore necessary to develop strategies to delay puberty. These strategies should meet both consumer acceptance and the economic interests of aquaculture. However, significant gaps exist in our knowledge as regards the physiological regulation of puberty, which preclude developing strategies to approach the problem. Similarly, although it is already known that differences in the genetic background within a species can result in differences in the timing and/or incidence of early male puberty, there is virtually no information on how genetic differences are reflected in differences in reproductive physiology. The same holds true for the potentially very interesting option of combining suitable genetic traits from identified sibling groups with certain photoperiod treatment regimes. Since photoperiod control appears to be one of the most promising techniques for controlling puberty in farmed fish, this project focuses on:

1. improving the understanding of the physiological regulation of puberty;
2. the interactions with factors such as genetic background, nutrition and adiposity;
3. notably clarifying how the photoperiod affects the BPG axis during puberty.

The aims are to further develop photoperiod protocols to be used on Atlantic salmon and sea bass, and also to provide a scientific framework for the future use of such (or similar) protocols in new farmed species such as cod, halibut and turbot.

OBJECTIVES

Our overall objective is to develop improved photoperiod protocols for delaying first sexual maturation (puberty) in commercially farmed European fish species by:

1. improved knowledge on the mechanisms of activation of the BPG axis during puberty in fish, including development of new tools to study the BPG axis in salmon, rainbow trout and sea bass;
2. improved understanding of the importance of differences in light intensity and spectral quality in affecting the BPG axis and the initiation/postponement of puberty, by assessment of pineal melatonin production *in vitro* and *in vivo* in salmon and sea bass;
3. improved understanding of the interactions between photoperiod protocols, genetic background and adiposity in arresting/promoting puberty in salmon and sea bass.

Specific objectives are to:

1. alter the timing of puberty by use of different photoperiods, nutritional treatments and different sibling groups to (i) more fully understand how these factors interact with the initiation/suppression of puberty by their effects on the BPG axis, and (ii) further develop photoperiod protocols to reliably delay unwanted sexual development in salmon and sea bass under commercial farming conditions;
2. identify the pineal sensitivity to light of different intensities and spectral compositions to determine threshold values for artificial light to control puberty in salmon and sea bass in outdoor fish farms/sea cages;
3. further develop tools to study the roles of selected components of the BPG axis (gonadotropin-releasing hormones, gonadotropins, gonadal steroids and the receptors for these hormones) in determining puberty in fish by use of different model species such as Atlantic salmon, rainbow trout and sea bass in order to fill gaps in our knowledge with respect to the activation of the BPG axis;

4. define critical periods in the season and life cycle, during which the timing of puberty might be altered by photoperiodic protocols and study, by *in vivo* and *in vitro* approaches, the endocrine changes that accompany enhanced/delayed puberty;
5. measure growth rate, body size and lipid stores in genetically defined sibling groups at assumed critical points in the life cycle and season to identify putative thresholds for puberty.

EXPECTED RESULTS AND ACHIEVEMENTS

The project aims to identify environmental and physiological key factors responsible for initiating puberty in fish along with the development of photoperiod protocols to reliably control puberty in farmed fish. The project will study a broad range of parameters during natural puberty, or in response to environmental treatments (photoperiod and nutrition), in the context of different genetic backgrounds. Significant original information is expected from studies using different photoperiod treatments, diets and sibling groups to develop large differences in the incidence of early puberty. To combine this means with the thorough analysis of the endocrine processes during treatment-induced advancements or delays of pubertal development is the major innovative approach that characterises the experimental model used in this project. Significant progress is expected for both the applied and fundamental branches of aquaculture research, as well as for aquaculture industries.



Q5RS-2000-31141 'Silver Eel'. Photo courtesy of Kema BV

Area 4: Support for common policies — Development of methods of control, surveillance and protection including protection of land and prevention of soil erosion — Pre-legislative research designed to provide a scientific basis for Community legislation

Sub-area 4.3: Monitoring and enforcement of the CFP

**Technical efficiency in EU fisheries: implications for monitoring
and management through effort controls
TEMEC**

Contract number: QLK5-1999-01295
Contract type: Shared-cost project
Starting date: 1.1.2002
Duration: 36 months
Scientific Officer: Sigurdur Bogason
Project web site:
[www.pbs.port.ac.uk/econ/cemare/
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Technical efficiency in EU fisheries: implications for monitoring and management through effort controls

BACKGROUND

Effort control measurements in the EU are currently based largely on the reduction of capacity, measured in terms of days fished, engine power and gross tonnage. However, effort depends on factors other than the physical characteristics of the boat and the number of days fished. These factors manifest themselves as differences in the level of technical efficiency of the vessels. Understanding the extent to which technical efficiency varies in different fishing fleets has implications for the targeting and effectiveness of effort control programmes. Differences in apparent technical efficiency may be due, however, to misreporting of landings. Multi-output measures of technical efficiency will be derived and applied to a range of different fishing fleets. The possible effects of misreporting on these measures will be estimated and implications for monitoring and effort control measures derived.

OBJECTIVES

1. To estimate the distribution of technical efficiency of selected EU fishing fleets using:
 - single-output measures (e.g. revenue);
 - multi-output measures (e.g. landings of different species).
2. To examine the contribution of different factors to the level of technical efficiency (and, conversely, inefficiency) of different types of fishing boats.
3. To examine how average technical efficiency has changed over time in selected EU fishing fleets.
4. To identify implications for effort reduction or control programmes.
5. To determine the extent to which under-reporting of landings can be identified by using multi-output measures of technical efficiency.

EXPECTED RESULTS AND ACHIEVEMENTS

The milestones included reports on:

1. methodology;
2. fisheries to be examined;
3. single-output measures of technical efficiency;
4. multi-output measures of technical efficiency;
5. implications for effort controls and measurement of non-reported catch.

The results indicated that efficiency varies considerably across the EU fleets. Multi-output measures were less susceptible to the output mix of the vessels examined, and generally resulted in higher average estimates of efficiency. Multi-output measures were also successfully used in identifying non-recorded catch.

**Establishing traceability for cod (*Gadus morhua*):
determining location of spawning and harvest
CODTRACE**

Contract number:	Q5RS-2001-01697	Coordinator	Bret Danilowicz
Contract type:	Shared-cost project		University College Dublin
Starting date:	1.1.2002		Department of Zoology
Duration:	36 months		Belfield
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Establishing traceability for cod (*Gadus morhua*): determining location of spawning and harvest

BACKGROUND

Cod is one of the EU's most economically important fish species; yet, as cod cannot be traced to their origin, problems arise with stock management and consumer safety. We will develop methods to establish traceability for cod, placing unknown cod to their location of spawning and of harvest. Our objectives are to differentiate fish spawned in different basins, identify their harvest location including differentiating wild-caught and farm-reared individuals, and place the results in a context of the EU common fisheries policy and law. Objectives will be achieved through the use of multiple tracing techniques (genetics, chemistry and molecular/physical markers) followed by multivariate statistics. Our technique will provide a high statistical probability of correctly classifying individual cod to their location of spawning and harvest. Our research will be patented, published, and presented to potential end-users at a dedicated forum.

OBJECTIVES

Cod (*Gadus morhua*) is one of the European Union's most economically important fish species, yet cod cannot be traced to their origin. This lack of traceability of cod, or of nearly all marine fish and shellfish, results in numerous socioeconomic problems (most notably with stock management and consumer confidence and safety). There is one major goal of the Codtrace project: to establish legally indisputable evidence of the origin of cod. This major goal can be subdivided into two component parts, each of which involves optimising methodology to:

1. differentiate individual fish spawned in different basins;
2. identify the location of harvest of an individual fish.

