DEEPFISHMAN
Management And Monitoring Of Deep-sea Fisheries And Stocks

Project number: 227390

Small or medium scale focused research action
Topic: FP7-KBBE-2008-1-4-02 (Deepsea fisheries management)

DEEPFISHMAN document 1

Title: Review of drivers from and interactions with other projects in the NE Atlantic

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Organization Name of lead coordinator: Ifremer

Dissemination Level: PU (Public)

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Review of drivers from and interactions with other projects in the NE Atlantic

1. Introduction

This document provides an overview of past and current research projects whose objectives and results are relevant to the DEEPFISHMAN project. It covers projects funded under FP6 and FP7 and some other relevant initiatives.

For each relevant project the report provides

- title (acronym and full title) and name of coordinator
- web site address
- main objectives
- main outcomes
- major publications (special journal issue, book,..)

Twenty-nine projects were reviewed. The projects are ordered in alphabetical order of project acronym. For several recent project, the outcome and publication can be found on a website. Some projects that had a website during their course have no more accessible website after the end of the project. A few projects carried out in the 1990s are included in the review. These older projects have no websites and their outcome and publications may be difficult to trace. Publications are nevertheless accessible from literature search but as search engines do to allow to search on words included in acknowledgements article from past project are not directly searchable.
Some projects with a contribution from SAMS (Scottish association for Marine Science) could nevertheless be well documented because SAMS maintains a website were project outcome and publication are provided. Some reports of these projects are also available from this SAMS website.

2. Projects overview

2.1. AFRAME (Improved fishery management through fleet- and area-based assessments)

2.1.1. Period

2007-2009 (FP6)

2.1.2. Coordinator

AZTI-Tecnalia

2.1.3. Web site address

http://wiki.azti.es/aframe/doku.php

2.1.4. Main objectives

AFRAME will develop a framework for fleet and area-based fishery management through case studies of the North Sea (data rich, species poor); the English Channel, Celtic Sea and the Bay of Biscay (intermediate); and the Mediterranean (species rich, data poor). Each of these studies will:

* Develop and test frameworks for describing fleet activity in terms of the fisheries in which the fleet participates, and how it allocates its effort across these regions
* Develop an indicator approach to summarising information and presenting advice in relation to multi-fleet and multi-species fisheries
* Analyse stakeholder perceptions and institutional implications of a shift to fleet- and area-based management

2.1.5. Main outcomes

AFRAME further developed the framework Fcube (Fleets and Fisheries Forecast) Fcube(Ulrich *et al*., 2006; Reeves and Ulrich, 2007), focuses on fisheries and fleets rather than stocks. Fcube provides a much more flexible and realistic framework for management advice, one that recognizes that fishery impacts extend far beyond the major target species. Because Fcube suggests a way to evaluate the extended impact of fishing, it provides a bridge between the traditional single-species advice and the ecosystem. In AFRAME, Fcube was implemented on the Bay of Biscay and Celtic Sea fleets. Different scenarios have been deployed based on economic or TAC based management objectives. After the implementation, the strengths and weaknesses of the model have been pointed out and some other alternative options were analysed.

2.1.6. Major publications

No peer reviewed publications is reported on the AFRAME WIKI.

Ane Iriondo, Dorleta García, Marina Santurtún, Iñaki Quincoces, Leyre Goti, Jose Castro, Stephanie Mahevas and Alex Tidd (2008). The use of Fcube (Fishery and Fleet Forecasts) method for mixed fisheries management: Western Waters case study. CM 2008/ I:03 , 25pp.

2.2. BASBLACK (Environment and biology of deep-water species *Aphanopus carbo* in the NE Atlantic: basis for its management

2.2.1. Period

2.2.2. Coordinator

Instituto de Investigação das Pescas e do Mar, Portugal (IPIMAR) was the coordinator. The partners were from the UK (SAMS and FRS), Spain (Institut Mediterraneo de Estudios Avanzados, Palma de Mallorca and Centro Oceanografico de Vigo) and Portugal (DRP Madeira-Direção de Serviços de Investigação das Pescas (DSIP) and Departmento de Oceanografia e Pescas da Universidade dos Açores (DOP).

2.2.3. Web site address

No site maintained
see executive summary at:
http://www.sams.ac.uk/research/SAMS%20Honorary%20Fellows/dr-john-gordon/deepwaterfish/research/SAMS%20Honorary%20Fellows/dr-john-gordon/deepwaterfish/aphanopus

2.2.4. Main objectives

The objective of the project was to provide the basis for the development and implementation of a programme for the routine study and management of the black scabbardfish (*Aphanopus carbo* Lowe, 1839). Owing to the lack of biological and environmental information critical for the assessment and management of the species a special effort was placed on investigations of its biology, stock discrimination and habitat characterisation.

2.2.5. Main outcomes

The main objective of the Project "Environment and biology of deep-water species Aphanopus carbo in the NE Atlantic: basis for its management (BASBLACK)" (EC DG XIV Study Project 97/0084) was to provide the basis for the development and implementation of a programme for the routine study and management of the black scabbardfish (*Aphanopus carbo* Lowe, 1839). Owing to the lack of biological and environmental information that are critical for the assessment and management of this species a special effort was put into research on its biology, on stock discrimination and on habitat characterisation.

The historical data collected either during research surveys or under the landings sampling program available in the Portuguese EEZ (Mainland and Madeira) from 1979 to 1989 were compiled and included in the BASBLACK database. Additional historical information collected during surveys carried out in ICES areas Va, VI, VII, X and XI, was also included in the Database.

An annotated bibliography containing about 166 references was prepared, and the content of each paper or report included in it was briefly summarised.

During the Project a length sampling program in order to collect data both from commercial landings and research surveys was established and regularly executed. According to this Program a total of 21,884 fish were measured for length structure. The sampling program was established taking into consideration the historical data from Portuguese, French and Spanish commercial fisheries, and from research surveys carried out in NE Atlantic by Portugal, U.K., France, Germany and Iceland. A further 5300 fishes were sampled. The sampled fishes constituted the basic material for the different studies. Sexual maturity scales for both male and females were established and validated by histological analysis of gonads. An atlas on the reproduction which included detailed information for each macroscopic stage was published. More than 2200 fish stomachs were examined for species diet composition, but the results were not conclusive as most of sampled specimens had empty stomachs or had eaten the bait used in the fishery. About 3950 otoliths were extracted and used in the growth study undertaken in the project. An ageing workshop to standardise methodologies and criteria was organised. Investigation on otolith microstructure, and validation of the otolith macrostructure using microstructure analysis was also carried out. Due to the fact that in Scotland fishes are usually landed with the head removed, a conversion factor of post-anal length to total length, using a robust statistical regression was established. In addition since some historical length data refer to standard length, a conversion factor from standard to total length was determined using a similar statistical approach.

Methodologies for population discrimination based on DNA and otolith microchemistry analysis were developed and standard methodological protocols were established for the species. After this initial stage some polymorphism for Madeira was detected, which should be more deeply studied in the future. In addition, otolith microchemistry analysis indicated that this might be a useful tool for stock discrimination of the species. It is thus strongly recommended that future studies in both approaches be carried out, especially due to the large distribution area of the species. As a complement to these two studies and not referred to in the research activities initially proposed, morphometric studies were carried out. Morphometric data collected in different geographical areas were statistically analysed. The results obtained were not successful in discriminating between geographical areas because the confounding effect of both latitude and fishing gear could not be definitely separated. Nevertheless, it was recognised by all that in the future more studies on morphometrics should be undertaken in order to clarify this problem.

Observations on board a volunteer fishing vessel off Portuguese mainland fishing grounds were carried out from February 1999 until January 2000. Each month, observers went on board the fishing vessel to take temperature measurements using TDR (Temperature Depth Recorder), and to record catch information. Methodologies to use fishing vessels as observational platforms were developed.

Heavy metal (Hg, Cu, Zn, Cd, Pb, As) content was determined for samples collected at Madeira, Sesimbra, Rockall Trough, and Azores and a bioaccumulation database was constructed. Black scabbardfish livers are cause for concern for the health, especially in communities that treat the liver as a local delicacy. The concentration of mercury in muscle tissue is generally lower than in liver, and may therefore present less of a risk for consumers. Organic contaminants appear to pose no threat to the health of people consuming black scabbardfish.

2.2.6. Major publications

Figueiredo, I., Bordalo-Machado, P., Reis, S., Sena-Carvalho, D., Blasdale, T., Newton, A., Gordo, L. S. (2003). Observations on the reproductive cycle of the black scabbardfish (Aphanopus carbo Lowe, 1839) in the NE Atlantic. Ices Journal of Marine Science 60(4), 774-779

Gordo, L.S., Carvalho,D.S. Figueiredo, I., Machado, P.B., Newton, A. and Gordon, J. (2000).Escala de maturação sexual do peixe-espada preto. Uma Abordagem macro e microscópia. The sexual Maturity scale of black scabbardfish. A macro and microscopic approach. Celta Editora:36 pp.

Morales-Nin, B., Canha, A., Casas, M., Figuereido, I., Gordo, L. S., Gordon, J. D. M., Gouveia, E., Pineiro, C. G., Reis, S., Reis, A., Swan, S. C. (2002). Intercalibration of age readings of deepwater black scabbardfish, Aphanopus carbo (Lowe, 1839). Ices Journal of Marine Science 59(2), 352-364.

Swan SC, Gordon JDM and Shimmield T (2003). Preliminary investigations on the uses of otolith microchemistry for stock discrimination of the deep-water black scabbardfish (Aphanopus carbo) in the North East Atlantic. Journal of Northwestern Atlantic Fisheries Science, 31, 221-231

2.3. Project CAFÉ Capacity, F and Effort

2.3.1. Period

01.02/2006 –01/02/2009

2.3.2. Coordinator

Dr Anna Korre, Imperial college for Science, technonolgy and medecine

2.3.3. Web site address

https://cafe.jrc.ec.europa.eu/home

2.3.4. Main objectives

Capacity reduction and effort limitation are major tools in fisheries management. CFP reform aims to match European fleet capacity to resource availability. Links are assumed between these and fishing mortality, but the scientific basis for these has not been fully established, particularly for pelagic fisheries.

