SCIENCE FOR SUSTAINABLE MARINE BIORESOURCES

A report for the Natural Environment Research Council (NERC), the Department of Environment, Fisheries and Rural Affairs (DEFRA) and the Scottish Executive for Environment and Rural Affairs (SEERAD)

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Executive Summary

The Natural Environment Research Council (NERC), the Department for Environment, Food and Rural Affairs (DEFRA) and the Scottish Executive Environment and Rural Affairs Department (SEERAD) commissioned a study to explore the possibility for improvements in the science supporting current and future management needs in the area of Marine Bioresources. The study was endorsed by English Nature (EN), Scottish Natural Heritage (SNH), Joint National Conservation Committee (JNCC), the National Federation of Fishermen’s Organisation (NFFO) and the Department of Agriculture & Rural Development in Northern Ireland (DARDNI). These improvements are expected to broaden and integrate the science on which management is based by establishing multi-disciplinary research teams drawn from across diverse science sectors. It is recognised that this may require new organisational structures that cut across traditional sectoral, disciplinary and institutional boundaries. Significant changes in the funding relationships between governmental and non-governmental bodies are expected as a result. The ultimate objective is to achieve a culture change in the way partners engage in this science area.

The study was conducted over two months in the period January to April 2005, and included visits to key institutions (Universities, NERC Centres, and fisheries laboratories), interviews with scientists and the analysis of submitted forms describing existing research projects.

The study confirmed a number of key issues that need to be addressed:

a) The appreciation that human exploitation of the seas and environmental change are together causing widespread ecosystem change at a pace that is challenging our ability to provide effective scientific advice. As a result, the sustainability of the marine ecosystem is in question.

b) The concern that the marine ecosystem science base in the UK is poorly integrated and highly fragmented. Division in the funding mechanisms, research priorities and research focus between research councils and government departments, and the lack of a clear national marine research strategy is contributing further to this fragmentation. As a result, the use of UK’s marine ecosystem science is not maximised or pulled-through effectively to policy.

c) The realisation that changes in the EU Common Fisheries Policy (CFP), favouring a move towards longer-term forecasting more resilient to uncertainties, a progressive regionalisation of the advice, and a determined intention to apply ecosystem considerations in resource management, provides a window of opportunity to re-focus our research approach, long-term vision and science delivery.

The study concludes that a more strategic and holistic ecosystem-oriented research programme is required, integrating aspects from the natural, social and economic sciences. This programme would be conducted in partnership with conservation bodies and user communities to deliver effective ecosystem-based management solutions. This recognises that the necessary framework for understanding and protecting the structure and function of ecosystems has been lacking. This ambitious programme would need a new implementation platform that reflects the diversity of the scientific and stakeholder communities. It is suggested that this platform takes the name of the Marine Ecosystem Research Partnership (MERP), with the following objective:

“to provide underpinning interdisciplinary knowledge of the functioning of UK’s regional ecosystems to develop sustainable exploitation strategies for marine bioresources, compatible with conservation, and supportive of a diverse and profitable industry”.

The Marine Ecosystem Research Partnership (MERP) should be implemented as a virtual centre of excellence to demonstrate the long-term commitment of the partners to its objectives and goals.

1 ‘Marine bioresources’ is used here as a generic term to describe living resources potentially supplied by marine-based organisms [of all trophic levels] across the whole ecosystem, including humans. This definition excludes aquaculture, but includes non-food products.
However, a central physical body for the Partnership is required to implement the science, to facilitate data access and mobility of resources, and to develop the communication and knowledge-transfer tools required to carry the knowledge through to management applications.

A research programme for the first phase of the MERP is proposed, based on an analysis of the UK’s strengths, weaknesses and gaps in this science area, and after broad community consultation. The programme is based on four research modules and one cross-cutting data, communication and knowledge-transfer module:

- Module 1 – Long-term patterns of marine ecosystem variability and change
- Module 2 – Comparative ecosystem functioning of UK’s regional seas
- Module 3 – Spatial and temporal dynamics of key bioresources and ecosystem units
- Module 4 – Governance, ecosystem co-management, and the development of innovative scientific advice
- Module 5 – Data Management, communication and knowledge-transfer

It is suggested that specific research activities be implemented on the basis of consortia bids that address not only scientific needs but also the structural and institutional issues mentioned above. In a second phase, MERP’s research should focus on providing effective feedback to support and optimise existing monitoring strategies of the marine ecosystem, and on the delivery of ecosystem-based management applications capable of reconciling both conservation and the needs of user communities.

Finally, it is recognised that the common European ownership of many marine resources requires the integration of MERP’s research with activities of other European partners. Principles for achieving this integration are briefly introduced.

In conclusion, a number of recent UK-commissioned reports (PMSU 2004, RSE 2004, RCEP 2005), policy changes (CFP 2003), and international agreements, have provided a unified vision of the challenges facing the UK with regards to the conservation and sustainable use of the marine ecosystem. A window of opportunity is offered to respond to these challenges with inclusive scientific vision, but further delay will eventually limit the ability of science to make a difference.
1. Introduction

The Natural Environment Research Council (NERC), the Department for Environment, Food and Rural Affairs (DEFRA), the Scottish Executive Environment and Rural Affairs Department (SEERAD) are seeking to establish a joint venture to tackle critical issues in the area of sustainable exploitation of marine bioresources. The overall thrust expects to:

- integrate the knowledge of fisheries assessment and management, fisheries ecology, marine ecosystems, oceanography, biology and economics held by UK academic, research council and government research organisations

- develop multi-disciplinary research teams drawn from across the UK science sectors, working together under an organisational structure which cuts across traditional sectoral and institutional boundaries, to deliver the best science and management advice that the UK can provide

- achieve a culture change, involving both an opening up of multi-disciplinary access and engagement in this area of marine science, and a significant change in the funding relationships between governmental and non-governmental science.

The first step towards this end was a brainstorming workshop held at the SEERAD-FRS laboratory in Aberdeen on 24-25 May 2004; At this workshop some provisional key science priorities were identified:

- Linking ecosystem variability, fisheries and socio-economics

- Synthesis of knowledge through modelling

- Underpinning of UK marine monitoring programmes

The workshop was followed by a community meeting held at Murrayfield Stadium, Edinburgh on Thursday, 2 September 2004, with the aim of identifying a number of potential scientific foci as well as the nature of such a venture.

To follow on the momentum created, and to crystallise the ideas put forward in these meetings a scoping study was commissioned to identify new areas of underpinning science and possible ways of implementation/partnerships required to achieve a step-change improvement in the sustainable ecosystem-based management of marine bioresources. This scoping study was to include visits to key organisations and stakeholders, and an open call for inputs/views. The study was endorsed by English Nature (EN), Scottish Natural Heritage (SNH), Joint National Conservation Committee (JNCC), the National Federation of Fishermen's Organisation (NFFO) and the Department of Agriculture & Rural Development in Northern Ireland (DARDNI).

The terms of reference of the study are available in Appendix 1.
2. Why a new research activity on “Sustainable Marine Bioresources”?

It is widely acknowledged that a combination of environmental change and human activities are contributing to worldwide changes in marine ecosystems. The pace of these changes is challenging our ability to provide innovative, adaptive scientific advice, and as a result the sustainable and profitable use of the marine ecosystem services is in question.

In addition, the credibility of scientific advice has been challenged. Scientists affiliated to government laboratories are not perceived as independent by all stakeholders; Regularly, their advice is criticised as outdated or incomplete, because it depends on unreliable catch data, because it does not reflect the immediate state of the stocks (the advice process has substantial lags between the most recent data incorporated in the analysis and the implementation of the advice) and because it has no mechanism to incorporate perceived useful knowledge (e.g. changes in distribution or spawning areas as observed by fishers). More often than not though, the lack of credibility for scientific advice reflects poor understanding of scientific methods by the fishing industry as a result of poor communication. Building understanding of and confidence in scientific advice is a significant driver behind the scoping study, and should go hand in hand with improvements in data collection, appropriate treatment of scientific uncertainty and a substantial enlargement of the context of stock assessments. In return this should lead to better access to data and more accurate reporting, thus promoting scientific confidence.

Credibility loss in marine bioresources science is not exclusive to UK. Recognising this fact, the current President of ICES recently recommended a three-pronged approach: separating scientific institutions from management bodies, promoting collaborative research with the fishing industry, and providing transparent quality assurance of scientific advice in a three-pronged approach to address this issue (Sissenwine and Mace 2003).

Governance issues make the management of European fisheries resources extremely complex, and for this reason scientific advice should be robust, historically consistent and therefore justifiably conservative. The other side of the coin though is that EU fisheries management is criticised for “over-simplifying the problem” by relying on single species modelling that assumes that future catches can be forecasted, and that species interactions and ecosystem dynamics can be overlooked. Critics point out that biological uncertainties are not addressed adequately, and that the advice is geared towards providing optimal solutions instead of a set of flexible policy options and associated consequences. There is considerable support to move EU fisheries management beyond short-term forecasts by providing broader advice that takes account of ecosystem dynamics and policy options. This move would be consistent with the European Commission’s desire to move towards a system of advice less sensitive to error, such as one based on harvest-control rules (e.g. European Commission 2004, ICES 2005a).

Many UK institutions currently undertake relevant research in the area of Marine Bioresources, but most of them do not participate in the advisory process conducted through ICES working groups. This is primarily because there is no funding available to invite non-governmental scientists to attend ICES working groups. On the other hand, government scientists are not eligible for many research council and academic funding mechanisms, thus limiting their involvement in R+D projects. These constraints do not encourage cross-fertilization between academic and applied research communities, effectively limiting the ability to develop and apply innovative science. Division of funding mechanisms and priorities between Research Councils and Government Departments, and changes in the funding of science in support of the Common Fisheries Policy by Brussels are a barrier to collaboration, which if removed, could provide a substantial enhanced science base to support marine resource management. The lack of a coordinated, strategic vision and direction across this diverse research base means that non-government science is often poorly focused and of low utility to policy makers while government science is dominated by short-term pressures (reactive science) that inhibit strategic science. The development of strategic research objectives across academic and government Institutions would ensure that fisheries science and advice is accessible, diverse and understood outside a small inner circle.

A strong integrated and interactive science base would address some of these shortfalls, while at the same time would increase the UK’s influence while providing the EU with robust evidence to support policy areas that the UK wishes to develop. The urgency in addressing the reality
expressed above has been recently brought about by a number of scientific, policy and structural drivers, summarised as follows:

2.1. Scientific Drivers

2.1.1 Climate change – Climate change has already been identified as the biggest threat to the planet by the UK Chief Scientific Advisor. It is likely to cause significant changes in the physical, biochemical and biological functioning of the oceans, and its consequences are already obvious. Annual sea surface temperatures around the UK coastline have warmed by 0.5°C in the period 1871-2000. Winter bottom temperatures at all North Sea fishing grounds show a 1.5°C warming since the 1970s (DEFRA 2005). Such changes have already been identified as causing many changes in distribution, diversity (Beaugrand et al. 2002), and phenology (Edwards and Richardson 2004) of marine plankton, plus fish and other nekton (Hawkins et al. 2003). The UKCIP02 climate change scenario report (Hulme et al. 2002) suggests that a continued rise in the temperature of UK’s coastal waters is expected, with the shallowest seas such as in the southern North Sea and English Channel warming the most (between 2-4°C up to the year 2080, AFMEC 2005) whilst those off northwest Scotland expecting to warm the least. Ocean warming will have a direct as well as indirect impact on the marine environment. More responsive and adaptive research will be required, linking monitoring and ecosystem modelling efforts with climate-dependent model parameterisation.

2.1.2 Overfishing – The proportion of commercial fish populations in the area covered by the International Council for the Exploration of the Sea (ICES) that is inside ‘safe biological limits’ has declined from 26% to 16% between 1996 and 2001 (RCEP 2004). In the UK these declines have particularly affected the whitefish sector (cod, haddock, sole and plaice), which are under intense biological and fishing pressure (PMSU 2004). Fishing pressure is particularly intense on large fish. This selective exploitation is known to have caused impacts in ecosystem structure and functioning (Hall 1999, see below), biodiversity loss, and fish stock volatility. There are indications that exploited populations may be losing genetic diversity, which is believed to affect the stock’s capacity to adapt to climate change as well as to local conditions. Other indirect effects of, for example, stock volatility, are that it increases the dependence of marine populations on a favourable environment, because of a reduction in the population age structure and a reliance on new recruits to sustain them. While most experts agree that governance, rather than science, is the weakest link in the management chain (Cochrane 2004, Mace 2004), our research base needs to adapt to help manage resources successfully balancing exploitation and conservation needs, rather than react to excessive ecosystem use.

2.1.3 Changes in ecosystem functioning – Climate change and fishing pressures are both impacting the functioning of our seas. These changes are not necessarily linear or geographically consistent though, because of inherent differences in the functioning of the UK’s regional seas. For example, the Celtic Sea currently requires twice as much secondary production than the North Sea to support pound for pound in landed fish, yet we do not know whether this reflects natural differences in the functioning of the systems or an indication of differential external impacts. As North Sea fisheries are focussed on lower trophic levels in the marine food web than in the Celtic Seas (industrial fisheries for planktivores in the North Sea versus piscivores in the Celtic Seas), the latter hypothesis seems worryingly possible. Trophic analysis suggests that the trophic level of the North Sea has decreased over the last two decades (Jennings et al. 2002), partially as a result of total fish biomass declines, suggesting a reduction in the complexity of the marine ecosystem, with potential consequences for ecosystem resilience. Many other examples of differential changes in the functioning of marine ecosystems have
been observed in UK waters, from climate-induced changes in the biomass and seasonality of phytoplankton blooms (Reid et al. 1998) to fishery-driven changes in seabird abundance as a result of fishing discards (Votier et al. 2004). Clearly, a more adaptive, holistic and innovative science, capable of addressing both climate and anthropogenic impacts at ecosystem level is required.

2.1.4 Need for integrated natural and socio-economic research – Resource managers do not manage the marine ecosystem, but rather the use of ecosystem resources by humans. Therefore, the role of people in the successful management of these resources cannot be overemphasised. However, scientific advice for the purpose of fisheries management is almost entirely void of social and economic components (partially because this research sector is poorly developed in fisheries), creating distrust in and conflict with user communities. The need to build trust between politicians, scientists and the fishing industry through multidisciplinary research that incorporates the concerns, aspirations and knowledge of the user communities is not as recognised as it should be. There are several reasons for this mistrust, including poor understanding of the process leading to the scientific advice, but the principal cause is the exclusion of the fishing industry from the process. Scientific advice is often criticised for been outdated and for using unreliable (misreported) fishing statistics, even though the science cannot be blamed for the lags between the scientific assessment and the implementation of management decisions, nor can it be responsible for the poor reporting of those criticising the advice. There is little doubt, however, that the continuous deterioration in the quality of fisheries data, which is required in the stock assessment process, is compromising the accuracy of the scientific advice, funnelling a spiral of further distrust and potential conflict. This state of affairs can only be addressed through the development of co-management tools involving all stakeholders with adequate buy-in. Cross-disciplinary research in support of co-management arrangements must focus especially on the impacts of management decisions on the stocks themselves, on the ecosystem, on the fishing communities and on the fishing industry, taken into account adaptation and vulnerability issues in both the natural and socio-economic domains. The reformed CFP makes specific reference to the potential of spatially-explicit management to improve sustainability. It would be crucial to develop science that takes into account, at the proper scales, not only the dynamics of the resources, but also of the communities making use of them, in a more innovative, holistic, spatially-explicit and adaptive manner.

2.2. Policy Drivers

UK, European and international policy has evolved steadily and substantially from the implementation of the 1992 United Nations Law of the Sea. Many of these policy changes have not been reflected in our research priorities, in the way we conduct research or on the structures needed to deliver advice. These policy changes, however, provide useful guidelines for future scientific implementation:

2.2.1 The Convention on Biological Diversity – The 5th ordinary meeting of the Conference of the Parties (CoP V, Nairobi 2000) agreed (Decision 6) to “endorse the description of the ecosystem approach ..., call upon Parties .... to apply, as appropriate, the ecosystem approach..., and invited Parties... to identify case-studies and implement pilot projects ...and strengthen regional, national and local capacities on the ecosystem approach;

2.2.2 The 2001 UN Food and Agriculture Organization (FAO) Reykjavik Declaration – The 47 country signatories of this Declaration (UK included) reached agreement to “...individually and collectively work on incorporating ecosystem considerations into management”. For this purpose the signatories agreed to “identify and describe the structure, components and functioning of relevant marine
ecosystems, diet composition and food webs, species interactions and predator-prey relationships, the role of habitat and the biological, physical and oceanographic factors affecting ecosystem resilience”.

2.2.3 The 2002 Johannesburg World Summit for Sustainable Development – The WSSD agreed to target the developing of a coherent network of marine protected areas by 2012 and to restore depleted fish stocks to maximum sustainable yields by 2015.

2.2.4 The reformed European Common Fisheries Policy (2003) – This expresses the need to “…regionalise the management of CFP through the establishment of seven Regional Advisory Councils”. In addition the new CFP has adopted a stronger commitment to the protection of the marine environment as a fundamental objective, and the progressive implementation of an ecosystem-based approach to management.

2.2.5 The European Union “Habitats Directive” (2004) - The aim of this Directive is to contribute towards ensuring bio-diversity through the conservation of natural habitats and of wild fauna and flora in the European territory of the Member States to which the Treaty applies, through a coherent European ecological network of special areas of conservation (Natura 2000).

2.3. Structural Drivers

Finally, a number of recent UK commissioned reports and Institutional statements identify structural issues that need to be considered:

2.3.1 The Department of Food and Rural Affairs (DEFRA) strategy entitled “Safeguarding our seas” (DEFRA 2002), which highlights the need for an ecosystem approach to marine stewardship.

2.3.2 The Science & innovation investment framework 2004 – 2014 (DTI 2004) noted that “Research Councils’ programmes [should be] more strongly influenced by and [science] delivered in partnership with end users of research”, to contribute to greater responsiveness of the publicly-funded research base to the needs of the economy and public services.

2.3.3 The Prime Minister’s Strategy Unit report (PMSU2004) calls for Research Councils, universities and government agencies to pool their scientific expertise to deliver the knowledge and understanding needed to progress the objectives and practice of ecosystem-based fisheries management. The report also highlights the importance of innovative and integrated research to widen the scientific scope of fishery management. This conclusion was endorsed by the Inter-Agency Committee for Marine Science and Technology (IACMST), recognising that fisheries science has diverged from other related sciences, like oceanography and community ecology, in maintaining a focus on single-species descriptions.

2.3.4 The RCEP Report (RCEP2004) recommended changes in the emphasis of research away from management of fish populations towards a wider focus on the marine environment. In order to deliver responsible governance scientific advice needs to be relevant, responsive, respected and right, but it must also provide a better means of dealing with the uncertainties associated with ecosystem complexities.

2.3.5 The DEFRA Integrated Assessment of the State of UK Seas “Charting Progress” (DEFRA 2005) which recommends the development and publication of indicators of ecosystem state, in conjunction with OSPAR and EU works.
programme. This report also recommends the creation of a partnership to provide a national lead in the management and stewardship of marine data and information (MDIP).

2.3.6 The FAO has recognised that the implementation of the Ecosystem Approach to Fisheries (EAF) would require a change of present science and management infrastructures (S. Garcia in ICES 2004b), with particular attention to the following scientific areas:

- Better understanding of ecosystem functioning, variability and change
- Better uncertainty and risk assessment and management
- Improved forecasting capacity
- Identification of key indicators
- Provision for assessment of policy and management options
- Integration of socio-economic sciences
- Broader and effective communication with society
- Area based, possibly with nested structures.
- Goals and choices must be scoped with involvement of stakeholders (including fishermen) from an early stage.
- Cross-sectoral advice to governments, Institutes and stakeholders, possibly through new platforms, such as RACs.

in pursuit of the following EAF objectives (FAO 2003):

- Maintain ecosystem integrity
- Consider species interactions
- Minimize fisheries impact
- Broaden stakeholders participation
- Promote sectoral integration

There is general support of the view that changing the institutions and processes by which fisheries management is applied, as part of the implementation of the EAF, will have immediate payoffs in improving fisheries sustainability (Botsford et al. 1997). While filling scientific gaps is needed, the real challenge may be in crafting new local and regional institutions to deliver policy-relevant science and adequate governance.
3. State of the research in the UK

Having identified the problems, and outlined scientific, policy and structural issues to be addressed, it is important to assess the ability and readiness of the research base to provide the required paradigm shift. As part of the scoping study members of the research, policy, conservation and end-user communities were consulted to identify strengths, gaps and opportunities with regards to scientific expertise in the UK in this area of science. The consultation process was based on the following:

a. Attendees to the Aberdeen and Murrayfield meetings were approached by e-mail and invited to contribute “scoping forms” to describe existing (or completed in the last 2 years) research activities (Figure 1). They were encouraged to circulate this invitation further, but otherwise no attempt was made to actively engage institutions to submit scoping forms. This should be taken into account in interpreting the results. Scientists were asked to fill one form per research project, and were encouraged to send as many forms as necessary (see Appendix 2).

b. The sponsoring organisations of the scoping study were consulted to draft a list of organisations/individuals that should be approached for direct consultation (table 1). However, not all relevant institutions could be visited due to logistical difficulties and time constraints. Over one hundred individuals were consulted. In these visits individuals were encouraged to introduce their research, provide their own view of the state of the research on Marine Bioresources (including Institutional issues), promote support for specific areas of research, and contribute views to implementation arrangements for a new activity in this area. Most interviewees contributed scoping forms to back up the conversations.

Figure 1. Distribution of the 191 scoping forms received by research institution (see Appendix 2 for further details).
Table 1. List of institutions and individuals consulted during the scoping study, through personal visits, e-mail exchanges or telephonic consultation (excluding correspondence related to the submission of scoping forms. See Appendix 2).

<table>
<thead>
<tr>
<th>VISITS</th>
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<tbody>
<tr>
<td>British Oceanographic Data Centre (BODC) – Roy Lowry, Juan Brown</td>
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<tr>
<td>CEFAS – Mike Armstrong, Ewen Bell, Chris Darby, Georgi Daskalov, Clive Fox, Trevor Hutton, Simon Jennings, Andrew Kenny, Steve Malcolm, Julian Metcalfe, Jose de Oliveira, Andy Payne, Ted Potter.</td>
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<tr>
<td>CEH Banchory – Sarah Wanless, Morten Frederiksen, Francis Daunt, Mike Harris</td>
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<tr>
<td>DARDNI – Richard Briggs, Richard Gowen, Matt Service</td>
</tr>
<tr>
<td>DEFRA Fisheries Science Unit – John Lock, Michelle Verrecchia</td>
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<tr>
<td>DEFRA Policy Division – Colin Penny, Anthony Hines, Ed Dyson</td>
</tr>
<tr>
<td>DEFRA Marine and Waterways Division – John Roberts, Beth Greenaway, Paul Leonard</td>
</tr>
<tr>
<td>European Commission DG Fish – Jacques Fuchs, Ernesto Peñas, Miriam Garcia Ferrer, Armando Astudillo</td>
</tr>
<tr>
<td>Glasgow University – Bob Furness</td>
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<tr>
<td>Joint Nature Conservation Committee – Mark Tasker, Ian Mitchell, Tom Blasdale, Lee Hastie</td>
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<tr>
<td>Marine Biological Association of the UK – Stephen Hawkins, David Sims, Matt Frost</td>
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<tr>
<td>MET Office – Mike Bell, John Siddorn, Rosa Barciele Bell</td>
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<td>National Federation of Fishermen’s Organisation – Doug Beveridge</td>
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<td>NERC SMRU – Ian Boyd, John Harwood</td>
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<td>North Sea Commission – Tony Hawkins</td>
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<td>Plymouth Marine Laboratory – Icarus Allen, Jerry Blackford, Mel Austen</td>
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<td>Proudman Oceanographic Laboratory – Roger Proctor, John Huthnance</td>
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<td>SAHFOS – Chris Reid, Anthony Richardson, Martin Edwards</td>
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<td>Scottish Fishermen Federation – Fiona Gowland</td>
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<td>Scottish National Heritage – David Donnan, Dominic Counsell</td>
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<td>SEERAD FRS – Robin Cook, Bill Turrell, Mike Heath, Nick Bailey</td>
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<td>Strathclyde University – Bill Gurney, Doug Speirs, Eddie McKenzie, Jessica Andrews</td>
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<td>University College London – Sophie des Cleres</td>
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<td>University of Newcastle – Christopher Frid, Nicholas Polunin, Selina Stead</td>
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<td>University of Plymouth – Lawrence Mee</td>
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<tr>
<td>University of Portsmouth (CEMARE) – Sean Pascoe, Premachandra Wattage, Aaron Hatcher, Pierre Failer, Trond Bjørndal</td>
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<tr>
<td>University of Wales Bangor – Michel Kaiser, Gary Carvalho</td>
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<tr>
<td>University of Aberdeen – Tara Marshall, Graham Pierce, Monty Priede, Paul Thompson, Beth Scott, Martin Solan</td>
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<td>University of St Andrews – Steve Buckland, John Harwood, Chris Lynam</td>
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<thead>
<tr>
<th>CORRESPONDENCE/ TELEPHONIC/ VIDEOCONFERENCE</th>
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<tr>
<td>CEFAS – Carl O’Brien, John Pinnegar</td>
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<td>Council for Wales (CCW) – Clare Eno</td>
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<td>DFO Canada – Jake Rice (ICES WG Regional Ecosystem Descriptions)</td>
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<td>English Nature – Helen Beadman, Daniel Suddaby</td>
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<td>FAO – Kevern Cochrane</td>
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<td>Imperial College – Murdoch McAllister</td>
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<td>North Atlantic Fisheries College – Ian Napier</td>
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<td>NOAA National Marine Fisheries Service – Pat Livingston</td>
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<td>Royal Commission on Environmental Pollution – Jonny Wentworth</td>
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<td>SAMS – Graham Shimmield</td>
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<td>UK Cabinet Strategy Unit – Robert Gould</td>
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<td>University of East Anglia – Edward Allison</td>
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<td>University Marine Biological Station Millport – Rupert Ormond</td>
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Table 2. Classification of scoping forms by science categories. Note that some projects may contribute to several categories.

A total of 191 scoping forms were received as a result of the call. Although they do not reflect the entirety of the research effort on Marine Bioresources, they provide good indications of strengths and weakness, both scientifically and institutionally. They also highlight the commitment of the community to the spirit of this initiative. Figure 1 presents the results by research Institution, and Table 2 breaks down the forms into research areas. From the forms received and the consultations undertaken, the following overall conclusions were reached:

1. CEFAS and SEERAD are by far the strongest players in this research area. Both institutions (as well as DARDNI) would need to be full partners in any successful UK-wide new research initiative on Marine Bioresources.