During the project, the numerous scientific/technological objectives focus on optimising physical, genetic, chemical, and molecular techniques for the purpose of cod traceability. Specifically, 10 different techniques (herein called Codtrace techniques) will be optimised for fish traceability; seven for determining both the location of where a fish was spawned and where it was harvested, two exclusively for determining the harvest location of a fish, and one for determining where a fish was spawned. It is the use of these multiple techniques simultaneously, or a multivariate approach, which will pinpoint the specific location of spawning and of harvest for samples of cod which have come from unknown locations.

Most of the techniques we propose to use for fish traceability are currently used routinely in other areas of marine research. However, not all these techniques have been optimised for use with cod or over the span of waters surrounding the European Union. Therefore, the first objective for this project is to optimise Codtrace techniques for discriminating among cod stocks in the major marine basins of the EU (Atlantic Ocean (Irish shelf), Baltic Sea, Irish Sea, North Sea, Icelandic waters). Furthermore, all 10 techniques will be employed on the same fish, ensuring that results are not confounded by using different fish samples for each technique. While using the exact same fish samples across techniques is logistically more difficult to implement, it will ensure the results of this study are the most precise and accurate possible.

Specifically, we will optimise the determination of the location of spawning using the following techniques:

1. otolith core microchemistry;
2. otolith morphometry;
3. allozyme analysis of tissue;

4. mtDNA analysis of tissue;
5. microsatellite DNA analysis of tissue;
6. *Syp* I analysis of tissue;
7. fish parasite assemblages;
8. body morphometry.

The component parts of each of these Codtrace techniques (e.g. the number and type of morphometric measurements, primers, otolith element concentrations, etc.) need to be manipulated so each technique can discriminate among at least two locations of spawning in the major EU basins, ensuring every technique will usefully contribute to a multivariate analysis of spawning locations of cod.

The second objective of the project is to optimise Codtrace techniques to determine the specific basin of where a fish was harvested from among the five marine basins being examined. Specifically, we will optimise the determination of harvest location using the following techniques: fish parasite assemblages, fish bacterial assemblages, otolith surface microchemistry, body morphometry, otolith morphometry, allozyme analysis of tissue, mtDNA analysis of tissue, microsatellite DNA analysis of tissue, and *Syp* I analysis of tissue. The component parts of each of these Codtrace techniques (e.g. parasite species monitored, bacteria species monitored, otolith element concentrations, etc.) need to be manipulated so each technique can discriminate among at least two harvest locations for fish from the major EU basins, again ensuring each technique will usefully contribute to a multivariate analysis of cod harvest location.

As listed above, it is apparent that some techniques are expected to provide useful information on both the location of where a fish was spawned and where it was harvested, while other techniques will only benefit one analysis or the other. By examining both spawning location and harvest location in concert, the shared techniques do not have to be replicated in separate projects. This will result in a huge additional amount of information on cod movement and stock mixing being gained at a small additional cost, and both types of information will immediately be of use to fisheries management across the EU. Furthermore, we expect that such a broad multivariate analysis of individual fish will result in a uniform methodology which could be quickly transferred to the management of other commercially important fish species.

Multivariate statistical techniques will be used to determine the variance of the techniques and the power of correctly classifying each individual fish. After all samples have been processed, each technique will be tested separately to ensure that it has sufficient discrimination capacity to place some individual fish to their correct basin for location of spawning or of harvest. Multivariate statistics will be run to test the increased power of using the data of all Codtrace techniques in a factorial design, which will explore if any of the techniques used only provide redundant information to other techniques. We fully expect the use of multiple techniques in concert will greatly increase the statistical probability of correctly classifying the basin where an individual fish was spawned and where it was harvested.

The third objective of the project will be to determine if Codtrace techniques may be able to provide legally indisputable evidence for the location of spawning and harvest of unknown cod. To explore the possibility that Codtrace techniques might confer traceability on cod, we will (i) perform reciprocal transplants of eggs and larvae of cod among countries to determine the plasticity of the different techniques through the ontogeny of cod, and (ii) identify the spawning and harvest locations of unknown cod using a double-blind sampling design. These two tests will provide insight into both the potential power and limitations of Codtrace techniques.

We intend to make full use of the results of this study in both industry and in the EU community. Towards this end, we will initially and quickly patent results where possible.

We will then place our findings in a user-friendly format for potential end-users in the EU community (fisheries managers, seafood wholesalers, and others). This will first involve interacting with interested end-users throughout the study on a web site designed to attract comments, suggestions, and even implications of the study for use with fisheries management and consumer safety. Analytical and statistical results will then be synthesised with the EU common fisheries policy and law by a legal academic specialising in international natural resources law. A cost–benefit analysis will be performed on each Codtrace technique in isolation and in combination with every other technique. The conclusions from the project results and patents, the synthesis with EU law and the cost–benefit analysis will be presented at a dedicated ICES forum proximate to the end date of the project. By developing the necessary methodology and overall project using these guidelines, and presenting the results in an easily interpreted and open manner, our methods could then be quickly transferred to other targeted species in EU waters. We will use this project plan to ultimately meet our main goal: to establish legally indisputable evidence of the origin of cod.

EXPECTED RESULTS AND ACHIEVEMENTS

This project will develop a standard protocol to determine the origin of cod, through the optimisation of techniques for identification of the spawning and harvest locations of individual cod. This will include a determination of the statistical resolution of Codtrace techniques, in isolation and combined. The statistical resolution of techniques will be validated with double-blind testing of samples. We will be able to determine which characters identified as useful for traceability are inducible to alteration from their original patterns. The Codtrace results will be presented in a legal and user-friendly context at a dedicated forum.

**Improving fisheries monitoring through integrating passive
and active satellite-based technologies
IMPAST**

Contract number:	Q5RS-2001-02266	Coordinator	Robert Ringrose
Contract type:	Shared-cost project		QinetiQ Ltd
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Improving fisheries monitoring through integrating passive and active satellite-based technologies

BACKGROUND

Both in European and international waters, there is a need for control measures to ensure that agreed management measures are respected. Monitoring the fisheries, i.e. the operation of the fishing fleet, is an important aspect of fisheries control. Furthermore, to be effective, the information needs to be made available as soon as possible, preferably in real time, and the information must be compatible with systems presently used by fisheries authorities. Satellite surveillance systems have a potential for being coupled with existing vessel monitoring systems in a way that could significantly improve the efficiency of the fisheries control.

OBJECTIVES

The main objective of the project is to explore the possibilities of extending the existing capabilities in fisheries monitoring and control by integrating a passive system based on satellite imagery into a complete monitoring package. In particular, the project will develop, improve and assess methodology and tools that will allow near real-time access to space-borne synthetic aperture radar (SAR) imagery and integration and comparison of this information with the vessel monitoring system (VMS) position reports in order to improve and support control activities.

EXPECTED RESULTS AND ACHIEVEMENTS

Development of vessel detection and identification server. Development of an image database. Integrating active and passive system (extending FMCs' software to include, elaborate and visualise SAR detected positions, developing a decision support tool). Improvement of communication links. Development of an overall concept for fisheries monitoring. A workshop will be held at the end of the project in one of the fisheries monitoring centres (FMCs).