The project will examine the relationship between these factors for six case studies; North Sea, Biscay & East Mediterranean pelagic fisheries; and North Sea, western (Biscay & Celtic Sea) and north east Mediterranean demersal fisheries. It will review existing approaches to measuring capacity and effort and control measures derived from these. It will collate data on fleets (catch, vessel & gear metrics, costs & profits, and investment & capital values) and on fish stocks (abundance, distribution, fishing mortality). It will include analyses of fisher's behaviour from targeted fine scale studies. Statistical and mathematical modelling tools will be used to explore and quantify relationships between metrics for the three factors. Metrics will be selected that are suitable for capacity and effort and have good explanatory power in the model systems. Appropriate models and metrics will be developed to quantify the links between capacity, effort and species mortality, partitioned by fleet and area. A key element will be a study of capacity utilisation, i.e. the match between capacity and real effort, including a quantitative study of the factors controlling capacity change, i.e. investment strategy, control legislation and economic factors.

Finally, the project will propose a series of new effort and capacity control measures and scenarios. These will be tested and compared to current measures using operational models. At all stages explicit measures will be taken to quantify structural and parametric uncertainty. The final outcome will be a comprehensive review of possible management measures and their likely effect in conserving fish stock resources.

2.3.5. Main outcomes

Not identified

2.3.6. Major publications

Not identified
There was at least to communication in the Theme Session I "Fishing capacity, effort, and fishing mortality—the understanding of fishery dynamics and their links to management" of ICES ASC 2008.

2.4. Project CEDER

2.4.1. Period

01/01/2006-31/12/2007

2.4.2. Coordinator

Mr David Bestwick, avanti Communication limited

2.4.3. Web site address

https://ceder.jrc.ec.europa.eu/

2.4.4. Main objectives

The primary objective of CEDER was to harness technologies, such as the Vessel Monitoring System and electronic logbooks, to provide more accurate and timelier information on catches, effort, landings, discards and quota and TAC uptake and to assess the benefits of this information for fisheries management.
The objectives were:

- the production of a harmonized database for fisheries data of six different fisheries;
- the construction of relationships between these data and national catches, landings;
- an assessment of the accuracy of such relationships;
- the production and testing of a near-real-time system that can monitor catch, effort, discards and landings of these fisheries;
- the delivery of an outline design for introducing such a system into operation;
- an assessment of the benefits to industry, authorities and to the sustainability of stock and the fishery.

2.4.5. Main outcomes

The implementation plan details how CEDER project outputs can be applied at the fishery policy management level to ensure envisioned benefits from implementation of project findings can be achieved (see D3.2 CEDER benefits report v10.pdf at https://ceder.jrc.ec.europa.eu/, under documents/deliverables).

2.4.6. Major publications

Final report on the project website. No peer reviewed publication identified

2.5. CEVIS (Evaluating alternative, participatory management models for EU fisheries)

2.5.1. Period

2005-2008 (FP6)

2.5.2. Coordinator

Douglas Wilson, Danish Institute for Fisheries Management and Coastal Community Development (IFM)

2.5.3. Web site address

http://www.ifm.dk/CEVIS/index.htm

2.5.4. Main objectives

The Comparative Evaluations of Innovative Solutions in European Fisheries Management (CEVIS) Project was a three year exploration of how science can address policy questions at perhaps their most general level. With an eye toward possible implementation under the CFP we evaluated four management innovations that were receiving the most attention in current discussions of potential changes in European fisheries management at the time we developed the project:

- Participatory approaches to fisheries governance;
- Rights-based regimes;
- Effort-control regimes; and,
- Decision-rule systems.

While we use the term 'innovations' to indicate that these approaches to management had not been used extensively in Europe at the time we developed the project, these were not new or untested ideas and all of them had been incorporated into modern fisheries management regimes in developed countries. All of them were also being widely discussed within Europe as options for the Common Fisheries Policy (CFP) as the CFP moved towards a more adaptive and ecosystem-based approach to fisheries management.

The project had two phases. The first phase used a cross-disciplinary approach. During this phase we carried out four in-depth studies of areas outside of Europe where innovative fisheries management regimes have been implemented. These were New Zealand, Canada, Alaska, and Iceland. The visits were made by teams that included at least one social scientist and one natural scientist. Cross-disciplinary teams carried out the research using social science methods based on carrying out and analyzing in-depth interviews. They did a literature review of fisheries management in the area and then made visits of approximately two weeks where they interviewed various stakeholders. These areas were chosen because they had implemented at least two of the innovations that CEVIS was interested in investigating. Chapters Two through Five of this book are the reports of these studies.

The second phase was carried out in disciplinary working groups and took a basically multi-disciplinary approach. Each working group focused on one of the objectives identified in the original project call to be used as the basis of the evaluation of the innovations. In order to get a handle on the objective described in that call as 'robustness with respect of varying conditions' we decided to focus on the 'biological robustness' of the fish stocks and the 'social robustness' of the management institutions. So the disciplinary working groups were four: two run by economists examining the innovations with respect to economic efficiency

and costs of management; a group of biologists examining the innovations with respect to biological robustness; and, a group of social scientists examining social robustness. All four groups used data from Europe, including the Faroe Islands. Their assignment was to identify and test specific hypotheses about the relationship between the innovations and their objectives using the methods and data that could be feasibly applied from their discipline. The approach we took was predicated on the following levels of analysis:

- Social robustness would be examined at the level of the fishing community;
- Economic efficiency would be examined at the level of the fleet;
- Biological robustness would be examined at the level of the fish stock; and,
- Costs of management would be examined at the level of the polity.

2.5.5. Main outcomes

See annexe I

2.5.6. Major publications

Book:
Hauge, K. H. and Wilson, D. C. (Eds.) (2009) Comparative Evaluations of Innovative Fisheries Management: Global Experiences and European Prospects. Springer Verlag, 272 pp.

2.6. COMARGE (Continental margin ecosystems)

2.6.1. Period

Part of Census of Marine Life (http://www.coml.org/)

2.6.2. Coordinator

Depends on project

2.6.3. Web site address

http://www.ifremer.fr/comarge/en/index.html

2.6.4. Main objectives

The issues address by COMARGE concern two main scales of margin heterogeneity:

- The fragmented habitats of high biomass production and/or distinctive species composition collectively termed Hotspots
- The environmental variability found along latitude and depth gradients.

To achieve its goals, COMARGE intends to create a network of researchers to facilitate coordination among projects and cruises, to foster data sharing, to support data archiving and finally to assure the maximum synergistic value for continental margin studies. As a first step, the purpose and questions of the project will be disseminated to a wide community of scientists. A challenge of the Census of Marine Life - COMARGE will be to overcome taxonomic impediments in order to disseminate through OBIS comprehensive species lists for a wide range of habitats. COMARGE's intent, together with other deep-sea CoML field projects, is to foster the development of taxonomic expertise through workshops and exchange of taxonomists.

Regional projects:

- Biozaire: African equatorial margin
- Northeast Pacific
- Southeast Pacific

2.6.5. Main outcomes

2.6.6. Major publications

The Multidisciplinary BIOZAIRE Program - A Contribution to Census of Marine Life. A special issue of Deep Sea Research II edited by Myriam Sibuet and Annick Vangriesheim.

2.7. COMMIT (Committing to tailor-made long-term fishery management strategies)

2.7.1. Period

2004-2007 (FP6)

2.7.2. Coordinator

Centre for Environment Fisheries and Aquaculture Science (Cefas)

2.7.3. Web site address

http://www.cefas.co.uk/projects/creation-of-multi-annual-management-plans-for-commitment-%28commit%29.aspx

2.7.3.1. Main objectives

COMMIT aims to improve the scientific basis for the long-term sustainable planning of fishery management, while identifying any short-term biological and socio-economic consequences. The project will:

* Evaluate management plans that reduce annual fluctuations in exploitation and encourage stakeholder commitment
* Base these strategies upon harvest rules and develop them explicitly to recognise various uncertainties
* Carry out a socio-economic analysis to identify mechanisms affecting the commitment of key stakeholders

2.7.4. Main outcomes

Major publications

2.8. COST Project (Common Open Source Tool for raising and estimating properties of statistical estimates derived from the Data Collection Regulation)

2.8.1. Period

12/07/2007 – 12/05/2009
(Studies and Pilot projects for carrying out the common fisheries policy, response to the lot N°2 of the call for tenders FISH/2006/15, Project no SI2.467814)

2.8.2. Coordinator

Joël Vigneau, Ifremer

2.8.3. Web site address

http://www.ifremer.fr/cost/

2.8.4. Main objectives

COST was financed as part of the European Commission Data Collection Regulation (DCR). The objective of the study is to develop a common "open source" tool (COST) for assessing the accuracy of the biological data and parameters estimates collected for stock assessment purposes within the framework of the Data Collection Regulation. The tool consists of R libraries allowing to import and handle fisheries data (COSTcore), to explore the data (COSTeda), to estimate the parameters and related precision (COSTdesign & COSTbayes) and finally to do simulation (COSTsim)

2.8.5. Main outcomes

An open-source software developed in R and consisting of different packages that develop validated methods to investigate and estimate parameters for (i) discards volume, (ii) length and age structure of catches and landings, and (iii) biological parameters such as growth, maturity and sex-ratio. Where appropriate, the estimates are calculated according to one out of a fixed number of agreed raising procedures, based on the methods already developed by some Institutes. Linkage with ICES end-users has been consolidated through the exportation method to ICES own storage database (InterCatch) and to the R environment usually used for stock assessment working group (FLR).
All information, documents and packages related to the project can be found on the project dedicated website : http://wwz.ifremer.fr/cost.

2.8.6. Major publications

ICES, 2009. Definition of Standard Data-Exchange Format for Sampling, Landings, and Effort Data from Commercial Fisheries ICES Cooperative Research Report, N° 296, July 2009. 48pp.