2. In addition, a large number of UK institutions contribute to this science area to variable extent. Their contribution complements, and occasionally duplicates, work conducted at the research laboratories. However, some of these institutions appear close to critical mass, and are likely to lose further competitiveness unless their expertise is harnessed better (see below). This provides clear evidence of the fragmented nature of the research base alluded to in the introductory section.

3. Collaborations between academic centres and fisheries research laboratories are evident and successful. However, links are informal and based on personal contacts. No formal platforms of collaboration exist, with the result that the capacity of the community is not maximised. In fact, partnerships between UK fisheries laboratories and their European counterparts are stronger than between UK academic and fisheries laboratories.

4. UK institutions have expertise in a wide range of topics in the area of Marine Bioresources research, in particular stock assessment/ management and fish biology (although with substantial gaps in, for example, physical-biological interactions, population processes such as recruitment, food web interactions and spatially-explicit modelling). Ecosystem understanding is fragmented, and modelling approaches to this end are largely academic and are generally not carried through to management applications.
5. Several UK institutions conduct research in support of the Ecosystem Approach to Management, mostly through European Union projects under Framework 6 and specific DEFRA funding. The research is often conducted in close cooperation with European fisheries laboratories. However, it is not adequately framed as part of a comprehensive scientific strategy or programme of research that would maximise the impact of their outputs and engage the scientific community as a whole.

6. In general academic institutions and Fisheries laboratories have a limited understanding of each other's strengths, research activities, delivery pressures and potential to meet each other's research needs. Institutions generally prefer to focus on work that "we can do ourselves" rather that seek out assistance and collaboration to tackle new issues. However, individuals are more flexible and willing to collaborate. Although in principle open to competition, the funding base for applied and academic marine science, both nationally and at European level, is effectively separated, entrenching these Institutional divisions. For example, progressive changes in the European Commission research funding in support of the Common Fisheries Policy have favoured government laboratories because Universities have been reluctant to invest in policy driven science as a result of RAE pressures. Considerable intellectual synergy between academia and fisheries laboratories could be achieved through a concerted effort to coordinate funding opportunities from research councils and government departments in this area of science.

7. There is concern that applied scientists are driven away from academic institutions, because of the emphasis placed on high impact publications in the HEI Research Assessment Exercises (RAE). Penalties on applied research are driving quantitative scientists towards more academic problems or to other countries where applied research is better valued. As a result, the ability of the UK HEI to train future generations of applied marine ecosystem scientists is in question.

8. Academic institutions have little appreciation of the pressures placed on scientists from fisheries laboratories with respect to ICES working group’s demands and the need to respond to and advise government (often at very short notice). A 'sharing of the burden' through MERP would be cost effective and would allow space and time for fisheries laboratories to develop collaborative innovative research.

9. Data access remains one of the most significant stumbling blocks in fostering better collaborative science. This refers to issues of data availability, access and knowledge. Surprisingly, this is not only a problem in terms of Academic institutions accessing fisheries laboratories data (and viceversa), but also between fisheries laboratories across UK national borders.

Further analysis of the scoping forms and visits would not be appropriate. However, the information collected is sufficient to propose some basic principles for a new research activity which could address gaps in knowledge and build on inter-disciplinary strengths and needs.
4. Principles behind a new research activity

If Marine resource management is to take into account ecosystem considerations, its supportive science needs to be developed to support this style of management. A more strategic and coordinated ecosystem-oriented research is required so as to build sufficient knowledge of ecosystem functioning, and to assess spatial and temporal change. Research should be policy-led to assist in the development of regulations, and should be multidisciplinary to include assessments of social and economic issues. A fully integrated and system-wide research programme may be the first useful step towards an effective Ecosystem-Based management of UK seas.

The previous section of this report has shown that the UK has a technically expert, but fragmented research base, which impacts on its ability to compete effectively nationally and at European level. What is required is an overarching effort to bring the players together in a collaborative manner, rather than promoting further competition and disintegration.

It is suggested that this collaboration should take the form of a new partnership for additional scientific delivery, here named the Marine Ecosystem Research Partnership (MERP, Figure 2). The implementation of a research programme for the partnership is discussed later in this report. This partnership would require a common research strategy in order to rally the community in the same direction. In developing this common strategy the following preliminary aim is proposed:

**The aim of the Marine Ecosystem Research Partnership is to provide underpinning interdisciplinary knowledge of the functioning of UK's regional ecosystems in order to develop sustainable exploitation strategies for marine bioresources, compatible with conservation, and supportive of a diverse and profitable industry**

More specific objectives include:

- To expand existing mono-specific modelling/management approaches to achieve a more ecosystem process-oriented modelling approach,
- To identify ecologically critical processes and consider the spatial and temporal dimension of these processes,
- To model such processes through multi-disciplinary scientific groups (ecologists, oceanographers, economists, social scientists and fisheries experts), and with full participation of stakeholders,
- To develop advisory, management and governance tools based on the approach outlined above, including addressing the social and economic consequences of decisions and conservation objectives.

In turn this approach should:

- Reduce scientific fragmentation in the science base
- Increase the capacity and scientific basis of Marine Bioresources scientific advice
- Foster collaboration with Industry and conservation bodies, thus contributing to rebuild trust and scientific credibility.

This aim is to be undertaken predominantly through a set of multi-scale modelling activities so as to bring together the required integrative and synthetic understanding. It would need to be efficiently integrated with UK’s marine monitoring efforts. This holistic approach is inspired by the concept of the ecosystem approach to fisheries (EAF, FAO 2003), in sharp contrast to previous philosophies.
for managing the marine environment that led to fragmented, sectoral and short-term driven scientific advice\(^2\).

**Figure 2. The Marine Ecosystem Research Partnership would involve partners from Fisheries laboratories, Research Council Centres, High Education Institutions (HEI), Government departments as well as conservation and user communities.**

![Diagram of the Marine Ecosystem Research Partnership](image)

### 4.1. Geographical scale

The application of the Ecosystem Approach to marine bioresources requires the establishment of agreed geographical regions for which ecological objectives are to be defined and research activities conducted. Many of the activities needed to build integrative and synthetic understanding should be spatially and temporally explicit, while others will require the combination of data from functional geographical areas, in response to potential spatial management needs (e.g. EC Regional Advisory Councils, RAC).

For the purpose of this report, the proposition is to use the biogeographical regions defined by the Review of Marine Nature Conservation (DEFRA 2004, Figure 3), which are delineated in reference to physical and biological features such as tidal fronts, seabed flora and fauna and functional ecosystem properties. The RMNC classification is similar to the “Charting Progress” regional reporting areas (DEFRA 2005), and provides better ecological definition than the OSPAR or ICES Ecoregions, although it may not be appropriate in all situations. In any case, MERP should agree from the onset on a set of sub-ecosystems that would help shaping the proposed science, rather than leaving the geographical scale of operation open to the interpretation of individual scientists.

\(^2\) The ecosystem approach has its origins in Chapter 17 of Agenda 21 of the 1992 Rio Declaration on Environment and Development. It “…strives to balance diverse societal objectives, by taking account of the knowledge and uncertainties about biotic, abiotic and human components of ecosystems and their interactions and applying an integrated approach to fisheries within ecologically meaningful boundaries” (FAO 2003).
4.2. Hydrodynamic framework

Hydrodynamic modelling has developed recently to such an extent that further investment would not be cost-effective under this initiative. MERP should adopt particular hydrodynamic modelling outputs as standard, and build ways of linking these to the biological/ ecosystem/ socio-economic modelling to be developed.

**Figure 3. Biogeographical regions defined by the recent review of marine nature conservation (DEFRA 2004)**

In UK waters, several model structures have been used extensively in recent years, providing an excellent base for further biological modelling, including:

- **HAMSOM** ([HAMburg Shelf Ocean Model](http://www.ifm.uni-hamburg.de/~wwwsh/res/HAMSOM/hamsom.html)) - A three-dimensional shelf sea model developed at the Institute of Oceanography, University of Hamburg. An extended version of the model includes interactive coupling to a thermo-hydrodynamic sea-ice model. HAMSOM has been applied to the simulation of circulation and hydrography of the North Atlantic (e.g. NERC Marine Productivity Thematic).

- **POLCOMS** (Proudman Oceanographic Laboratory Coastal Ocean Modelling System, [http://www.pol.ac.uk/home/research/polcoms/](http://www.pol.ac.uk/home/research/polcoms/)) - The central core of POLCOMS is a sophisticated 3-dimensional hydrodynamic model that provides realistic physical forcing to interact with, plus transport, environmental parameters.

The UK Meteorological Office, the Proudman Oceanographic Laboratory, Plymouth Marine Laboratory, National Oceanography Centre Southampton and the Environmental Systems Science Centre at Reading have recently formed a strategic partnership through the National Centre for Ocean Forecasting (NCOF, [www.ncof.gov.uk](http://www.ncof.gov.uk)), with the mission to establish ocean forecasting as part of the national infrastructure. NCOF uses the Forecasting Ocean Assimilation Model (FOAM) and POLCOMS to make predictions of the 3-dimensional properties (temperature, salinity, currents) of the oceans and of sea ice. Furthermore, NCOF are able to make predictions of biological parameters for the global oceans through inclusion of the Hadley Centre Ocean Carbon Cycle (HadOCC) model in FOAM, and through the coupled POLCOMS-ERSEM system (see below) for UK and surrounding waters. While biological models must be built on the most adequate physical model for their purposes it would be strategic to use models that build on the forecasting capability of NCOF and its partners.
5. A scientific programme for the new Marine Ecosystem Research Partnership (MERP)

The proposed scientific programme of the Partnership is divided into 4 research modules, designed to address the strategic needs identified above (Figure 4, Table 3). The modules are designed to generate synthetic understanding through predominantly (but not exclusively) modelling approaches.

Justification for each Module, a research approach, and key issues to be investigated, are provided below. A selection of potential “blue skies” and “applied” outcomes are also identified for each module. This research structure would allow substantial community input in the design of specific research activities. These would have to be developed on the basis of consortia bids and possibly through planning workshops.

Modules 1-3 are reasonably self-contained, although they support each other through significant commonalities. In fact, the overall programme relies strongly on the synchronic development of each Module. Module 1 will coordinate the use of the extensive climatological, oceanographical and biological datasets available in the UK to obtain estimates of baseline variability and to generate understanding of the broad forcings operating on marine ecosystems. The Module aims at moving away from specific correlations, which tend to be ephemeral and carry little process understanding, while recognising the parallel changes between many local, regional, basin-scale and planetary variables at decadal scale.

Module 2 will synthesize key aspects of biomass, production and energy flow, at all levels of the food web, by constructing simplified static and dynamic ecosystem models of UK regional seas. These models would be based on functional groupings of ecosystem elements, a process that has been successful for biochemical and phytoplankton modelling, but not as effective in capturing all aspects of the variability in higher trophic level species. The purpose of this Module is to provide a broad ecosystem context to interpret the more detailed dynamics of target species and components of UK marine ecosystems investigated under Module 3, and to provide functional answers to patterns observed under Module 1. This modelling needs to incorporate the top-down controls caused by exploitation practices, as well as bottom-up ecosystem processes.

Module 3 focuses on developing spatially and temporally-resolved models of target ecosystem species or components. This need is triggered by current developments towards spatial management in the European Area, including the establishment of Protected Areas and stock recovery plans, requiring a good understanding of the spatial and temporal dynamics of target resources and of their interactions. The approach proposed recognises the importance of scale in ecosystem processes affecting higher trophic levels, as well as the need to simplify the complexity of marine ecosystems in model generation by focusing on target species.

Module 4 addresses governance issues, management applications and management advice in the broadest sense, and would have to be largely inter-disciplinary. It will focus research on developing assessment methodologies to valuate ecosystem services and place fisheries in the broader context of multiple ecosystem use. It would also develop inter-disciplinary co-management tools with full buy-in, that recognise biological uncertainty and drives towards setting probabilistic management options rather than the current approach towards an optimal solution.

Finally, Module 5 is a cross-cutting effort, providing overall support to the programme through effective data facilitation initiatives, communication and knowledge transfer. This Module needs strong Data access duties, in recognition of the diversity of data sources, banks, formats and access requirements that would need to be bridged in support of the research programme. A strong emphasis on communication and on the development of institutional platforms for stakeholder collaboration will be set up from the onset. This Module would have to liaise closely with UK and European management and advice bodies to facilitate the transfer of policy-driven knowledge. An adequate communication strategy is considered absolutely necessary to promote adequate buy-in from all stakeholders and to facilitate the integration of scientific and local knowledge into management and advice. It would also cement the role of the Partnership in driving the research agenda and providing independent advice on relevant marine ecosystem issues.
The scientific focus and objectives of the Modules have not been discussed extensively with the community, but were developed as a result of the consultation process.

Figure 4. Scientific elements of MERP and their interconnection.
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5.1. Module 1 – LONG-TERM PATTERNS OF MARINE ECOSYSTEM VARIABILITY AND CHANGE

**Overarching Questions:** Are biological processes in the marine ecosystem interconnected and responding to atmospheric or oceanographic signals at decadal time scales? How is climate change affecting these interconnections? What are expected levels of decadal baseline natural variability?

Marine ecosystems and their components are impacted by a number of factors, including intrinsic natural cycles, biological interactions, climatic impacts and anthropogenic activities. Determining the relative importance of these factors is both difficult and urgent, particularly now that ecosystem health appears under threat from both over-exploitation and climate change. In order to apportion responsibilities to driving factors at appropriate temporal and spatial scales, a comprehensive analysis of past records providing a full picture of the dynamics of UK ecosystems over past decades is needed. A coordinated analysis of multi-agency, long-term data sets would provide some basic principles regarding the role of internal and external forcings in determining trends and dynamics in the marine ecosystem at broad scales. These data sets should include multi-scale climatological, atmospheric, oceanographic and biological variables from all available monitoring programmes (including phyto- and zooplankton, benthos, nekton, fisheries-dependent and fisheries-independent surveys, as well as bird and mammal assessments). It must be noted that the UK has, thanks to historical interest in monitoring the marine environment, unparalleled data series available for this purpose, which could be exploited more effectively.

The UK has a substantial body of knowledge linking environmental variables to changes in species biomass and distribution patterns, with significant ecological breakthroughs. For example, the concept of synchronic ecosystem cycles (Russell 1973), the interpretation of ecosystem dynamics through the 1920-1940s warm periods (Cushing 1982), the identification of changes in production (Fromentin and Planque 1996, Coombs 1975), diversity (Beaugrand et al. 2002) and phenology (Reid et al. 1988, Edwards and Richardson 2004) of plankton communities, the linkages between sandeels and seabirds (Fredriksen et al. 2004), or the causes of the 1960-70s gadoid outbursts (Heath and Brander 2001) among others. While causal relationships are not often resolved (e.g. Southward et al. 1995, Beaugrand et al. 2002, Attrill and Power, 2002), this body of knowledge provides useful stepping stones towards building ecological theory on broad patterns of ecosystem functioning and on the relative importance of climate change on assemblage composition (Hawkins et al. 2003).

A common characteristic of long-term studies is that the species or units analysed are selected (only results from those showing a trend are published), and that only a few of all possible ecosystem interconnections are explored at any given time, often through simple correlations. In the end, full ecosystem understanding cannot be arrived at through specific correlations which provide no evidence for direct causal links and are ephemeral in nature. However, when we see parallel changes in climate, oceanography and biology we are forced to accept (or explore) the nature of the connectivity at broad scales. Ecosystem-wide analyses and synoptic meta-analyses of different compartments are therefore encouraged to provide significant scientific advancement in this area.

The ultimate objectives of this module are: the identification of linkages between external forcings and ecosystem dynamics; the quantification of baseline variability at multiannual to decadal scales; the selection of key processes, periods of change, variables and indicators; and the development of general ecological theory on marine ecosystem functioning. These objectives require a new research platform to facilitate interdisciplinary analysis of long-term data, involving observational scientists, modellers, theoretical ecologists and statisticians, to combine sufficient critical mass. This platform would work towards developing ecological theory on the functioning of open ocean ecosystems, an area that clearly lags behind terrestrial ecological research. For example, terrestrial ecology has demonstrated that the sensitivity to climate variation increases with trophic level (Voigt
et al. 2003), a crucial concept when exploring potential climate impacts across entire ecosystems. While models have suggested a similar dynamics in the marine ecosystem (Taylor et al. 2002), this requires considerable development before it is fully understood.

This module would provide scientific underpinning and feedback to existing monitoring programmes by providing a functional basis for monitoring variables at ecosystem level. This functional basis is expected of most monitoring programmes (e.g., the EU ‘Habitats Directive’, 92/43/EEC, for the conservation of natural habitats and wild fauna requires member states to monitor and promote the maintenance of biodiversity as a means of assessing the ecosystem health), but is not always achieved.

Specific issues to be investigated through this module include, inter alia,

- **Large-scale earth system drivers of variability in the marine ecosystem.** There is widespread recognition that the global climate drives ecological dynamics at large temporal and spatial scales, but we are still learning to disentangle the mechanisms involved. Indices of the Earth’s rotation rate (Stephenson and Morrison 1995), surface air temperature anomalies (Bell et al. 2000) or patterns in air pressure systems (Hare and Mantua 2000, Stenseth et al. 2003) have revealed both long-term trends and multi-decadal fluctuations in planetary dynamics. These have been linked to biological indicators at the multi-decadal to centennial (e.g., Baumgartner et al. 1992), decadal to multidecadal (e.g., Chavez et al. 2003) and interannual to decadal scales (e.g., Stenseth et al. 2003). Some conceptual hypotheses linking indices to biological processes have been developed, but they appear to operate only at particular time/space scales, such as the “Optimal Environmental Window” (Cury and Roy 1989), proposed to explain fish recruitment variability in upwelling areas, or the links between the North Atlantic Oscillation and the recruitment of cod and herring in the Barents Sea (Hjermann et al. 2004a). Most hypotheses are still conceptually tenuous, like the climate causes of herring variability in the Bohuslan region during the Little Ice Age (Alheit and Hagen 1997), or the remarkable – and unexplained – synchronies in decadal to multi-decadal variability in pelagic fish production in distinct ecosystems (Lluch-Belda et al. 1992). Closer to home, the mechanisms that gave rise to the 1960’s gadoid outburst remain unclear, although the links with oceanographic patterns at the North Atlantic scale (NAO, North Atlantic and slope Currents indices, Sea Surface Temperatures, etc.) are well known (Heath and Brander 2001). Understanding and ultimately predicting large-scale forcings and their impacts throughout the UK regional Seas is an urgent ecological need, and one capable of providing for substantial development of ecological science in the marine (particularly open ocean) environment.

- **Climate change impacts in the marine environment.** Recent revelations that the rate of increase in atmospheric concentrations of carbon dioxide are even greater than predicted by worst-case scenarios have further heightened concerns over potential effects on biological diversity and its provision of ecosystem services. Models suggest that sea surface temperature will increase by 1-4°C over the next century in some parts of the ocean (Bopp et al., 2001). This is likely to have a direct impact on marine ecosystems, including changes in productivity (lower export production in a warm ocean, Bopp et al. 2001), biodiversity (O’Reilly et al. 2003), food web dynamics (McGowan et al., 2003) and biogeographical ranges (Holbrook et al. 1997). High-latitude sea ice melting could additionally alter the food web dynamics of sub-arctic ecosystems, making climate change impacts one of the most critical research areas for the foreseeable future. Since the 1950s, Arctic sea-ice extent has declined by about 10–15%, and in recent decades, there has been about a 40% decline in Arctic sea-ice thickness during late summer to early autumn (Houghton et al. 2001). However, it would be important to study climate impacts in the context of the substantial exploitation of UK regional seas, as causing, respectively, “bottom-up” and “top-down” controls. Adapting our management procedures to the cycles of climate-driven productivity of the marine ecosystem is crucial to reduce the risk of resource collapses (Barange et al. 2004, O’Brien et al. 2000). Priority research issues include investigating impacts of changes in circulation, ventilation and stratification (e.g., Hansen et al. 2003, Curry et al. 2003), impacts of changes in frequency and intensity of extreme and episodic events (Urban et al. 2000), and direct effects of changes in ocean conditions...
temperature and light environment, (e.g. phenotypical changes, Edwards and Richardson 2004) on the productivity of marine ecosystems. This research should be linked to climate modelling initiatives by the Meteorological Office’s Hadley Centre and other groups (Cox et al. 2000) which are expected to produce climate change scenarios for the UK/ European shelf by 2005.

Figure 5. First Principal Component Analysis of biological indicators in the North Sea, mean number of copepod species per assemblage (temperate species in red, sub-arctic species in blue, Sea Surface temperature in the Central North Sea, and North hemisphere temperature anomalies, 1958-1999, supporting the existence of a regime shift in the North Sea round 1987 (modified from Beaugrand 2004).

- **Estimating baseline ecosystem variability at decadal to multi-decadal scales: the concept of “stable ecosystem states”**. Throughout most of the 20th century, marine ecosystems were regarded as fundamentally stable entities, with fishing considered the only factor capable of upsetting that essential natural stability in a major way (but see Southward 1980). However, this conventional view has been challenged. Around 1977 many zooplankton, invertebrates and fish populations throughout the North Pacific underwent rapid changes in distribution, productivity and abundance (Hare and Mantua 2000). These changes persisted for a decade, followed by a new decade of broad positive productivity (King 2004). The fact that these changes were pervasive and widespread pointed to climate or ocean conditions as the causal factors. In the late 1980s, scientists observed dramatic biological changes in the North Sea, coinciding with the highest positive NAO index records for more than a century (Figure 5). Indicators of such a shift are increased phytoplankton and zooplankton abundances and horse mackerel fish catches (Beaugrand 2004). Alterations in the centre of deep water convection from Greenland to the Labrador Sea and increases in the flow of oceanic water into the North Sea through the Shelf Edge Current appear to be the main drivers for such changes. The events in the North Pacific, North Sea, and other areas (e.g. Baltic Sea, Köster et al. 2001) helped to coin the concept of “regime shifts” between “stable ecosystem states” (Steele and Harris 2004).

The existence of alternate ‘stable ecosystem states’, either driven by climate dynamics or pushed by excessive removals of ecosystem components, is now well accepted in the ecological scientific literature. However, the process by which ecosystems change state by demonstrating dramatic and differential changes in the productivity of many species is
poorly understood. Also in need of research are issues such as the regional variability of changes of state, the interactions between climate and fishing pressures in driving (or speeding up) state shifts, and ultimately their predictability. Are shifts driven by common mechanisms affecting both the open ocean (traditionally controlled from the bottom up) and shelf seas (commonly seen as controlled from the top down)? Are changes in state preceded by a loss of resilience (Scheffer et al. 2001), and therefore provide some avenue for predictability? Failure to tackle this issue adequately would leave UK’s marine bioresources in a vulnerable state. For example, it is only recently that scientists have recognised that, at the time of the collapse of the North Atlantic cod stocks off the East coast of Canada, the northwest Atlantic Ocean was suffering from widespread ecosystem change (Choi et al. 2004, 2005). Decadal scale variability in ecosystem productivity exacerbated excessive fishing pressure, with well known consequences for the sustainability of the cod stocks. To resolve the dynamic inter-play between ocean physics, biology and exploitation patterns, and avoid similar resource collapses, we need ecosystem understanding at decadal scales, with emphasis placed on the identifying inflexion points that apply across marine ecosystems (Scheffer et al. 2001, Choi et al.2005).

- **Strategic and “blue skies” outcomes:**
  - Identification of medium (interannual) to long-term (decadal) changes in UK regional seas across several ecosystem levels;
  - Characterisation of drivers for large-scale ecosystem change;
  - Climate change impacts on marine ecosystem components;
  - Interactions between climate-driven cycles of productivity and exploitation patterns as contributing to causing changes in ecosystem stable states;
  - Generation of hypotheses on linkages between ecosystem elements to be explored through trophic models;
  - Development of ecological theory on marine ecosystem functioning;
  - Definition of ‘stable ecosystem states’.

- **Applied and policy-driven outcomes:**
  - Provision of baseline variability for model parameterisation at decadal scales;
  - Selection of interannual to decadal scale indicators of ecosystem function;
  - Exploratory scenarios of ecosystem changes resulting from global change;
  - Development of responses to changes in ecosystem stable state;
  - Underpinning and value-adding UK monitoring efforts;
  - Provision of datasets for modelling activities under Modules 2, 3 and 4.
5.2. Module 2 – COMPARATIVE ECOSYSTEM FUNCTIONING OF UK’s REGIONAL SEAS

Overarching Questions: What are the main pools and flows of energy in UK regional seas? What are the differences in the functioning of UK regional seas? How are these patterns affected by excessive fishing and how would they determine ecosystem responses to climate and anthropogenic forcing?

This module will attempt to synthesize key aspects of biomass, production and energy flow, at all levels of the food web, by constructing simplified static and dynamic ecosystem models of UK regional seas. The ultimate goal is to provide a broad ecosystem context to interpret the dynamics of key species and ecosystem units under Module 3, and to provide functional answers to patterns observed under Module 1. This will require investigating spatial and temporal differences and similarities in ecosystem functioning, with particular attention to transitions between stable states at the inter-annual to decadal scale, across food webs. This effort requires both extensive data integration and critical examination of model assumptions, particularly conditions of quasi-equilibrium. It must consider the large changes in ecosystem structure and functioning that have been brought about by intense harvesting. While fundamentally hind- and nowcasting, some of the models developed under this Module may supply some forecasting ability, thus providing significant synergies with the efforts of the recently created National Centre for Ocean Forecasting (NCOF). This has the potential to further UK leadership in the area of forecasting capability.

Simplified ecosystem functioning models at decadal scales would assist the interpretation of systemic changes in terms of ecosystem functioning investigated under Module 1. For example, how do changes in zooplankton composition and seasonality (Beaugrand 2004), anchovy and sardine abundance in the North Sea (Beare et al. 2004), or declines in white fish biomass affect the functioning of our seas? How do these changes interact with patterns in fishing effort? Can we synthesise these effects in terms of indicators of trophic structure (Pinnegar et al. 2002, Jennings et al. 2002); and can we use the results to feedback into existing monitoring and data collection efforts?

This module should include several methodological approaches. Energy or mass-balanced models with different degrees of spatial and temporal resolution are particularly good at addressing top-down (consumption-driven) issues. They would be useful to investigate, for example, the broad consequences of shifts in ecosystem structure, changes in carrying capacity, and fisheries impacts on trophic flows. Spatially-resolved dynamic production models are particularly effective to investigate bottom-up (production-driven) issues, including climate change scenarios and fisheries impacts on benthic biodiversity and nutrient cycling (Widdicombe et al. 2005). Although the complexity of high trophic level species has limited their ability to reflect fully the dynamics of ecosystems (de Young et al. 2004), a combination of dynamic and static mass models should be supported to advance our understanding of the functioning of UK’s regional seas.