Development and testing of an objective mesh gauge OMEGA

Contract number: Q5CO-2002-01335
Contract type: Shared cost (combined research and demonstration project)
Starting date: 1.10.2002
Duration: 29 months
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Development and testing of an objective mesh gauge

BACKGROUND

The OMEGA project evolves from the need for an objective mesh gauge to be used for fisheries inspection and research and by the industry (fishermen and netting manufacturers). Previous work has shown that the present EU legislation for mesh measurement is not sufficiently precise and allows for variation in both the construction of the official wedge gauge and the operational procedures. It was recommended to develop a new, more objective mesh gauge. A new mesh gauge will be built and tested. The different tasks of the project are:

1. to build a prototype of the new instrument and to subject it to a series of acceptance tests;
2. to compare the new instrument with the existing mesh gauges, both under laboratory conditions and at sea;
3. to draft a protocol for using the new mesh gauge;
4. to inform research institutes, fisheries inspectorates and the industry on the progress of the work and to give them the opportunity to comment and advise.

OBJECTIVES

The main objective of the combined research and demonstration project is to build and test a new, objective mesh gauge suitable for fisheries inspection, fisheries research and the fishing industry. In support, a protocol will be written for using the new mesh gauge for control and scientific purposes.

The specific scientific and technological objectives of the project are:

1. to build prototypes of the new mesh gauge;
2. to refine the new design after initial testing;
3. to build sufficient prototypes for extensive testing and demonstration.

The specific demonstration objectives of the project are:

1. to compare the prototype with the existing mesh gauges and to determine the capabilities of the new instrument (laboratory tests);
2. to test the new gauge in the field;
3. to draft a protocol for using the new mesh gauge for control and scientific purposes;
4. to demonstrate the new mesh gauge to inspection services, fisheries scientists and the fishing industry (netting manufacturers and fishermen) of EU fishing nations, Iceland, Norway, Poland and EU contracting parties to the agreement (North-East Atlantic Fisheries Commission, North-West Atlantic Fisheries Organisation) with the aim of obtaining wide acceptance of the new instrument and protocol.

EXPECTED RESULTS AND ACHIEVEMENTS

The achievement of this project will be a new, modern mesh gauge capable of making measurements of the mesh opening unbiased by the operator. The new mesh gauge, used according to the protocol, will yield unambiguous mesh measurements, acceptable to European courts. The new instrument will be available at a reasonable price so that all users will be able to purchase it. Hence, the project will contribute to the aspiration for one single type of mesh gauge for all user groups. The new instrument will also meet the requirement of easy and technically modern data logging and processing.

Sub-area 4.4: Social and economic basis of the CFP

**Value of exclusion zones as a fisheries management tool in Europe:
a strategic evaluation and the development of an analytical framework
VALFEZ**

Contract number: QLK5-1999-01271
Contract type: Shared-cost project
Starting date: 1.1.2000
Duration:
24 months + 6 months' extension
Scientific Officer: Sigurdur Bogason
Project web site:
[www.port.ac.uk/departments/economics/
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Value of exclusion zones as a fisheries management tool in Europe: a strategic evaluation and the development of an analytical framework

BACKGROUND

Exclusion zones have a long history in Europe. However, the analysis of their potential and value for fisheries management is lacking, as is management advice. This project aimed to evaluate the ecological and socioeconomic value of exclusion zones as tools of fisheries management and develop robust multidisciplinary analytical frameworks and models for use in the evaluation and development of exclusion zones (utilising secondary data and the findings of research to date). The modelling frameworks were multidisciplinary (bioecological, socioeconomic and institutional), with space-structured, multispecies, multifleet and intertemporal bioeconomic components at their core. Also, as far as the data and modelling frameworks permitted, the sensitivity of value and the model(s) developed to data uncertainty was evaluated, thereby highlighting future research needs to optimise the returns to fisheries management.

OBJECTIVES

1. To strategically evaluate the ecological and socioeconomic value of exclusion zones as tools of fisheries management, including to:
 - evaluate global current and past initiatives and identify typologies of European exclusion zones, their common attributes and distinguishing features and performance;
 - elicit the ecological and socioeconomic value of European exclusion zones by type and case study;
 - evaluate the potential for wider application within European fisheries management;
 - clarify the criteria required for their evaluation and development.
2. To develop robust multidisciplinary analytical framework(s) and model(s) for use in the evaluation and development of exclusion zones, which use readily available secondary data and the findings of research to date.
3. To prioritise future research needs via the development of an analytical approach to test the sensitivity of value and the model(s) developed to data uncertainty.

EXPECTED RESULTS AND ACHIEVEMENTS

1. Provision of baseline knowledge for modelling.
2. Collation of data sets and estimation of functional relationships and indicators for use in the modelling process.
3. Completion of model(s) and user guide.
4. Value estimates against multiple objectives and comparisons of alternative management strategies.
5. Sensitivity of models to data uncertainty and prioritising of research needs.

**Multiple objectives in the management of EU fisheries
MOFISH**

Contract number: QLK5-1999-01273
Contract type: Shared-cost project
Starting date: 1.2.2000
Duration: 36 months
Scientific Officer:
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Multiple objectives in the management of EU fisheries

BACKGROUND

The common fisheries policy embodies multiple objectives (biological, economic and social) in its aims for the management of fisheries in EU waters. However, there has been significant criticism of the CFP concerning its effectiveness to these aims. The main reason for this is that important sectors of the industry feel that their best interests are not being taken account of when management policy is being defined. This project analyses the objective structure throughout EU fisheries, from the perspectives of all key players: managers, politicians, fishermen, researchers and other interest groups. Objectives' preferences and opinions from these groups are to be elicited. Multi-objective models will be developed and analysed to consider existing and future management goals for several case studies: English Channel, North Sea and Spanish fisheries. The project is multidisciplinary drawing on expertise from economics, mathematics, computer science and fisheries.

OBJECTIVES

1. To develop a multi-objective framework for analysis of fisheries management in line with the aims of the CFP.
2. To define the objectives and criteria intrinsic to the fisheries management process and CFP, as well as other attributes and goals.
3. To elicit preferences of the different interest groups with significant interests in the EU fisheries management process.
4. To develop several case studies of EU fisheries (English Channel, North Sea and Spanish fisheries) to model the defined objectives and attributes using the elicited preferences.
5. To analyse the results and trade-offs between the multi-objectives for all case studies to investigate the main question of how an optimally managed fishery would look from the perspectives of the groups individually, by country and EU wide.

EXPECTED RESULTS AND ACHIEVEMENTS

This project has considered multiple objectives in detail, analysing the effectiveness of multi-objective methodology for the analysis of fisheries management plans from the perspectives of a range of groups with differing aims and concerns from management. Several real-world case study fisheries from around Europe reflecting the diversity have been analysed. This project has considered methodology not previously applied in such detail to European sea fisheries. The results have shown that there is considerable scope for their use in future fisheries management.

**Margins along the European seafood value chain —
Impact of the salmon industry on market structures
SALMAR**

Contract number: QLK5-1999-01346
Contract type: Shared-cost project
Starting date: 1.1.2000
Duration: 36 months
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Margins along the European seafood value chain — Impact of the salmon industry on market structures

BACKGROUND

The basic issue of the project is to look at the economic impact of salmon farming on the European seafood value chain. While imports and aquaculture are often considered by their harmful effects on the European fishing industry, it is expected that the development of fish farming and increased imports may have been job creating and value adding at the overall economic level of the seafood value chain (processing, trade companies, wholesaling, retailing, etc.), resulting in implications for the implementation of the common fisheries policy. This hypothesis will be analysed with various quantitative (time series analysis, industrial organisation models, system dynamics) and qualitative (survey) methods.