2.9. Project DEGREE

2.9.1. Period

01/02/2006-01/04/2009

2.9.2. Coordinator

Dr Bob Van Marlen, IMARES

2.9.3. Web site address

http://www.rivo.dlo.nl/degree/

2.9.4. Main objectives

The main objective was to develop new gears/fishing techniques that have a lower impact on benthic habitats, to quantify the potential reduction of the physical impact as well as the effects on benthic communities, to weigh the socio-economic consequences of these changes against those of alternative management measures, e.g. closing of areas.
DEGREE aimed at developing a generic approach in which cases studies (e.g. North Sea, Mediterranean) could be worked out. The aim was to assess the overall ecological impact to benthic systems by developing physical/biological models verified by tests at sea. and that can be provided as a tool to fisheries managers to identify gear and sediment type combinations which will minimise impact to the habitat.
The objectives include an appraisal of the socio-economic consequences of the new gears and techniques. Gear types under study involve: otter trawls, beam trawls and dredges. The project consisted of six work packages:
WP 1: Management and co-ordination
WP 2: Modelling and quantification of benthic impact
WP 3: Otter trawl modifications
WP 4: Beam trawl and Dredge modifications
WP 5: Economics
WP 6: Dissemination and implementation

2.9.5. Main outcomes

Not identified, access to the project web site is restricted.

2.9.6. Major publications

2.10. CORALFISH (Ecosystem based management of corals, fish and fisheries in deep waters in Europe and beyond)

2.10.1. Period

2008-2012 (FP7)

2.10.2. Coordinator

Anthony Graham, National University of Ireland, Galway

2.10.2.1. Web site address

http://eu-fp7-coralfish.net/

2.10.2.2. Main objectives

CoralFISH will assess the interaction between corals, fish and fisheries, in order to develop monitoring and predictive modelling tools for ecosystem based management in the deep waters of Europe and beyond.
CoralFISH aims to:
* develop essential methodologies and indicators for baseline and subsequent monitoring of closed areas;
* integrate fish into coral ecosystem models to better understand coral fish-carrying capacity;
* evaluate the distribution of deepwater bottom fishing effort to identify areas of potential interaction and impact upon coral habitat;
* use genetic fingerprinting to assess the potential erosion of genetic fitness of corals due to long-term exposure to fishing impacts;
* construct bio-economic models to assess management effects on corals and fisheries to provide policy options;
* produce habitat suitability maps both regionally and for OSPAR Region V to identify areas likely to contain vulnerable habitat. The latter will provide the EU with the tools to address the issues raised by the UNGA resolution.

2.10.3. Main outcomes

Ongoing. CoralFISH is a major project for interaction with DEEPFISHMAN.

2.10.4. Major publications

Auster, P. J., Gjerde, K., Heupel, E., Watling, L., Grehan, A., Rogers, A. D. (in press). Definition and detection of vulnerable marine ecosystems on the high seas: problems with the "move-on" rule. ICES Journal of Marine Science, fsq074. 10.1093/icesjms/fsq074

Braga-Henriques, A., Carreiro-Silva, M., Porteiro, F. M., de Matos, V., Sampaio, I., Ocana, O., Avila, S. P. (in press). The association between a deep-sea gastropod Pedicularia sicula (Caenogastropoda: Pediculariidae) and its coral host Errina dabneyi (Hydrozoa: Stylasteridae) in the Azores. ICES Journal of Marine Science, fsq066. 10.1093/icesjms/fsq066

Carreiro-Silva, M., Braga-Henriques, A., Sampaio, I., de Matos, V., Porteiro, F. M., Ocana, O. (in press). Isozoanthus primnoidus, a new species of zoanthid (Cnidaria: Zoantharia) associated with the gorgonian Callogorgia verticillata (Cnidaria: Alcyonacea). ICES Journal of Marine Science: Journal du Conseil, fsq073. 10.1093/icesjms/fsq073

Heymans, J. J., Howell, K. L., Ayers, M., Burrows, M. T., Gordon, J. D. M., Jones, E. G., Neat, F. (in press). Do we have enough information to apply the ecosystem approach to management of deep-sea fisheries? An example from the West of Scotland. ICES Journal of Marine Science, fsq065. 10.1093/icesjms/fsq065

A number or other publication are expected in the special issues "Issues confronting the deep oceans: the economic, scientific and governance challenges and opportunities of working in the Deep Sea" of ICES journal of marine science.

Some other works were presented at the 12th deep-sea biology conference (see books of abstracts at http://12dsbs.hi.is/).

2.11. Deep-water Demersal Fishes: Data for Assessment and Biological Analysis

2.11.1. Period

1994-1997 (Commission of the European Communities Shared Cost Study Contract DGXIV/C/1 94/C 144/04)

2.11.2. Coordinator

Dr. J.D.M. Gordon, Scottish Association for Marine Science

2.11.3. Web site address

http://www.sams.ac.uk/research/SAMS%20Honorary%20Fellows/dr-john-gordon/deepwaterfish/research/SAMS%20Honorary%20Fellows/dr-john-gordon/deepwaterfish/demersal

2.11.4. Main objectives

The objectives were:

- To extract and work up the historical data obtained during the UK Ministry of Agriculture fisheries and Food (MAFF) deep-water fisheries surveys of the continental slopes to the west of the British Isles in the 1970s.
- To age deep-water fishes using otoliths collected by MAFF and SAMS

2.11.5. Main outcomes

See executive summary at:
http://www.sams.ac.uk/research/SAMS%20Honorary%20Fellows/dr-john-gordon/deepwaterfish/research/SAMS%20Honorary%20Fellows/dr-john-gordon/deepwaterfish/demersal

2.11.6. Main publications

Gordon, J.D.M. and Swan, S.C. (1997) Final Report of EC DGXIV/C1 Contract 94/017 Deep-water demersal fishes: data for assessment and biological analysis. 208 pp

2.12. Deep-water Fish Species - Biological Parameters

Commission of the European Communities, Shared Cost Study Contract DG XIV/C/1, 1992/10

2.12.1. Period

1992-1993 (Commission of the European Communities, Shared Cost Study Contract DG XIV/C/1, 1992/10)

2.12.2. Coordinator

Dr. J.D.M. Gordon, Scottish Association for Marine Science

2.12.3. Web site address

No site maintained, summary and main outcome available at http://www.sams.ac.uk/research/SAMS%20Honorary%20Fellows/dr-john-gordon/deepwaterfish/research/SAMS%20Honorary%20Fellows/dr-john-gordon/deepwaterfish/bioparam

2.12.4. Main objectives

Assess the use of otolith microchemistry as a possible tool for defining the stocks of different deep-water fish species of the Atlantic and Mediterranean. It is known that fish otoliths incorporate elements from the environment as they grow and the otoliths are assumed to be metabolically inert. It is therefore reasonable to suppose that if a species lives and grows in a discrete area, the elemental signature in its otolith would be distinct. However, if a species has its early life in one area or depth zone and moves to another later in its life cycle, then it should be possible to distinguish changes in the elemental signature in samples from different parts of the otolith.

2.12.5. Main outcomes

The report ends with a number of recommendations relevant to the management of the resource.

- There is a clear need for information on the age of these deep-water species.
- It is important that the managers are aware of the differences in the food-chains between the shelf and the deep-sea. All the species likely to be exploited are top-level predators and many feed on smaller fishes.
- It is essential that data on all fish species is collected, as has been done in the SAMS survey. This will enable biologists to assess the effects of the removal of top-level predators by the fishery. The SAMS data base is a valuable resource on the virgin state of the fish assemblages.
- The deep-sea, at least in temperate latitudes, must no longer be thought of as a system where everything is adapted to survival in a low-energy environment.
- Consideration must be given to the best methods of catching deep-sea fish.
- More research is required on stock identification and migrations. The stocks of many of these species may extend into international waters and the implications of uncontrolled fisheries in these areas must be considered.

- There are likely to be major problems in the identification of the catches by fishermen which will have implications for the management of the resource.

2.12.6. Main publications

Gordon, J.D.M. and Swan, S.C. (1993) Biological parameters of deep-water fish species. Report to the Commission of the European communities, DG XIV/C/1, 1992/10, 122 pp + appendices.

2.13. EC MAST2 (Community Structure and Processes in the Deep-sea Benthos)

2.13.1. Period

1992-1995 (?) - Shared Cost Contract MAST2-CT920033

2.13.2. Coordinator

Dr Tony Rice of the Southampton Oceanography Centre

2.13.3. Web site address

No site maintained, only an abstract of the contribution for SAMS is available at: http://www.sams.ac.uk/research/SAMS%20Honorary%20Fellows/dr-john-gordon/deepwaterfish/research/SAMS%20Honorary%20Fellows/dr-john-gordon/deepwaterfish/benthos

2.13.4. Main objectives

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2.13.5. Main outcomes

2.13.6. Main publications

2.14. Development of Elasmobranch Assessments (DELASS)

2.14.1. Period

(Jan 2000-Dec 2002) European Commission Shared Cost Study Contract DGXIV 99/055 (FP5)

2.14.2. Coordinator

This project was coordinated by RIVO, Ijmuiden, Netherlands and had 15 partners from nine European countries. SAMS had a role in providing survey data and compiling a bibliography for the deep-water shark element of this project.

2.14.3. Web site address

no website maintained.

2.14.4. Main objectives

• to collate existing data and start the collection of new data on elasmobranchs, and
• to develop assessment methods for 9 case study species.

Species selected

9 Case study species were selected, based on ecological and practical criteria: *Raja clavata* (thornback ray), *Raja naevus* (cuckoo ray), *Centroscymnus coelolepis* (Portuguese dogfish), *Centrophorus squamosus* (leaf-scale gulper shark), *Dalatias licha* (kitefin shark), *Galeus melastomus* (blackmouth catshark), *Squalus acanthias* (spurdog), *Scyliorhinus canicula* (lesser spotted dogfish), *Prionace glauca* (blue shark)

2.14.5. Main outcomes

2.14.6. Major publications

Ellis, J., Dulvy, N., O'Brien, C., Sims, D., Southall, E. (2005). FOREWORD Shark, skate and ray research at the MBA and Cefas. Journal of the Marine Biological Association of the UK 85(05), 1021-1023.

Ellis, J. R., Dulvy, N. K., Jennings, S., Parker-Humphreys, M., Rogers, S. I. (2005). Assessing the status of demersal elasmobranchs in UK waters: a review. Journal of the Marine Biological Association of the UK 85(05), 1025-1047.

Heessen, H.J.L., ed., 2003. Development of Elasmobranch Assessments DELASS: DG Fish Study Contract 99/055.