- **Mass- or energy-balance food web models** – Mass- or energy-balance food web models provide a way for evaluating the importance of predator/prey relationships. The roles of top-down and bottom-up forcing in modelled ecosystems, and the changes in ecosystem structure resulting from environmental perturbations (natural or anthropogenic). Such models have been developed in the past (Steele 1974, Jones et al. 1982, Greenstreet et al. 1997), balancing energy budgets constructed from biomass estimates, diet analysis, evacuation and consumption rates (Figure 6). They provide useful tools to compare seasonal and decadal snapshots of energy flows and standing stock biomasses at different geographical scales. Such models are constructed on simplified functional groupings of species which share similar traits and display similar responses to multiple environmental conditions and therefore can contribute to improving services predictability without having to model every species in detail, particularly at decadal scales.
A similar approach, but with a different structure, is the ECOPATH model (Christensen and Pauly, 1992) which has the advantage of having been used in over 160 ecosystems, thus providing ample opportunity for comparative analysis. ECOPATH creates static mass-balanced snapshots of trophically-linked biomass groups and their interactions. Each biomass group may consist of a single species or species groups, potentially split into age groups. ECOPATH is used to address ecological questions, ecosystem effects of fishing and to explore management policy options (Pauly et al. 2000). The evaluation of multifaceted policy goals are explored through the ECOPATH extension ECOSYM, a time-dynamic simulation module which has built-in policy exploration methods. ECOSIM expresses biomass flux rates as a function of time varying biomass and harvest rates, and predator-prey interactions are moderated by prey behaviour, so that flux patterns can show either bottom-up or top down controls. ECOSIM simulations allow for the fitting of predicted biomasses to time series data, thereby providing more insights into the relative importance of ecological, fisheries and environmental factors in the observed trajectory of one or more species or functional groups. A further development of this suite of models includes the EwE (ECOSIM with ECOSPACE). The latter is a spatial and temporal dynamic module primarily designed for exploring impact and placement of protected areas (Walters et al. 1999). ECOPATH models have been used, for example, to evaluate responses to fisheries management as part of a broad Fisheries Ecosystem Plans, but cannot be used to predict individual species trajectories reliably.

Updated functional food web models would allow comparisons between the functioning of the different Regional seas at different temporal scales, thus addressing issues such as differential carrying capacity and responses to change.

Figure 6. North Sea food web in the 1960-1970s, in Carbon/year units (from Mike Heath, SEERAD, after Jones 1984 and Bryant et al. 1995). Note that the microbial loop is absent.
Dynamic ecosystem models - The tools to study ecosystem functioning over relevant temporal and spatial domains have been developing at a considerable pace in recent years. NERC, for example, has funded (partly through the Thematic programme Marine Productivity) the development of a community model system comprising POLCOMS (Proudman Oceanographic Laboratory Coastal Ocean Modelling System) and ERSEM (European Regional Seas Ecosystem Model, Figure 7). This system is considered state-of-the-art in shelf seas coupled physical-lower ecosystem models. This system was designed to address the complex processes involved in simulating and understanding the three-dimensional physical-biogeochemical interactions involved in the pelagic and benthic ecosystems, making it possible to assess conflicting hypotheses rigorously. ERSEM is based on the concept of “functional groups”, which has been successful in modelling biochemical processes. This approach is particularly useful to simulate changes in ecosystem function, but is currently limited to the dynamics of lower trophic levels, up to mesozooplankton (despite early attempts to include fish, Bryant et al. 1995).

The development of ERSEM to higher trophic levels is a challenge, and the ability of the “functional group” approach to encapsulate the dynamics of zooplankton and fish species has been questioned (de Young et al. 2004). The main difficulty in predicting changes in higher trophic species through mass models is that the processes are demographic rather than biomass-based, and the variation in vital rates between juvenile and adult stages is significant, not linear with body size and difficult to parameterize with confidence. The combined use of mass models with explicit species-based demographic models (proposed in Module 3) would be particularly useful, and would be able to clarify whether the new generation of mass models are capable of detecting and explaining major changes in fish biomass.

The modelling approach proposed in Module 2 is aimed at providing a more detailed comparative understanding of production processes in UK regional seas, and of factors...
controlling the dynamics of broad ecosystem units. Reconstructing food webs and energy budgets during contrasting decadal time periods will provide added value to the work undertaken under Module 1 (e.g. by investigating transitions between critical periods), and will generate hypotheses to be tested under Module 3. The static and dynamic modelling approaches discussed will rely on past and present survey programmes of UK continental shelves. However, given the changes that have occurred over the last decades, it would be important to ensure that existing field programmes conduct low intensity diet monitoring of as many fish species and areas as possible. This is in order to develop models that reflect present trophic linkages. This low intensity monitoring is apparently not available at present (Joe Horwood, CEFAS, pers. comm.).

- **Strategic and “blue skies” outcomes:**

  - Comparative functional dynamics of regional seas (carrying capacity, turnover rates, ecological implications of the balance between pelagic/ demersal energy flows in different regional seas, stability and vulnerability, resilience to external impacts, among others);
  
  - Investigate transitions between decadal cycles of productivity across regional ecosystems;
  
  - Consequences of differential pelagic versus demersal flows in shelf ecosystems;
  
  - Potential assessment of differential responses to climate regimes and fishing pressures at community and ecosystem level.
  
  - Optimal trophic strategies for exploiting regional ecosystems

- **Applied and policy-driven outcomes:**

  - Description of “viable ecosystems”;
  
  - Provision of indicators of ecosystem functioning at regional scale;
  
  - Evaluation of ecosystem effects of fishing on benthic and pelagic energy flows and turnover rates;
  
  - Explore broad ecosystem management options;
  
  - Contribute to Fisheries Management Plans;

  - Provision of datasets for modelling activities under Modules 3 and 4.
5.3. Module 3 – SPATIAL AND TEMPORAL DYNAMICS OF TARGET BIORESOURCES AND ECOSYSTEM UNITS

Overarching questions: What are the spatial and temporal structures and dynamics of key marine bioresources and ecosystem units? Can we model the interactions between these structures and the dynamics of user communities? Can we use these models to investigate impacts of management decisions on these resources and on the user communities exploiting them?

The importance of incorporating spatial dynamics in stock assessment is well recognised both to avoid misinterpreting fisheries statistics and to design spatial management tools. For example, decreases in fishing mortality estimates through VPA could result in fishing out particular sub-stocks if the species is managed disregarding potential sub-stocks (Daan 1991). Current developments towards developing spatial management tools for fish resources in the European Area, including the potential establishment of Protected Areas, the implementation of stock recovery plans and the regionalisation of scientific advice, requires a good understanding of the spatial and temporal dynamics of these resources and of their interactions. Spatial understanding has been dwindling through time in the ICES area as a result of the present management procedures that only require statistics per “fishing area” and that disregard spatial dynamics inside each area.

Concerns over loss of genetic diversity due to differential fishing impacts, further supports research on spatial dynamics. Intense harvesting causes rapid genetic changes in life history parameters (e.g. age at maturity, Hutchinson et al. 2003). Changes in genetic structure are likely to be reflected in behavioural differences, reduction in evolutionary potential (Hauser et al. 2002), and therefore may affect recovery rates. A combination of demographic spatial modelling using traditional and innovative units (e.g. numbers per genetic sub-stocks), should be encouraged to develop spatial management tools based on adequately-resolved and meaningful biological processes.

However, spatially and temporally-resolved models are difficult to implement because of knowledge gaps. This has been successfully overcome by concentrating modelling resolution on specific key bioresources whilst decreasing resolution with distance up and down the trophic scale, in models of skipjack tuna in the Pacific (Lehodey et al. 2003) and Calanus finmarchicus in the North Atlantic (Gurney et al. 2001). It is possible to make solid synthetic advances in our understanding of the dynamics of key bioresources and ecosystem units by concentrating model resolution as illustrated above, and by making full use of existing databases and monitoring programmes. An effective partnership with the fishing industry to get access to high resolution vessel and catch information would be useful. It is, however, likely that some additional field work may be needed, because of the limited available knowledge of the most basic processes affecting our fish resources. This field work should be limited to providing data for model parameterisation of processes such as:

- Recruitment processes (location, distribution, abundance and survival of spawners)
- Migration processes from larval stages to adults (including the use of microsatellite genetic markers to determine routes and rates, Nielsen et al. 2001, and other innovative technologies)
- Fishing fleet dynamics

Other processes requiring specific field work may be identified during the process of model definition. Limited exercises to test model results would also be needed.

The overall goal of this Module is to generate a comprehensive understanding of the functioning of key bioresources and ecosystem units, through the following modelling approaches:

- **Individual-based models (IBM)** - Individual Based Models are particularly useful to synthesise information of processes between spawning and recruitment. Understanding
recruitment success, the most important factor in determining interannual variability in spawning stock biomass, remains one of the most challenging scientific areas in fisheries. IBMs are based on the release of particles, endowed with biological properties (e.g., buoyancy, swimming, growth, feeding relationships, dispersion patterns, etc.) in the virtual currents resulting from the output of hydrodynamic models. Features are generally age-dependent, and sensitive to the ambient fluid state (temperature, salinity, stratification, turbulence) and to the biological environment (e.g., prey concentrations, predation). The particles can be tracked through virtual time and space and their final locations assessed in terms of previously defined criteria. For the purpose of MERP these models should be coupled with physical models (such as HAMSOM or POLCOMS), and should benefit from outputs from ERSEM and other lower trophic level models developed under Module 2. IBM models could be used to examine hypotheses relating biotic (e.g., zooplankton prey production, predation, cannibalism) and abiotic (e.g., temperature, salinity, advective patterns, the role of the cold pool and fronts, climate change) factors to the population dynamics of key species, particularly with respect to recruitment success. It is understood that, in addition to past and existing egg and larval field programmes conducted by fisheries laboratories, a new 4/5-year long research programme of fish egg surveys is about to be established in the Irish Sea (C. Fox, CEFAS, pers. comm.), with the main objective of monitoring cod stocks during the recovery programme. Adequate modelling support to this activity would add substantial value to it, both academically and in terms of applications.

• **Demographic or age-structured models** – The development of spatio-temporal models of fish populations is essential for spatial management. These models track the numbers of fish in each length or age class in each spatial and temporal unit, and allow the inclusion of specific behavioural traits during the life cycle (e.g., fecundity, maturation, transport to feeding grounds, etc.), which could be specified for each sub-stock or geographical area. This flexibility is important because experimental work has showed that, for example, cod in the North and Irish Sea display contrasting behaviour in relation to their foraging ecology (Righton et al. 2001). However, our knowledge of the spatial and temporal dynamics of our main resources remains extremely patchy. The continuation and expansion of tagging programmes to elucidate behavioural patterns, and genetic identification techniques to investigate the existence of sub-stocks and the degree of exchange between them, are thus strongly supported. To illustrate this, it has been hypothesised that cod has separate stocks in the North Sea favouring different optimal environments. Combined with observed shifts in the distribution of cod between decades (Hedger et al. 2004, Figure 8) this suggests that the southern North Sea may be becoming too warm to support a large resident cod population (Figure 7). Capturing the environment-fish sensibilities in the spatial models to be developed would be essential to predict distributional changes (as in the Newfoundland cod stocks, Rose et al. 2000), and to determine the success of spatial management tools, and to influence monitoring programmes.

These models should rely in particular on data from the International Bottom Trawl Surveys (IBTS), and from the different pelagic surveys conducted in the ICES area (see collation efforts in ICES 2005b). An effort must be made to avoid exclusively physico-biological models, by incorporating sufficiently-resolved models of fleet dynamics. This is in recognition that fishing interacts, and thus may also affect the spatio-temporal dynamics of the stocks. The use of high-resolution vessel positioning and catch information to understand the spatial component of the fleet (and the resources targeted), can provide an extra dimension to the outcome. However, accessing such data may not be straightforward. Substantial interaction with government laboratories of other European member states may be required, as well as with local fleet managers. It is suggested that MERP uses the excellent relationships between CEFAS, DARDNI and SEERAD and other European counterparts to access such data under some collaborative arrangements.

Some of the biological models suggested above are currently under development, for example for cod (Andrews et al., in prep.), but do not incorporate the dynamics of the fleet in the way proposed here. The development of socio-economic models of the fleets, and possibly of the social communities exploiting the resources, would provide an extremely innovative avenue for interdisciplinary work, adding substantial scientific underpinning to
investigate alternative management options such as MPAs and seasonal closures. Changes in the social structure of the fishing communities, from the use of migrant workers to the relative importance of part-time versus full-time fishers in the exploitation of the different bioresources may need to be incorporated in the models.

Figure 8. Spatial distributions of mature cod, 1980-1989 and 1990-1999 (Hedger et al. 2004).

- **Multi-species predator-prey models** – Biological components of ecosystems interact with each other through complex food web dynamics, driven by differential climatic and anthropogenic forces. Yet, the majority of the world’s fisheries are managed ignoring these dynamic ecological feedbacks. The single-species TAC approach that dominates European fisheries is unable to work effectively in the mixed fisheries that characterise the sea, leading to discarding and blackfish landings. The need to incorporate ecological considerations is particularly evident in dealing with inter-dependent components of some ecosystems (ecosystem units), to evaluate and reconcile exploitation patterns and conservation needs.

Community models capable of capturing crucial interactive processes (species-species, species-fisheries) while accommodating major sources of uncertainty are a crucial necessity\(^3\). For example, the dynamics of Barents Sea capelin (*Mallotus vitosus*) has been proven to be strongly influenced by direct harvesting, ecological interactions with herring and cod (both subject to differential harvesting), and climate impacts. Modelling the three species together, taking into account the climate as well as differential harvesting has been recognised to be essential to address the short-comings of single-species management (Hjermann *et al.* 2004b).

In the UK, a classic example of this inter-dependent “ecosystem units” is the herring-sandeel-seabird component of the North Sea (see Figure 9). In addition to substantial environmental influence, differential harvesting on sandeels and herring appears to play a considerable role in driving the dynamics of this unit (Fredriksen *et al.* 2004). An EU-funded project (IMPRESS) is currently developing coupled physical-biological numerical models to determine whether variability in oceanographic features and primary production can influence both seabird breeding success and sandeel population characteristics. This multidisciplinary approach should be supported further, but with the addition of models of fleet dynamics to fully capture the complex nature of these processes. This analysis should

\(^3\) Note that in this case the modelling conducted may not be spatially-resolved, as may be expected from the title of this module. However, community-level modelling fits better under this module because of its focus on species dynamics.
focus on establishing interactive hypothesis and build observational models capable of quantifying structural and parameter uncertainties, rather than rely on correlative approaches. These hypotheses would feed to field programmes and into operational management models as described in Module 4, aimed at developing conservation and exploitation co-management strategies. The research outlined would be significant in advancing multi-species management plans.

Figure 9. Herring spawning stock biomass, sandeel total stock biomass (x10), breeding success of kittiwakes and Arctic skuas (chicks per pair) in Foula, Shetland, 1975-2005 (Data courtesy of Bob Furness, University of Glasgow)

- **Strategic and “blue skies” outcomes:**
  - Synthetic understanding of the spatial and temporal dynamics of key elements of UK ecosystems;
  - Genetic loss and sustainability of resources;
  - Differential behavioural traits among fish populations;
  - Estimate direct impacts/links of climate forcing on ecosystem components at local/regional scales;
  - Relative importance of natural versus human activities in the dynamics of key interlinked ecosystem components;
  - Development of quantitative understanding of multi-species interactions;
  - Dynamics of fishing communities and the social structure of fishing;

- **Applied and policy-driven outcomes:**
  - Provision of quantitative tools to investigate recovery scenarios of key resources;
  - Development of spatial management tools marrying social and biological objectives;
- Investigate the minimum size, location, timing and effectiveness of MPAs, as well as their natural and socio-economic impacts;

- Ecological support to the development of innovative stock assessment/management methodologies based on full error estimation and species interactions;

- Potential to assess impacts of fishing on dependent ecosystem units and elaborate common exploitation and conservation strategies with stakeholders;

- Provision of datasets for modelling activities under Module 4.
5.4. Module 4: GOVERNANCE, ECOSYSTEM CO-MANAGEMENT AND THE DEVELOPMENT OF INNOVATIVE SCIENTIFIC ADVICE

Overarching questions: What are the management and governance implications of an increased regionalisation of fisheries management? What is the socio-economic feasibility and what are the consequences of alternative advisory scenarios? What marine ecosystem assessment methodology do we need in the UK? Is it possible to develop management policies that reconcile fisheries needs and conservation obligations?

The UK has been a pioneer in fisheries management. The UK was a founding member of the ICES in 1902, and one of the first countries to establish regulations on minimum landing sizes (1933). London hosted a conference on overfishing as far back as 1946. However, fisheries have developed to such an extent that nowhere in the world is the crisis surrounding fisheries and their management more explicit than in North Atlantic waters. Media and public attention on management failures, overfishing, dumping of by-catch and impacts of fishing on the marine ecosystem (see RCEP 2005) has lead to broad questioning of the performance of fisheries management and, as a result, of our stewardship of the commons.

There is general world-wide acceptance that governance is the weakest link in the management chain (Cochrane 2004, Mace 2004), a fact that is compounded by the inherent complexity of European fisheries (centralised decision-making, multi-national ownership, access, exploitation and scientific advice). Governance is used here in its most general interpretation, including issues such as poor implementation of advice, conflicting policy strategies, poor follow-up of management decisions, and failure to recognise the importance of people and people's management, among others. Addressing governance through MERP is even more essential to effect change than filling science gaps.

Over the last few decades we have developed policy strategies, at European as well as at national level, with contrasting (and sometimes opposed) objectives and outcomes. Structural policies aimed at expanding and modernising the fishing industry have been promoted hand in hand with attempts to address conservation issues. Policy decisions have been taken in support of a lean and efficient industry, easy to monitor and control, while at the same time we encouraged the development of a vibrant and diverse collection of fishing villages with their associated cultural values. A concerted effort is needed (perhaps through a future Marine Act) to develop a strategy for our seas and their use. The type of marine ecosystems we want to have and the kind of Industry we want to see develop are very much lacking debate and policy alternatives. As a result, management struggles to deal with the multiple and conflicting objectives that a diverse stakeholder base provides, having to handle extremely polarised views on a regular basis without an appropriate decision-making framework.

One of the disturbing results of the present state of affairs is the loss of confidence in scientific advice in support of fisheries management. Frequently the science is blamed for management failures even though the protracted policy process in Brussels often results in decisions that do not necessarily follow the letter of the scientific advice. However, it is also true that mistrust has sometimes been fuelled by scientific procedures that understated (or hid) uncertainty, as well as some simplistic examinations of the overfishing problem. In addition, the increasing pressures for short-term management solutions have driven scientific advice towards fast-response, “quick fixes”, allowing little time, space and capacity to treat uncertainty and natural variability adequately or address lags between observation and implementation measures. Confidence in scientific advice requires the development of co-management solutions with acceptable “buy-into” which take consideration the socio-economic consequences of the advice and that reduce stakeholders’ interest in short-term gains by increasing interest in the long-term.

It is also increasingly apparent that fisheries need to be managed in the context of wider ecosystem health and balance issues. Changes in governance frameworks may be required in order to create
the conditions for effective management while accounting for the need for greater cross-sectoral cooperation, such as (MA 2005):

- Integration of ecosystem management goals within other sectors and within broader development planning frameworks
- Increased transparency and accountability of government and private-sector performance in decisions that affect ecosystems, including through greater involvement of concerned stakeholders in decision-making
- Development of institutions that devolve (or centralize) decision-making to meet management needs while ensuring effective coordination across scales
- Development of institutions to regulate interactions between markets and ecosystems
- Development of institutional frameworks that promote a shift from highly sectoral resource management approaches to more integrated approaches.

In the case of marine bioresources management this new approach requires a paradigm shift that considers fisheries as an important ecosystem use that interacts with other commercial and non-commercial uses. This shift must include new ways of engaging stakeholders, providing alternative advisory and implementation mechanisms and developing innovative management plans.

A multi-sectoral, multi-disciplinary effort towards this paradigm shift would provide UK leadership in the management of European marine resources. However, the pan-European ownership of many of the resources considered in this report, adds a considerable degree of complexity that cannot be addressed from the UK alone. Much of the research to be developed under Module 4 requires the cooperation of other European Member States, through flexible and pragmatic research partnerships. Nevertheless, substantial work can be conducted from the UK, both to provide intellectual leadership in the governance of European resources, and to address resource use in the 6-12 n. mile UK territorial waters.

Several avenues are considered under this module, addressing ecosystem assessment valuations, participatory management and the development of more experimental management plans:

- **Development of fisheries ecosystems services assessment methodology** – Although the impacts of fisheries activities are well established (RCEP 2005), fishing is just one of the many human uses of the marine environment, others include extractions of aggregate resources, deployment of fixed platforms, pipelines and sub-marine cables, etc. So far, these uses are managed by different government departments, devolved administrations and advisory bodies, involving different stakeholder groups with different policy objectives. Fisheries and conservation are addressed by separate Units within DEFRA and most of its devolved equivalents (with contributions from advisory organisations such as the Joint Nature Conservation Committee). Oil and gas extractions and the regulation of offshore wind, waves and tidal energy generation sit with the Department for Trade and Industry. The Department for Transport and its agencies oversee ports, harbours and shipping and the Office of the Deputy Prime Minister manages aggregates extraction. There are also over a hundred Parliament Acts governing the marine environment with often confusing and overlapping spatial jurisdictions. The current development of a Marine Act may assist in placing fishing in its relevant framework, a process that would require an ecosystem assessment exercise to decide what services have to be secured (for example, the protection of small cetaceans is not an option but a statutory obligation), what ecosystems we want to promote as a result of the services that need to be secured and therefore what policy objectives we need to develop.

This assessment exercise must consider all ecosystem services and their benefits, encompassing several temporal, spatial and functional scales from species to ecosystems and habitats, across services, from conservation to commercial fisheries and to aggregate and oil extractions etc. (see MA, 2003). What marine ecosystem we want to support will be driven by compromises on the services we want to secure. Research on valuing and assessing provisioning (e.g. fish catches), regulating (e.g. ocean’s role as a climate regulator), and cultural services (e.g. UK’s marine culture as a source of identity and stability) is required to contribute to cross-sectoral management and governance plans.
A number of technical approaches are viable under this topic, in a framework that combines concepts of equity, sustainability, livelihood, capability and ecosystem stewardship (MA 2003). One specific useful methodology is the livelihoods approach, which has been used to achieve a better understanding of natural resource management systems (Allison 2005), and which involves, *inter alia*:

- Placing social and economic activities of end users at the centre of the analysis
- Address economic, social and political marginalisation
- Transcend sectoral boundaries and incorporate over-arching issues (health, education, etc.) in the valuation of management alternatives
- Link local and national economic and social benefits

Another approach is the development of the economic valuations based on the concept of Total Economic Value (TEV, Barbier et al. 1997). This approach deals with the difficulties posed by the need to evaluate, on one hand, changes in the properties of exploited populations and their habitats and on the other hand to estimate non-use values as expressed in concepts of “option value” and “existence value”. TEV provides a framework to comprehensively evaluate natural and environmental resources, which distinguishes between use values and non-use values for marine ecosystems, incorporating the *willingness to pay* for specific services and the *willingness to accept* specific outcomes of service use. Issues to be investigated from an interdisciplinary point of view include:

- Ecological, social and economic advantages and adverseness of protecting specific habitats or species throughout the UK, including cross-sectoral issues.
- Evaluation of new spatial and temporal management tools (e.g. MPAs), including ecological and socio-economic impacts at UK level

**Development of participatory governance and management policy** – While fisheries policy formulation and decisions are centralised in Brussels, management implementation in the UK is based on a complex set of arrangements. Outside “territorial waters” (the 6-12 n. mile zone) management is through the EC Common Fisheries Policy, regulated through a quota system managed by the Producers Organisations (PO). Territorial waters are largely marginal to the CFP, regulated nationally, and traditionally exploited by vessels under 10 m. These vessels are excluded from the main sectoral quota system and catch instead against a combined quota. In England and Wales responsibility for the management of this ‘non-sector’ quota is devolved to the 12 Sea Fisheries Committees (SFC) and the Environment Agency (EA), while in Scotland this management is consolidated centrally (Phillipson and Symes 2001).

In this sense there is considerable devolved management in the UK through the 19 PO, responsible for the administration of sectoral quotas and, in England and Wales, the SFC, responsible for inshore management. However, considerably less progress has been made towards effective user participation in the area of policy formulation at national and local level. Despite recent efforts, consultation arrangements still lack transparency, significance and formality. This is a clear paradox between delegated responsibilities combined with poor consultation. The increasing regionalisation of fisheries, both at sub-European (the EC Regional Advisory Councils) and sub-national level, offers good opportunities for the development of integrated co-management plans, from policy formulation to implementation, with a view to integrate fisheries management and marine nature conservation. Integrated management plans should set objectives for the ecological, biological, economic, social, cultural and administrative aspects of management, through the adoption of an ecosystem-based approach, with full participation (not just consultation) of all key stakeholders.

Research on management options must include trade-offs between exploitation and conservation in terms of multi-annual and multi-fleet management *versus* annual management, effort *versus* catch controls and stock-based *versus* area-based management. It would be important to evaluate:
Past failures in assessment, decision making and management implementation
Potential use (or consequences of not using) social, economic and environmental knowledge in the decision making process (Perry and Ommer 2003)
Management options in data-poor situations

**Development of appropriate fisheries management frameworks in the face of uncertainty** – The points above have specifically referred to the need to broaden fisheries policies to incorporate other needs and uses of the marine environment, most notably nature conservation. However, there is still a need to modernise and improve single and multi-species scientific advice. The scientific information on the functioning of UK’s regional seas to be obtained through Modules 1 to 3 will need to be considered, but it would also open up new layers of scientific uncertainty. These must be recognised, and incorporated through cross-sectoral analysis, in the development of the ecosystem approach to fisheries (Rice 2001). Of particular use in this context is the development of operational management procedures in line with those that have emerged in the International Whaling Commission (Kirkwood 1997), and that have been followed in other regions, like Australia (Smith et al. 1999) and South Africa (Butterworth et al. 1997). Management procedures are not commonly used in fisheries at present, but their principle is straightforward. All stakeholders (scientists, policy makers, fishers, conservationists) should agree to a set of clearly defines rules before the management game is played. What characterises a management procedure, however, is that the selection of steps to be taken is determined by the inspection of the trade-offs among anticipated levels of medium term reward (catch/profit), risk of stock collapse, interannual catch variability, etc., arrived at through simulation. The philosophy behind these procedures is based on dealing explicitly with uncertainty, on the development of co-operative management objectives, and on evaluating the consequences of alternative strategies instead of seeking “optimal” solutions. Some work along these lines is currently under development in the UK, pointing to important shortcomings in current management systems. For example, Kell et al. (2005) have developed a management procedure for North Sea roundfish stocks, concluding that the inclusion of realistic sources and levels of uncertainty can result in sub-optimal management outcomes based on current procedures.