OBJECTIVES

The substantial technological progress of salmon and trout aquaculture in some European countries has deeply modified the seafood value chain on the European fish markets. Important foreign trade flows have been created between major supplying countries and processing/consuming countries, partly harming the domestic producers of substitutable products, and partly creating new jobs and wealth in Europe.

The main objective of the project is to understand the dynamics of the seafood value chain over the last 20 years in Europe in order to assess the value added and its distribution between countries and stakeholders: What has been the value added by the recent evolution of the farmed fish and increased imports and what have been the effects on the organisation of the seafood value chain in some European countries?

EXPECTED RESULTS AND ACHIEVEMENTS

1. Completion of a time series database on prices of fish products at different stages of the value chain.
2. Analysis of prices and margins for various seafood marketing chains through very recent cointegration models, system dynamics, structural models and survey techniques.
3. Implications of the ongoing structural changes for the common fisheries policy.

**Fishery regulation and the economic responses of fishermen:
perceptions and compliance
FISHREG**

Contract number: QLK5-1999-01405
Contract type: Shared-cost project
Starting date: 1.4.2000
Duration: 38 months
Scientific Officer: Sigurdur Bogason
Project web site:
[www.pbs.port.ac.uk/econ/cemare/
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Fishery regulation and the economic responses of fishermen: perceptions and compliance

BACKGROUND

Most fisheries are subject to regulation to a greater or lesser extent, and in many fisheries (including most European fisheries) regulation forms the primary means of controlling levels of resource exploitation. Examples of such regulation would include imposed limits on landings or on fishing time. Other types of regulation are designed to modify patterns of exploitation for biological or social reasons (e.g. conflict resolution). Compliance is necessary in order that regulations achieve their intended objectives. It is therefore important that regulations are designed and implemented in such a way that acceptable levels of compliance are ensured. In most cases, policy-makers and regulatory authorities focus only on the quantity and quality of external enforcement as the key to achieving regulatory compliance, but enforcement is costly. To the extent that regulations can be self-enforcing (i.e. that there is 'voluntary' compliance), the process of fishery management will be more efficient as a result. A better understanding of the factors which will tend to produce self-enforcement has the potential for improving the design and implementation of regulations and hence improving the efficiency of the management process.

OBJECTIVES

The central aim of this project is to develop a better understanding of the way in which fishermen respond to regulations. This includes their knowledge of the regulations which apply to them, their perceptions of the economic implications of regulations, normative and other psychic responses to regulations (such as judgments about the rightness of compliance and the perceived legitimacy of the regulations and of the regulatory authority), their perceptions of the attitudes of fellow fishermen to the regulations, and how all these factors affect their behaviour, in particular their compliance with regulations.

The detailed objectives are:

1. to develop a methodology to characterise and investigate the regulatory environment of a fishery from the fishermen's perspective;
2. using this methodology, to investigate the regulatory environment of six case study fisheries (three in the Atlantic/Channel and three in the Mediterranean);
3. to analyse the results of the case studies in order to derive empirical relationships between types of regulation, their mode of implementation and the recorded perceptions and responses of fishermen;
4. to undertake a comparative analysis of the results.

EXPECTED RESULTS AND ACHIEVEMENTS

The project will seek to draw conclusions about the importance of various factors in determining regulatory compliance. It is hoped that the results will inform policy-makers and regulatory authorities of ways in which regulations could be better designed and implemented in order to improve levels of self-enforcement in the fishery.

**Economic assessment of European fisheries
EAEP**

Contract number:	Q5CA-2001-01502	Coordinator	Erik Buisman
Contract type:	Concerted action		LEI
Starting date:	1.1.2002		PO Box 29703
Duration:	36 months		Burgemeester Patijnlaan 19
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Economic assessment of European fisheries

BACKGROUND

The project FAIR-CT97-3541 has established procedures for the compilation of existing economic data regarding the performance of specific fishing fleets. The most recent report, the 1999 report, was published by the European Commission in September 2000 (ISBN 92-828-9600-5). The proposed project primarily aims to continue and expand the work which has been initiated.

The project will compile economic information on fishing fleets of all coastal EU Member States, Norway, Iceland, Poland and the Baltic republics. This information will be standardised in terms of definitions, storage in a database and presentation for users. It will be used for the preparation of an annual economic report (AER), economic interpretation of Advisory Committee for Fisheries Management (ACFM) advice (EIAA), and the creation of a database to facilitate further use of the available data. Work consists primarily of compilation of existing data from national and local sources, preparation of accompanying analysis and participation in meetings where reports will be completed and discussed.

The project contains major innovations. A more complete coverage of European fisheries will be pursued by adding new segments in countries already covered and by the inclusion of the fisheries of Poland and the Baltic republics. The compiled data will be organised in a new database. More stress will be put on the analysis of the data and development of applications. Statistical reliability will be assessed. Estimations will be developed to evaluate the performance of fleets for which data are lacking and to check the reliability of various results. The EIAA model will be further tested and developed.

OBJECTIVES

The general objectives are to integrate and analyse the economic information available on European fisheries and to develop analytical tools in order to contribute to effective fisheries management.

The specific objectives are as follows:

1. An annual economic report (AER) on economic performance of selected fleet segments will be elaborated and submitted to the Scientific, Technical and Economic Committee for Fisheries (STECF) for review:
 - continue reporting established by FAIR-CT97-3541;
 - expand to new fleet segments;
 - develop methods for economic analysis of EU-wide fisheries;
 - cover entire Baltic area.
2. Annual economic interpretation of the ACFM advice (EIAA) will be prepared and submitted to the STECF for review:
 - continue reporting established by FAIR-CT97-3541;
 - expand to new fleet segments;
 - improve forecasting methods.
3. Establish a database to organise, store and retrieve economic data on European fisheries.

EXPECTED RESULTS AND ACHIEVEMENTS

The project will produce two clearly identifiable results in a strict time frame. In three years, the AER and EIAA reports will be produced annually and submitted to the STECF for review in November. The reports will be disseminated widely in hard copy and electronically.

A secondary milestone will occur in the June meeting of the project, when the database and other miscellaneous topics will be discussed. Priorities set by the project in relation to the newly identified issues will also be presented to the STECF.

**Bioeconomic modelling of Mediterranean fisheries
BEMMFISH**

Contract number: Q5RS-2001-01533
Contract type: Shared-cost project
Starting date: 1.11.2001
Duration: 36 months
Scientific Officer: Sigurdur Bogason
Project web site: www.bemmfish.net

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Bioeconomic modelling of Mediterranean fisheries

BACKGROUND

The purpose is to develop a bioeconomic model for Mediterranean fisheries and the realisation of simulation computer software allowing the testing of different management strategies. The work will be divided into the following areas: development of a theoretical background and building the conceptual model; development of the numerical model; elaboration of simulation computer software; validation of the model through case studies and dissemination. This project is expected to contribute both in practical and theoretical ways to the understanding of the functioning of Mediterranean fisheries and their management. The project integrates fisheries economists, fisheries biologists and computer scientists. A paramount aspect of this project is the exploration of new mathematical approaches, and their application to the modelling of Mediterranean fisheries. This will be ensured by bringing together specialists in different fields of applied mathematics.