Rodríguez-Cabello, C., Fernández, A., Olaso, I., Sánchez, F. (2005). Survival of small-spotted catshark (Scyliorhinus canicula) discarded by trawlers in the Cantabrian Sea. Journal of the Marine Biological Association of the UK 85(05), 1145-1150.

Sánchez, F., C. Rodríguez-Cabello, and I. Olaso. 2005. The Role of Elasmobranchs in the Cantabrian Sea Shelf Ecosystem and Impact of the Fisheries on Them. *J. Northw. Atl. Fish. Sci.*, **35**: 467-480. doi:10.2960/J.v35.m496

2.15. EFIMAS (OPERATIONAL EVALUATION TOOLS FOR FISHERIES MANAGEMENT OPTIONS)

2.15.1. Period

2004-2008 (FP6)

2.15.2. Coordinator

J Rasmus Nielsen, Danish Institute for Fisheries Research

2.15.3. Web site address

http://www.dfu.min.dk/dfu/dfuvis.asp?id=109

2.15.4. Main objectives

EFIMAS will develop a robust framework within which to simulate and evaluate the biological and socio-economic consequences of a range of fishery management options and objectives. The project will:
* Use models that will run stochastic simulations incorporating data from selected EU fisheries
* Compare range of management options generated with the current management of the test fisheries
* Compare the performance of a range of management options under alternative management systems and objectives

2.15.5. Main outcomes

The EFIMAS project has developed the **FLR** tools to take account of the dynamics in the fisheries systems in Europe, including policy priority areas such as fleet and mixed fisheries interactions. The evaluations include such things as using alternative stock and fishery assessment models and can include economic components. Importantly, emphasis is placed on many kinds of uncertainties including those found in the data collection, assessment, modelling, advisory, management and implementation processes. The input data are generated by a descriptive model, called the “operating model” which is assumed to represent the “true” system. The input data are then processed by the “knowledge production model”, which can either be a traditional stock assessment model or one of several alternative fish stock or bio-economic fleet based assessment models. By simulating the effect that the resulting management actions would have on the “true” system a range of performance measures are generated, covering the resource and the fishery. The tools can consider many management alternatives such as minimum mesh size, minimum landing size, closed areas, closed seasons and effort regulations. The performance measures enable the comparison of a range of management options under alternative management systems and objectives.

2.15.6. Major publications

Book
L. Motos and D. Wilson (Eds.) 2006. The Knowledge Base for Fisheries Management. Developments in Aquaculture and Fisheries Science, Volume 36, ELSEVIER.

2.16. Project EMPAFISH

2.16.1. Period

01/03/2005-01/03/2006

2.16.2. Coordinator

Dr Pirez-Ruzafa Angel, Murcia University

2.16.3. Web site address

http://www.um.es/empafish/

2.16.4. Main objectives

EMPAFISH has a number of general and operational objectives.
Reviewing the effectiveness of different MPA regimes across Europe in protecting sensitive and endangered species, habitats and ecosystems from the effects of fishing.
Formulating integrated policy proposals and practical measures for establishing MPAs in the Atlanto-Mediterranean.

2.16.5. Main outcomes

- Ecological, fisheries and socio-economic database framework were done.
- A report showing global parameter issued from meta-analysis of ecological data has been produced.
- Results showing temporal and spatial analyses of the catch/landings, yields, all the other selected biological catch parameters, and the distribution and evolution of the fishing effort and evaluation of patterns and trends of the fishery regimes have been analyzed.
- Methodological guidebook for socio-economic field survey has been produced.
- A document showing the conceptual model on relationships among components related with effects of MPAs has been produced.
- Set of documents with the best indicators in each defined dimension to assess effects of MPAs have been produced.
- A Public-domain software package for the bio-economic analysis of MPAs has been developed and it has been applied in one of the EMPAFISH case studies producing a document with the results of the bio-economic and cost-benefit analysis
- Recommendations on management strategies applicable in MPAs have been compiled in a document
- A manual including guidelines for MPA management has been produced

2.16.6. Major publications

Three booklet are available on the project website

Planes, S., García-Charton, J.A., Marcos. C & Pérez-Ruzafa, A. (Coord.) 2006. *Ecological effects of Atlanto-Mediterranean Marine Protected Areas in the European Union*. EMPAFISH Project, Booklet nº 1. 158 pp.

Vandeperre, F., Higgins, R., Santos,R., Marcos. C. & Pérez-Ruzafa, A. (Coord). 2006.Fishery Regimes in Atlanto-Mediterranean European Marine Protected Areas. EMPAFISH Project, Booklet nº 2. 108 pp.

Alban,F., Appére, G & Boncoeur, J. 2006. Economic Analysis of Marine Protecetd Areas. A literature review. EMPAFISH Project, Booklet nº3.51pp.

2.17. EUROSITES

2.17.1. Period

2.17.2. Coordinator

2.17.3. Main objectives

EuroSITES is a FP7 Collaborative Project which aims to form an integrated European network of 9 deep-ocean (>1000m) observatories. With the deep-sea being a final sink for contaminants, the project can link to ways for in situ long-term time-series ocean observations.

2.17.4. Main outcomes

On-going. SItes in EuroSITES and mainly deeper than the distribution of deep-water fisheries. EuroSITES will provide data on state and variations at the scale of oceanic basin. The website includes links to every EuroSITES deep-ocean observatories and other ocean observatories.

2.17.5. Major publications

2.17.6. Web site address

http://www.eurosites.info

2.18. Project FAIR CT 95 0655

Full title: Developing Deep-water Fisheries: Data for Their Assessment and for Understanding Their Interaction with and Impact on A Fragile Environment

2.18.1. Period

01.12.1995-31.05.1999

2.18.2. Coordinator

Dr. J.D.M. Gordon, Scottish Association for Marine Science

2.18.3. Web site address

Not maintained

2.18.4. Main objectives

The objectives of this project were:

- To describe in detail the deep-water fisheries presently being prosecuted by member states with particular reference to geographic area, depth of occurrence, seasonal distribution, migration patterns, aggregations and other parameters. To record and describe the gears, both mobile and static, which are currently being used for specified fisheries.
- To make an inventory of existing survey data on deep-water resources and ensure that historical data sets are preserved and are accessible. To support the working up of survey data.
- To describe and quantify the bycatch of unwanted species and undersized fish of target species by fishery.
- To sample at the markets and accurately record the quantities of species landed with particular reference to fishes that are not presently identified to species level.
- To use the information collected by research and commercial surveys and, from market sampling past and present, to provide data on biological parameters of both target and bycatch species, which will be of value for the assessment and management of the resource. Particular importance will be paid to studies on age determination, growth and reproduction.

2.18.5. Main outcomes

The Project compiled and analysed new information on parameters such as descriptions of fishing activities, distribution, landings, discards, CPUE and biological characteristics. In the Atlantic area these data have been used by the ICES Study Group on the Biology and Assessment of Deep-sea Fisheries Resources. The second objective was to provide data to assess the impact of deep-water fisheries on and their interaction with the ecosystem. The working up of historical surveys and the accurate recording of landings and discards are essential prerequisites for such studies. A knowledge of the community structure and the biological parameters, especially age and reproduction, is also essential. The Project has provided such data and these data have or are being used for this purpose.

2.18.6. Major publications

The theme session O, on deepwater fish and fisheries at the ICES annual science conference 1998 (Lisbon, Portugal) was held by the end of the project. Several communications were issued from the project, some of which were published in a special issues of Fisheries research. The full list of communications to ICES ASC is available at: http://www.ices.dk/products/CMdocs/94-99/yel98.asp#DeepwaterFish.

Some of the communication from the theme session above were published in a special issue in Fisheries Research, Volume 51, Issues 2-3, Pages 105-417 (May 2001).

2.19. FISBOAT (FISHERY INDEPENDENT SURVEY BASED OPERATIONAL ASSESSMENT TOOLS)

2.19.1. Period

2004-2007 (FP6)

2.19.2. Coordinator

Pierre Petitgas, Ifremer, France

2.19.3. Web site address

http://www.ifremer.fr/drvecohal/fisboat/

2.19.4. Main objectives

FISBOAT will tackle the major issue of unreliable fish stock assessment through the use of new methods based exclusively on research vessel survey data.

The project will:
* Evaluate how these methods perform in producing advice within defined management criteria, such as determining the optimum level of harvesting
* Study the sensitivity of the methods in anticipating changes in population biology and survey performance
* Compare, through case studies, test results and the corresponding management advice with historical records and actual events in specified fisheries

2.19.5. Main outcomes

The Fisboat project was aimed at developping fish stock assessment tools that are based on fishery independent research survey data only and evaluate how these tools perform in providing diagnostics and advice in different management contexts. The survey-based assessment included indices of demography, total mortality, spatial occupation, biological traits leading to comprehensive stock diagnostics. The project involved several disciplines: population biology, survey methods, stock assessment, management. The project case studies spanned a diversity of European stocks and regional seas : Barents sea cod, North Sea cod and herring, Baltic sea cod, Bay of Biscay hake and anchovy, Thyrrenean sea red mullet, Ionian sea hake, Aegean sea hake.
The project has developed fishery-independent survey-based methods and tools to assess on fish stocks. The project has developed the capacity to calculate fish populations' indices of abundance, vital traits and spatial distribution, monitor changes in their time series and formulate comprehensive indicator-based diagnostics. The successful application of methods and tools to all project case studies proved the feasability of the procedures and the operationality of the tools in providing fisheryindependent survey-based assessment and advice. Methods and applications were compiled as published manuals (ICES CM 2007/O:27 and O:16). The Fisboat indicator-based procedures suggest a way to achieve an operational and comprehensive monitoring system of fish stocks with an ecosystem perspective. The project has also developed survey-data-only assessment models which span a diverse range of data requirements, from aggregated biomass to length-structured and age-structured models. These models allow for the estimation of abundance, catchability and mortality indices. Models preformances were bench-mark tested using simulated test data sets with known

characteristics. A manual of methods compiling models documentations and performances was produced (ICES CM 2007/O:04).
Because survey-based assessment procedures used indices and indicators, simulation evaluating their performance was a natural complement. The project developed under the FLR framework a simulation evaluation loop comprising an age-structured population model, a survey-like observation model, a harvest model as well as graphical and statistical outputs summarising simulation results. The tools and their case study applications were documented in specific manuals. The simulation experiments that were run on the case studies allowed to investiage key issues including which are the harvest rules that are robust to uncertainties in the population dynamics as well as in the precision of survey indices. The FLR simulation plateform was appropriate for the current TAC-based management context within ICES waters. Another simulation plateform (ALADYM) was also developed. It used a more biologically complex population model, which was useful in other management situations, e.g. Mediterranean waters, where fishery landings are not controlled and where so called 'technical measures' are envisaged as management options. The ALADYM simulation plateform allowed to investigate combinations of fish stock biological traits with management measures on the long-term sustainability of the population. Methods, tools and results of applications to case studies were reported in documents produced as manuals. In all, the project developed operational tools and applied these on case study applications with success, thus demonstrating the possibility to monitor fish stocks using fishery-independent survey-based procedures and provide advice in different management contexts. The comprehensive indicator-based diagnostics combined with simulation evaluation tools had the potential to increase the reliability of the diagnostics and advices. Ways on how to create comprehensive assessments have been reported in a document cross-cutting all project aspects.