**Development of scientific frameworks for providing ecosystem-based advice** – There is worldwide recognition that an adequate scientific framework to evaluate and protect ecosystem components, structure, and function is lacking, thus requiring a paradigm shift as indicated throughout this report. In recent times a number of quarters have requested management decisions that would reduce the ecosystem impacts of fishing (RCEP 2005) as well as provide ecological forecasts to decision-makers in the selection of policy choices (Clark et al. 2001). These needs require the development of appropriate scientific analysis at ecosystem level, which would form one of the scientific cornerstones of the application of the Ecosystem Approach (Gislason et al. 2000). Specific management plans or management procedures, as outlined above may be appropriate in some cases, while in others an overarching assessment of ecosystem health and impacts may be required to address other –probably medium to longer term- objectives. This assessment framework should have four main objectives:

- to maintain predator-prey relationships
- to maintain a balanced energy flow
- to maintain biological diversity, and
- to maintain the integrity of the essential habitats of exploited species.

taking full cognisance of the role of climate as well as human forcing as agents of ecosystem change, and accepting that sustainability depends on the retention of the integrity of ecosystems. Each one of these objectives would require a set of sub-objectives tailored to the ecosystem under assessment, and each of these a set of indicators with associated threshold levels. Such a framework would take information from existing environmental and fisheries monitoring programmes, as well as the outputs of the modelling approaches conducted in modules 1-3 above. It would also benefit from
integration of existing research initiatives in this area, like the European-wide INDECO project, funded by the European Union. INDECO aims at a) identifying quantitative indicators for the impact of fishing on the ecosystem state, functioning and dynamics, as well as indicators for socio-economic factors and for the effectiveness of different management measures, b) assessing the applicability of such indicators; and c) developing operational models with a view to establishing the relationship between environmental conditions and fishing activities.

The traffic light system proposed by Caddy (1999) may be an appropriate way of integrating the results of numerous indicator trends and of providing a structured way of making management decisions, at least initially. This approach has been applied by the Regional Ecosystem Study Group for the North Sea (ICES 2004a), and is implemented in the management of Alaskan fisheries (Livingston et al. 2005). The traffic light approach has also been used to develop a framework for the use of indicators of single species, multispecies, habitat and ecosystem functioning in data-poor developing countries (Dengbol and Jarre 2004). A similar approach, based on the integrated assessment of biotic and abiotic variables extracted using empirical, reductionist and holistic methods, has recently been successfully used in the Canadian East coast (Choi et al. 2005).

• **Strategic and “blue skies” outcomes:**
  - Ecological and socio-economical assessments of UK’s fisheries ecosystems;
  - Formal definition of “healthy ecosystems”;
  - Policy implications of regional fisheries management;

• **Applied and policy-driven outcomes:**
  - Development of operational fisheries management advice using an ecosystem approach;
  - Contribution to assessments of new spatial and temporally-explicit management tools;
  - Development of innovative stock assessment methodology with full error estimation, species interactions and socio-economic impacts;
  - Development of multi-sectoral Management Plans to reconcile fisheries needs and conservation obligations.
5.5. Module 5: Data management, Communication and Knowledge-Transfer

Ecosystem science and management are information-intensive activities. Databases are continuously managed and extended at the Fisheries research laboratories in England, Northern Ireland and Scotland, environmental monitoring agencies, data Centres and research institutions. There are also output data from computer-based predictive models (e.g. POLCOMMS/ FOAM/ ERSEM), which can be regarded as data even though they do not constitute measurements. These data have different degrees of protection and access rules, and some are accessible only through purchase. In addition, data from completed research projects are occasionally deposited in data Centres (e.g. data from most NERC-funded marine research sits at BODC), but many are held by individual scientists in their PCs. Finally, there is a vast amount of data on fishing and fisheries operations, available in vessel logbooks, ICES and national databases, and others. Aggregated data is easily accessible, but high resolution information is generally difficult -if not impossible- to access. The MERP Partnership should focus on developing mechanisms to facilitate access to data for research purposes, and should rely on the data basing procedures of partner institutions for protection, curation and stewardship of existing and newly-collected data. Data management efforts under the MERP must focus on:

- Search, identify and catalogue existing data sets relevant to MERP;

- Facilitate access to and maximise use of these data sets by developing rules for data access and use with the data owners, while protecting the rights of the collectors and owners of the data;

- Develop a strategy for long-term data management and use of MERP products, in consultation with data management plans of MERP partners.

Insufficient or inadequate communication between public, users, policy makers and scientists has long been recognised as an important issue in the promotion of co-management arrangements and the development of scientific credibility, legitimacy and user compliance. Fisheries management is a closed-information activity in the sense that only a small circle are capable of accessing and understanding all the relevant information on which decisions are taken, as a result of the complexity of the process. The science of fisheries management is highly technical and difficult to understand; the decision-making process from the ICES working groups to the European Commission recommendations, and the implementation of these recommendations at national level is opaque to say the least. Confidence and acceptability needs to be built on a platform of clarity of information. MERP needs to emphasise this need and actively improve the flow of information between users, science and policy.

Communication and Data Management issues have to be addressed in parallel in a determined attempt to open up the scientific and management process, from advice to implementation. For this reason, a cross-cutting module on Data Management and Communication is proposed.

5.5.1 Data Management node – MERP’s data management node would facilitate access and use by: collating catalogues of datasets; developing a data portal; and designing tools and mechanisms of data access in close coordination with those managing data banks. The portal would provide a central method of browsing and searching the contents of all the available data resources. After rules of access, use, and data protection have been agreed upon with each data bank, a system of e-certification should be developed to ensure that only certified MERP scientists make use of the data bases for the purpose of the research project they are involved with. Specific objectives of this node include:

- Identify what existing data sets are needed, where are they based, how to access them and under what conditions,

- Develop strategies to store, manage and steward MERP products,

- Develop tools for shared access and analysis of data sets by MERP scientists,
• Clarify the rules and procedures of a MERP central data node.

The development of e-Science applications would be encouraged and facilitated through the node. E-Science was conceived to conduct collaborative science using distributed computing and data resources, thus mapping well with MERP’s objective to facilitate collaboration between partners. E-Science involves the sharing of computers and data across the Internet, and has been strongly supported from UK’s central government. Appropriate linkages between MERP and existing UK Centres of Excellence on e-Science would be consistent and synergistic (see http://www.nesc.ac.uk/).

5.5.2. Communication node – Besides facilitating the communication of MERP products, the goal of this cross-cutting unit would be to engage stakeholders in building two-way communication systems that allow the development of co-management schemes in parallel to the implementation of Module 4. The development of a communication strategy would be important to identify specific Objectives and Outcomes of the communication effort, as well as expected Actions from those receiving the communication and Evaluation procedures to assess communication success.

The ultimate objective of this node if to develop MERP as a ‘knowledge-based’ partnership through the strategic development and implementation of effective approaches to knowledge management, communication, exchange and transfer both externally and internally.

Investment in these cross-cutting issues of MERP is important to secure success.
6. Implementation Strategy

The move towards sustainable management and the application of the ecosystem approach must involve the development of “fit-for-purpose” Institutional changes (S. Garcia in ICES 2004b), whereby multi-disciplinary scientists and stakeholders (from Industry to conservation bodies) are aligned and implicated in multidisciplinary teams of problem solvers. Success requires removing the polarisation between industry and scientists, and between natural and socio-economic science by agreeing on the direction and speed of movement towards specified goals.

Figure 10. The Marine Ecosystem Research Partnership would involve partners from Fisheries laboratories, Research centres, HEIs, as well as conservation and user communities.

The research programme proposed above provides a collection of scientific objectives through which new mechanisms to conduct marine ecosystem research will evolve. This process should develop in parallel to the conventional fisheries assessment process, with a progressing interaction between both approaches. In other words, the MERP would not be replacing present methodologies, but rather would initiate a step-wise progression so as to combine present tools with more innovative, ecosystem-based methods, in synchrony with the medium-term view of the European Commission (A. Astudillo, DGFISH, pers. comm. February 2005). It is expected that the proposed cross-sectoral, inter-disciplinary science of MERP would provide intellectual leadership in Europe by providing the paradigm shift and step-wise development requested by the sponsors of the scoping study.

It is suggested that the basic operating principles of MERP would be as follows:

1. MERP is intended to broaden the science base for fisheries and ecosystem management advice and to address scientific and Institutional fragmentation. Therefore, it would be essential to ensure that research teams are developed from a diverse number of scientific institutions and across disciplines. Teams must include representatives of the conservation and user communities. It is thought that favouring a small number of strong institutions at the expense of smaller or more specialised ones would continue the process of fragmentation.
2. MERP is aimed at driving a paradigm shift around the way we research, interpret and manage marine ecosystems. As such it requires broad support from research bodies (NERC and ESRC in particular) as well as government agencies (DEFRA and its devolved bodies). Furthermore, should it prove itself, MERP should develop over a period in excess of the standard 3-year research grants. The only useful existing parallels are the Centres of Excellence established by the Research Councils through the UK, to address similar issues of critical mass and science maximisation.

3. Should MERP be implemented along the concept of a Centre of Excellence, it should consist of a number of distributed centres or nodes, perhaps along the lines of research modules. A Central node would be established, in charge of its cross-cutting management, data and communications, knowledge-transfer and resource mobilisation activities.

4. Partners of MERP should demonstrate a strong commitment to the process through, for example, secondments of scientists to work for MERP for a period of time, commitment to provide berths or modify field programmes should the need arise, etc. Research Council Centres may consider including aspects of MERP’s research programme in their Core Programmes. Other ways of expressing commitment may be explored by the partners. However, substantial funding would be needed to fund central activities and to top-up partner’s contributions. The process of identifying funding needs and their source must follow this report, as it should be driven by the leading partners.

5. A particular novelty of MERP, required to address fragmentation issues and to break the culture of division between fisheries laboratories and academic institutions, would be to find mechanisms for the mobilisation of resources through the partners, such as:

   a. To fund mobility of scientists between the government and non-government sectors that would facilitate, for example, the access to ICES working groups by non-government scientists and the participation of government scientists in research council funded meetings.

   b. To fund mini-sabbaticals of academic scientists in Fisheries laboratories, and fisheries laboratories scientists at Universities and NERC research centres, to conduct research under MERP.

   c. To facilitate access to facilities not generally accessible to fisheries laboratories, such as genetic or microbiological facilities and NERC super-computing facilities, and to share available vessel berths.

6. The first phase of MERP’s research programme, as outlined above, would be strongly driven by the development of new integrative and synthetic understanding, and the expansion of the tools for scientific advice and management. Subsequent phases would have to be driven more specifically towards providing management advice and establishing two-way links with monitoring programmes of the marine ecosystem.

7. MERP advice along ecosystem considerations would not supplant conventional fisheries management advice, but should be used to modify regulations along ecosystem concerns (as in Murawski 2000). With time, as metrics of ecosystem structure and function develop into more provide practical implementation tools (Hall and Mainprize 2004), this parallel process would evolve towards a single ecosystem-based advice, in line with the European Commission vision (A. Astudillo, pers. comm., EC DGFISH, February 2005). Given the European nature of many of the policy drivers of MERP (CFP, Habitats Directive, etc. see p. 9), and of the resources considered, MERP should play a pivotal role in contributing scientific advice to ICES, RACs, and any other regional and European advisory
bodies that may be established in the future.

8. Because many marine bioresources are owned by the “European commons” it would be fundamental to involve other European teams in the research projects, albeit at their cost (similar to the way European Framework programmes handled collaborations from outside the ERA). The development of MERP-led proposals for funding under EU Framework 7 should be strongly encouraged.

9. The research programme of MERP should be steered by an inter-disciplinary, cross-sectoral committee that includes not only members of the scientific communities, but conservation and user bodies. This committee should have sufficient powers to influence the research rather than rubber-stamp approved proposals. It is suggested that this committee includes external advisors from countries that are actively involved in developing science programmes in response to the Ecosystem Approach, such as Australia, Canada or the USA.

The research programme proposed for MERP provides a scientific umbrella identifying areas of science, research approaches, common objectives and deliverables. Specific research activities need to be developed from the bottom up, precisely through the mechanisms that the MERP partnership aims to provide. Therefore, it would not be appropriate to provide specific details of manpower required, equipment to be mobilised or costs of the different activities. However, the design of each research Module provides some suggestions as to the type of investment that would be required to succeed. Basic implementation approaches for each Module are provided below:

⇒ Module 1 – Long-term patterns of marine ecosystem variability and change
  - Would require several scoping and Data analysis workshops.
  - Based on a small number of Consortia bids.
  - Involve no new field work but substantial data rescuing/ formatting.
  - Require investment on statistical analyses and data interpretation.
  - Mobility of scientists important (targeted fellowships and training opportunities).

⇒ Module 2 – Comparative ecosystem functioning of UK’s regional seas
  - Workshops required to agree on model framework and structures, parameterisation, testing, ground-truthing and interpretation.
  - Based on a small number of Consortia bids.
  - Very limited field work required, specifically to parameterise models and test hypothesis (e.g. to estimate changes in benthic-pelagic fluxes as a result of fishery-driven changes in benthic fauna from suspension feeders to deposit feeders and scavengers). Adaptations to existing field work probably needed (e.g. to obtain better diet information and spatial coverage).
  - Mobility of scientists essential, as well as access to shared computer facilities.

⇒ Module 3 – Spatial and temporal dynamics of key bioresources and ecosystem units
  - Workshops required primarily to plan incorporation of new field data to models, and to agree on methodology for the natural and social science interfaces.
  - Based on several Consortia bids, possibly with wide institutional participation.
• New field work may be required, to fill gaps in spatial and temporal dynamics, to incorporate strategic tag-release programmes, apply specific genetic tools for stock identification and diversity loss, to test hypotheses related to recruitment success and to collect social science information on fishing communities and fleets.

• Because of the need to access high resolution catch information the involvement of fishing organisations is essential.

• Mobility of scientists is essential as well as access to shared computer and analytical resources.

✈ Module 4 – Governance, ecosystem co-management, and the development of innovative scientific advice

• Workshops required for: building cross-sectoral teams to develop management frameworks, to research participatory governance projects and to agree on service assessment methodologies. Workshops would be strongly cross-sectoral, inter-disciplinary, and interfaced with policy bodies.

• To be based on a number of diverse and probably small Consortia bids focused on pilot studies.

• Probably no field work required (some pilot studies may need new data, but only at small scales)

• Mobility of scientists essential

✈ Module 5 – Data Management, Communication and Knowledge-Transfer

• Cross-cutting module requiring initial workshops and consultation throughout.
7. The international context

The scoping study was specifically requested to place the research proposal in an international context. There is a general international move towards Ecosystem-Based Management (EBM), recognising that the necessary framework for protecting the structure and function of ecosystems has been lacking. The implementation of EBM worldwide is intended to ensure that large-scale impacts on ecosystems do not result in detrimental consequences to human societies.

The application of EBM approaches is in its infancy, and most countries are adapting the concept to their own needs and requirements. MERP is intended to provide underpinning to EBM of UK waters. In this section we place this view in context by briefly outlining how EBM is applied in Canada, USA, Australia and South Africa, as well as in the Commission on the Conservation of the Antarctic Marine Living Resources (CCAMLR).

7.1 Canada – Canada enacted their Oceans Act in 1997, outlining a new approach based on the premise that oceans must be managed as a collaborative effort amongst all stakeholders that use the oceans, and accepting that new management tools and approaches were required. The Oceans Act has changed the legislative basis for management and now requires consideration of the impacts of human activities on Canada’s ecosystems in marine resource management plans. A number of initiatives have since emerged in support of EBM stemming from the Oceans Act. Canada’s Oceans Strategy was published in 2002 (Anon., 2002), including the need for co-ordinated Integrated Management (IM) programmes to define how best to manage designated areas. “Integrated Management” is defined as “a commitment to planning and managing human activities in a comprehensive manner while considering all factors necessary for the conservation and sustainable use of marine resources and the shared use of ocean spaces” (Anon. 2002). IM is in its initial stages in Canada, and some research needs have already been identified (Jamieson et al. 2001), including,

- Develop sustainability objectives (environmental, biological, social, economic, cultural)
- Define indicators and reference points for ecosystem-level objectives
- Identify conservation objectives for specific ecosystem components
- Compilation of ecosystem-level data and study their use in ecosystem function measurements

7.2 USA – Two recent reports echoed the calls for ecosystem based fisheries management in the USA. The official US Commission on Ocean Policy (2004) recommended “to strengthen the use of science and move toward a more ecosystem-based management approach”. Such approach needs to, “be regionally directed, take account of ecosystem knowledge and uncertainty, and consider multiple external influences”. Prior to the Ocean Policy Commission an Ecosystem Principles Advisory Committee was formed to recommend measures to Congress (NMFS EPAP, 1999). Its main recommendation was that Fishery Ecosystem Plans should form the basis for advancing ecosystem-based management in US regional fisheries. The following scientific issues were flagged as requiring attention for these Plans to succeed:

- Improve predictive capacity with regard to climate and human impacts on ecosystems: model refinement and regime shift analysis to drive recruitment scenarios
- Develop EBM objectives
- Develop indicators and objective criteria to measure success in achieving desired ecosystem states
• Develop formalised decision-making frameworks, including standardised tools for objective analysis

Jamieson and Zhang (2005) provides a full description of the implementation of Ecosystem-based fishery management in the USA.

7.3 South Africa – Much of the ecosystem-oriented research in the southern Benguela took place under the umbrella of the Benguela Ecology Programme, established in 1982 with the objective “to provide scientific information on the structure and functioning of the constituent ecosystems, to complement the knowledge which is required for the management of the renewable natural resources of the Benguela Current region”. The programme has had many successes (Payne et al. 1997; Payne et al. 1992; Pillar et al 1988) that have modified single species and ecosystem management approaches. Key examples are the assessments of the impact of cape fur seal on Cap hakes (Punt and Leslie 1995), work on Marine Protected Areas (Attwood and Harris 2003), seabird survival and population size in relation to availability of food (Crawford 2004), and the development of subsistence fisheries in South Africa (Branch 2002). The South African Marine Living Resources Act of 1998 provides the mandate for progressing towards an Ecosystem Approach to Fisheries, in synchrony with the scientific developments that preceded the Act. The major concern over the application of EAF in South Africa is that its implementation will make additional demands on already stretched political and social will, capacity and resources. To address these concerns the FAO and the South African government are currently conducting pilot studies to identify where changes and enhancements of the existing management strategies will be required (K. Cochrane, FAO, pers. comm. January 2005).

7.4. Australia - Australia's Oceans Policy was launched in 1998 to develop an integrated and ecosystem based approach to planning and management in Australia’s entire marine jurisdiction for all ocean users. The Policy is currently under revision. The primary mechanism for implementation of this ecosystem approach in Australia is through Regional Marine Plans (RMPs) for areas consistent with ecosystem boundaries. In research terms, the most recent and innovative application of the EA is the North West Shelf Joint Environmental Management Study (NWSJEMS), began in 1999 and jointly funded by the Western Australian Government and CSIRO Marine Research. The general objective of this four-year study was to develop and demonstrate practical science-based methods that support, under existing statutory arrangements, integrated regional planning and management of the NWS marine ecosystem, to:

• compile, extend and integrate the scientific information and understanding of the coastal marine ecosystems of the NWS; and

• develop and demonstrate practical science-based methods that support integrated regional planning and multiple-use management for ecologically sustainable development.

A computer-based Management Strategy Evaluation (MSE) framework is used in the Study, to evaluating prospective multiple-use management strategies for the NWS. This is the first time an attempt has been made to develop and apply a MSE to multiple-use management of a large coastal marine ecosystem. The MSE is applied to four sectors: oil and gas, conservation, fisheries, and coastal development. For each sector, a selection of development scenarios, provided by the relevant interest group, is represented. These scenarios include prospective future sectoral activities and their impacts, and the sectoral response to management policy and strategies. Preliminary results allow interactions between ecosystem users and regulators to examine the consequences of multiple-use management and the cumulative impacts of human uses on the ecosystem. The MSE framework relies on a biophysical model that emulates the physical and biological features of the natural marine ecosystem (McDonald et al. 2004), which is arrived at through research similar to the scientific programme proposed for MERP.
The example of the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) is mentioned because it is the only international Convention that specifically makes use of the ‘Ecosystem Approach’ and because of the UK’s involvement and leadership in CCAMLR through NERC’s British Antarctic Survey. In the mid-1970s, it was realised that the conservation of krill was fundamental to the maintenance of the Antarctic marine ecosystem. Consequently, serious concerns were raised about effective management and sustainable utilisation of Antarctic marine living resources. These concerns were taken up and resulted in the CCAMLR Convention, which came into force in 1982. In common with other international agreements, CCAMLR does not impose regulations, but rather attempts to reach agreement on issues which Members of the Convention are then obliged to implement. However, in contrast to other multilateral fisheries conventions, CCAMLR is concerned not only with the regulation of fishing, but also has a mandate to conserve the ecosystem. This ‘ecosystem approach’, which considers the whole Southern Ocean to be a suite of interlinked systems, is what distinguishes CCAMLR from other multilateral fisheries conventions. The Convention applies to all marine living resources (except seals south of 60°S and whales in general) inside an area whose northern boundary is roughly delineated by the mean position of the Antarctic Polar Front and thus follows the physical and biological boundaries of the Antarctic. Article II of the Convention establishes a number of conservation principles, including:

- “maintenance of the ecological relationships between harvested, dependent and related populations of Antarctic marine living resources…”
- “prevention of changes or minimisation of the risk of changes in the marine ecosystem which are not potentially reversible over two or three decades…, taking into account … the effects of associated activities on the marine ecosystem and of the effects of environmental changes…”

Article II embodies two concepts that are vital to CCAMLR’s approach to management: the precautionary approach (reversal of the burden of proof) and the ecosystem approach. By pioneering the ecosystem approach, CCAMLR has chosen to deal with the difficulty of describing the full complexity of marine ecosystems by designating species considered to be most important in the food chain (so-called ‘indicator’ species) or by focusing on stocks within somewhat arbitrarily defined geographic regions or management areas. In the case of krill, CCAMLR has considered not only krill but also a subset of dependent species, including seabirds and seals, which are monitored by the CCAMLR Ecosystem Monitoring Program (CEMP).
8. Conclusions

Marine ecosystems are under threat from the combined impact of excessive resource exploitation and global environmental change. The pace of this impact is challenging our ability to provide timely and effective scientific advice. In addition, there are increasing demands to place exploitation of bioresources in the broader context of the multiple human uses and conservation needs of the marine ecosystem. In order to address these issues, a paradigm shift in the way we manage marine ecosystem goods and services is required. This shift would include a broader interdisciplinary science base in support of management and the development of science and management alternatives in synergy cooperation with stakeholders.

Of concern is the fact that the marine ecosystem science base in the UK is poorly integrated and highly fragmented. This historical fragmentation has been entrenched through an effective separation in the funding mechanisms and research priorities between research councils and government departments. After observation and consultation it is concluded that greater interagency coordination and a more cohesive scientific response is required, in order to exert greater leadership both nationally and internationally.

The creation of a new Marine Ecosystem Research Partnership (MERP) is recommended as a platform to achieve scientific integration, and to spearhead the development of the ecosystem approach to resource management in the UK. The ultimate aim of MERP is to provide scientific management advice that reconciles exploitation and conservation needs based on interdisciplinary ecosystem knowledge. MERP would evolve in parallel to conventional fisheries management advice, initiating a step-wise progression towards ecosystem-based management. This evolution recognises that the necessary framework for understanding and protecting the structure and function of marine ecosystems is currently lacking. The Marine Ecosystem Research Partnership should be implemented as a virtual Centre of Excellence seeking to demonstrate the long-term commitment of the partners to its objectives and goals.

For the first phase of MERP, a strategic and holistic ecosystem-oriented research programme is proposed. The programme is based on four research modules, primarily constructed on a set of multi-scale modelling activities, and one cross-cutting data, communication and knowledge-transfer module. It is suggested that specific research activities under each module be implemented on the basis of consortia bids that address not only integrative scientific needs but also the structural and institutional issues mentioned above. The research needs to be strongly coordinated with activities of other European partners, in recognition of the European ownership of most marine resources. The first research phase of MERP would be driven by the need for integrative ecosystem understanding and to expand tools for scientific advice. Subsequent phases should focus on delivering ecosystem management advice linked to monitoring strategies.

In conclusion, the UK is facing a window of opportunity to respond to the conservation and sustainable exploitation needs of the marine ecosystem with a holistic and inclusive vision. MERP is proposed as a mechanism to harness this vision. Science and policy agencies and institutions must use this opportunity to implement fit-for-purpose changes to build upon and maximise the value and quality of scientific advice.
9. Acknowledgements

I would like to thank all the participants in this study, for their willingness to collaborate in a very positive way and for investing time and effort in filling research scoping forms. I am appreciative of the time given to me by the institutions and individuals I interviewed, and the understanding of those I could not visit due to time constraints. While parts of this report have been discussed at different stages with some individuals, the opinions expressed remain solely mine.
9. References


505-510.


Daan, N. 1991. Bias in virtual population analysis when the unit stock assessed consists of sub-stocks. ICES Council meeting papers, ICES, Copenhagen, Denmark , 16 pp


Greenstreet, S.P.R., A.D. Bryant, N. Broekhuizen, S.J. Hall and M.R. Heath 1997. Seasonal variation in the consumption of food by fish in the North Sea and implications for food web dynamics. ICES Journal of


Hilborn, R. 2004. Ecosystem-based fisheries management: the carrot or the stick. Marine Ecology Progress Series 274: 275-278


MA 2003 Ecosystems and Human Well-being: A Framework for Assessment Island Press, World Resources Institute. 245 p. (see http://www.millenniumassessment.org/)


Ecology 84: 2444-2453


APPENDICES
APPENDIX 1: Terms of reference of the scoping study

Purpose:

To carry out a scoping study to identify the new areas of fundamental underpinning science, and possible modes of implementation/partnerships, required to achieve a step-change improvement in the sustainable ecosystem-based management of marine bioresources.

Deliverables:

A written ~10,000-word report (excluding annexes) to:

1. Provide a brief overview of the science that is being done by the UK into understanding the sustainable use and ecosystem based management of marine bioresources (focusing on fish and shellfish stocks), and an indication of how the various sectors work together to link science and policy.

2. Describe the current and likely future issues in marine bioresource sustainability in UK and European shelf/slope and estuarine waters, and identify key new areas of underpinning science required to address them, drawing on experiences and relevant science from the Southern Ocean and developing-country waters, as appropriate.