OBJECTIVES

The objective of the research is to develop a theoretical bioeconomic model for Mediterranean and Mediterranean-type fisheries, and a practical computer simulation model addressed to the management of these fisheries. This model and software should be sufficiently general and flexible to accommodate easily the realities of most Mediterranean fisheries, and include multiple species and their interactions, multiple fleets and gear types, and all fisheries management tools currently used by Mediterranean fisheries managers. It should produce a wide range of fisheries performance measures, be dynamic, i.e. capable of simulating the fisheries over a long period of time, be stochastic to incorporate uncertainty in data and models, and run on the Windows platform.

EXPECTED RESULTS AND ACHIEVEMENTS

The following practical and theoretical results are expected:

1. a ready-to-use software package for distribution among managers, fishermen and scientists;
2. a contribution to strengthening the scientific basis of the common fisheries policy and its application to the Mediterranean;
3. the establishment of a sound theoretical framework for the bioeconomic analysis of Mediterranean fisheries.

**Modelling fishermen's behaviour under new regulatory regimes
MFBUNRR**

Contract number:	Q5RS-2001-01535	Coordinator	Frank Asche
Contract type:	Shared-cost project		Foundation for Research in Economics and Business Administration
Starting date:	1.1.2002		Centre for Fisheries Economics
Duration:	30 months		Helleveien 30
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Modelling fishermen's behaviour under new regulatory regimes

BACKGROUND

Fishermen's behaviour under regulatory systems based on individual vessel quotas (IVQs) has not been specifically modelled. This is important because the fishermen's incentives under these management systems are different from those under traditional management systems. In particular, under these systems, quantity landed is not a choice variable for the fishermen. A cost function rather than a profit function approach should therefore be used. However, a number of measures of fishermen's behaviour have been developed in relation to profit functions. The project will derive similar measures in a cost function context. The approach will be used empirically to analyse and compare British, Danish, Icelandic, Norwegian and Swedish fisheries where IVQs, both transferable and non-transferable, have been implemented.

OBJECTIVES

The main objective of this project is to provide models for empirical specification of fishermen's behaviour under regulatory systems based on individual vessel quotas (IVQs). The objective will be attained by employing a stepwise process consisting of:

1. reviewing the use of profit functions to describe fishermen's behaviour, and focusing particularly on measures for rent collection, fleet size and overcapacity;
2. data collection;
3. investigating cost functions as a tool to describe fishermen's behaviour, as well as measures unique to cost functions;
4. the choice of functional form, which is necessary before the empirical analysis, since the choice of functional form is essential for which measures we can derive analytically and therefore which functional forms should be used in the empirical analysis;
5. empirical analysis undertaken by each of the partners using the methods developed earlier;
6. results from the empirical analysis which will then be compared with a focus on how well different versions of IVQ systems perform with respect to different economic measures. In this context, it is of particular interest whether or not transferability of the quotas seems to make a difference. The results from all the work packages will then be combined in the final report.

EXPECTED RESULTS AND ACHIEVEMENTS

The first output from the project is a review of the economic approaches to empirically model fishermen's behaviour under traditional management regimes. Since individual quota systems, independently of whether the quotas are transferable, fundamentally change fishermen's incentives, this needs to be reflected in the empirical specification. We show that a cost function approach is the appropriate specification when the fishery is managed with individual quotas. We then derive measures from this cost function of actual rents generated in the fishery, potential rents and how much capacity must be reduced to generate these rents, and also discuss features of different functional forms when obtaining these measures. In many fisheries, some species are regulated by individual quotas, while others are under a traditional management regime. We show how fishermen's behaviour in such cases can be modelled with a restricted profit function where some, but not all, outputs are treated as fixed.

Empirical analysis is being carried out for fisheries in Denmark, Iceland, Norway, Sweden and the UK. All fisheries are operating under a form of individual quota scheme. However, the transferability varies from full in Iceland to very limited or zero in Denmark and

Sweden. The empirical results will then allow us to determine how large the potential rents are, how much of these rents are captured under the current regulations, and how much the fleet must be reduced to capture all rents. By comparing the results from the different countries, we will also derive information with respect to how important the changed incentives are relative to the capacity reduction in individual quota schemes for the rent generation and, therefore, the profitability of the fisheries.

**Élaboration et application d'un modèle calculable d'équilibre général à
l'analyse de la contribution des activités halieutiques
au développement régional
PECHDEV**

Contract number: Q5RS-2001-02277
Contract type: Shared-cost project
Starting date: 1.2.2002
Duration: 36 months
Scientific Officer: Sigurdur Bogason
Project web site: Under development

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Élaboration et application d'un modèle calculable d'équilibre général à l'analyse de la contribution des activités halieutiques au développement régional

BACKGROUND

The principal objective of this project is to develop new tools and models to assess the contribution of fisheries and aquaculture activities to the development of coastal areas, and the degree of interrelationships which maritime activities maintain with components of other economic sectors in the same area. The exercise has a wider scope in that it can facilitate the decision process at the level of public policy-makers and the firm. It will provide tools and models as decision-making aids (and, in particular, in taking the appropriate decisions with respect to the structural measures relating to the fishing sector).

OBJECTIVES

The Programme is organised in six work modules, each sanctioned by the delivery of a product marking a step in the model development to evaluate the contribution of aquaculture and fisheries to coastal area development and their interaction with other sectors of the regional economy. The main thread throughout is to improve existing tools, and to develop new techniques which can account for interactions between economic, environmental and social factors. The measurable objectives of the project can be summarised as follows:

1. To develop an in-depth debate on the objectives of models measuring regional effects (particularly the I/O model) and their capacity to take account of the reality of economic development effects and of the interrelations between activities.
2. To construct, on the basis of the conclusions drawn from the first phase, a model which comes closer to reality and is hence more efficient. The computable general equilibrium model (CGEM) in this respect is the model now offering the greatest potential for application to the domains of regional economy.
3. To calibrate and apply the CGEM to five European regions (level NUTS 3) selected as case studies and studied in detail during the last socioeconomic study (1999).
4. To validate the model and to define the prospects for its generic utilisation.
5. To make the model accessible to public decision-makers, at both European Community and national or regional levels.

EXPECTED RESULTS AND ACHIEVEMENTS

1. A computable general equilibrium model (CGEM) applied to assess the regional contribution of fisheries and aquaculture. The CGEM will be articulated around three main components: economy, ecology and biology. By merging three different models into one, it will be possible to consider how ecosystem changes (spatial and temporal variations) affect the functioning of fishing activities and therefore the regional economy. On the other hand, the CGEM will allow us to show how fishing activities affect the marine ecosystems. Overall, the CGEM will be very useful to understand the relationships between human activities and the marine environment.
2. A multidisciplinary method to assess the contribution of fisheries to regional development. By bringing together scientists from ecology, economy and biology, the Pechdev project will benefit from expertise in different scientific disciplines that are not usually associated. Throughout the project, the multidisciplinary team will develop an approach to put together different scientific knowledge and competences.