2.19.6. Major publications

Special issue: Fish Stock Assessments Using Surveys and Indicators, Aquatic Living Resource, Vol. 22 / 2 - April-June 2009

2.20. HERMES (Hotspot Ecosystems Research on the Margins of European Seas)

2.20.1. Period

2005-2009 (FP6)

2.20.2. Coordinator

NERC/National Oceanography Centre Southampton, UK

2.20.3. Web site address

http://www.eu-hermes.net/

2.20.4. Main objectives

HERMES studied "hotspot" ecosystems: discontinuous environments that are constrained by chemical, physical, topographic and geological factors and which contain a wealth of unknown species that thrive in insular habitats. Determining the distribution as well as the resilience of these ecosystems is fundamental to producing plans for their sustainable management.

2.20.5. Main outcomes

:Commercial fishing in the NE Atlantic could be harming deep-sea fish populations a kilometre below the deepest reach of fishing trawlers, according to a 25-year study published on 11 March 09. Scientists have long known that commercial fishing affects deep-water fish numbers, but its effects appear to be felt twice as deep as previously thought.
Populations of NE Atlantic commercial deep-water fish have dwindled since deep-water fishing started in the area in the late 1980s, but it wasn't until 2003 that catch quotas were recommended. Researchers started mapping the distribution of deep-water fish on the slopes off the west coast of Ireland in 1977 up to 1989 - before any fishery was established in the region, and again from 1997 until 2002. As part of HERMES, the researchers then compared the abundance of fish in the two different periods. They unexpectedly found that deep-sea fish numbers down to 2500 metres - a kilometre below the deepest reach of fishing trawlers - were lower in the later 1997 to 2002 period. Not only this, but target species and non-target species were both affected and in much deeper parts of the ocean. Numbers of one species of eel has dropped by half. Most deep-water trawlers harvest down to 1600 metres.

2.20.5.1. Major publications

Hermes species issue: Oceanography, volume 22 (1), March 2009.

Bailey et al. (2009) Long-term changes in deep-water fish populations of the north-east Atlantic. Proc.Royal Soc. B

Priede, I. G., Godbold, J. A., Niedzielski, T., Collins, M. A., Bailey, D. M., Gordon, J. D. M., Zuur, A. F. (in press). A review of the spatial extent of fishery effects and species vulnerability of the deep-sea demersal fish assemblage of the Porcupine Seabight, Northeast

Atlantic Ocean (ICES Subarea VII). ICES Journal of Marine Science, fsq045. 10.1093/icesjms/fsq045

Full list of papers accessible at: http://www.eu-hermes.net/publications_public.html

2.21. Project IBEFISH (Interactions between Environment and Fisheries)

2.21.1. Period

01/12/2006-01/09/2007

2.21.2. Coordinator

Mr Riku Varjopuro, Finnish Environment Institute

2.21.3. Web site address

http://www.environment.fi/syke/ibefish

2.21.4. Main objectives

IBEFish had two major objectives: 1) to share the results and theoretical understandings gained in past projects with regard to the ecosystem approach in fisheries management, with a special focus on the role of participation in integrated management of the interaction between environment and fisheries; and 2) to make practical recommendations for improving fisheries management towards an ecosystem-based approach especially emphasising the need for an enhanced knowledge-base, legitimacy and trust-building in the management.

2.21.5. Main outcomes

The project concludes that institutional innovation is required for implementing ecosystem-based approach to fisheries management (EBAFM), and that such innovation can best be achieved by engaging in a delicate process of societal decision-making. IBEFish defined an analytical frame consisting of four main criteria: Information management, Legitimacy, Social dynamics and Costs. Six important lessons regarding these four criteria and two transversal issue (scale and cross-sector interaction) can be drawn regarding the institutional innovation towards ecosystem-based approach to fisheries management.

See details on http://www.environment.fi/default.asp?contentid=339510&lan=EN

2.21.6. Major publications

Special issue of Marine Policy, Volume 32, Issue 2, Pages 147-254 (March 2008) Interaction Between Environment and Fisheries

2.22. Project IMAGE (Indicators for fisheries management in Europe)

2.22.1. Period

01/11/2006 – 01/11/200 (FP6)

2.22.2. Coordinator

Dr Gerjan Piet, IMARES

2.22.3. Web site address

http://www.fishindicators.eu/

2.22.4. Main objectives

- to develop an operational framework of candidate indicators to support ecosystem-based fisheries management,
- to elaborate these indicators into comprehensive dashboards to support management decision making,
- to develop methodology to integrate this information into tools supporting the decision making process,
- to develop a framework that can evaluate management strategies based on indicators, and
- to test their applicability in regional case studies, taking into account the diversity of the fishery systems in Europe.

2.22.5. Main outcomes

2.22.6. Major publications

Blanchard, J. L., Coll, M., Trenkel, V. M., Vergnon, R., Yemane, D., Jouffre, D., Link, J., Shin, Y.-J. (2010) Trend analysis of indicators: a comparison of recent changes in the status of marine ecosystems around the world. ICES Journal of Marine Science, 67, 732-744.

Cotter, J., Petitgas, P., Abella, A., Apostolaki, P., Mesnil, B., Politou, C.-Y., Rivoirard, J., Rochet, M. J., Spedicato, M. T., Trenkel, V. M., and Woillez, M. 2009. Towards an ecosystem approach to fisheries management (EAFM) when trawl surveys provide the main source of information. Aquatic living resources, 22: 243-254.

Dambacher, J. M., Gaughan, D. J., Rochet, M. J., Rossignol, P. A., and Trenkel, V. M. 2009. Qualitative Modelling and Indicators of Exploited Ecosystems. Fish and Fisheries, 10: 305–322.

Daurès, F., Rochet, M. J., Van Iseghem, S., and Trenkel, V. M. 2009. Fishing fleet typology, economic dependence, and species landing profiles of the French fleets in the Bay of Biscay, 2000-2006. Aquatic living resources, 22: 535–547.

De Lara, M., Doyen, L., Guilbaud, T., and Rochet, M.-J. 2007. Is a management framework based on spawning stock biomass indicator sustainable? A viability approach. ICES Journal of Marine Science, 64: 761-767.

Frisk, M. G., Duplisea, D. E., Trenkel, V. M. In press. Exploring the abundance-occupancy relationships for the Georges Bank finfish and shellfish community from 1963-2006. Ecological Applications.

Lorance, P., Bertrand, J. A., Brind'Amour, A., Rochet, M. J., and Trenkel, V. M. 2009. Assessment of impacts from human activities on ecosystem components in the Bay of Biscay in the early 1990s. Aquatic living resources, 22: 409-431.

Piet, G. J., Jansen, H. M., and Rochet, M.-J. 2008. Evaluating potential indicators for an ecosystem approach to fishery management in European waters. ICES Journal of Marine Science, 65: 1449-1455.

Prigent, M., Fontenelle, G., Rochet, M.-J., and Trenkel, V. M. 2008. Using cognitive maps to investigate fishers' ecosystem objectives and knowledge. Ocean & Coastal Management, 51: 450-462.

Rochet, M. J., Prigent, M., Bertrand, J. A., Carpentier, A., Coppin, F., Delpech, J.-P., Fontenelle, G., Foucher, E., Mahé, K., Rostiaux, E., and Trenkel, V. M. 2008. Ecosystem trends: evidence for agreement between fishers' perceptions and scientific information. ICES Journal of Marine Science, 65: 1057-1068.

Rochet, M. J., and Trenkel, V. M. 2009. Why and how could indicators be used in an ecosystem approach to fisheries management? In Future of Fishery Science in North America, pp 209-226. Ed. by R. J. Beamish and B. Rothschild. Fish & Fisheries Series, 31, Springer,

Rochet, M. J., Trenkel, V. M., Carpentier, A., Coppin, F., Gil de Sola, L., Léauté, J.-P., Mahé, J.-C., Maiorano, P., Mannini, A., Murenu, M., Piet, G. J., Politou, C.-Y., Reale, B., Spedicato, M. T., Tserpes, G., and Bertrand, J. A. Submitted. Do changes in environmental pressures impact marine communities? An empirical assessment.

Trenkel, V. M., and Rochet, M.-J. In press. Combining time trends in multiple metrics for identifying persistent changes in population processes or environmental stressors. Journal of applied ecology,

Trenkel, V. M., and Rochet, M. J. 2009. Intersection-union tests for characterising recent changes in smoothed indicator time series. Ecological Indicators, 9: 732 – 739.

Trenkel, V. M., Rochet, M.-J., and Mesnil, B. 2007. From model-based prescriptive advice to indicator-based interactive advice. ICES Journal of Marine Science, 64: 768-774.

2.23. Project INDECO (Developing environment indicators for assessing fishery management)

2.23.1. Period

01/12/2004 – 01/12/2006

2.23.2. Coordinator

Mrs Indrani Lutchman, Institute fro European environmental policy, London, UK

2.23.3. Web site address

http://www.ieep.org.uk/research/INDECO/INDECO_home.htm (apparently not maintained)

2.23.4. Main objectives

INDECO seeks to ensure a coherent approach to the development of indicators at EU level, in support of environmental integration within the CFP and internationally. It achieve this by:

- Synthesising existing research and analysis from national, EU and international sources
- Using operational models establishing the relationship between fishing activities and changes in the marine environment to underpin some of the ecological indicators
- Identifying data gaps and ways of addressing them
- Seeking ways of ensuring that agreed indicators are subsequently used in the policy process

2.23.5. Main outcomes

The Final Analysis and Evaluation of the INDECO Indicators (Lutchman et al. 2007) presents an evaluation of the list of INDECO indicators with specific consideration of their usefulness, practicability and to what extent they address the policy objectives of the CFP. The financial, administrative and institutional feasibility of implementing these indicators are discussed and final recommendations are proposed.