3. Explore the relevance of, and potential for, involvement of the social and economic science sectors and to present an informed view as to:
   a. The key science areas and players in the social and economic sciences that would be relevant to this study area.
   b. The risks/reward of involving, and the consequences of not involving, social sciences.

4. Present short-term and long-term options for how a joint initiative across the stakeholder spectrum could tackle the key areas under deliverable 2, indicating the estimated costs and effort required to address each one and what could be achieved by doing so (including an indication of pull-through to policy).

5. Suggest implementation mechanisms by which such an initiative could be run, providing illustrative examples of optimal structures for joint working.

6. Comment on the international context of the above deliverables.
APPENDIX 2: Scoping forms received

INSTITUTION: British Antarctic Survey
DEPARTMENT/ UNIT: Biological Sciences Division
Address: High Cross, Madingley Red, Cambridge, CB3 0ET

Contact person: Keith Reid
e-mail and/or webpage:k.reid@bas.ac.uk

Research Activity: Southern Ocean Ecosystem Modelling
Duration: 2005-2010 Cost: £ 610k
Funding: x NERC

Principal Investigator: Dr Eugene Murphy
e-mail or contact (if different from above): e.murphy@bas.ac.uk

Objective/ Goal (100 words max.):
The Ocean Ecosystems and Management project, which is a component part of the
Discovery 2010 programme will use the Southern Ocean as a model to address two
primary objectives that have direct relevance to the global implementation of ecosystem
approaches to the management of fisheries:
1. The determination of the analytical procedures and feedback mechanisms required to
incorporate the results from long-term monitoring of the exploited ecosystem into
management processes, and
2. The development of a methodology for the implementation of ecosystem-based
fisheries management at the space and time scales appropriate to the operation of the
ecosystem and the fishery.

How are the results communicated?
The results of this project will form a major part of the UK input to fisheries management
in the Southern Ocean through Commission for the Conservation of Antarctic Marine
Living Resources (CCAMLR), as well as in the peer reviewed literature.

Can the results be used to support resource management, and if so how?
CCAMLR has adopted an ecosystem approach to fisheries management. The experience
working with an RFMO that has an ecosystem based approach has been recognized as a
key strength of BAS especially as NERC has been identified as one of the bodies that
should be involved in providing the scientific basis for such approaches in the UK/EU.
INSTITUTION: Centre for Environment, Fisheries and Aquaculture Science  
DEPARTMENT/ UNIT: Fisheries Management Science Area  
Address: CEFAS, Pakefield Road, Lowestoft, Suffolk, NR33 0HT, UK  
Contact person: John K. Pinnegar  
e-mail and/or webpage: j.k.pinnegar@cefas.co.uk  www.cefas.co.uk

Research Activity: ‘Alternative Future Scenarios for Marine Ecosystems’ (AFMEC)  
[project SO304/C2055], with Climatic Research Unit (CRU) University of East Anglia,  
Science & Technology Policy Research (SPRU) University of Sussex, Centre for Social  
and Economic Research on the Global Environment (CSERGE) University of East Anglia.

Duration: 2004-2005  
Cost: £ 111,225  
Funding: DEFRA

Principal Investigator: John K. Pinnegar  
e-mail or contact (if different from above):

Objective/ Goal (100 words max.):  
The goal of this study will be to encourage debate about alternative futures for marine  
ecosystems, and to develop a series of future scenarios that can be used by Defra and  
other stakeholders for strategic planning. The key policy relevance of the project is that it  
encourages a wider ‘ecosystems’ view, where marine protection objectives can be  
considered within the context of sustainable social and economic goals. The project takes  
ton into account views of the wider stakeholder community and will involve two workshops  
where scenarios are constructed, reviewed and refined. The project will be undertaken by  
four complimentary organisations. CEFAS will contribute broad cross-disciplinary  
knowledge of the marine environment and will draw on staff directly involved in  
management and monitoring of particular marine stressors. CRU will contribute  
knowledge of climate impacts but also experience in formulating future scenarios. SPRU  
and CSERGE will contribute knowledge of socio-economic drivers and will ensure that the  
marine-futures envisaged are in line with wider UK and European initiatives. The results of  
this project will inform a wide variety of potential users: fisheries organisations, offshore  
operators, coastal engineers and managers, regional development agencies, marine  
biologists, conservationists and tourist authorities.

How are the results communicated?  
2 stakeholder workshops  
Project web-site (www.cefas.co.uk/marine-futures/)  
Summary and technical report published early in 2005

Can the results be used to support resource management, and if so how?  
One of the most effective ways to communicate complex issues is in the form of a  
relatively small number of contrasting “scenarios”. One of the main goals of this study will  
be to encourage debate about alternative futures for marine ecosystems that can be used  
by Defra and other stakeholders for strategic planning.
Research Activity: Development of ecological indicators and models to monitor and predict the ecosystem effects of fishing (MF0731) (with Plymouth Marine Laboratory, University of Wales (Bangor), Fisheries Research Services, Aberdeen and University of Newcastle upon Tyne)

Duration: 2002-2007  
Funding: DEFRA

Principal Investigator: Simon Jennings  
e-mail or contact (if different from above):

Objective/ Goal (100 words max.):

To develop indicators of the ecological effects of fishing and to develop validated models that help to predict the impacts of fishing, and changes in fishery management practices, on the marine ecosystem. The indicators will be suitable for tracking fishery-induced changes in diversity, productivity, trophic structure and functional processes in marine ecosystems, and will be validated using historic and experimental data collected in the areas impacted by the main North Sea cod, haddock, whiting and saithe fisheries.

How are the results communicated?

Peer reviewed scientific literature  
Presentations to conferences and stakeholders  
Through ICES Working Groups, Study Groups and Advisory Committees

Can the results be used to support resource management, and if so how?

Yes. The validated models will allow us to advise on the ecosystem consequences of implementing catch controls, effort controls and technical measures (including closed areas) and will provide the basis for establishing a system to monitor and report the impacts of fishing on the marine environment.
INSTITUTION: Centre for Environment, Fisheries and Aquaculture Science
DEPARTMENT/UNIT: Fisheries Biology Science Area
Address: CEFAS, Pakefield Road, Lowestoft, Suffolk, NR33 0HT, UK
Contact person: Simon Jennings
e-mail and/or webpage: S.Jennings@cefas.co.uk

Research Activity: Assessing the abundance, distribution and vulnerability of rare and declining species impacted by fisheries (MF0729)
Duration: 2002-2007
Cost: 612K
Funding: DEFRA

Principal Investigator: Simon Jennings
e-mail or contact (if different from above):

Objective/ Goal (100 words max.):
To provide validated quantitative assessments of the abundance, distribution and vulnerability of rare and declining species that are impacted by fisheries. These assessments are used to determine the validity of claims that particular species are threatened or not threatened by fishing. The research is also testing the effectiveness of existing fishery surveys to provide information on the abundance and distribution of species that are shown to be threatened by fishing.

How are the results communicated?
Peer reviewed scientific literature
Presentations to conferences and stakeholders
Through ICES Working Groups, Study Groups and Advisory Committees

Can the results be used to support resource management, and if so how?
Yes. Results are used to support advice on rare and declining species that are threatened by fisheries, in support of the integration of environmental protection requirements into the Common Fisheries Policy and the Biodiversity Action Plan for Fisheries. Results will also support the assessment, selection and validation of ecological quality objectives (Ecological Quality Objectives- EcoQOs) for threatened and declining species that will be proposed following the 5th North Sea Conference.
Research Activity: The development of fishing gears with reduced impacts on the seabed and the marine environment

Duration: 2002 - 2005  
Cost: £ 350 K
Funding: DEFRA Contract M0706

Principal Investigator: Andy Revill. e-mail or contact (as above):

Objective/ Goals

1. To develop modifications to existing fishing gear designs (primarily beam trawls) which reduce the current existing adverse environmental impacts

2. To investigate the potential efficacy of environmental impact-reducing fishing gear modifications or new gear designs under development globally.

3. To develop modifications to various trawl designs which reduce discarding of non-target fish.

How are the results communicated?

1. Implementation scheme with fishermen funded under the FIFG programme
2. Press releases, peer reviewed scientific literature, ICES working groups
3. Presentations and participation of stakeholders in advisory groups
4. Reports and presentation to Defra

Can the results be used to support resource management, and if so how?

Yes. The technical mitigation measures developed / assessed under this programme are specifically intended for use in commercial fisheries. Testing / evaluation is undertaken on commercial vessels under fully commercial fishing conditions. The tools developed / evaluated under this programme could potentially be used to reduce the environmental impact of commercial fishing operations. This work can therefore be used to directly support resource management and ecosystem objectives.
Research Activity: M0431: Impacts of environmental change on commercial fish stock recruitment

Funding: x DEFRA

Principal Investigator: C Fox/S Pitois

e-mail or contact (if different from above):

Objective/ Goal (100 words max.):
Collaborative project involving CEFAS and SAFHOS. To evaluate changes in zooplankton abundance and size spectra over European shelf over last 4 decades; To link these changes to possible impacts on larval fish growth and survival via individual based models; to improve the uptake of CPR data into fisheries science

How are the results communicated?
Peer reviewed journal articles
Attendance at ICES Zooplankton Ecology Working Group
To Defra via project reviews

Can the results be used to support resource management, and if so how?
Results should contribute towards improved understanding of role of long-term change in fisheries and thus to issues of stock sustainability. Results will be used to support medium to long-term scenario projections.
Research Activity: Population dynamics models of European cod stocks

Duration: 2001-2005 (5 years)  Cost: £ 500K

Funding: DEFRA (contract MF0427)

Principal Investigator: Dr Carl M. O’Brien

e-mail or contact (if different from above):

Objective/ Goal (100 words max.):

To build models of the important UK cod stocks, incorporating the accumulated knowledge of the biology and environmental influences on recruitment and survival, in order to improve the basis for defining sustainable harvesting strategies. The approach will be to develop a series of linked stage-structured models capable of representing the various spawning populations of cod in northern European waters extending from the English Channel to the northern North Sea and including the West of Scotland, Irish Sea and Celtic Sea. The models will explicitly represent the dynamics of pre-recruitment stages, as well as the survival of immature and adult fish.

How are the results communicated?

Peer-reviewed scientific literature.
Presentations to conferences (national and international) and asset holders (fishers).
Through the scientific committees of ICES (Working Groups, Study Groups and Advisory Committees – ACFM & ACE) and NAFO.

Can the results be used to support resource management, and if so how?

Yes! Current ICES practice is to advise on medium-term exploitation strategies that are predicted to maintain each stock within safe biological limits. These limits are defined for each stock in terms of an upper threshold of fishing mortality and a lower threshold of spawning stock biomass beyond which the precedent of historical data suggests that the risk of collapse becomes unacceptable. The models will be used to investigate the sensitivity of current stock forecasts to the inclusion of greater biological realism and to possible environmental influences.
**INSTITUTION:** Centre for Environment, Fisheries and Aquaculture Science  
**DEPARTMENT/UNIT:**  
Address: Pakefield Road, Lowestoft, Suffolk, NR33 OHT  
Contact person: C Fox  
e-mail and/or webpage: c.j.fox@cefas.co.uk

**Research Activity: M0423:** Development of spatially explicit models for Irish Sea plaice  
Duration: 2000-2005  
Cost: £330k p.a.  
Funding: DEFRA  
Principal Investigator: C Fox  
e-mail or contact (if different from above):

**Objective/Goal (100 words max.):**

A consortium project involving CEFAS, Port Erin Marine Lab, Imperial College and NIOZ. To improve understanding of recruitment mechanisms for plaice (*Pleuronectes platessa*) via field and modelling studies based in the eastern Irish Sea; To develop Bayesian population dynamics models incorporating the full biological cycle including movements of fish between putative sub-stocks.

**How are the results communicated?**

Peer reviewed journal articles  
Attendance by project members at relevant ICES Assessment working groups  
To Defra via project reviews

**Can the results be used to support resource management, and if so how?**

Data from egg surveys from M0423 have been used to support the re-evaluation of the status of the Irish Sea plaice stock leading to an increase in the TAC; the Bayesian models have been used to compare with traditional XSA approach; the spatial models will be used to evaluate the importance of including spatial evaluations in the assessment.
**INSTITUTION:** Centre for Environment, Fisheries and Aquaculture Science  
**DEPARTMENT/UNIT:** Fisheries Biology Science Area  
**Address:** CEFAS, Pakefield Road, Lowestoft, Suffolk, NR33 0HT, UK  
**Contact person:** Ewen Bell  
**e-mail and/or webpage:** e.d.bell@cefas.co.uk  
www.cefas.co.uk

**Research Activity:** Multispecies Fisheries Management: A Comprehensive Impact Assessment of the Sandeel Fishery Along the English East Coast.

**Duration:** 2003-2007  
**Cost:** 1,835k  
**Funding:** DEFRA

**Principal Investigator:** Ewen Bell  
**e-mail or contact (if different from above):**

**Objective/Goal (100 words max.):**

To investigate ways of managing sandeel fisheries with minimal impact on other stocks. The project will therefore produce a spatially explicit, multispecies model in which the dynamics of sandeels and their predators can be explored in relation to a range of local management options. A broader scale ecosystem model will also be used to examine the effect of management choices through the whole ecosystem. In order to achieve this, a three year field programme has been designed to collect data, using novel and existing techniques, regarding the physical environment and local dynamics and behaviour of sandeels and their predators.

**How are the results communicated?**

Presentations to Defra  
Peer reviewed scientific literature  
Presentations to conferences and stakeholders  
Through ICES Working Groups, Study Groups

**Can the results be used to support resource management, and if so how?**

The main purpose of the project is to produce a software tool specifically for the purpose of supporting resource management.
Objective/ Goal (100 words max.):
The project aims to develop models of fisheries incorporating a broader range of uncertainties and processes than currently considered. The project is developing methods to model the interactions between fisheries management, exploitation, biology and our ability to monitor and assess them. The more realistic treatment of interactions proposed would improve both the prediction of system response and the allocation of management resources, greatly facilitating precautionary management. A modelling framework is being developed that can be used to determine the relative benefits of tactical and strategic choices available to managers and to provide case-specific advice.

How are the results communicated?
Report to the European Commission.
ICES Working Groups, Study Groups, Advisory Committees and the Annual Science conference.
Peer-reviewed scientific literature.
Presentations to conferences and stakeholders

Can the results be used to support resource management, and if so how?
Yes, the project intends to provide robust advice to managers, consistent with the precautionary approach. It will illustrate the new methods and models with a variety of case studies for stocks of importance to both DEFRA and DG-FISH.
### Research Activity

**Spatial and temporal distribution of predators and predator/prey interactions.** (MF0317)

- **Duration:** 1999-2004
- **Cost:** £3,200K
- **Funding:** DEFRA (Fish III)

**Principal Investigator:** David Righton

e-mail or contact (if different from above): d.righton@cefas.co.uk

### Objective/ Goal (100 words max.):

To identify and measure the interactions between fish predators (cod) and fish prey (sandeels). The project will: identify suitable field sites; determine local densities and distributions of cod and sandeels; describe the movements of cod in relation to the distribution of sandeels; establish feeding preferences of cod; and interact with the development of multispecies models at CEFAS and ICES.

### How are the results communicated?

- Reports
- Peer reviewed scientific literature
- Presentations to conferences and stakeholders
- Through ICES Working Groups, Study Groups and Advisory Committees

### Can the results be used to support resource management, and if so how?

Yes. Outputs from the project provide biological information that is fundamental to the understanding of predator-prey dynamics that underpins fisheries science and can be used to support the development of fishery management and conservation strategies.
Objective/ Goal (100 words max.):

The project undertook case-specific evaluations of management/assessment procedures for the North Sea flatfish and other fisheries. It evaluated the efficacy of alternative management approaches under a variety of scenarios, and suggested ways in which management and assessment might be improved for wider use within ICES, given concerns about data quality and cost, the lack of conventional data for certain stocks and realistic measures of uncertainty in estimates. The approach is motivated by moves towards precautionary management. Stock assessment methods will include the estimation of appropriate reference points for management, as well as techniques for assessing current stock status.

How are the results communicated?

Reports to the DEFRA ICES Working Groups, Study Groups, Advisory Committees and the Annual Science conference.
Peer-reviewed scientific literature.
Presentations to conferences and stakeholders

Can the results be used to support resource management, and if so how?

Yes. The benefits to policy will be through improved advice on the particular fisheries and stocks studied, and through better general advice based on experience with case studies.
**Research Activity:** Development of integrated systems for shellfish data collection, assessment and management  
**Duration:** 2003-2008  
**Cost:** £885,000  
**Funding:** DEFRA  
**Principal Investigator:** Mike Bell  
**Objective/ Goal (100 words max.):**  
The purpose of the project is to underpin regular quantitative assessments of key shellfish stocks in order to provide advice on their status and management. This requires an improved understanding, not just of the dynamics of exploited shellfish stocks, but also of how these dynamics are reflected through the medium of monitoring and the application of stock assessment methods. There are inherent uncertainties and approximations in our perception of stock status, and in how this perception is translated into management advice. This project aims to identify and quantify these uncertainties, and thereby determine how best to deploy available resources towards monitoring and assessment. Crucial to this aim is the development of frameworks within which the processes of data collection, stock assessment and fishery management can be integrated.

**How are the results communicated?**  
Peer-reviewed scientific literature.  
Presentations to conferences and stakeholders.  
Articles in Shellfish News.

**Can the results be used to support resource management, and if so how?**  
Yes. The results of the study will: (i) inform our programmes for monitoring and assessment of exploited shellfish stocks; (ii) provide management models and tools; and (iii) provide data and parameters in support of management. These will feed into practical resource management through advice to Defra, Sea Fisheries Committees and others.
**Research Activity:** Investigating the behaviour and movements of cod in the English Channel and southern North Sea  
**Duration:** 6 months  
**Cost:** £24,000  
**Funding:** DEFRA

**Principal Investigator:** David Righton  
e-mail or contact (if different from above): d.righton@cefas.co.uk

**Objective/ Goal (100 words max.):**
The purpose of the proposed research is to develop a greater understanding of the behaviour and movements of cod in and between ICES divisions VIIId and IVc. This work is needed to assist CEFAS in advising Defra on stock identity and separation issues with respect to the application of fisheries management and conservation policies.

**How are the results communicated?**
- Official contract reports  
- Peer reviewed scientific literature  
- Presentations at conferences and to stakeholders  
- Through ICES Working Groups, Study Groups and Advisory Committees  
- Articles in fishing press

**Can the results be used to support resource management, and if so how?**
Present fish stock assessments assume that the stock of cod in VIIId and IVc is a single unit and currently this is assessed and managed as one stock. Limited historical tagging data support this assumption, but recent concerns have been raised that this assumption may not be be valid. The hypothesis that the stock in VIIId is a non-migratory stock (as has been observed for cod in other areas within its range e.g. Placentia Bay, Newfoundland) and should therefore be managed a a unit stock has been put forward by fishermen. The study will help to resolve this issue.
**Research Activity:** Electronic telemetry tags: development of behaviour sensors for fish. (MF0155)

Duration: 2004-2009  
Cost: £609K

Funding: DEFRA (Fish III)

**Principal Investigator:** Julian Metcalfe

e-mail or contact (if different from above):

**Objective/ Goal (100 words max.):**

To develop sensors that can monitor physical movements and can be incorporated into acoustic transmitting and electronic data storage tags (DSTs) for deploying on free-ranging marine fish. The immediate application is to monitor feeding in predatory fish such as cod to provide information about feeding behaviour (e.g. prey consumption rates) in relation to the environment at the appropriate spatial and temporal scales. This is needed to parameterise multi-species and ecosystem models used to advise on the ecological impacts resulting from changes in the environment and fishing intensity, and is fundamental to the understanding of fish ecology that underpins fisheries science.

**How are the results communicated?**

- Reports
- Peer reviewed scientific literature
- Presentations to conferences and stakeholders
- Through ICES Working Groups, Study Groups and Advisory Committees

**Can the results be used to support resource management, and if so how?**

Yes. Outputs from the project provide the technologies required to provide the biological information that is fundamental to the understanding of fish ecology that underpins fisheries science and can be used to support the development of fishery management and conservation strategies.
INSTITUTION: Centre for Environment, Fisheries and Aquaculture Science
DEPARTMENT/UNIT: Fisheries Biology Science Area
Address: CEFAS, Pakefield Road, Lowestoft, Suffolk, NR33 0HT, UK
Contact person: Julian Metcalfe (Head of Fish Populations and Behaviour research)
e-mail and/or webpage: j.d.metcalfe@cefas.co.uk www.cefas.co.uk

Research Activity: Linking the behaviour, spatial dynamics and the environment of cod and ray populations to evaluate fisheries scenarios
Duration: 5 years Cost: £856,000
Funding: DEFRA
Principal Investigator: David Righton
e-mail or contact (if different from above): d.righton@cefas.co.uk

Objective/Goal (100 words max.):
The purpose of the research is to develop a more comprehensive understanding and integration of behavioural, environmental and fisheries data to predict the response of cod and ray stocks to changes in the environment and fisheries. This work will assist CEFAS in advising Defra on a range of forward-looking fisheries management and conservation policies. A key element of the proposed research will be linking individual-based behavioural data-sets and environmental data-sets in order to determine the ecological drivers of cod and ray movements, and the impact of the environment on the growth and reproduction of individuals.

How are the results communicated?
Official contract reports
Peer reviewed scientific literature
Presentations at conferences and to stakeholders
Through ICES Working Groups, Study Groups and Advisory Committees

Can the results be used to support resource management, and if so how?
Yes. Outputs from the project provide biological information that is fundamental to the understanding of the spatial dynamics of commercially or ecologically important fish. Such information contributes to fisheries assessment and management and can therefore be used to provide evidence for the development of fishery management and conservation strategies.
Research Activity: Validation and testing of biologically-based movement models for North Sea plaice and implementation in management and assessment. (MF0152)

Duration: 2003-2007

Funding: DEFRA (Fish III)

Objective/ Goal (100 words max.):

Based around the validation, testing and implementation of a biologically-based simulation model of population movement for North Sea plaice, the project firstly aims to assess the potential impact of different management procedures on fish stocks using adult female behaviour data. Secondly, male and juvenile plaice will be tagged to extend the scope of the model. Thirdly, geochemical analysis of otoliths returned from plaice tagged with data storage tags will be used to determine the lifetime movements of the fish. The output from the models will be used to support advice on the effects of closed areas and closed seasons.

How are the results communicated?

Reports
Peer reviewed scientific literature
Presentations to conferences and stakeholders
Through ICES Working Groups, Study Groups and Advisory Committees

Can the results be used to support resource management, and if so how?

Yes. Outputs from the project provide information on North Sea plaice population dynamics that can be used to support the development of fishery management and conservation strategies (effects of closed areas and closed seasons)
Objective/ Goal (100 words max.):

To describe the detailed movements of individual thornback rays over extended periods using electronic data storage tags and to calculate the proportion of time spent by each fish in each part of its geographical range. This will be used to describe the spatial dynamics of rays that use the Thames Estuary. Integration of this information with a spatial and temporal analysis of fishing effort will be used to advise Defra on the likely effects on ray stocks of closing particular areas. It will also provide information on the potential benefits to the commercial fishery in terms of improved stock biomass.

How are the results communicated?

Reports
Peer reviewed scientific literature
Presentations to conferences and stakeholders
Through ICES Working Groups, Study Groups and Advisory Committees

Can the results be used to support resource management, and if so how?

Yes. Outputs from the project provide information on ray population dynamics in the southern North Sea that can be used to support the development of fishery management and conservation strategies.
**Research Activity:** Development of data storage tags (DST) (phase 3): tag miniaturisation & development of fishery independent methods of data retrieval. (MF0145)

**Duration:** 1998-2004  
**Cost:** £844K

**Funding:** DEFRA (Fish III)

**Principal Investigator:** Julian Metcalfe

**Objective/ Goal (100 words max.):**

To develop appropriate specialised telemetry technologies to support CEFAS’ biological research programmes on marine fish that provide the understanding of fish behaviour and ecology that underpins fisheries science. The project had two separate but linked aims. The first was to miniaturise the Mk 3 electronic data storage tag (developed under a previous Defra project) so that it would be small enough for deployment on male and juvenile plaice, juvenile cod and on Dover sole. The second was to develop fishery independent methods of data retrieval to maximise data recovery and improve the cost benefit of electronic tagging experiments.

**How are the results communicated?**

- Reports
- Peer reviewed scientific literature
- Presentations to conferences and stakeholders
- Through ICES Working Groups, Study Groups and Advisory Committees

**Can the results be used to support resource management, and if so how?**

Yes. Outputs from the project provide the technologies required to provide the biological information that is fundamental to the understanding of fish ecology that underpins fisheries science and can be used to support the development of fishery management and conservation strategies.
### INSTITUTION
Centre for Environment, Fisheries and Aquaculture Science

### DEPARTMENT/UNIT
Address: Pakefield Road, Lowestoft, Suffolk, NR33 OHT  
Contact person: Clive Fox  
e-mail and/or webpage: c.j.fox@cefas.co.uk

### Research Activity
**C2016: Identification of gadoid eggs from North Sea ichthyoplankton survey**  
**Duration:** 2004-2006  
**Cost:** £75k p.a.  
**Funding:** x DEFRA

### Principal Investigator
M Taylor (UEA)/C Fox  
e-mail or contact (if different from above):

### Objective/Goal (100 words max.)
Collaborative project involving CEFAS and UEA.  
To use genetic probes developed by us under previous Defra contracts to identify early stage eggs of gadoids collected across the North Sea in 2004 by the International PLACES consortium (PLACES, Plaice and Cod Egg Surveys, ICES sponsored)

### How are the results communicated?
- Peer reviewed journal articles  
- Planned article in Fishing News  
- ICES Living Resources Committee and North Sea Assessment WG  
- To Defra via project reviews

### Can the results be used to support resource management, and if so how?
Results will be first comprehensive survey of spawning areas of cod in the North Sea.  
Results will be highly relevant to definition of possible closed areas and evaluation of need for spatial management in relation to cod recovery plan
INSTITUTION: Centre for Environment, Fisheries and Aquaculture Science  
DEPARTMENT/ UNIT: Fisheries Biology Science Area  
Address: CEFAS, Pakefield Road, Lowestoft, Suffolk, NR33 0HT, UK  
Contact person: Julian Metcalfe  
e-mail and/or webpage: j.d.metcalfe@cefas.co.uk  
www.cefas.co.uk

Research Activity: Conservation genetics of Basking Sharks (C1946)  
Duration: 2004-2006  
Cost: £174K  
Funding: DEFRA (GWD)

Principal Investigator: Julian Metcalfe  
e-mail or contact (if different from above):

Objective/ Goal (100 words max.):  
To determine, using modern molecular genetics, the population structure and dynamics of basking sharks in the north-east Atlantic. In particular to determine whether there are discrete populations/stocks of basking sharks, the likely boundaries between any such populations and to what degree mixing between populations occur. To characterize the degree and frequency of gene flow within the whole population, or the extent to which populations are isolated or fragmented. The results will provide information in support of the management for recovery and sustainability, and the avoidance of unnecessary mortality.