**Technical developments and tactical adaptations
of important EU fleets
TECTAC**

Contract number:	Q5RS-2002-01291	Coordinator	Paul Marchal
Contract type:	Shared-cost project		Institut Français de Recherche pour l'Exploitation de la Mer
Starting date:	11.9.2002		BP 699
Duration:	36 months		150, quai Gambetta
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Technical developments and tactical adaptations of important EU fleets

BACKGROUND

The fish stocks managed under the European common fisheries policy are considered to be in danger because of excessive fishing mortalities. A common concern of fisheries managers is to be able to reconcile the objectives of maintaining fisheries profits whilst safeguarding the fish resources, especially when these are exploited beyond biological safe limits. In EU waters, the management of fisheries and fish resources has been adversely altered by the lack of consensus on management targets and strategies, and also the poor understanding of the links between management tools, fleet developments and the pressure exerted on fishing communities. The carrying idea is the investigation of the dynamics of the elements that cause changes in fleet dynamics: the technological advances in both gear and vessel equipment, and also the overall tactical adaptation of fishing vessels. How do they occur? Why do they occur? What are their consequences on the resource and their socioeconomics?

OBJECTIVES

The overall objective of this project is to address the poor understanding of the links between management tools, fleet developments and the pressure exerted on fishing communities, and more precisely to supply fisheries managers with a modelling tool that will allow them to evaluate the impact of regulations (TACs, multiannual guidance plans (MAGPs), area and season closures, subsidies) on the dynamics of fleets and fishing mortality. Examples will be drawn from a wide selection of demersal fleets operating in the Baltic Sea, the North Sea, the eastern Channel, the Celtic Sea and the Bay of Biscay.

To identify, analyse and model the fundamental elements underlying fleet dynamics.

Commercial fishermen continuously adapt their activities to the prevailing conditions by changing the physical inputs of production (technological development) and the way these inputs are used to harvest target species (tactical adaptation). It is generally perceived that the efficiency of fishing vessels has increased over the last decades, as a result of changes in both technology and tactical adaptations. Quantifying the importance of fishermen's reactions relies on the ability to define appropriate standardised effort measures, which depends on the data available on fishing effort. Fishing effort is traditionally estimated by combining available physical measurements of fishing capacity (fixed production inputs) and of fishing activity (variable production inputs). Fishing capacity is frequently approached (also within MAGPs) by some physical attribute of the operating vessel (engine power, gross tonnage) but is also dependent on other factors, including gear technology and equipment onboard, which are generally ignored. The introduction of new gear and technology includes both larger marked technological investments (e.g. acoustic fish-finding equipment, electronic navigation tools) and smaller stepwise improvements of the gear (e.g. stronger netting material, changes in the design of trawl panels), which themselves do not result in marked changes of a vessel's capacity, but in conjunction give a noticeable capacity increase over time. Fishing activity is typically estimated by the duration of fishing trips ignoring developments that have increased the amount of gear deployed or the effective time used for fishing. In addition, data are typically aggregated over geographical units that may encompass several fishing grounds and depths that may include heterogeneous species compositions, implying that the current window of observation of effort data is only partially informative with regard to the tactical adaptation of the fishing fleets.

EXPECTED RESULTS AND ACHIEVEMENTS

The expected achievements of Tectac will be:

1. to collect information on technological development (e.g. gear, materials, electronics) and to assess their importance for the catching efficiency of the fleets.

2. to collect information on fleet activity changes (including within trip information on timing and positioning of individual operations) and to assess their importance;
3. to collect retrospective information on regulatory orders, fish prices, operating costs, and fish density;
4. to identify major patterns and trends in the important fleet utilisation of the resource base;
5. to model catch rates relative to stock abundance;
6. to estimate the contribution of external factors (management, socioeconomics, stock abundance) to fleet dynamics;
7. to model variations in fishing effort through the technical development and the tactical adaptation of fishing fleets in relation to management regulations;
8. to model the relationship between fleet dynamics, fishing mortality and fisheries profits;
9. to model the impact of management regulations on fishing mortality, fleet dynamics and fisheries profits.

**Les femmes dans la pêche et les cultures marines en Europe
FEMMES**

Contract number: Q5TN-2002-01560
Contract type: Thematic network project
Starting date: 1.10.2003
Duration: 36 months
Scientific Officer: Sigurdur Bogason
Project web site: www.fishwomen.org

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Les femmes dans la pêche et les cultures marines en Europe

BACKGROUND

The production of seafood products in all European coastal areas is dominated by family, artisanal-based organisation. Although the role of women is significant in this type of organisation of production, most of the time it remains unrecognised. In the 1990s, women's organisations and movements increased considerably in the fishing sector and throughout the seafood industry in Europe. The crisis that occurred at the beginning of that decade was a major event related to this development, starting from a certain number of previous initiatives. Actually, being involved in either local or national actions, fisherwomen appeared in the public debate. In a few places, they have succeeded in bringing to the highest political levels claims for the recognition of their role in production activity and have even played a major part in giving birth to significant juridical innovations. They focused upon diverse issues such as security at sea and training, and now affirm their place in functions of representation. In this sector, basically led by men, such a movement livens up many established facts and schemes. Concurrently, research in the social sciences, in the field of women's issues, remains very limited, far below what has already been done in many other fields of activity. Besides, the numerous organisations act independently, with very few relations between one another, resulting in a poor mutual awareness of the work that can be initiated and completed by a given women's organisation. This situation can be explained in Europe as the result of cultural, linguistic, and financial reasons.

OBJECTIVES

1. To establish links between social science researchers working in the field of fisheries and aquaculture, the women involved in this sector, and the representative structures of women's organisations such as social institutions and administrative and training institutions.
2. To make an inventory of the initiatives already existing in this field in Europe, concerning fisherwomen's organisations and research actions, and to provide a 'place for exchanges and reflections' at the European level.
3. To provide a preliminary opportunity to create a network of relationships between the fisherwomen's organisations at the European level and make initial contacts with similar networks in other sectors of activity.
4. To promote within the field of social sciences the theme of research about women in fisheries from this study, and through the identification of research themes to be developed.
5. To make a preliminary assessment, in the form of discussion workshops between researchers and actors, of the role of women in this sector, and ensure the communication and dissemination of information, including the popularisation of scientific research work.

The thematic network activity will be concentrated on fisherwomen's movements, and notably fisherwomen's associations, in order to encourage the exchanges of experiences at the EU level. In the network, researchers will be deeply involved in the debate through scientific contributions to the debates and through the transmission of knowledge. The presence of representatives of administration or training institutions must contribute to the enhancement of the whole debate by allowing direct exchanges with the institutions that women often have to contact. The network must play a specific role consisting in conducting the debate and, in parallel, favouring the development of research about women in the fishing industry.

Four workshops will be organised between scientists, fisherwomen and administration dealing with the role of women and private space (enterprise and legal status) and women in public space ('constructing and conducting women's organisations', and 'women within collective action').

EXPECTED RESULTS AND ACHIEVEMENTS

1. Produce a register of fisherwomen's organisations in Europe.
2. Create the basis for the foundation of a European fisherwomen's network.
3. Transfer of scientific knowledge to fisherwomen (through the popularisation task).

Two documents will be addressed to decision-makers:

1. Agenda for research on fisherwomen: definition of research themes dealing with fisherwomen in order to develop research on this issue. It will be addressed to the people in charge of the definition of research policies (EU or national research centres).
2. Agenda for women's action: participation of fisherwomen in the definition and in the implementation of policies in the fields of fisheries and aquaculture. Support of training and recognition of women's organisations. It will be addressed to decision-makers (MPs, senators, ministers and other local, national or European personalities, etc.).