2.23.6. Major publications

INDECO reports are available at (enter "indeco" in the search box):
http://www.ieep.eu/publications/publications.php?search=41&page=0&limit=5

Lutchman, I., Rochet, M.-J., Tasker, M., Brown, J., (2007). Final Analysis and Evaluation of the INDECO Indicators, INDECO, Project Deliverable Numbers 23 and 24, 39 pp.

2.24. OTOMIC (Otolith microchemistry as a means of identifying stocks of deep-water demersal fish)

2.24.1. Period

January 1999 to December 2001 (Shared Cost FAIR Contract 98-4365)

2.24.2. Coordinator

Dr. J.D.M. Gordon, Scottish Association for Marine Science

2.24.3. Partners

Institut Mediterraneo de Estudios Avanzados, Palma de Mallorca , Spain
Port Erin Marine Station, University of Liverpool, Uk

2.24.4. Web site address

Not maintained
See executive summary at:
http://www.sams.ac.uk/research/SAMS%20Honorary%20Fellows/dr-john-gordon/deepwaterfish/research/SAMS%20Honorary%20Fellows/dr-john-gordon/deepwaterfish/otolith

2.24.5. Main objectives

The main objective of OTOMIC was to assess the use of otolith microchemistry as a possible tool for defining the stocks of different deep-water fish species of the Atlantic and Mediterranean.
It is known that fish otoliths incorporate elements from the environment as they grow and the otoliths are assumed to be metabolically inert. It is therefore reasonable to suppose that if a species lives and grows in a discrete area, the elemental signature in its otolith would be distinct. However, if a species has its early life in one area or depth zone and moves to another later in its life cycle, then it should be possible to distinguish changes in the elemental signature in samples from different parts of the otolith.

2.24.6. Main outcomes

See executive summary at:
http://www.sams.ac.uk/research/SAMS%20Honorary%20Fellows/dr-john-gordon/deepwaterfish/research/SAMS%20Honorary%20Fellows/dr-john-gordon/deepwaterfish/otolith

2.24.7. Main publications

Gordon, J. D. M., Swan, S. C., Geffen, A. J. and Morales-Nin, B. 2001. Otolith microchemistry as a means of identifying stocks of deep-water demersal fishes (OTOMIC). NAFO SCR Doc. 01/100 Serial No. N4488.

Swan, S. C.; Gordon, J. D. M.; Morales-Nin, B.; Shimmield, T.; Sawyer, T.; Geffen, A. J. (2003) Otolith microchemistry of Nezumia aequalis (Pisces: Macrouridae) from widely different habitats in the Atlantic and Mediterranean. Journal of the Marine Biological Association of the UK, 83, 883-886.

2.25. POORFISH (Probabilistic assessment, management, and advice model for fisheries management in the case of poor data availability)

2.25.1. Period

2005-2008 (FP6)

2.25.2. Coordinator

Pierre Failler, University of Portsmouth

2.25.3. Web site address

http://www.poorfish.eu/

2.25.4. Main objectives

The objective of the project was to create an advisory system (assessment, advice, and/or management) approach based on methods able to deal with data poor systems (utilizing both expert knowledge and published information in addition to existing data sets). In practical words, this implied the development of guidelines for assessment and management of fisheries for sustainability in data poor situations.
There are basically at least three types of data poor situations:

- Small scale fisheries with usually several target species of otherwise mixed fisheries (many coastal fisheries in Mediterranean and northern Baltic areas)
- Large scale, but recently developed fisheries (many deep sea fisheries belong to this group)
- Large scale fisheries, where the quality of data is getting worse (poor data due to e.g. misreporting and discarding)

2.25.5. Main outcomes

Early in the project two general frameworks were identified to underpin advice – Bayesian approaches (Bayesian belief networks and WinBUGS) and the FLR framework. These methods formed a continuum where an increase in data available allowed the scientist to flexibly progress between approaches. These frameworks were tested and developed using eight data poor case studies within the project. A number of scientific presentations and papers were produced to demonstrate this approach. Guidelines on these approaches are soon to be published within the Fisheries Research journal. One of the case studies focused upon blue ling and utilized the FLR approach. A scientific paper analyzing the information to underpin the model has been published (Large et al., 2010), and the model results of the potential impacts of closed areas on the stock were presented at the project international workshop in Majorca, 2008. Work to further refine these approaches will continue in other projects (including DEEPFISHMAN).

2.25.6. Major publications

Large, P. A., Diez, G., Drewery, J., Laurans, M., Pilling, G. M., Reid, D. G., Reinert, J., South, A. B., Vinnichenko, V. I. (2010). Spatial and temporal distribution of spawning aggregations of blue ling (Molva dypterygia) west and northwest of the British Isles. ICES J. Mar. Sci. 67(3), 494-501.

Pilling, G.M., Apostolaki, P., Failler, P., Floros, C., Large, P.A., Morales-Nin, B., Reglero, P., Stergiou, K.I., and Tsikliras, A.C. 2008. Assessment and management of data-poor fisheries. In Advances in Fisheries Science. 50 years on from Beverton and Holt, pp. 280-305. Blackwell Publishing, Oxford. xxi + 547 pp

2.26. PRONE (Precautionary risk methodology in fisheries)

2.26.1. Period

2006-2008 (FP6)

2.26.2. Coordinator

Sakari Kuikka, University of Helsinki

2.26.3. Web site address

http://www.prone-fish.eu/

2.26.4. Main objectives

The aim of the project is to improve the Assessment, Management and Communication of risk and to provide an integrated approach including biological, economic and social objectives. Within the field of biological risk analysis progress has been made in evaluating management systems using simulation (Kell et al., in press) and currently effort is being made to integrate economic aspects. However, a systematic approach including biological, economical and social risks is missing in European fisheries management. A strategic approach to risk management is clearly needed. The tasks of the project are therefore:

- Review the current state of the art, identify weaknesses within the current fisheries science and management framework (assessment, management and communication of risk information) and identify potentially useful approaches being used elsewhere (economics, engineering, food safety, toxicology, etc).
- Identify the knowledge requirements for existing fisheries management systems and link these to the ability to reach management objectives using the available control tools.
- Identify the key controllable elements in different management systems and their ability to manipulate the system to achieve management objectives.
- Improve risk assessment and management tools to develop, implement and run appropriate risk management strategies in fisheries.
- Provide an executive summary of the elements required within differing fisheries management system to meet management objectives.
- Link together the biological, economic and social elements to be used in fisheries advice.
- Evaluate the understandability and interest to use risk information in alternative management schemes.
- Create a risk framework, where risk classification is used to communicate risks and show the responsibilities of actors and their dependencies.
- Suggest a risk framework for European fisheries management and advice on the adaptation of it to advisory systems and international agreements.

2.26.5. Main outcomes

2.26.5.1. Major publications

2.27. SAFMAMS (Scientific Advice for Fisheries Management on Multiple Scales)

2.27.1. Period

2005-2008 (FP6)

2.27.2. Coordinator

Douglas Clyde Wilson, Innovative Fisheries management -Aalborg University Research Centre, Danmark

2.27.3. Web site address

http://www.ifm.dk/Safmams/index.htm

2.27.4. Main objectives

2.27.5. Main outcomes

SAFMAMS collated insights from existing research projects and management processes on the most useful forms of scientific advice for marine environmental management and communicated those insights to scientists and decision makers. The product is an outline of the various forms that such advice can take and a description of the circumstances under which these various forms are the most useful and cost effective.

The project involved three basic tasks.

First, we collated information relevant to the forms that scientific advice can and should take from research projects focussed on fisheries management.

Second, we interacted with nine sets of stakeholders involved in fisheries management decision making at various scales to help us sharpen the practical lessons from what we gathered from the research results.

Third, we carried these lessons from fisheries to the broader marine management community, and beyond to people with a general interest in the relationship between science and policy, through specific networking and dissemination activities. This audience included various levels of government, science policy scholars, user groups and conservation NGOs. Lessons are applicable in a broad sense across Europe in Atlantic, Mediterranean and freshwater fisheries as well as other areas where science and policy converge.

2.27.6. Major publications

2.28. TECTAC

2.28.1. Period

2002-2005 (FP5)

2.28.2. Coordinator

Paul Marchal, Ifremer, France

2.28.3. Web site address

web site no longer maintained

2.28.4. Main objectives

The overall objective of the TECTAC project was to supply fisheries managers with a modelling tool that would allow them to evaluate the impact of regulations (TACs, MAGPs, area and season closures, subsidies) on the dynamics of fleets ("fishing effort"), catch rates and the pressure exerted on fish stocks ("fishing mortality").

2.28.5. Main outcomes

The TECTAC project has allowed major improvements to be undertaken in the modelling of fishing effort and lead to the inclusion of novel modules in the TEMAS and ISIS-Fish models, two bio-economic models for fisheries advice and management, which may be exploited by fisheries advisers and decision makers. In addition, its results are directly relevant to a "Communication on improving fishing capacity and effort indicators under the Common Fisheries Policy" (COM (2007) 39 final) that was adopted by the Commission in February 2007, and aims to open a debate on the most appropriate way to quantify fishing capacity and fishing effort in the framework of the Common Fisheries Policy.

2.28.6. Major publications

Some pre-publications of the papers listed below can be found at http://archimer.ifremer.fr/ together with PhD thesis and a few other document in French related to the TECTAC project (enter TECTAC in the search field).
The main part (i.e. not including appendices) of the final TECTAC report is available at: http://www.ifremer.fr/deepfishman

Drouineau, H., Mahevas, S., Pelletier, D., Beliaeff, B. Assessing the impact of different management options using ISIS-Fish: the French Merluccius merluccius - Nephrops norvegicus mixed fishery of the Bay of Biscay. *Aquatic living resources* 19 (1), 15-29.