How are the results communicated?  
Reports  
Peer reviewed scientific literature  
Presentations to conferences and stakeholders  
Through ICES Working Groups, Study Groups and Advisory Committees

Can the results be used to support resource management, and if so how?  
Yes. Outputs from the project will provide information on basking shark population structure and dynamics to Defra and other organisations to support the development of conservation strategies.
Research Activity: Determination of Plaice lifetime movements in the North Sea by linking natural and electronic data records (C1894)
Duration: 2003-2007    Cost: £92K
Funding: EU Marie Curie EIF

Principal Investigator: Ewan Hunter
e-mail or contact (if different from above): E.hunter@cefas.co.uk

Objective/ Goal (100 words max.):
The goal of this project is to describe the lifetime movements of plaice, *Pleuronectes platessa* L., in the North Sea, by linking the geographical movements recorded by fish tagged with electronic data storage tags to chemical signals simultaneously laid down in the ear-stones (otoliths) of the same fish. By linking these state of the art techniques, we aim to provide information on the population dynamics of North Sea plaice, which would be otherwise unattainable using conventional methods.

How are the results communicated?
Reports
Peer reviewed scientific literature
Presentations to conferences and stakeholders
Through ICES Working Groups, Study Groups and Advisory Committees

Can the results be used to support resource management, and if so how?
Yes. The results of this study have the potential to improve the parameterisation of assessment methods currently applied in fisheries management, and will therefore feed directly into management advice designed to promote sustainability.
**Research Activity:** Critical Interactions Between Species and their Implications for a PreCAutionary FiSheries Management in a variable Environment - a Modelling Approach (BECAUSE).

**Duration:** 2004-2007  
**Cost:** 163k (Defra 81k)  
**Funding:** EU

**Principal Investigator:** Ewen Bell  
e-mail or contact (if different from above):

**Objective/ Goal (100 words max.):**

The principle objective of this program is the identification and quantification of critical biological interactions between and within commercial target fish species and noncommercial top predators leading to a description of food web structures and the derivation of precautionary reference points for ecosystem oriented fisheries management. These precautionary reference points and limit values accounting for interacting mechanisms with the environment are necessary for the development of adaptive strategies in fisheries management.

**How are the results communicated?**

web-site, workshops, reports, scientific journals and public printed media.

**Can the results be used to support resource management, and if so how?**

The project seeks to improve on the current state of multispecies modelling. Progress in this area will directly feed into scientific advice coming from within CEFAS as well as from ICES/STECF.
**INSTITUTION:** Centre for Environment, Fisheries and Aquaculture Science  
**DEPARTMENT/UNIT:** Fisheries Management Science Area  
**Address:** Pakefield Road, Lowestoft, Suffolk NR33 0HT, UK  
**Contact person:** Laurence Kell  
**e-mail and/or webpage:** l.t.kell@cefas.co.uk  
www.cefas.co.uk

<table>
<thead>
<tr>
<th>Research Activity:</th>
<th>Creation Of Multiannual Management Plans for Commitment (COMMIT)</th>
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<tbody>
<tr>
<td><strong>Duration:</strong></td>
<td>01/01/04 – 31/03/07</td>
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<tr>
<td><strong>Cost:</strong></td>
<td>€458 377 (≈ £314 441)</td>
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<tr>
<td><strong>Funding:</strong></td>
<td>EU</td>
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**Principal Investigator:** Laurence Kell  
**e-mail or contact (if different from above):**

**Objective/Goal (100 words max.):**  
The study is inter-disciplinary and focuses on which elements are essential to multi-annual management strategies to make these strategies acceptable for fishers and other stakeholders, and thus ensure their commitment and consequent compliance with management regulations. Case studies will focus on mixed fisheries, and will consider fishery- (as opposed to stock-) based advice. Various sources of uncertainty related to fishery systems and their management will be explicitly considered. Harvest rules will be developed on a case-specific basis by evaluating the biological and economic impacts of candidate rules, including the effect of non-compliance.

**How are the results communicated?**  
Peer-reviewed scientific literature.  
Presentations to conferences and stakeholders  
Through ICES Working Groups, Study Groups and Advisory Committees

**Can the results be used to support resource management, and if so how?**  
Yes, they will highlight the key elements of multi-annual management strategies that will help ensure greater commitment from stakeholders, and consequently improve compliance with management regulations.
**INSTITUTION:** Centre for Environment, Fisheries and Aquaculture Science  
**DEPARTMENT/ UNIT:** Fisheries Management Science Area  
**Address:** Pakefield Road, Lowestoft, Suffolk NR33 0HT, UK  
**Contact person:** Laurence Kell  
**e-mail and/or webpage:** l.t.kell@cefas.co.uk www.cefas.co.uk

<table>
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<tr>
<th>Research Activity: Fisheries Independent Survey Based Operational Assessment Tools (FISBOAT)</th>
<th>Duration: 3 years</th>
<th>Cost: €125 000 (~ £85 749)</th>
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<tbody>
<tr>
<td><strong>Funding:</strong> EU</td>
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| **Principal Investigator:** Pierre Petitgas  
**e-mail or contact (if different from above):** Pierre.Petitgas@ifremer.fr |

**Objective/ Goal (100 words max.):**  
FISBOAT aims to develop fish stock assessment tools based solely on survey and other fisheries-independent data. A variety of methods are proposed to obtain direct estimates (and associated errors) of population abundance, mortality, spatial occupation and maturity at age. Assessment tools are evaluated within a simulation-testing framework, and their ability to capture changes in population biology and survey catchability is evaluated. The sensitivity of the assessment tools to uncertainties in survey estimates is also tested, so that alternative survey designs can be explored. The approach considers specific case studies, and the resultant advice is compared with current advice.

**How are the results communicated?**  
Peer-reviewed scientific literature.  
Presentations to conferences and stakeholders  
Through ICES Working Groups, Study Groups and Advisory Committees

**Can the results be used to support resource management, and if so how?**  
Yes, the project develops fisheries-independent tools to help manage fish stocks, useful for cases where fisheries-based data are poor or unreliable.
**Research Activity:** Operational Evaluation Tools for Fisheries Management Options (EFIMAS)

**Duration:** 4 years  
**Cost:** £279,877 + matched funding  
**Funding:** EU

**Principal Investigator:** Laurence Kell  
**e-mail or contact (if different from above):**

**Objective/ Goal (100 words max.):**

EFIMAS aims to develop a framework that allows evaluation of the trade-off between management objectives when choosing between different management options. The evaluation framework will be developed to inform an exploratory, adaptive decision-making process. These tools will be used to investigate the biological, social and economic effects of fisheries management measures in the EU, and will be applied to important fisheries. The tools will take account of the dynamics in the fisheries systems, as well as of uncertainties, and will include risk assessments.

**How are the results communicated?**

- Peer-reviewed scientific literature.
- Presentations to conferences and stakeholders
- Through ICES Working Groups, Study Groups and Advisory Committees

**Can the results be used to support resource management, and if so how?**

Yes, the operational evaluation framework will allow the biological, social and economic effects of alternative management options on fisheries systems to be investigate prior to their implementation.
Research Activity: C1730: EUROpean GELatinous zooplankton: Mechanisms behind jellyfish blooms and their ecological and socio-economic effects (EUROGEL), in collaboration with University of Bergen, University of Hamburg, Institut de Ciències del Mar, University of Southern Denmark – Odense, Institute of Fisheries and Aquaculture – Varna, Danish Institute for Fisheries Research, University of Aberdeen, National University of Ireland, North Atlantic Fisheries College, Shetland, and Instituto Español de Oceanografía

Duration: 2001-2005  
Cost: £13 856

Funding: EU FW5, CEFAS is subcontracted by IFA, Bulgaria

Principal Investigator: Ulf Bamstedt, University of Bergen, e-mail or contact (if different from above): Ulf.Bamstedt@bio.uib.no

Objective/ Goal (100 words max.):

The overall objective of EUROGEL is to identify and quantify key factors regulating the abundance and succession of gelatinous plankton species in European waters. The aim is to define the basic factors that govern reproduction, growth, and survival of species commonly occurring in high abundance. Five different habitats are investigated and results are put into historical perspective. Mathematical models are constructed to explore competitive effects between gelatinous plankton and fish. EUROGEL is strongly orientated towards socio-economic aspects of gelatinous plankton outbursts, and emphasis is on quantitatively defining problems related to the fishery, coastal industry and recreational activities.

How are the results communicated?

Peer-reviewed scientific literature  
Presentations to conferences, stakeholders and media

Can the results be used to support resource management, and if so how?

Yes. Mechanisms behind impacts of gelatinous plankton on fisheries resources are still largely unknown and/or neglected other than the huge evidence of such impacts on fish stocks e.g. *Mnemiopsis* in the Black and Caspian Seas. Better understanding of the mechanisms of interaction between fish and jellies would provide scientific basis for management of fish stocks in conditions of frequent blooms and approaches for regulation of gelatinous plankton populations.
**Research Activity:** SARdine DYNamics and stock structure in the North-east Atlantic (C1532)

Duration: 3 years  
Funding: EU  
Cost: 73092

**Principal Investigator:** Beatriz A. Roel  
e-mail or contact (if different from above):

**Objective/ Goal (100 words max.):** A comprehensive study of the life history and structural dynamics of the sardine (*Sardina pilchardus*) in Atlantic European waters with an emphasis on the factors required for improvement of the assessment and management of this species.

**How are the results communicated?**  
Annual reports, report to WGMHSA and peer review papers.

**Can the results be used to support resource management, and if so how?**  
Yes, the study will lead to the modification/extension of existing assessment models or to the development of a new model based on biologically defensible definition of the stock boundaries and an adequate description of the sardine dynamics within the stock area.
### INSTITUTION:
Centre for Environment, Fisheries and Aquaculture Science  
**DEPARTMENT/ UNIT:** Fisheries management Science area  
**Address:** Pakefield Road, Lowestoft, Suffolk, NR33 0HT, UK

**Contact person:** John Casey  
**e-mail and/or webpage:** j.casey@cefas.co.uk

### Research Activity:
Evaluation of the methodology to produce research based scientific advice under EU contract PKFM (contribute to WP4 and synthesis work-packages)

<table>
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<tr>
<th>Duration: 3.5 years</th>
<th>Cost: £26,400</th>
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<tr>
<td>Funding: EU with matched funding from DEFRA</td>
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**Principal Investigator:** Trevor Hutton  
**e-mail or contact (if different from above):** t.p.hutton@cefas.co.uk

### Objective/ Goal (100 words max.):
The overall objectives of the project are to identify and understand specific shortcomings in the European fisheries policy and its implementation, which have contributed to the problems evident in several European fisheries, and to devise means for their rectification. The project will focus on the knowledge production and decision-making within the fisheries management system, the interrelationships between these processes and the role played by stakeholders. Fisheries for North Sea cod will be adopted as a case study.

### How are the results communicated?
- Peer reviewed scientific literature (no publications at this stage only in draft form)  
- Presentations to conferences and stakeholders (presentations at the ICES, ASC)  
- Through ICES Working Groups (specifically the Working Group for Fisheries Systems; which PKFM contributes to directly), Study Groups and Advisory Committees

### Can the results be used to support resource management, and if so how?
Yes, directly. The results of the project which includes a review of the cod assessment and social studies on the institutional arrangements for fisheries management (undertaken by anthropologists in the team) are informing ICES in general, the ACFM and the EU Commission on the short-comings associated with the management of North Sea cod (on a technical basis and institutional)
INSTITUTION: Centre for Environment, Fisheries and Aquaculture Science
DEPARTMENT/ UNIT: Fisheries management Science area
Address: Pakefield Road, Lowestoft, Suffolk, NR33 0HT, UK

Contact person: John Casey
e-mail and/or webpage: j.casey@cefas.co.uk

Duration: 3 years Cost: £94,000
Funding: EU with matched funding from DEFRA

Principal Investigator: Trevor Hutton
e-mail or contact (if different from above): t.p.hutton@cefas.co.uk

Objective/ Goal (100 words max.):
The overall objective of this project is to more precisely to supply fisheries managers with a modelling tool that will allow them evaluating the impact of regulations (TACs, MAGPs, area and season closures, subsidies) on the dynamics of fleets and fishing mortality. The carrying idea is the investigation of the dynamics of the elements that cause changes in fleet dynamics: the technological advances in both gears and vessel equipment, and also the overall tactical adaptation of fishing vessels.

How are the results communicated?
Peer reviewed scientific literature (1 publications at this stage)
Presentations to conferences and stakeholders (presentations at the ICES, ASC) and 2 presentations (European Fisheries Economist and International IFFET).
Through ICES Working Groups, Study Groups and Advisory Committees, and STECF working groups and EU Commission

Can the results be used to support resource management, and if so how?
This project will contribute significantly to measuring the actual affects of technical change within North Sea fleets on fishing mortality and catchability, in addition to understanding the effects of any effort control regulations (such as days at sea regulations), as the research focuses on the relationship between effort and fishing mortality. Furthermore, studies in this project have modelled spatial effort allocation of fishing vessels, which is relevant to area closures (MPAs).
Research Activity: Cephalopod Stocks in European Waters: Review, Analysis, Assessment and Sustainable Management (C1508)

Duration: 3 years       Cost: 25152
Funding: EU

Principal Investigator: Beatriz Roel

e-mail or contact (if different from above):

Objective/ Goal (100 words max.):

Review current knowledge and issues in cephalopod fisheries science, to assemble, organise, analyse and synthesise data from ongoing national projects, previous and new EC-funded R&D projects, and to recommend future actions for scientists and cephalopod fishery managers in European waters.

How are the results communicated?
An annual report, Review papers, new research papers and a common database and GIS for cephalopod fisheries.

Can the results be used to support resource management, and if so how?
Yes, see objectives above
**INSTITUTION:** Centre for Environment, Fisheries and Aquaculture Science  
**DEPARTMENT/ UNIT:** Fisheries Management Science Area  
**Address:** Pakefield Road, Lowestoft, Suffolk NR33 0HT, UK  
**Contact person:** Laurence Kell  
**e-mail and/or webpage:** l.t.kell@cefas.co.uk [www.cefas.co.uk](http://www.cefas.co.uk)

<table>
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<tr>
<th>Research Activity: (MATES)</th>
<th>Duration: 1 Year (completed)</th>
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<tbody>
<tr>
<td><strong>Funding:</strong> EU</td>
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**Principal Investigator:** Laurence Kell  
**e-mail or contact (if different from above):**

**Objective/ Goal (100 words max.):**

MATES evaluated, through simulation, management strategies for roundfish stocks that stabilise catch levels by setting bounds on the inter-annual variability in TACs. An integrated modelling approach was used, which modelled both the ‘real’ and observed systems, and the interactions between all system components. This framework allowed evaluation of the robustness of candidate management strategies to both the intrinsic properties of the systems, and the ability to observe, monitor, assess and control them. Strategies were evaluated in terms of level of risk (probability of SSB falling below a threshold) and cumulative yield.

**How are the results communicated?**

- Peer-reviewed scientific literature.  
- Presentations to conferences and stakeholders  
- Through ICES Working Groups, Study Groups and Advisory Committees

**Can the results be used to support resource management, and if so how?**

Yes, stable future catch levels is an important consideration for fishers, and MATES investigated the ability of management strategies to provide these given the prevailing uncertainties in fisheries systems.
**Research Activity:** Evaluation of Research Surveys in relation to Management Advice (EVARES)

**Duration:** (completed)  
**Cost:** £223,914  
**Funding:** EU

**Principal Investigator:** Laurence Kell

**Objective/ Goal (100 words max.):**
EVARES estimated sampling error in indices of abundance obtained from research vessel surveys and evaluated its importance for stock assessment and subsequent scientific advice. Both data analysis and simulations techniques were conducted for a variety of European fish stocks and surveys using a common framework.

**How are the results communicated?**
- Report to the European Commission.
- Peer-reviewed scientific literature.
- Presentations to conferences and stakeholders

**Can the results be used to support resource management, and if so how?**
Yes, EVARES was commissioned by the EU specifically to perform a cost/benefit analysis for RV surveys and to identify their strengths and weaknesses. Results could be applied for preliminary evaluation of many other surveys.
Research Activity: Framework for the Evaluation of Management Strategies (FEMS)
Duration: 3 years  Cost: £95,693
Funding: EU

Principal Investigator: Laurence Kell
e-mail or contact (if different from above):

Objective/ Goal (100 words max.):
FEMS is developing a computer simulation framework for the evaluation of management strategies by undertaking a variety of case studies for stocks of importance to community states. The framework considers sources of uncertainty not currently routinely considered by International fisheries fora with the intention of developing methods that provide robust advice to managers consistent with the precautionary approach. FEMS will provide software and methodology that will be used by other EU proposals to evaluate the consequences of improving our understanding of fishery systems.

How are the results communicated?
Peer-reviewed scientific literature.
Presentations to conferences and stakeholders
Through ICES and ICCAT Working Groups, Study Groups and Advisory Committees

Can the results be used to support resource management, and if so how?
Yes, FEMS aims to develop methods that provide robust advice to managers, and help improve our understanding of fishery systems. The methodology has been adopted/used by other current and submitted EU projects (e.g. PKFM, EASE, RASER, COMMIT, EFIMAS, FISBOAT)
INSTITUTION: Centre for Environment, Fisheries and Aquaculture Science
DEPARTMENT/ UNIT: Fisheries Biology Science Area
Address: CEFAS, Pakefield Road, Lowestoft, Suffolk, NR33 0HT, UK
Contact person: Peter Witthames
e-mail and/or webpage: p.r.witthames@cefas.co.uk http://raser.imr.no
www.cefas.co.uk

Research Activity: Studies on Fish reproduction in cod and hake in relation to population structure considering fisheries and climate to develop Stock recovery Plans through joint collaboration between IMR Norway, AZTI Basque County Spain and IEO Spain.

Duration: 3 years
Funding: Matched DEFRA, and EU, Cost: €1059859

Principal Investigator: Peter Witthames
e-mail or contact (if different from above):

Objective/ Goal (100 words max.):
Development of more cost effective and accurate methods to provide data on the age dependence of cod and hake reproductive potential caught over a large part of their latitudinal range. These methods will be applied to improve fisheries independent assessment of spawning stock biomass using egg production and for modeling stock recovery in different fisheries and environmental scenarios.

How are the results communicated?
Peer reviewed scientific literature
Presentations to conferences and stakeholders through releases to the National Fisheries Press
Through ICES Working Groups, ICES Annual Science Theme Session 2005, Study Groups and Advisory Committees

Can the results be used to support resource management, and if so how?
Yes
• developing more cost effective and accurate methods for application in Fishery Independent assessment of SSB based on egg production.
• evaluating the impact on assessment and management of including models of more realistic variations in population reproductive potential for cod and hake.
INSTITUTION: Centre for Environment, Fisheries and Aquaculture Science  
DEPARTMENT/UNIT: Fisheries Biology Science Area  
Address: CEFAS, Pakefield Road, Lowestoft, Suffolk, NR33 0HT, UK  
Contact person: Julian Metcalfe (Head of Fish Populations and Behaviour research)  
e-mail and/or webpage: j.d.metcalfe@cefas.co.uk  www.cefas.co.uk

<table>
<thead>
<tr>
<th>Research Activity:</th>
<th>Cod spatial dynamics and vertical movements in European waters and implications for fishery management (CODYSSEY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration:</td>
<td>4 years</td>
</tr>
<tr>
<td>Cost:</td>
<td>£416,852</td>
</tr>
<tr>
<td>Funding:</td>
<td>EU collaborative, total EU contribution ~€2.25m</td>
</tr>
</tbody>
</table>

Principal Investigator: David Righton  
e-mail or contact (if different from above): d.righton@cefas.co.uk

Objective/Goal (100 words max.):  
The aim of the research is to improve understanding of the horizontal migrations and vertical movements of cod and the influence of environmental and biological factors on them in order to provide management relevant information as to the *horizontal availability*, *vertical accessibility*, and *individual vulnerability* of cod to fishing activities. The fulfilment of this objective will provide tools for the evaluation of stock assessment methodology, management and conservation of cod stocks in European waters and will be highly relevant to future stock assessment and the management of cod stocks under the soon-to-be renegotiated Common Fisheries Policy, and other fisheries management instruments.

How are the results communicated?  
Official contract reports  
Peer reviewed scientific literature  
Presentations at conferences and to stakeholders  
Through ICES Working Groups, Study Groups and Advisory Committees  
Website: www.codyssey.co.uk

Can the results be used to support resource management, and if so how?  
Yes. Outputs from the project provide biological information that is fundamental to the understanding of the spatial dynamics of this commercially important fish. Such information contributes to fisheries assessment and management and can therefore be used to provide evidence for the development of fishery management and conservation strategies.
Research Activity: “Enhancing the Outreach of Aquatic Biodiversity and Ecosystem Research in Support of the Transition Towards Global Sustainability” (ECOFISH) [ICA4-CT2002-50001, CEFAS project C1387].

Cost (total): 295200 EURO
Funding: EU-INCO

Principal Investigator: John K. Pinnegar CEFAS; (Project leader: Dr. R. Froese, Institute of Marine Research, Kiel, Germany).

e-mail or contact (if different from above): r froese@ifm.uni-kiel.de

Objective/ Goal (100 words max.):
The specific objectives of Ecofish are: Strengthening of networking among Fishbase and EwE (Ecopath with Ecosim) users in Europe and developing countries (Africa, South America and Asia) by creating a functioning information network; co-ordination of research among Ecofish partners (25 scientist from 19 countries) with a view to enhance relevance for global and regional sustainability; increasing the impact of research co-operations through dissemination of results to other scientists, decision makers and the public at large; involvement of the interested public (such as anglers and divers) in monitoring fish biodiversity.

How are the results communicated?
6 workshops (in Germany, Senegal, Greece, Spain and Mexico)
Project web-site (www.ecofish.org)
Regular e-mail newsletter (‘FishBytes’ www.fisheries.ubc.ca/publications/fishbytes/)
Through the FishBase website www.fishbase.org

Can the results be used to support resource management, and if so how?
The main purpose of this project is to provide training and a forum for transferral of knowledge/expertise from European scientists to individuals from Africa, South America and Asia. The project is aimed mainly at supporting participation at workshops.
| **INSTITUTION:** Centre for Environment, Fisheries and Aquaculture Science  
**DEPARTMENT/UNIT:** Environmental Quality Science Area  
**Address:** Remembrance Avenue, Burnham on Crouch, Essex  
**Contact person:** Andrew Kenny  
e-mail and/or webpage: Andrew.Kenny@cefas.co.uk  
www.cefas.co.uk |
| --- |

**Research Activity:** Towards operational oceanography – improving Smart Buoy technology.  
Duration: 2 years  
Funding: DEFRA  
Principal Investigator: Dave Mills  
e-mail or contact (if different from above):  
**Objective/Goal (100 words max.):**  
To develop autonomous buoy systems that will deliver improved data and information on the nutrient status and ecosystem response of UK coastal waters and shelf seas. These tools and data are to support Defra responsibilities under the Nitrate Directive, Urban Waste Water Treatment Directive and the OSPAR Convention.  
**How are the results communicated?**  
By peer reviewed publication, conferences (national and international) and ICES mainly via the Plankton Ecology WG.  
**Can the results be used to support resource management, and if so how?**  
The results of this programme provide vital observational data to parameterise ecosystem models such as ERSEM.
**INSTITUTION:** Centre for Environment, Fisheries and Aquaculture Science  
**DEPARTMENT/UNIT:** Environmental Quality Science Area  
**Address:** Remembrance Avenue, Burnham on Crouch, Essex  
**Contact person:** Andrew Kenny  
**e-mail and/or webpage:** Andrew.Kenny@cefas.co.uk www.cefas.co.uk

<table>
<thead>
<tr>
<th>Research Activity:</th>
<th>Role of seabed mapping techniques in environmental monitoring.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration:</td>
<td>4 years</td>
</tr>
<tr>
<td>Cost:</td>
<td>£1 milion</td>
</tr>
<tr>
<td>Funding:</td>
<td>DEFRA</td>
</tr>
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</table>

**Principal Investigator:** Sian Boyd  
**e-mail or contact (if different from above):**

<table>
<thead>
<tr>
<th>Objective/Goal (100 words max.):</th>
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<tbody>
<tr>
<td>To critically evaluate an array of state of the art seabed mapping techniques in order to establish their suitability for application to areas of environmental management of direct relevance to Defra and to develop methodologies including survey design using such techniques for a range of assessment applications.</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>How are the results communicated?</th>
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<tbody>
<tr>
<td>By peer reviewed publication, conferences (national and international) and ICES mainly via the marine habitats working group (WGMH).</td>
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<tr>
<th>Can the results be used to support resource management, and if so how?</th>
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<tbody>
<tr>
<td>The mapping of habitats is vital in understanding the spatial distribution of benthic bioresources and potential pelagic links.</td>
</tr>
</tbody>
</table>
Research Activity: Development and validation of biological techniques for marine monitoring.

Duration: 10 years  Cost: £800,000
Funding: DEFRA

Principal Investigator: John Thain
e-mail or contact (if different from above):

Objective/ Goal (100 words max.):
To develop a suite of validated biological effects techniques that can be readily applied on behalf of Defra to meet the need for assessment of the quality of water and sediment in the marine environment. This will ensure that Defra has the ability to deploy suitable and up to date biological effects techniques for surveying marine quality, both in long term strategic quality assessment programmes such as the UK National Marine Monitoring programme and in emergency responses.

How are the results communicated?
By peer reviewed publication, conferences (national and international) and ICES mainly via the WG on Biological Effects WGBEC which is chaired by John Thain.

Can the results be used to support resource management, and if so how?
The results of this programme provide a vital link between ecosystem level effects and specific causality of biological change particularly in relation to contaminants.
Research Activity: Linking hydrographic frontal activity to ecosystem dynamics in the North Sea and Skagerrak: importance to fish stock recruitment.

Duration: 3 years  Cost: £210,000

Funding: EU

Principal Investigator: David Righton
e-mail or contact (if different from above): d.righton@cefas.co.uk

Objective/ Goal (100 words max.):
Perform field studies to quantify cross frontal and along frontal migration of selected piscivorous species and to analyse stomach samples to quantify species and life stage/size-specific diet composition of 0-group gadoid fish in and around frontal systems.

How are the results communicated?

Official contract reports
Peer reviewed scientific literature
Presentations at conferences and to stakeholders
Through ICES Working Groups, Study Groups and Advisory Committees

Can the results be used to support resource management, and if so how?