SUPPORT FOR RESEARCH INFRASTRUCTURES



Q5RS-2002-01603 'Survival'

Area 5: Facilities for aquaculture and fishing research

**Development of a network to support an open access, online,
fish technology knowledge base
FISH-TECH-DB**

Contract number: QLRI-CT-2000-00216
Contract type: Shared-cost project
Starting date: 1.4.2001
Duration: 24 months
Scientific Officer: Bernard Mulligan
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Development of a network to support an open access, online, fish technology knowledge base

BACKGROUND

The primary aim of the project is to enhance the knowledge infrastructure for fish-processing technology and related areas, thereby enabling more effective development of R & D, application of technology, and better quality and safety in this area for the European Union and associated States. This will be achieved within a web-based, knowledge management system known as oneFish. A future objective, but beyond the scope of this project, will be to establish a global network on fish technology through the efforts of the Fisheries Department of the Food and Agriculture Organisation (FAO).

OBJECTIVES

The main objectives are:

1. to improve the knowledge base and enhance the information infrastructure for the area of post-harvest fisheries technology and utilisation;
2. to facilitate effective development of R & D, application of technology, and better quality and safety in this area for the European Union and associated States.

This will be achieved by developing:

1. a cooperative network of experts and user centres to input information into an online, open access, fish technology database, searchable by keywords and with multiple linkages and cross-referenced; this will be nested in the new open knowledge directory oneFish on the Internet being developed by the FAO for the fisheries research and development community;
2. a fish technology discussion forum within the oneFish platform to facilitate online discussion, develop ideas, identify contacts, source information, initiate new linkages and access mailing lists.

Once the network and the forum are established, the user centres will support the input of information and its quality assurance. The FAO will continue to host and maintain the system on behalf of the network.

EXPECTED RESULTS AND ACHIEVEMENTS

OneFish is being developed as an open access, web-based knowledge management system produced by the Food and Agriculture Organisation of the United Nations (FAO, participant No 2), and will serve the whole area of fisheries and aquatic sciences.

More specifically, the following results are expected from the project:

1. collection of data on fish-processing technology;
2. a prototype electronic knowledge base, including a discussion forum;
3. the knowledge base populated with data and compatible with the oneFish portal;
4. the knowledge base tested and bugs removed;
5. the knowledge base operating with the oneFish portal;
6. network enlarged and supporting the knowledge base on a long-term basis.

**European network supporting infrastructures
for arctic charr culture and conservation
CHARNET**

Contract number: QLRI-CT-2001-00007
Contract type: Thematic network project
Starting date: 1.3.2002
Duration: 36 months
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European network supporting infrastructures for arctic charr culture and conservation

BACKGROUND

The global aim of the project is to promote the creation of a unique network of research infrastructures involving arctic charr in Europe. The network will include academic and commercial research infrastructures, together with potential users and conservation interests. The network will operate at international level, with national gateways, and will include a strong Internet presence. It will lead to the production of a manual of protocols and best practice within such infrastructures at a European level. The project will also stimulate more access by researchers to the infrastructures.

OBJECTIVES

1. to form a network of major centres of infrastructure currently working with arctic charr. This will be achieved by planned meetings, in person, of key workers, by electronic communication and by a shared Internet web site including local web pages.
2. to inform and include a wider network of interested parties. Each network partner will operate its own sub-network with associated members. These members include SMEs with commercial interests in arctic charr aquaculture and those which hope to service such companies — such as feed providers. Other members represent conservation or game preservation interests.
3. to encourage greater cooperation and complementarity between infrastructure holders. Each partner will undertake a visit to one other partner for one week in each of the three years of the project. This, together with an annual meeting of all participants, will encourage cooperation.
4. to identify, prioritise, and standardise protocols and best practice at a European level. Standardisation of protocols and best practice will encourage consistency and quality in the operations of the existing infrastructures.
5. to encourage wider access for researchers to the infrastructures and to encourage wider links for the dissemination of knowledge.
6. to encourage effective and Europe-wide innovative research and development of arctic charr utilising the infrastructures and centres of expertise.
7. to manage and make effective evaluation of the project during its 36-month duration.
8. to report and disseminate information.

EXPECTED RESULTS AND ACHIEVEMENTS

1. Fully operational and active web site of high profile on search engines and directories.
2. Central database secured between partners.
3. Heightened national/local awareness of the value of the research infrastructure for arctic charr development.
4. Manual standardising protocols and best practice throughout the infrastructure of all participants.
5. Full programme of visits between contractor participants.

**Database trawl surveys
DATRAS**

Contract number: QLRI-CT-2001-00025	Coordinator
Contract type: Concerted action and thematic network project	G. J. Piet
Starting date: 1.12.2001	Netherlands Institute for Fisheries Research
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Database trawl surveys

BACKGROUND

As part of the assessment of the status of the fish stocks in the North Sea, Baltic Sea and western European waters (i.e. Celtic Sea, Bay of Biscay and eastern Atlantic from the Shetlands to Gibraltar), fisheries institutes of the bordering countries have for many years carried out research vessel surveys to estimate the recruitment of the youngest age groups of a number of commercial fish species. Besides information on commercial species, information on the length compositions of all other fish species in the catch was also collected on a routine basis. Therefore, the data collected during these surveys are not only relevant for the management of commercially important fish stocks but also provide a valuable source of information for studies into the spatial and temporal variation in the fish community, biodiversity or the status of the ecosystem.

Although initially these surveys were coordinated at the national level, over the years a number of these trawl surveys have evolved into standardised international research programmes, most often coordinated by the International Council for the Exploration of the Sea (ICES). At present, three major international trawl surveys can be distinguished: the international bottom trawl survey (IBTS), the Baltic international trawl survey (BITS) and the beam trawl survey (BTS).

OBJECTIVES

The main objectives of the project are as follows:

1. To establish an international database of trawl survey data at the ICES headquarters including:
 - IBTS North Sea, Skagerrak, Kattegat: first quarter of 1965 to present, other quarters (1991 to present);
 - IBTS western and southern divisions;
 - BTS North Sea, Channel and Irish Sea: third quarter of 1985 to present;
 - BITS Baltic Sea: 1990 to present.

The database should be updated annually; formats of the database and exchange files should follow the concepts developed by the IBTS and BITS databases.

2. To standardise input and quality assurance of the survey data through:
 - expansion of the survey manual and further standardisation of procedures among participants;
 - availability of species identification sheets and agreement on nomenclature and level of identification;
 - definition of the data quality checks required prior to incorporation of data into the database;
 - development of software for quality control;
 - agreement on exchange format and work plan for loading data onto the database.

The standardisation should not only be pursued within each survey among participating laboratories but also between surveys.

3. To improve access to the survey data through:
 - a user's guide containing a description of the content of the database;
 - development of standardised data extractions depending on user-specific demands;

- availability on the web of aggregated data, standard tables and figures that are annually updated;
- web facilities that allow access through the same database front-end.

EXPECTED RESULTS AND ACHIEVEMENTS

This project will result in a comprehensive database of the major international trawl surveys that is annually updated. The database will contain data from three surveys, covering the Baltic Sea, Skagerrak, Kattegat, North Sea, Channel, Celtic Sea, Irish Sea, Bay of Biscay and the eastern Atlantic from the Shetlands to Gibraltar and span a period of up to 35 years. The quality of the data will be assured through quality checks by both the national laboratories which collected the data and ICES according to a protocol that will be developed. The procedures for collection and registration of the data will be standardised as much as possible, not only among participants within a particular survey but also between surveys. Data quality will be assured through the development of a protocol and software routines. Manuals for the respective surveys will be expanded and updated. Access to the data will be accomplished through web facilities including standardised data extractions and availability of aggregated data, standard tables and figures.