Holley, J.-F., and Marchal, P. 2004. Fishing strategy development under changing conditions: examples from the French offshore fleet fishing in the North Atlantic. *ICES J. Marine Science*, 61, 1410-1431.

Hutton, T., Mardle, S., Pascoe S., and Clark, R. A. 2004. Modelling fishing location choice within mixed fisheries: English North Sea beam trawlers in 2000 and 2001. *ICES Journal of Marine Science*, 61, 1443–1452.

Marchal, P., Andersen, B., Bromley, D., Iriondo, A., Mahévas, S., Quirijns, F., Rackham, B., Santurtun, M., Tien, N., and Ulrich, C., 2006. Improving the definition of fishing effort for important European fleets by accounting for the skipper effect. *Canadian Journal of Fisheries and Aquatic Sciences*, 63, 510-533.

Marchal, P., Andersen, B., Caillart, B., Eigaard, O., Guyader, O., Hovgaard, H., Iriondo, A., Le Fur, F., Sacchi, J., and Santurtún, M., 2007. Impact of technical creeping on fishing effort and mortality for a selection of European fleets. *ICES Journal of Marine Science*, 64, 192-209.

Marchal, P., Poos, J.-J., and Quirijns, F., 2007. Linkage between fishers' foraging, market and fish stocks density: examples from the North Sea fisheries. *Fisheries Research*, 83, 33-43.

Pascoe, S., Koundouri, P., Bjoerndal, T. (2007). Estimating Targeting Ability in Multi-Species Fisheries: A Primal Multi-Output Distance Function Approach. *Land Economics* 83(3), 382-397.

Soulie, J. C., Thebaud, O. (2006). Modeling fleet response in regulated fisheries: An agent-based approach. *Mathematical and Computer Modelling* 44 (5-6), 553-564.

Ulrich, C., and Andersen, B.S. 2004. Dynamics of Danish fisheries, and flexibility of Danish vessels activity between 1989 and 2001. *ICES Journal of Marine Science*, 61, 308-322.

2.29. UNCOVER (Understanding the Mechanisms of Stock Recovery)

2.29.1. Period

2006-2010

2.29.2. Coordinator

Cornelius Hammer, Institute for Baltic Sea Fisheries Rostock

2.29.3. Web site address

http://www.uncover.eu/

2.29.4. Main objectives

The purpose of UNCOVER is to develop recovery strategies for EU fish stocks that are outside safe biological limits. The principle objectives are to:

- Identify changes occurring during stock decline and their consequences for the prospects of stock recovery
- Enhance the understanding of environmental and biological mechanisms of fish stock recovery

To fulfil these objectives, UNCOVER will take a multidisciplinary approach to:

- Synthesise and integrate relevant information from previous and ongoing research programmes
- Evaluate and develop strategies that incorporate biological and environmental factors, as well as technical and socio-economic constraints

2.29.5. Main outcomes

The introduction to an ICES/PICES symposium entitled "Rebuilding depleted fish stocks: biology, ecology, social science, and management strategies" provided an overview of the project outcome as the main conclusion from the symposium held at the end of the project (Hammer et al. in press). Some of the main symposium outcome were that:

- on-going exploitation impacts the recovery rate of depleted stocks as well as biotic (trophic) and environmental conditions);
- Modelling results indicate that full rebuilding to the original state in terms of genetic and phenotypic stock structure could be extremely slow, much slower than the estimates of stock biomass recovery alone would suggest;
- simulation tools allowing to integrating existing and non-existing knowledge and for converting uncertain science into practical advice for management support are available
- Integration of socio-economic aspect into policies for rebuilding requires a participatory approach involving fishers, managers, scientist and NGOs
- Monitoring and management strategies of rebuilding are still under development but they require clear management objectives. Stock rebuilding requires objective performance criteria to be developed and agreed upon, followed by rapid reduction of fishing mortality tuned to the specific life-history of the depleted stock.

2.29.6. Major publications

ICES/PICES/UNCOVER Symposium 2009 on Rebuilding Depleted Fish Stocks -

Biology, Ecology, Social Science and Management Strategies, 3 – 6 November 2009 Warnemünde/Rostock, Germany (book of abstracts at: http://www.uncover.eu/index.php?id=85)

Andersen, K. H., Rice, J. C. (in press). Direct and indirect community effects of rebuilding plans. ICES Journal of Marine Science. 10.1093/icesjms/fsq035

Hammer, C., Kjesbu, O. S., Kruse, G. H., Shelton, P. A. (in press). Rebuilding depleted fish stocks: biology, ecology, social science, and management strategies. ICES Journal of Marine Science. 10.1093/icesjms/fsq039

Payne, M. R. (in press). Mind the gaps: a state-space model for analysing the dynamics of North Sea herring spawning components. ICES Journal of Marine Science. 10.1093/icesjms/fsq036

Petitgas, P., Secor, D. H., McQuinn, I., Huse, G., Lo, N. (in press). Stock collapses and their recovery: mechanisms that establish and maintain life-cycle closure in space and time. ICES Journal of Marine Science. 10.1093/icesjms/fsq082

Rijnsdorp, A. D., van Damme, C. J. G., Witthames, P. R. (in press). Implications of fisheries-induced changes in stock structure and reproductive potential for stock recovery of a sex-dimorphic species, North Sea plaice. ICES Journal of Marine Science. 10.1093/icesjms/fsq049

Vikebo, F. B., Husebo, A., Slotte, A., Stenevik, E. K., Lien, V. S. (in press). Effect of hatching date, vertical distribution, and interannual variation in physical forcing on northward displacement and temperature conditions of Norwegian spring-spawning herring larvae. ICES Journal of Marine Science. 10.1093/icesjms/fsq084

Annexe I

CEVIS Publishable Summary

3. Problem and Research Strategy

The Comparative Evaluations of Innovative Solutions in European Fisheries Management (CEVIS) Project was a three year exploration of how science can address policy questions at perhaps their most general level. With an eye toward possible implementation under the CFP we evaluated four management innovations that were receiving the most attention in current discussions of potential changes in European fisheries management at the time we developed the project:

- Participatory approaches to fisheries governance;
- Rights-based regimes;
- Effort-control regimes; and,
- Decision-rule systems.

While we use the term 'innovations' to indicate that these approaches to management had not been used extensively in Europe at the time we developed the project, these were not new or untested ideas and all of them had been incorporated into modern fisheries management regimes in developed countries. All of them were also being widely discussed within Europe as options for the Common Fisheries Policy (CFP) as the CFP moved towards a more adaptive and ecosystem-based approach to fisheries management.

The project had two phases. The first phase used a cross-disciplinary approach. During this phase we carried out four in-depth studies of areas outside of Europe where innovative fisheries management regimes have been implemented. These were New Zealand, Canada, Alaska, and Iceland. The visits were made by teams that included at least one social scientist and one natural scientist. Cross-disciplinary teams carried out the research using social science methods based on carrying out and analyzing in-depth interviews. They did a literature review of fisheries management in the area and then made visits of approximately two weeks where they interviewed various stakeholders. These areas were chosen because they had implemented at least two of the innovations that CEVIS was interested in investigating. Chapters Two through Five of this book are the reports of these studies.

The second phase was carried out in disciplinary working groups and took a basically multi-disciplinary approach. Each working group focused on one of the objectives identified in the original project call to be used as the basis of the evaluation of the innovations. In order to get a handle on the objective described in that call as 'robustness with respect of varying conditions' we decided to focus on the 'biological robustness' of the fish stocks and the 'social robustness' of the management institutions. So the disciplinary working groups were four: two run by economists examining the innovations with respect to economic efficiency and costs of management; a group of biologists examining the innovations with respect to biological robustness; and, a group of social scientists examining social robustness. All four groups used data from Europe, including the Faroe Islands. Their assignment was to identify and test specific hypotheses about the relationship between the innovations and their objectives using the methods and data that could be feasibly applied from their discipline.

The approach we took was predicated on the following levels of analysis:

- Social robustness would be examined at the level of the fishing community;

- Economic efficiency would be examined at the level of the fleet;
- Biological robustness would be examined at the level of the fish stock; and,
- Costs of management would be examined at the level of the polity.

4. CEVIS Results

The results of CEVIS have been published in the form of a book entitled Comparative Evaluations of Innovative Fisheries Management: Global Experiences and European Prospects, which is forthcoming from the Springer Publishing Company. This summary is abstracted from the introduction and conclusion of that volume. The overall results are extensive and complex. This summary is not meant as an alternative to reading the more detailed discussions of issues of interest. However, it does provide a shortcut to the main findings for busy people interested in general fisheries management policy. The section is organized by the four main innovations and offers a few general findings about each.

4.1. PARTICIPATORY GOVERNANCE

1. **Participation can increase the quality of many aspects of fisheries management**. Participation in fisheries management may take many forms, and in this book they include consultation in regulation questions, local management, fishermen's contribution to the knowledge base, and consultation on the overall objectives and means. Participatory governance can increase the quality of many aspects of fisheries management, including increased support of the system and better conflict management. The case studies on New Zealand, Canada, Alaska and the Faroe Islands revealed pride among management stakeholders. It is worth noting, however, that in many cases after a set of institutional changes the group of stakeholders that remains involved is smaller than before and the voices of those who are excluded are no longer heard. Even in broadly participatory programmes the highest positive regard from stakeholders for the system will be from the representatives of stakeholder groups rather than grassroots members. Of course, they are the voices of their group and are the ones that managers have to deal with most directly.
The Baltic case shows what may happen when innovations or new forms of regulations are implemented in a top-down fashion. The management system lacks acceptance and trust and fishermen comply much less frequently with the rules. A fundamental distrust may make any change difficult to accept and thereby hamper institutional learning. Participatory governance may thus help manage conflicts, which are increasing and spreading with the advent of spatial management being carried out in the context of broader marine spatial planning. Participation and trust can also create institutional contexts in which it is easier for people to behave responsibly and thereby have a positive effect on biological robustness. The Community Management Boards in Canada demonstrated increased responsibility for the resource and improved the commitments to scientific advice. A similar sense of responsibility was observed in the Alaska case, where scientific advice enjoyed trust and respect in the participatory TAC-setting process in the Fisheries Management Council.
2. Excluding the broader civil society may reduce gains from participation.
While almost all CEVIS cases included some form of participatory governance, both European and non-European cases include examples where representation of organisations from civil society is limited. The civil society may be less relevant in the direct management of the fishery. For example direct participation by civil society in the Biesheuvel Groups in the Netherlands or the Community Management Boards in Canada, where day-to-day conservation is acted out, would have less impact on reaching fisheries management goals than it would in the European Regional Advisory Councils where broader conservation goals

are set. A relevant issue for future Europe is to discuss the role of environmental NGOs and civil society in general and at what scale their influence is most relevant. The Alaska case exemplifies that environmental organisations have used campaigns, court cases and eco-labelling as tools to influence public opinion. However, they also expressed a wish to have a voting member on the North Pacific Fisheries Management Council, implying that they did consider a role in negotiations as fruitful for achieving their objectives.