Yes. Outputs from the project provide important biological information. Such information contributes to fisheries assessment and management and can therefore be used to provide evidence for the development of fishery management and conservation strategies.
| **INSTITUTION:** Centre for Environment, Fisheries and Aquaculture Science  |
| **DEPARTMENT/UNIT:** Fisheries Biology Science Area |
| **Address:** CEFAS, Pakefield Road, Lowestoft, Suffolk, NR33 0HT, UK |
| **Contact person:** Julian Metcalfe |
| **e-mail and/or webpage:** j.d.metcalfe@cefas.co.uk  www.cefas.co.uk |

**Research Activity:** Basking Shark Population Assessment (C1310)

**Duration:** 2000-2005  **Cost:** £291K

**Funding:** DEFRA (GWD)

**Principal Investigator:** Julian Metcalfe

**e-mail or contact (if different from above):**

**Objective/ Goal (100 words max.):**
To elucidate elements of the life history of basking sharks in the north-east Atlantic, especially within European Union and UK territorial waters. Modern satellite telemetry (pop-up archival transmitting tags) has been used in conjunction with remote sensing imagery, sightings and strandings data to determine the movement patterns and migrations, over-wintering areas, and site fidelity of basking sharks in EU waters. The results contributed to the successful UK CITES listing proposal (2002) and will provide information in support of the management for recovery and sustainability, and the avoidance of unnecessary mortality.

**How are the results communicated?**
- Reports
- Peer reviewed scientific literature
- Presentations to conferences and stakeholders
- Through ICES Working Groups, Study Groups and Advisory Committees

**Can the results be used to support resource management, and if so how?**
Yes. Outputs from the project directly supported the successful UK CITES listing proposal (2002) and will provide information on basking shark population dynamics to Defra and other organisations to support the development of conservation strategies.
Research Activity: Long-term seabird studies on the Isle of May

Duration: 30 years +  
Cost: basic staff costs 30K£/year augmented in some years by external income of up to 80K

Funding: NERC, JNCC

Principal Investigator: Morten Frederiksen, Sarah Wanless

e-mail or contact (if different from above):

Objective/ Goal (100 words max.):
This study aims to understand and predict the dynamics of North Sea seabird populations, using long-term data collected on the Isle of May (Firth of Forth). North Sea seabirds feed on sandeels during the breeding season, and the dynamics of sandeel stocks, their prey as well as the physical environment are integral to an understanding of seabird dynamics. Conversely, seabirds provide valuable information about marine ecosystems, and in collaboration with researchers working on different trophic levels we aim to exploit this to attribute observed changes to specific drivers (such as climate change), and to help understand and resolve environmental conflicts.

How are the results communicated?
Annual contract reports, primary scientific papers, popular articles etc.

Can the results be used to support resource management, and if so how?
Data from seabirds provide cost-efficient information about the marine environment, particularly sandeels. Both direct (number and quality of fish fed to chicks) and indirect (time budgets, breeding success, survival) measures help to understand fish stocks at a scale and resolution difficult to achieve through fisheries surveys. Through statistical modelling observed changes in seabird demographic parameters can be attributed to different environmental drivers, allowing robust assessment of e.g. fishery impacts.
Research Activity: Seabird foraging dynamics and diet

Duration: 20 years
Cost: c40-100K£/year (depends on amount allocated to loggers & software)
Funding: NERC, EU, JNCC

Principal Investigator: Sarah Wanless

e-mail or contact (if different from above):

Objective/ Goal (100 words max.):
This research aims to determine feeding distributions, foraging activity and prey capture rates of six species of North Sea seabirds using state-of-the-art bird borne logging devices. These detailed locational and energetic results are being integrated with diet data collected using conventional methods and emerging techniques such as stable isotope and fatty acid signature analyses. Data on foraging dynamics and diet are being integrated to determine the functional relationships between seabirds and the marine environment. To date effort has focussed on the breeding season but is currently broadening to include the overwintering and pre-breeding phase.

How are the results communicated?
Peer-reviewed publications, popular articles and contract reports

Can the results be used to support resource management, and if so how?
Detailed data on where avian predators of known origin and status feed throughout the year are urgently needed to identify key marine areas. In combination with dietary information they enable spatially and temporally explicit assessments of consumption by seabirds of commercially exploited prey. In conjunction with prey abundance and distribution they also potentially enable us to develop multispecies functional responses of seabirds, an essential step in establishing the impact of fisheries on top predators in the North Sea.
<table>
<thead>
<tr>
<th><strong>INSTITUTION:</strong></th>
<th>Natural Environment Research Council</th>
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<tbody>
<tr>
<td><strong>DEPARTMENT/ UNIT:</strong></td>
<td>Centre for Ecology and Hydrology Dorchester</td>
</tr>
<tr>
<td><strong>Address:</strong></td>
<td>Winfrith Technology Centre, Winfrith Newburgh, Dorchester, Dorset DT2 8ZD</td>
</tr>
<tr>
<td><strong>Contact person:</strong></td>
<td>Prof Bland J. Finlay/ Dr Genoveva F. Esteban</td>
</tr>
<tr>
<td><strong>e-mail and/or webpage:</strong></td>
<td><a href="mailto:gent@ceh.ac.uk">gent@ceh.ac.uk</a>; <a href="http://dorset.ceh.ac.uk/Population_andConservationEcology/Dynamytes/Dynamytes.htm">http://dorset.ceh.ac.uk/Population_andConservationEcology/Dynamytes/Dynamytes.htm</a></td>
</tr>
</tbody>
</table>

| **Research Activity:** | Macroecology; Microbial eukaryotes |
| **Duration:** | 3 years |
| **Cost:** | £268,946 |
| **Funding:** | NERC, Marine and Freshwater Microbial Biodiversity Thematic Programme |

| **Principal Investigator:** | Prof B.J. Finlay FRS |
| **e-mail or contact (if different from above):** | bjf@ceh.ac.uk |

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<tr>
<th><strong>Objective/ Goal (100 words max.):</strong></th>
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<tr>
<td>Biodiversity at the microbial level may be fundamentally different in character from that of macroscopic organisms. It has been claimed that the astronomical abundance of microorganisms drives their dispersal across geographical boundaries that halt migrations of larger animals and plants, and that microbial species are ubiquitous. Are the smaller microbial eukaryotes really so numerous that each species has a fair chance of being distributed to all parts of the world? In what size range of organisms does the ‘ubiquity’ begin to break down? For species that are ubiquitous, does this also apply to genetic and physiological variants within species? And if microbial ubiquity is the norm, what are the consequences for ecosystem functions (e.g. nitrogen cycling, natural bioremediation). We investigated two contrasting environments, a freshwater pond in England and a marine brackish water bay in Denmark. The project involved 21 researchers from UK and Europe.</td>
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<tr>
<th><strong>How are the results communicated?</strong></th>
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<tbody>
<tr>
<td>Mainly in peer-reviewed international journals; popular magazines like NERC’s Planet Earth; lectures/talks at national and international meetings; web site; lectures to stakeholders.</td>
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<tr>
<th><strong>Can the results be used to support resource management, and if so how?</strong></th>
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<tbody>
<tr>
<td>Our claim is that size-frequency distributions of species are self-similar at all spatial scales (i.e. fractal or nearly so); this, combined with interpolation, provides simple tools for predicting the diversity of species at any spatial scale. We have proved this with insects and protists, but the same procedure could be used with large taxonomic groups, e.g. birds, mammals, fish. In the case of fish we can even begin to see some practical economic benefits of the approach. For example, a continuously monitored size-frequency distribution of the fish in the North Sea would provide a snapshot of the relative abundance of large, small and medium-sized fish – exactly the type of synthetic approach that is being sought by NERC and other associated bodies. Thanks to FishBase, all we need is the names or sizes of the fish and the total number of species.</td>
</tr>
</tbody>
</table>
INSTITUTION: Cornwall Sea Fisheries
DEPARTMENT/UNIT: Address: Old Bonded Warehouse, Quay Street. Penzance, Cornwall, TR18 4BD
Contact person: Edwin Derriman
e-mail and/or webpage: ederriman.seafisheries@cornwall.gov.uk

Research Activity: Baseline Study Shellfish Stock Survey
Duration: 3 years Cost: £23000
Funding: EU Objective One
Principal Investigator: Sam Davis
e-mail or contact (if different from above): sdavis.seafisheries@cornwall.gov.uk

Objective/Goal (100 words max.):
• Baseline data on Cornish shellfish stocks (population structure, seasonality and health etc)
• Baseline data on effort in the industry and whether it is exploited to maximum potential.
• Improved future management of the fishery through the use of this data.
• A preliminary assessment of the future potential growth of the fishery.
• An assessment of the potential to improve productivity without increase of effort.
• Involve the stakeholder in collection and use of fishery data.

How are the results communicated?
• Production of two annual reports and a final report in 2006
• Regular interim reports to the Cornwall Sea Fisheries Committee

Can the results be used to support resource management, and if so how? Yes,
• The Committee regulates the fishery by the use of byelaws. Baseline data obtained from the study will assist in ensuring that any future byelaws are focused on problem areas, or in areas where the best gains and benefits will be realised.
• Stakeholders want to become more involved in the management of the fishery. This project involves seven vessels (spread geographically) and their crews over the three year programme in the collection of data. These crews fully committed to the programme and are much better equipped to understand some of the issues surrounding fisheries management. Their positive attitude has now started to permeate through the local industry and other vessel owners have asked to be involved in any future projects. Such tacit support from the stakeholders helps enormously if/when restrictive measures are needed.

Note: Also undertaken work for Abalone (Ormer) but completed over two years ago.
Involved in the National Lobster Hatchery (NLH).
Research Activity: Fishery Independent Investigations of Irish Sea fish stocks

Duration: Ongoing  
Cost: £300k

Funding: DARDNI

Principal Investigators: R. Briggs; P-J. Schon

e-mail or contact (if different from above):

Objective/ Goal (100 words max.):
To obtain fishery independent information through the use of acoustic, trawling and other forms of research vessel survey on the distribution, abundance and population structure of fish and shellfish stocks in the Irish Sea. These data are used in stock assessment, conservation and fishery management. In year objectives include completion of groundfish surveys in October 2005 and March 2006 and Nephrops trawl/camera surveys in April and August 2005 respectively. It is also planned to do an Irish Sea herring and sprat survey in September 2005, a herring larva survey in November 2005 and a Scallop dredge survey in February 2006.

How are the results communicated?
Through the International Council for the Exploration of the Sea and scientific publication.

Can the results be used to support resource management, and if so how?
Yes, the objective of the project is to provide resource managers with a data upon which management decisions to be made and policy formulation, i.e. Total Allowable catches and technical conservation measure.
**Research Activity:** In Situ Coastal Monitoring Programme

**Duration:** 2 years  
**Cost:** £180K  
**Funding:** DARDNI, Environment and Heritage Service, Loughs Agency.

**Principal Investigator:** M Service  
**e-mail or contact (if different from above):**

**Objective/ Goal (100 words max.):**  
Coastal water quality parameters are being remotely measured across a network of sites around Northern Ireland by a collaborative project between the Environment and Heritage Service (EHS) and The Department of Agriculture and Rural Development (DARDNI).

This site aims to provide NEAR REAL TIME DATA ON COASTAL WATER QUALITY acquired from a network of remotely moored monitoring stations that telemeter data through GSM modem links. Studies of sea loughs and estuaries around the coast of Northern Ireland suggest that three sites are eutrophic - these have been identified as Sensitive Areas (SA’s) under the terms of the EC Urban Waste Water Treatment Directive (UWWTD). This directive is designed to reduce the pollution of freshwater, estuarine and coastal waters by effective monitoring and improved management of pollution sources.

**How are the results communicated?**

Through the web site and scientific publication.

**Can the results be used to support resource management, and if so how?**

Yes, the objective of the project is to provide resource managers with near real time data to allow management decisions to be made. i.e. operation of tidal barriers.
INSTITUTION: Department of Agriculture and Rural Development  
DEPARTMENT/ UNIT: Aquatic Systems, AFESD  
Address: Newforge Lane  
Belfast BT9 5PX  
Contact person: M Service  
e-mail and/or webpage: matt.service@DARDNI.GOV.UK http://www.searchmesh.net/

Research Activity: The Sensitivity of Benthic Habitats in NW Irish and Malin Shelf

Duration: 3 years Cost: £180K  
Funding: DARDNI, EU Interreg

Principal Investigator: M Service  
e-mail or contact (if different from above): 

Objective/ Goal (100 words max.):  
DARD AFESD aquatics branch are one the lead UK groups in the development of habitat assessment of the UK shelf seas. A number of previous projects and demonstration exercises have indicated the range and extent of sea bed habitats within adjacent waters. The project will sit to complete synoptic maps of key areas in the NW Irish Sea, N Channel and Maling Shelf. Subsequent analysis will set to indicate sensitivity to:  

- Fishing;  
- Aquaculture;  
- Land Run off;  
- Gravel extraction and other offshore development such as windfarms.  
- Identify Gaps in knowledge (usurveyed areas) and rank in order of relevance. Begin targetted surveying using acoustic technology  
- Develop video database of N Ireland benthic habitats  
- review techniques for quantifying video data.  
- Develop sensitivity indices and predictive models for benthic habitats  
- Produce maps on GIS format

How are the results communicated?  
Through the web site and scientific publication.

Can the results be used to support resource management, and if so how?  
Yes, the objective of the project is to provide resource managers with near real time data to allow management decisions to be made. i.e. operation of tidal barriers.
**INSTITUTION:** Department of Agriculture and Rural Development  
**DEPARTMENT/UNIT:** Aquatic Systems, AFESD  
**Address:** Newforge Lane  
Belfast BT9 5PX  
**Contact person:** Dr Richard Briggs  
e-mail and/or webpage: Richard.briggs@dardni.gov.uk

**Research Activity:** Population dynamics and assessment of Irish Sea fish and shellfish stocks  
**Duration:** Ongoing  
**Cost:** £600k  
**Funding:** DARDNI

**Principal Investigators:** R.Briggs; P-J. Schon  
e-mail or contact (if different from above):

**Objective/Goal (100 words max.):**  
To provide information on the biology, population dynamics and status of Irish Sea fish and shellfish stocks of importance to Northern Ireland, as required for conservation of the stocks and management of the fisheries. To further develop the sampling and analytical procedures in order to improve the scientific basis for fishery management. In year objectives include the collection of fisheries data on cod, whiting, herring, haddock, scallops and Nephrops and to attend relevant ICES meetings and perform stock assessments.

**How are the results communicated?**

Through the International Council for the Exploration of the Sea and scientific publication.

**Can the results be used to support resource management, and if so how?**  
Yes, the objective of the project is to provide resource managers with a data upon which management decisions to be made and policy formulation. i.e. Total Allowable catches and technical conservation measure.
INSTITUTION: Department of Agriculture and Rural Development (NI)
DEPARTMENT/ UNIT: Aquatic Systems Group, AFESD
Address: Newforge Lane Belfast BT9 5PX
Contact person: R Gowen
e-mail and/or webpage: richard.gowen@dardni.gov.uk

<table>
<thead>
<tr>
<th>Research Activity:</th>
<th>marine ecology</th>
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<tbody>
<tr>
<td>Duration:</td>
<td>ongoing</td>
</tr>
<tr>
<td>Cost:</td>
<td></td>
</tr>
<tr>
<td>Funding:</td>
<td>DARDNI</td>
</tr>
<tr>
<td>Principal Investigator:</td>
<td>R Gowen</td>
</tr>
<tr>
<td>e-mail or contact (if different from above):</td>
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Objective/ Goal (100 words max.):
The overall objective is to acquire scientific data, which will allow DARD to meet its current and future statutory and policy responsibilities and contribute to UK policy on marine environmental management. The study of Irish Sea ecosystem structure and functioning (at the plankton level) will, provide the base line against which future change can be quantified and the evidence base to determine the scale of anthropogenic influence in the Irish Sea. An important element of this work is the establishment of time-series of key variables (temperature, salinity, dissolved nutrients and plankton) in the western Irish Sea.

How are the results communicated?
Peer review publications, internal discussions with Policy, external meetings and workshops

Can the results be used to support resource management, and if so how?
Not at the present time, but the long-term aim is to use the environmental data to underpin fisheries management and support the development and implementation of marine environmental policy.
Research Activity: Shellfish/Ecosystem Carrying Capacity of Northern Irish Sea Loughs
Duration: 2 years  Cost: £200K
Funding: DARDNI
Principal Investigator: M Service
e-mail or contact (if different from above):

Objective/ Goal (100 words max.):
The key objectives of SMILE are:
1. To establish functional models at the lough scale, describing key environmental variables and processes, aquaculture activities and their interactions;
2. To evaluate exploitation carrying capacities (i.e. the standing stock at which the annual production of the marketable cohort is maximized) for aquaculture in the different loughs, considering interactions between cultivated species, for normal and alternative cultivation practises (i.e. marketable size of cultured organisms, cultivation period etc.);
3. To examine the effects of overexploitation on key ecological variables;
4. To examine bay-scale environmental effects of different culture strategies.

How are the results communicated?
Through the web site and by stakeholder meetings.

Can the results be used to support resource management, and if so how?
Yes, the objective of the project is to provide resource managers with usable models for management.
Research Activity: Applying modelling methods to identify information-rich ecosystem indicators and demonstrating how to use them. A workpackage in the Coordinated Action: Development of Indicators of Environmental Performance of the Common Fisheries Policy (INDECO)
Duration: 12/04-11/06 Cost: 35,000 Euros

Principal Investigator: Dr. Murdoch McAllister
e-mail or contact (if different from above):

Objective/ Goal (100 words max.):
Modelling methods that can incorporate informative indicators of the status of marine ecosystems are to be identified. The focus is on models that determine how measurable aspects of ecosystems may change as a result of fishing and environmental changes, multi-species fisheries models and models of the impacts of fishing on benthic communities, seabirds and mammals. In the case studies, models that can utilize measurable indicators will be identified and evaluated for their usefulness in helping analyse effects of fishing on fish assemblages, seabirds, mammals and benthic communities and distinguishing these effects from other factors such as eutrophication and anoxia.

How are the results communicated?
1. A document reviewing potentially useful modelling methods that can be used to identify the ecosystem indicators having the highest information value.
2. A document that explores the use of some of these potentially useful operational modelling methods that evaluate or estimate ecosystem indicators with regards to a few representative European marine fisheries ecosystems.
3. A document that synthesizes the findings of the review and case study application to provide conclusions about potentially useful operational modelling methods and generic indicators of marine ecosystem status.

Can the results be used to support resource management, and if so how?
Yes. The results of this work will (1) identify the most useful indicators of marine ecosystem status, (2) identify the most useful modelling methods available that utilize measurable indicators of the impacts of fishing on marine ecosystems, and (3) make recommendations about how such models should be applied to help manage fisheries impacts on marine ecosystems.
Research Activity: Developing a computer simulation-testing framework to evaluate management methods based on fisheries independent data. A workpackage in the SPECIFIC TARGETED RESEARCH PROJECT: FISHERIES INDEPENDENT SURVEY BASED OPERATIONAL ASSESSMENT TOOLS (FISBOAT).

Duration: 03/04-02/07  Cost: £103,750

Funding: EU,

Principal Investigator: Dr. Murdoch McAllister

e-mail or contact (if different from above):

Objective/ Goal (100 words max.):

A computer simulation-testing evaluation framework is to be built to test the potential performance of survey-based stock assessment procedures and management procedures based on them. The simulation-testing framework will enable evaluations when the underlying population dynamics is uncertain and survey catchability changes. It will allow testing of short-term management options based on such data. The simulation-testing framework includes three model components: a population dynamics model to simulate the underlying population dynamics, observation model to simulate the survey data to be collected, and harvest control rule module to simulate the fisheries management decision rule based on the assessment of the data.

How are the results communicated?

Documents are to be provided summarizing the evaluation of the performance of all tested methods with respect to robustness, precision, capability to capture stock trends and data requirements, stock risks, average yield and interannual variability in yield. Recommendations on which methods perform best for each of the case study species. The application of the computer simulation tools is to be demonstrated during workshops.

Can the results be used to support resource management, and if so how?

Yes. The results of this work will (1) develop simulation evaluation tools to allow fisheries managers to evaluate how well management methods based on fisheries independent data only will perform, (2) identify those management methods that utilize fishery independent data only that may perform sufficiently well for management purposes.

Duration: 04/04-03/07  
Cost: £89,750  
Funding: EU

Principal Investigator: Dr. Murdoch McAllister

e-mail or contact (if different from above):

Objective/ Goal (100 words max.):

(1) Design a computer evaluation framework to evaluate the long-term performance of multi-annual management methods for mixed stock fisheries taking into account multi-fleet dynamics, and responses of fishers to management. This will allow scenario-based computer simulation experiments to be conducted for a range of hypotheses about the system to be managed. (2) Implement within the framework a model for the key biological and economic interactions including uncertainty for the three case studies (i.e., operating model). (3) Develop alternative management procedures to those currently used that can be evaluated against different hypotheses about the true dynamics, as represented by the operating model.

How are the results communicated?

Documents are to be provided summarizing the evaluation of the performance of all tested methods with respect to robustness, precision, capability to capture stock trends and data requirements, stock risks, average yield and interannual variability in yield. Recommendations on which methods perform best for each of the case study species. The application of the computer simulation tools is to be demonstrated during workshops.

Can the results be used to support resource management, and if so how?

Yes. The results of this work will (1) develop simulation evaluation tools to allow fisheries managers to evaluate how well multi-annual fisheries management methods that account for uncertainty in stock and fishing fleet dynamics will perform, (2) identify those management methods that may perform sufficiently well for management purposes.
INSTITUTION: Imperial College  
DEPARTMENT/ UNIT: Biology  
Address: RSM Building, Prince Consort Road, London, SW7 2BP  
Contact person: Dr. Murdoch McAllister  
e-mail and/or webpage: m.mcallister@imperial.ac.uk

Duration: 04/04-03/08  
Cost: £ 57,960  
Funding: EU

Principal Investigator at Imperial College: Dr. Murdoch McAllister  
e-mail or contact (if different from above):

Objective/ Goal (100 words max.):  
A generic "operating model" will be developed that can appraise the biological, social and economic effects of the existing fisheries management measures in EU taking into account plausible hypotheses about the dynamics of the stocks and fleets. An operating model is a simulation model of the system to be managed that includes parameters and outputs from methods for monitoring and assessing the status of the system. The operating model will be applied to evaluate different management options using output parameters and results from empirical analyses of available data to address the main fisheries advisory and management problems.

How are the results communicated?  
Documents are to be provided summarizing the evaluation of the performance of all tested methods with respect to robustness, precision, capability to capture stock trends and data requirements, stock risks, average yield and interannual variability in yield. Recommendations on which methods perform best for each of the case study species. The application of the computer simulation tools is to be demonstrated during workshops.

Can the results be used to support resource management, and if so how?  
Yes. The results of this work will (1) develop simulation evaluation tools to allow fisheries managers to evaluate how well existing fisheries management methods that account for uncertainty in stock and fishing fleet dynamics will perform, (2) identify those management methods that may perform sufficiently well for management purposes.
INSTITUTION: Imperial College  
DEPARTMENT/UNIT: Biology  
Address: RSM Building, Prince Consort Road, London, SW7 2BP  
Contact person: Dr. Murdoch McAllister  
e-mail and/or webpage: m.mcallister@imperial.ac.uk

Duration: 11/03-10/06  
Cost: £104,277  
Funding: EU

Principal Investigator at Imperial College: Dr. Murdoch McAllister  
e-mail or contact (if different from above): 

Objective/Goal (100 words max.): 

(1) Develop spatial models of Atlantic swordfish population dynamics for use in fisheries stock assessment and evaluate the use of closed areas to enhance stock recovery and yield per recruit. Analyze swordfish tagging and fishing effort data to identify plausible scenarios for harvest rates and movement patterns at age. (2) Analyze tagging and fishing effort data to parameterize operating models for Atlantic bluefin population dynamics for the evaluation of multi-area based fisheries management control options for tuna. (3) Develop and test new data-based harvest control rules for tuna compatible with new understanding about stock structure, migration and multi-area management regimes.

How are the results communicated? 

Documents are to be provided summarizing the evaluation of the performance of all tested methods with respect to robustness, precision, capability to capture stock trends and data requirements, stock risks, average yield and interannual variability in yield. Recommendations on which methods perform best for each of the case study species. The application of the computer simulation tools is to be demonstrated during workshops.

Can the results be used to support resource management, and if so how? 

Yes. The results of this work will (1) develop new mark-recapture based methods for fisheries management that provide a stronger empirical basis for population and harvest rate estimation than more conventional stock assessment methods that use catch-age and indices of abundance, (2) identify management methods based on mark-recapture stock assessments that may perform sufficiently well for management purposes of the case study species.
INSTITUTION: Invest in Fish South West
DEPARTMENT/ UNIT: 
Address: 
Barn C, Boswednan Farm, 
Tremethick Cross, 
Penzance, 
Cornwall TR20 8UA

Contact persons: Heather Squires, Jen Storemski or Spike Searle 
e-mail and/or webpage: info@investinfishsw.org.uk  www.investinfishsw.org.uk

Research Activity: consulting stakeholders, commissioning reports on relevant fisheries issues, and constructing comprehensive bio-economic model of SW approaches to test management options.

Duration: January 2004-October 2006     Cost: 1.6 m
Funding:  DEFRA, EU, M&S, CFPO, SWFPO, WWF, EN etc

Principal Investigator: 
e-mail or contact (if different from above):

Objective/ Goal (100 words max.):

- To characterise the socio-economics, biology and ecology of the Cornish and South West England fisheries in the western English Channel, Western Approaches.
- Develop a transparent, integrated assessment tool to evaluate the costs and benefits of fish stock recovery options for the SW of England.
- Develop Cornish and South West England recovery plan options
- Evaluate their costs and benefits, and agree the recommended option(s).
- Communicate results to all stakeholders, interest groups and public

How are the results communicated?
Through steering group members, website and comprehensive comms strategy.

Can the results be used to support resource management, and if so how?