**Genetic catalogue, biological reference collections
and online database of European marine fishes
FISHTRACE**

Contract number: QLRI-CT-2002-02755
Contract type: Thematic network project
Starting date: 1.1.2003
Duration: 36 months
Scientific Officer: Bernard Mulligan
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Genetic catalogue, biological reference collections and online database of European marine fishes

BACKGROUND

The generation of biological data is costly and time consuming. Nevertheless, it is not clear how non-standardised data of fish genetics can be well employed for fisheries or food research in applied or basic science. Consequently, there is a requirement to promote common protocols, to interconnect expertise and to stimulate interoperability between complementary resources with the aim of generating an accessible database to researchers and control laboratories with standardised data of European marine fishes.

OBJECTIVES

The main aim of this thematic network is to catalyse the cooperation and pooling of material and data corresponding to the genetic identification and characterisation of around 180 European marine fish species to guarantee the source and authenticity of fish products. Expected results in the form of information and technology will directly focus on the safety of raw materials derived from fish and their traceability throughout the food chain and assist public policy decisions to enforce common policies in the fields of ecology, fisheries and food safety and labelling. Further applications of the results are related to the economic activities of the European fish market.

The general objectives of the project are:

1. to draw up a genetic catalogue of a large, representative number of marine fish species regularly commercialised in the European markets. The catalogue will include gene characterisation as a molecular marker related to morphological data as indisputable evidence for the origin of the fish and fish products;
2. to pool reference biological materials (including DNA and tissue samples) and to promote their use for standardisation and cross-referencing with respect to fish traceability through European markets;
3. to establish a public accessible database compiling the new standardised data generated in the network (taxonomy, molecular genetics and reference collections) with existing data from other sources;
4. to validate the information compiled in the database to ascertain its applicability for end-users, including biological research laboratories, control laboratories, consumers and regulatory bodies by the *de novo* designing and developing of cost-effective methodologies for the analysis, characterisation and commercial diagnosis of marine fish species with regard to fisheries and fish products;
5. to use the knowledge and technology gained in this network to lend support to European policies and to enforce these and national policies regarding fishery stocks, food traceability and environmental protection.

All these objectives are focused to achieve a critical mass of materials and human resources by interaction of partners belonging to different fields of knowledge, i.e. field taxonomists, natural history museums, molecular biology laboratories and software and database managing experts, in order to compile all necessary data for the obtaining of the expected results in a multidisciplinary approach, and to grant the long-term preservation and maintenance of the pooled data.

EXPECTED RESULTS AND ACHIEVEMENTS

The multidisciplinary nature of this proposal includes specific aspects of research and technological development in a well-defined innovative networking context designed to yield a high output of transferable results. The expected achievements include the maintenance of an online database with standardised molecular data for speeding up policies and administrative resources to fulfil public demands for regulation of the minimal ecological impact of fisheries in marine ecosystems and for certified food products. The results will serve to provide European fish products with authenticity labels (green labels) increasing their economic value and offering a guarantee of their origin and biological authenticity. Effective quality control systems will also be favoured for fish and derived products consumed in the EU, addressing consumer needs regarding food safety, food quality and low environmental impact. Furthermore, the expected results will improve the competitiveness of the European food industry and fisheries.

The resulting capacity for quick and sensitive technology to establish the traceability of fish species and their products will assist in the identification of food products from non-certified sources (within and outside the EU) thus avoiding the spread of undesirable attributes (e.g. contaminated foodstuffs) in food networks.

**Fish aggregating devices as instrumented observatories
of pelagic ecosystems
FADIO**

Contract number: QLRI-CT-2002-02773	Coordinator
Contract type: Shared-cost project	Laurent Dagorn
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Fish aggregating devices as instrumented observatories of pelagic ecosystems

BACKGROUND

Tropical pelagic species are known to aggregate around floating objects. The objective of this project is to define specifications and develop prototypes of (i) autonomous buoys equipped with 360° sonars to observe aggregations, data loggers to detect individuals carrying electronic tags and satellite uplinks for both, (ii) new electronic tags with ecological sensors. Also, a model of aggregation processes will be developed for interpreting data collected by currently available down-looking sonars mounted on buoys. Various field experiments will be conducted to assist in the development of specifications for the autonomous sonars. The new instrumented buoys will become observatories of pelagic ecosystems. They will reduce the dependence on research vessels and represent a major advance in fisheries research and the study of pelagic organisms.

OBJECTIVES

The aim of the project is to develop prototypes of autonomous instrumented buoys for observing the behaviour and abundance of tuna and other pelagic species. These instrumented platforms will work in concert with electronic tags to become long-term observatories of pelagic ecosystems. They will reduce dependence on research vessels and represent a major advance in fisheries research. The specific objectives are:

1. identification of behavioural components of structure-associated aggregations to define specifications for production of a prototype low-cost autonomous 360° sonar;
2. development of models of aggregation processes for interpreting data currently collected by available down-looking sonars;
3. identification of specifications for new electronic tags for detecting the schooling status of fish, associative behaviour and stomach fullness.

EXPECTED RESULTS AND ACHIEVEMENTS

1. Define specifications for a low-cost autonomous 360° sonar to estimate the characteristics of structure-associated aggregations and development of a prototype.
2. Model of aggregation processes to estimate the characteristics of aggregations from existing technology (instrumented buoys with commercially available vertical sonars).
3. Define specifications and develop prototypes of new electronic tags to determine the schooling status of fish, their associative behaviour and stomach fullness.

**Development of a European resource on the origins of pathogens
of aquaculture
EUROPA**

Contract number: QLRI-CT-2002-02819	Coordinator
Contract type: Thematic network project	Chris Secombes
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Development of a European resource on the origins of pathogens of aquaculture

BACKGROUND

The management and control of disease in aquaculture is the single most important limiting factor in the development of the industry in Europe. Molecular analysis of pathogens by nucleotide sequencing has provided extremely valuable information on the epizootiology of aquatic disease and is an increasingly important tool in disease management. At present, the development of such analyses is carried out in an ad hoc fashion, risking complementarity, duplication of effort or development of mutually exclusive data collections. The establishment of this thematic network will provide a harmonised data set for important pathogens, together with defined quality standards. Such a network will have considerable added value in terms of the data collections, information resources and epizootiological facilities for aquaculture research, development and management.

OBJECTIVES

The network will establish a resource to facilitate the tracking of pathogens of aquaculture within Europe for effective disease management in aquaculture. It will construct a resource in the form of a database of nucleotide sequence data related to aquaculture pathogens. The network will:

1. harmonise available information and create readily available up-to-date sequence data sets suited to the purpose of phylogenetic analysis from selected predefined genomic regions of notifiable fish pathogens;
2. establish a European centre of excellence responsible for advising on, establishing and maintaining such data sets;
3. establish an accessible and specific international database for the management and efficient dissemination of data sets and up-to-date phylogenetic information.

EXPECTED RESULTS AND ACHIEVEMENTS

A web-based database resource will be constructed to allow rapid access to aligned data sets for each selected pathogen of aquaculture, along with up-to-date phylogenetic information and advice. This will facilitate the rapid typing of new pathogen strains and create evolving and clearly defined data sets. Reference laboratories will be created for each pathogen to identify a source of advice for aquaculture health professionals, in addition to ensuring a coordinated approach to the future compilation of molecular epidemiological data.

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