3. Participation is important in science and data collection as well as management.

Participatory governance can also imply changes in the role of science from simply 'telling the answers' to cooperation with stakeholders on the knowledge production and evaluation. Icelandic fishermen decide half of the fishing locations for the scientific ground fish survey. Alaska stakeholders evaluate factors to ensure optimum yield. Canadian stakeholders work closely with the same set of scientists over long periods of time in facilitating stock assessments. The fishing industry in the Faroe Islands has a central role in evaluating the scientific advice for effort regulations, and the fishing industry in New Zealand has the responsibility to provide the necessary scientific basis for quota decisions. Participants in all of these exercises report that they increase the trust in scientists and confidence in their results, while scientists report that they are able to maintain scientific quality.

In CEVIS, the EU cases on the interface between science and stakeholders focus on the quality of catch data, i.e. discard data and illegal landings. Cooperation in these cases implies improvement of data in the scientific stock assessments. In terms of biological robustness, the studies on discard data suggest that it may be more important to identify and address possible sources of bias than to increase the sample sizes, but that biological robustness may not be affected when only immature fish is discarded. Cooperation to improve the catch data can also improve the economic performance of the fishing fleet. These results were conditioned on a TAC regime as the simulations indicated a slightly negative effect on economic results in an effort scenario. Getting proper data on management costs has been a challenge, but in the Spanish Basque case, the administration costs increased when the RAC was created. It is too early to conclude whether the increased costs will be permanent, or whether these are implementation costs.

4.2. RIGHTS-BASED APPROACHES

4. Transferable rights increase economic efficiency.

Increases in the qualities of fishing rights such as transferability, security and durability clearly increase economic efficiency. This is shown theoretically (Chapter Eleven) and empirically in the cases where Individual Transferrable Quotas (ITQs) have been implemented. These characteristics have developed a sense of ownership and have generated an involvement in management and enhancing of competitiveness. Further, it appears that the rights-holders are more concerned about protecting the resources and environment. An obvious benefit with rights-based systems is that it makes planning easier for rights owners. In Iceland and Alaska, this planning has resulted in efficiency gains, especially with regard to processing. This is particularly so in the latter case as the management system moved away from a dangerous race-for-fish. In Nova Scotia those Community Management Boards that do not allow transfers of IQ among members have had many more problems dealing with exits from the fishery than those that do.

The case studies show several examples where rights are given in exchange for increased responsibilities of the rights owners. The Alaskan cooperatives, the Biesheuvel group and the Canadian Community Management Boards were given the responsibility to do local level management, while the New Zealand industry had to provide and pay scientific advice. The extra burden has been possible to bear economically. In several of the cases the profitability

of the fisheries due to stronger rights has enabled the industry to shoulder additional management services, and hence reduces costs to the public.

5. Rights-based management programmes can and should have a flexible design.

There are many aspects to take into consideration when designing a rights-based management programme, including the nature of the property right, management units, determination of total allowable catch, monitoring and enforcement, need for other regulations, rent extraction and cost recovery and initial allocation. The Iceland and New Zealand cases illustrate that ITQ systems can develop over time so that sufficient flexibility should be built into the ITQ systems to be able to amend and adjust rules. In New Zealand the initial allocation was in fixed tonnage, which had to be changed to an allocation in percentages of the quota.

The case studies show that rights-based management systems change over time and that flexibility of the system combined with institutional learning improve this process. The systems of the North Sea, the Faroe Islands and the Western Shelf demonstrated capacities for institutional learning and for keeping a fairly high stakeholders' acceptance among the commercial actors. However, the institutional learning within the rights-based management RBM systems was mostly geared towards making rights more tradable and/or secure or exclusive. Future learning may thereby be reduced since rights-holders will want to maintain the value of their investment in the rights. The ITQ system in Nova Scotia has reduced potentials for adaptive management by locking ecological realities that evolve either naturally or as a result of greater scientific understanding into hard institutional boxes. A fish stock is an ecological reality that is hard to define and that interacts with other ecological realities. Property rights are powerful social constructs with strong implications for policy. Their treatment is much more likely to be determined by courts according to the principles and precedents of property and finance, than by marine managers seeking to take an ecosystem approach.

The initial allocation of quotas has proven to be especially difficult regarding legal aspects, where national rules of equal treatment, the right to a free choice of occupation and the protection against deprivation of property have challenged ITQ systems. Actors that have not received rights may perceive the system to be unfair. The equity problem was partly solved in the Alaska case by buy-out programmes and by offering alternative economic opportunities. In both the Canada and Alaska case though, most of the controversy in relation to the rights-based system stemmed from the initial allocation.

6. Transferability of rights has social costs that it is possible, but difficult, to mitigate.

When rights-based management is introduced it may be an important policy goal to avoid the concentrations of quota either geographically, or in numbers of owners, or both. As in the New Zealand and the Iceland case, the ITQ system in Nova Scotia has intensified the organizational and geographical concentration of the industry. It has also shifted more of the burden of reducing excess capacity to crew members than is perhaps fair. Attempts to reduce these negative impacts through the design of the system and closely related policies have had mixed results and remain controversial. Limits on transfers within groups have reduced concentration in the North Sea and Canadian cases. In the UK some mechanisms have been deployed to favour retiring skippers by maintaining their rights even when they leave the trade. These mechanisms are, however, criticized for creating a class of 'slipper skippers'. Furthermore, when nations aim at protecting fishing communities and own national interests, care must be taken to avoid infringement on European Community law and the EC Treaty. State aid of various forms and ways to shield quotas from being bought by other nationals may not comply with existing laws and agreements. Limits on transferability create a definite cost in economic efficiency. This is directly reflected in the prices of individual quotas which are lower where transferability is limited than where it is not. Determining what the cost in

efficiency actually is for some degree of limits on transferability remains a critical research question.

7. Transferable rights do not reduce capacity but rather make rapid capacity reduction smoother and more humane.

The New Zealand case shows that ITQ systems do not necessarily reduce capacity; capacity was reduced in both the Canadian ITQ system and the Alaska cooperative case, but the reductions cannot be directly traced to the ITQ system. In Alaska there was a buy-out and scrapping programme while the main engines for the reduction were much smaller quotas and the introduction of effective enforcement. The tendency of some stakeholders and even the general public, which we found particularly in the Icelandic and Canadian cases, to use ITQs to explain all the changes in population and employment patterns over the past two decades is a gross oversimplification. The basic lesson seems to be that it is the enforcement of restricted quotas or other fishing opportunities that is the real driver of a reduction in fishing capacity. While not minimizing the problems of equity and pain involved in initial rights allocations, transferable property rights do make the radical capacity reductions that are sometimes required less chaotic and more humane by providing alternatives to bankruptcy as the mechanism for exits from the fishery that are being made unavoidable by the enforcement of restrictions on fishing.

4.3. EFFORT CONTROL

8. Carefully designed MPAs increase biological robustness but with economic costs.

Simulations suggest that MPAs generally have a negative effect on the profitability of most fleets over a period of 10 years. MPAs create increased costs because of fewer options in fishing locations while at the same time reducing short-term catches. This also includes the Danish fleet except that some small fleet segments do show increased profit, likely based on advantageous location vis-a-vis the MPA. Further simulations indicate that spatial and/or temporal closures as a supplement to either TAC systems or effort control improve biological robustness. However, the robustness is very closely linked to how the effort is re-allocated between fleet-segments, areas, and seasons, and is also sensitive to the assumptions in relation to fleet specific catchability. Evaluations of the effect of closures thus require high resolution information on the actual effort allocation by vessel and about fleet behaviour.

9. Effort control increases biological robustness when the link between effort and mortality is controlled.

Simulation studies indicated that effort-based management is more biologically robust than TAC regulations, but that these results are conditioned on allowing sufficient year-to-year variation in effort. Explanatory factors are that advice for TAC-based management is more sensitive to knowledge uncertainties and that effort control results in less discards.

In the case of direct effort management, biological robustness is found to be conditioned on monitoring and controlling the link between fishing effort and fishing mortality. Such a control is challenged by the dynamics of species and fleets, but also environmental factors, all of which influence the relationship between effort and fishing mortality. An effort regime can account for such influences, e.g. by including additional measures on allocation of effort in certain seasons and/or areas. The Faroese case is a counter example where a failure to monitor and control increases in capacity has hampered biological robustness.

4.4. DECISION RULE SYSTEMS

10. Adaptive rule-based systems can increase biological robustness.

Implementing an adaptive approach in harvest control rules has the potential to improve the biological robustness in TAC regimes. This was shown by a simulation study where the TAC was adjusted within the fishing season by including the most recent information. In addition, long-term catches increased. Given the world-wide struggle to implement the ecosystem approach, the management of Alaska groundfish offers a rather pragmatic contribution: an upper limit to all catches in a given ecosystem. The more complex Traffic Light approach in Canada was tried and put aside because it was too complex to give clear guidance, however it is being experimented with again in shrimp management. The Alaska case suggests that TAC regulations can provide a precautionary harvest of groundfish, but that the success of a TAC regime also depends on management measures to make a harvest control effective. The TAC setting process is supported by most stakeholders, the exception being the environmental NGOs who call for greater consideration to reducing the ecosystem impacts of fishing. The same is true in the Regional Advisory Councils, where EU stakeholders are getting a role suggesting and evaluating decision rules, but where environmental NGOs also feel that their participation could be strengthened.