- By providing the concerned groups with a method of analysing and costing options generated by the stakeholder groups themselves
- By providing a transparent structure within which they can reach consensus about the best options to put forward
- By enabling the stakeholders to communicate these options to their own (and other) constituencies and interest groups
**INSTITUTION:** Joint Nature Conservation Committee  
**DEPARTMENT/ UNIT:** Seabirds and Cetaceans  
**Address:** Dunnet House, 7 Thistle Place, Aberdeen AB10 1UZ  
**Contact person:** Dr Jim Reid  
**e-mail and/or webpage:** jim.reid@jncc.gov.uk

<table>
<thead>
<tr>
<th><strong>Research Activity:</strong></th>
<th>Seabird population (and cetacean) survey and monitoring</th>
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<tbody>
<tr>
<td><strong>Duration:</strong></td>
<td>Ongoing</td>
</tr>
<tr>
<td><strong>Cost:</strong></td>
<td></td>
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<tr>
<td><strong>Funding:</strong> DEFRA, Various other organisations contribute at various times including private sector, other govt departments, and statutory nature conservation agencies</td>
<td></td>
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<tr>
<td><strong>Principal Investigator:</strong> Dr Jim Reid</td>
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<td><strong>e-mail or contact (if different from above):</strong></td>
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<tr>
<th><strong>Objective/ Goal (100 words max.):</strong></th>
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<tr>
<td>Various. We monitor breeding performance and numbers at several colonies, annually and at longer timescales. Special studies of seabirds at sea, distributional and ecological, are undertaken opportunistically. We currently are engaged in identifying protected areas at sea. Observations of cetaceans are made opportunistically and the results analysed to highlight dispersion and other aspects of ecology.</td>
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<tr>
<th><strong>How are the results communicated?</strong></th>
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<tr>
<td>Through various means – annual reports, special reports, scientific papers.</td>
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<tr>
<th><strong>Can the results be used to support resource management, and if so how?</strong></th>
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<tr>
<td>Breeding performance of seabirds in the North Sea (black-legged kittiwakes on Isle of May) is used as an indicator of sandeel availability. Sandeel fishery remains open dependent on breeding success.</td>
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<td>INSTITUTION:</td>
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<td>DEPARTMENT/ UNIT:</td>
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<td>Address:</td>
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<tr>
<td>Contact person:</td>
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<td>e-mail and/or webpage:</td>
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### Research Activity:
Monitoring Basking Shark sightings from the general public (Basking Shark Watch Project)

### Duration: 1987 - present
### Cost: Approximately €30k p.a.

### Funding:
Generally funding from SNCOs, Trust Funds and core funds.

### Principal Investigator:
Dr Jean-Luc Solandt

e-mail or contact (if different from above):

### Objective/ Goal (100 words max.):
Maintain the national database of information on numbers, geographical and size distribution, behaviour and movements of basking sharks in UK waters.

Collect and analyse sightings data to improve our knowledge of basking shark ecology, population dynamics and behaviour.

Provide information to support the objectives and targets in the UK Basking Shark Species Action Plan, and extended protection measures in Northeast Atlantic waters.

### How are the results communicated?
Results are communicated in the public press; scientific articles; Wildlife magazines; Maritime interest magazines. Also in posters; leaflets; summary reports; technical reports (2003 and 2005); management recommendations to individual devolved nations (2005) and also through the general communications and website of the Marine Conservation Society.

### Can the results be used to support resource management, and if so how?
- Can help to provide recommendations for protected areas for the species because of our large spatial and temporal database providing maps of hotspots of sharks around the UK.
- Can aid with local management (through the publication of a Code of Conduct) of the species, and how local authorities can provide information on how the general public can interact with the species without causing harm.
- Can aid with the dialogue with fishermen in relation to bycatch of the species (and others), and facilitate communication between the conservation and fishing sector (MCS will be running a biodiversity roadshow in Scotland this year) in order to help identify hotspots and reasons for bycatch.

Note: Also research on pink seafans, pink seafan anemone, survey Atrina fragilis populations and sea turtle populations and movements in the UK. Partners for all of these biodiversity action plans
**INSTITUTION:** Marine Biological Association of the UK  
**DEPARTMENT/ UNIT:**  
**Address:** The Laboratory, Citadel Hill, Plymouth, PL1 2PB  
**Contact person:** Dr David Sims  
e-mail and/or webpage: [dws@mba.ac.uk](mailto:dws@mba.ac.uk) ([www.mba.ac.uk/sims.htm](http://www.mba.ac.uk/sims.htm))

<table>
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<tr>
<th>Research Activity:</th>
<th>Movements and behaviour of free-ranging fish in relation to environmental variability</th>
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<tbody>
<tr>
<td><strong>Duration:</strong></td>
<td>(Oct 2000- present)</td>
</tr>
</tbody>
</table>
| **Cost:** | Defra: £145,768  
NERC: £193,633  
Other: £35,185 |
| **Funding:** | ✓ NERC, ✓ DEFRA, Fisheries Society, Royal Society, National Geographic Society |
| **Principal Investigator:** | Dr David Sims |
e-mail or contact (if different from above): |

**Objective/ Goal (100 words max.):**  
Our objective is to understand habitat selection processes in free-ranging fish through tracking their movements and behaviour to better identify why fish select certain habitats at particular times, and to understand the interplay between environmental variability and the spatial structure and dynamics of natural populations. We integrate movement trajectories from electronically tagged fish with environmental heterogeneity assessed remotely by satellite or by direct sampling. Our ultimate goal is to understand the behavioural ‘rules’ underpinning movements as a basis for developing process-based predictive models of fish dispersion patterns.

**How are the results communicated?**  
Results are communicated through peer-reviewed journals, presentations at international conferences, and to the wider public by media releases and National Science week events. Principal papers have been published in *Nature*, *Proc. R. Soc. B* (2 papers), *J. Anim. Ecol.* and *MEPS*.

**Can the results be used to support resource management, and if so how?**  
Understanding the spatio-temporal dynamics of fish movements resulting in realised patterns of distribution and abundance is a key component of resource management. The ability to understand and therefore be capable of predicting changes in fish population distributions in relation to natural and anthropogenic factors will be a crucial element of how fish stocks are managed within an ecosystem approach, or under adaptive management regimes.
Research Activity: Long-term changes of fish populations in relation to climate variability and fishing

Duration: (Oct 2000- present)  

Cost: Defra: £43,575

Funding: DEFRA

Principal Investigators: Dr David Sims, Dr Martin Genner (Hull), Prof. A.J. Southward, Prof. Steve Hawkins

e-mail or contact (if different from above):

Objective/ Goal (100 words max.):
The objective is to determine the influences of climate and fishing on marine fish using long-term datasets collected by the MBA. Since 1913 the MBA has recorded the species number, relative abundance, length and mass of fish from standardised trawls in the western English Channel. These datasets were used to investigate (1) how temperature changes during the 20th Century altered the migration phenology of commercially important species of flatfish and squid, (2) how climate variability influenced abundance trends of the fish community comprising about 90 species, and most recently, how fishing and climate effects on key species can be teased apart using multivariate methods. This work has demonstrated important regional differences and similarities in responses.

How are the results communicated?
Results are communicated through peer-reviewed journals, presentations at international conferences, and to the wider public by media releases and National Science week events. Principal papers arising from this work have been published in Proc. Roy. Soc. B (2 papers) and J. Anim. Ecol.

Can the results be used to support resource management, and if so how?
Understanding the relative influences of climate and fishing on fish is a key step in unravelling the mechanisms underpinning observed fluctuations in marine fish populations. By determining how fish responded to these effects in the past may contribute to our ability to predict population trajectories in the future. Our work indicates the importance of understanding fish responses at the regional level, the details of which may directly affect management choices in particular areas.
INSTITUTION: Marine Biological Association of the UK
DEPARTMENT/UNIT: Address: The Laboratory, Citadel Hill, Plymouth, PL1 2PB
Contact person: Nova Mieszkowska
e-mail and/or webpage: nova@mba.ac.uk www.mba.ac.uk/marclim

Research Activity: MarClim: Marine Biodiversity and Climate Change
Duration: 4 years (Apr 2001- Apr 2005)  Cost: £584,000

Principal Investigator: Professor S. J. Hawkins
e-mail or contact (if different from above): sjha@mba.ac.uk

Objective/Goal (100 words max.): MarClim has established a single focus to improve the understanding of the effects of global climate change on coastal marine biodiversity. The project focuses on a suite of temperature-sensitive invertebrate species that reach their northern or southern limits of distribution in Britain and Ireland. Using datasets extending back to the 1950s, combined with current re-surveys, MarClim is identifying changes in range and population structures within near-limit habitats that have occurred in response to the current period of rapid warming. The results are being used to help model and track future effects of climate change on marine biodiversity and inform policy and decision-makers.

How are the results communicated?
Peer-reviewed journals, scientific and government agency conferences, scientific reports, policy and conservation working groups, MarClim website: www.mba.ac.uk/marclim where all published material is available.

Can the results be used to support resource management, and if so how?
The scale and nature of marine climate change impacts now need to be built into how we manage human activities, establish site-based conservation mechanisms, monitor, assess and report on the status of habitats, species and ecosystems, as well as the structuring of underlying legislation and policies.

MarClim species are recommended by government agencies for inclusion as part of the key indicator set for marine and coastal biodiversity: they are easy and cost effective to measure, they are very responsive indicators of climate change signals, directly inform on climate change as a top policy priority of Government and inform and assess climate change risks and vulnerabilities on policies for sustainable development.
INSTITUTION: Marine Biological Association of the UK
DEPARTMENT/ UNIT:
Address: The Laboratory, Citadel Hill, The Hoe, Plymouth, PL1 2PB
Contact person: Stuart Jenkins
e-mail and/or webpage: sjen@mba.ac.uk  www.mba.ac.uk

Research Activity: Using long-term records to determine changes in fish- benthos interactions

Duration: (Nov 2000- present)  Cost: Defra: £64,600
NERC: £8,500

Funding: NERC, DEFRA

Principal Investigator: Dr S.R. Jenkins

Objective/ Goal (100 words max.): Our goal is to use existing long-term data from the Plymouth coastal area on demersal fish and benthic invertebrates plus historic and contemporary surveys of fish diet to understand how anthropogenic-induced change in the marine environment will impact fish-benthos interactions. Specifically, how will changes in availability of fish prey (benthic invertebrates) brought about both directly (climate change, physical disturbance from demersal fishing) and indirectly (changes in ecosystem functioning of benthic sediments) affect demersal fish populations? How will this interaction be modified by climate and fishing induced changes in fish community structure?

How are the results communicated?
Results are communicated through peer-reviewed journals, presentations at international conferences, and to the wider public by media releases and National Science week events.

Can the results be used to support resource management, and if so how?
Understanding of the linkages between benthic invertebrates and demersal fish is paramount in any ecosystem-based approach to fisheries management. Preliminary results from our work have indicated substantial changes in both infaunal community structure and diet composition in some demersal fish species over a 70-year time scale in the English Channel. However further work is required to better understand how changes in benthos brought about by anthropogenic pressures such as fishing, climate change and aggregate extraction impact on fish resources.
Research Activity: E1 / L5 long-term time series: measurement of physical parameters and plankton collection.

Duration: 3 years (restarted June 2002)  
Cost: £112,000  
Funding: DEFRA

Principal Investigator: Professor Stephen J. Hawkins  
e-mail or contact (if different from above): sjha@mba.ac.uk

Objective/ Goal (100 words max.):  
The time series at E1/L5 was restarted as part of the pilot phase of the MECN. The aim of the MECN is to ensure delivery and interpretation of long-term and broad-scale contextual information for water-quality monitoring and demonstrate the benefits of preserving and networking long-term time series data. As part of the contribution to the MECN, physical and biological (plankton) data from E1/L5 are being collated in a database and the methods of data collection included in intercalibration and quality assurance exercises. The goal is to analyse and cross-correlate the data with data from other time-series to determine potential mechanisms underlying environmental and anthropogenic change in marine communities. It is also planned to add benthos to the suite of parameters measured in the Western English Channel in order to provide a more comprehensive understanding of the WEC Ecosystem.

How are the results communicated?  
The data from E1/L5 have already been included in a review to Defra and is available through Defra and the MECN Website. Peer reviewed papers are given in the relevant publications and restart data is included in Defra reports.

Can the results be used to support resource management, and if so how?  
To deliver a management scheme that is ‘ecosystem based’ requires an understanding of how the various ecosystem components interact with each other and how they respond to natural and anthropogenic drivers. Data from E1 / L5 are crucial in assessing the relative importance of natural fluctuations and global (climate change), regional (e.g. eutrophication, fishing) and local (e.g. point source pollution, aggregate extraction) anthropogenic impacts. These data have already been utilised for the purpose of disentangling climate and fishing impacts by comparisons with other time series in the North Sea. It is also important to note that the measurements at E1 / L5 are in the western English Channel which is widely recognised to behave as an ecosystem and studies here over the past 100 years have contributed much of the current understanding of how marine ecosystems function. The MBA time series stations also provide boundary conditions for the rest of the English Channel.
**INSTITUTION:** National Lobster Hatchery, UK.  
**DEPARTMENT/ UNIT:**  
Address: South Quay, Padstow, Cornwall PL28 8BL  
Contact person: Dylan Taylor  
e-mail and/or webpage: www.nationallobsterhatchery.com

**Research Activity:** Refining lobster (Homarus gammarus) hatchery practices to improve efficiency and effectiveness  
**Duration:** Ongoing  
**Cost:** Hard to define maybe 25K per annum (part of core work)  
**Funding:** from own funds  
**Principal Investigator:** Dylan Taylor  
e-mail or contact (if different from above): hatchery@hatchery.plus.com

**Objective/ Goal (100 words max.):**
We do our own ongoing work into refining the aquaculture process used in the hatchery, such as disease diagnosis and treatment. This is published through Fish Farming International and hopefully Crustaceana this year.  
We also do collaborative work with the University of Plymouth, in 2004 we conducted a study looking at the use of functional nutritional supplements (mannan oligosaccharide) with lobster larvae, and aim to publish the results with reference to survival and growth rates.

**How are the results communicated?**
In the press, both mass media and industry news, and hopefully in 2005 in peer reviewed papers.  
We also publicise our work on our website to some extent.

**Can the results be used to support resource management, and if so how?**
Yes, other stock enhancement projects can pick up on refinements and improvements that we are making to improve their efficiency. (Three other projects in UK exist similar to ours). This can then be used in improved fishery enhancement practice.
INSTITUTION: National Oceanography Centre, Southampton
DEPARTMENT/ UNIT: DEEPSEAS Benthic Biology Group, George Deacon Division
Address: Empress Dock, Southampton, SO18 1UH

Contact person: Dr Brian J Bett
e-mail and/or webpage: bjb@soc.soton.ac.uk

Research Activity: Atlantic Margin Environmental Survey
Duration: Effectively on-going since 1996
Cost: Funding: AFEN (Atlantic Frontier Environmental Network) and Department of Trade and Industry

Principal Investigator: Dr Brian J Bett
e-mail or contact (if different from above):

Objective/ Goal (100 words max.):
Large-scale regional environmental assessment of UK deep-water territory, identifying features and processes in the geological and biological attributes of the seabed. Using acoustic remote sensing, seabed photography and direct sampling provide a state of the art description of the UK deep-sea environment. To map features and habitats and establish baseline environmental data for such features and habitats.

How are the results communicated?
Publically accessible reports (e.g. AFEN http://www.geotek.co.uk/; DTI Ecology http://www.offshore-sea.org.uk/; DTI Geology http://www.offshore-sea.org.uk/)
And a range of supporting conference and other materials.

Can the results be used to support resource management, and if so how?
Yes. Although perhaps one of the world’s best studied deep-water areas, the UK’s deep-water territory is still only poorly know. Appropriate management of deep-water bioresources is fundamentally dependant on a knowledge of what resources exist and where. Our knowledge of the basic functioning of such deep-water ecosystems is also limited as are the effects of extant, and future potential, human impacts on these systems.
<table>
<thead>
<tr>
<th><strong>Research Activity:</strong> Modelling biophysical interactions in the ocean</th>
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<tbody>
<tr>
<td><strong>Duration:</strong> ongoing</td>
</tr>
<tr>
<td><strong>Cost:</strong></td>
</tr>
<tr>
<td><strong>Funding:</strong> NERC</td>
</tr>
<tr>
<td><strong>Principal Investigator:</strong> Tom Anderson</td>
</tr>
<tr>
<td><strong>e-mail or contact (if different from above):</strong></td>
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<tr>
<th><strong>Objective/ Goal (100 words max.):</strong></th>
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<tbody>
<tr>
<td>To use ecosystem models embedded in 3D models to study biophysical interactions and the controls of community structure in the ocean, focussing in particular on the North Atlantic. Models include the high-resolution Harvard Ocean Prediction System models (HOPS), and the Ocean Circulation and Climate Advanced Modelling Project (OCCAM) which is global, with resolutions of 1, ¼ and 1/12 degrees.</td>
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<tr>
<th><strong>How are the results communicated?</strong></th>
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<tbody>
<tr>
<td>International journal papers, international and national conference/workshop presentations, project reports</td>
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<tr>
<th><strong>Can the results be used to support resource management, and if so how?</strong></th>
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<tbody>
<tr>
<td>Yes. This modelling of food web structure forms the basis of predicting transfer to higher trophic levels including fish.</td>
</tr>
</tbody>
</table>
Research Activity: Marine Productivity

Duration: 18 months  Cost: £172,795
Funding: NERC
Principal Investigator: Tom Anderson
e-mail or contact (if different from above): tra@noc.soton.ac.uk

Objective/Goal (100 words max.):

To establish a numerical model system providing a robust three-dimensional physical environment within which ecosystem and zooplankton models of different structure and complexity can be compared and assessed. To determine the optimal complexity of marine hydrodynamic and ecosystem models necessary to describe zooplankton dynamics in the Irish Sea.

How are the results communicated?

International journal papers, international and national conference/workshop presentations, project reports

Can the results be used to support resource management, and if so how?

Yes. This work assesses the contribution of top-down and bottom-up controls on phytoplankton species succession in biogeographical region 5 (Irish Sea) and can be adapted for use in the entire north west European shelf area. Understanding controls on phytoplankton community structure helps to identify/predict zooplankton (fish food) types.
INSTITUTION: **National Oceanography Centre, Southampton**  
DEPARTMENT/ UNIT: George Deacon division  
Address: University of Southampton, Waterfront Campus, European Way, Southampton, SO14 3ZH  
Contact person: Boris Kelly-Gerreyn  
e-mail and/or webpage: bag@noc.soton.ac.uk

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<tr>
<th>Research Activity:</th>
<th>FerryBox project</th>
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<tr>
<td>Duration:</td>
<td>3 years +</td>
</tr>
<tr>
<td>Funding:</td>
<td>EU &amp; NERC</td>
</tr>
<tr>
<td>Cost:</td>
<td>£200k+</td>
</tr>
</tbody>
</table>

**Principal Investigator:** David Hydes  
e-mail or contact (if different from above): djh@noc.soton.ac.uk

**Objective/ Goal (100 words max.):**

The European FerryBox Project is a multi-disciplinary research and development project to qualify and foster routine underway measurements from ferry boats to better monitor the environmental conditions of European Seas. They will demonstrate the validity of the hypothesis that FerryBox systems can: a) cost effectively deliver continuous information of immediate scientific value, b) prove that FerryBoxes are reliable systems for monitoring and management, and c) provide real-time data which can be effectively assimilated into prognostic numerical models to improve their accuracy.

**How are the results communicated?**

International journal papers, Web pages, international and national conference/workshop presentations, passenger leaflets and posters

**Can the results be used to support resource management, and if so how?**

Yes. This work will assess the variability in geographical locations 3 and 4 (Western and eastern English Channel) and help to refine the set of sub-ecosystems required within MERP. Monitoring and analysis of cross-margin exchanges will be critical in validating hydrodynamic ecosystem models.
**INSTITUTION:** National Oceanography Centre, Southampton  
**DEPARTMENT/ UNIT:** George Deacon Division  
**Address:** University of Southampton, Waterfront Campus, European Way, Southampton, SO14 3ZH  

Contact person: John Allen, Jane Read, Penny Holliday  
e-mail and/or webpage: jta@noc.soton.ac.uk, jfr@noc.soton.ac.uk, nph@soc.soton.ac.uk

<table>
<thead>
<tr>
<th>Research Activity: The extended Ellet line hydrographic and biogeochemical time series</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration: ongoing</td>
</tr>
<tr>
<td>Funding: NERC</td>
</tr>
<tr>
<td>Principal Investigator: John Allen</td>
</tr>
</tbody>
</table>
e-mail or contact (if different from above): jta@noc.soton.ac.uk

<table>
<thead>
<tr>
<th>Objective/ Goal (100 words max.):</th>
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<tbody>
<tr>
<td>Since 1996 the Southampton Oceanography Centre has been occupying an extended version of the historic Ellett Line (Oban to Rockall) that runs all the way to Iceland. The Extended Ellett line is important oceanographically because it completes the measurements of the warm salty water flowing into the Nordic Seas from the eastern North Atlantic. It also measures around half of the returning deep and cold current, the overflow water. More recently an extensive suite of bio-geochemical measurements has been added, these are aimed at determining the relative importance of opal and calcite production and how this changes with time.</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>How are the results communicated?</th>
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<tbody>
<tr>
<td>International journal papers, international and national conference/workshop presentations, project reports, Web pages etc.</td>
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<tr>
<th>Can the results be used to support resource management, and if so how?</th>
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</thead>
<tbody>
<tr>
<td>Yes. The line passes through the centre of region 8 on page 17. Further work could be accommodated.</td>
</tr>
</tbody>
</table>
**INSTITUTION:** National Oceanography Centre, Southampton  
**DEPARTMENT/UNIT:** George Deacon Division  
**Address:** University of Southampton, Waterfront Campus, European Way, Southampton, SO14 3ZH  
**Contact person:** John Allen  
**e-mail and/or webpage:** jta@noc.soton.ac.uk

<table>
<thead>
<tr>
<th>Research Activity:</th>
<th>Færøes, Iceland, Scotland, Hydrographic and Environmental Survey (FISHES)</th>
</tr>
</thead>
</table>
| **Duration:**     | BICEP comp. ends 1997  
| **Cost:**         | ~ £500 k  
| **Funding:**      | NERC  
| **Principal Investigator:** | John Allen  
| **e-mail or contact (if different from above):** | jta@noc.soton.ac.uk |

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<tr>
<th>Objective/Goal (100 words max.):</th>
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</table>
| Operational oceanography in which large scale hydrographic and biogeochemical measurements across the Iceland Basin were compared with ocean colour images to select a region and objectively plan a high resolution occupation for process studies and forecast modeling.  
Primary productivity parameters from a FRRF instrument were obtained in real time and concurrent with a data set including temperature, salinity, pressure, fluorescence, and particle size and abundance from an optical particle counter (OPC). Combined with in-situ sampling, we showed that the ageostrophic motions associated with an unstable from doubled the export potential of diatoms in the frontal zone. |

<table>
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<tr>
<th>How are the results communicated?</th>
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<tr>
<td>International journal papers, international and national conference/workshop presentations, project reports, Web pages etc.</td>
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<tr>
<th>Can the results be used to support resource management, and if so how?</th>
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<tbody>
<tr>
<td>Yes. The survey area is relevant to region 8, and the results show that mesoscale fronts and eddies may double the growth and export potential of seasonal overturning alone.</td>
</tr>
</tbody>
</table>
**INSTITUTION:** National Oceanography Centre, Southampton  
**DEPARTMENT/UNIT:** George Deacon Division  
**Address:** University of Southampton, Waterfront Campus, European Way, Southampton, SO14 3ZH

Contact person: Richard Sanders  
e-mail and/or webpage: rics@noc.soton.ac.uk

<table>
<thead>
<tr>
<th><strong>Research Activity:</strong></th>
<th>Estimating export production in the oceans</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Duration:</strong></td>
<td>ongoing</td>
</tr>
<tr>
<td><strong>Cost:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Funding:</strong></td>
<td>NERC</td>
</tr>
<tr>
<td><strong>Principal Investigator:</strong></td>
<td>Various within GDD</td>
</tr>
<tr>
<td><strong>e-mail or contact (if different from above):</strong></td>
<td></td>
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<th><strong>Objective/Goal (100 words max.):</strong></th>
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<tbody>
<tr>
<td>To estimate export production using a variety of tools including but not limited to 234Th, 15N, Remote sensing, Drifting sediment traps, nutrient budgets, deep sediment traps. We have applied these tools in a variety of environments including the Southern Ocean, the Irminger basin and the PAP site. We plan to deploy them on an oceanographic transect through region 8 on a regular basis.</td>
</tr>
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<tr>
<th><strong>How are the results communicated?</strong></th>
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<tbody>
<tr>
<td>International journal papers, international and national conference/workshop presentations, project reports</td>
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<thead>
<tr>
<th><strong>Can the results be used to support resource management, and if so how?</strong></th>
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<tbody>
<tr>
<td>Yes. The magnitude, timing and taxonomic composition of export production define the maximum quantity of new food available to secondary producers.</td>
</tr>
<tr>
<td><strong>INSTITUTION:</strong></td>
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<td>------------------</td>
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<tr>
<td><strong>DEPARTMENT/ UNIT:</strong></td>
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<tr>
<td><strong>Address:</strong></td>
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<tr>
<td><strong>Contact person:</strong></td>
</tr>
<tr>
<td><strong>e-mail and/or webpage:</strong></td>
</tr>
</tbody>
</table>

| **Research Activity:** | Monitoring effect of landslide on marine environment in Shetland |
| **Duration:** | 12 months |
| **Cost:** | £14,000 |
| **Funding:** | Community Economic Development Programme / Shetland Enterprise / North Atlantic Fisheries College / Fishing Industry |
| **Principal Investigator:** | Dr Suz Henderson / Dr Sue Marrs |
| **e-mail or contact (if different from above):** | |

| **Objective/ Goal (100 words max.):** | To monitor the effects of a landslide (19 Sept 2003) on the shellfish catches and water quality within two voes in the South of Shetland. |

| **How are the results communicated?** |
| Poster display at public open day at NAFC |
| Published Fisheries Development Note (NAFC publication) |
| Articles in local newspapers and in NAFC newsletter. |
| Direct communication to shellfish fishermen. |

<p>| <strong>Can the results be used to support resource management, and if so how?</strong> |
| Provides background information on the effects and length of recovery, that otherwise would have gone unnoticed, to the water quality and the marine environment and in particular shellfish stocks. |</p>
<table>
<thead>
<tr>
<th><strong>INSTITUTION:</strong></th>
<th>North Atlantic Fisheries College</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DEPARTMENT/ UNIT:</strong></td>
<td>Fisheries Section, Marine Sciences Dept.</td>
</tr>
<tr>
<td><strong>Address:</strong></td>
<td>Port Arthur, Scalloway, Shetland, ZE1 0UN</td>
</tr>
<tr>
<td><strong>Contact person:</strong></td>
<td>Dr Suz Henderson</td>
</tr>
<tr>
<td><strong>e-mail and/or webpage:</strong></td>
<td><a href="mailto:suz.henderson@nafc.uhi.ac.uk">suz.henderson@nafc.uhi.ac.uk</a></td>
</tr>
</tbody>
</table>

| **Research Activity:** | Investigation into the spatial and temporal differences in velvet crab fisheries biology around Shetland waters |
| **Duration:** | 18 months |
| **Cost:** | £25,000 |
| **Funding:** | Community Economic Development Programme / Shetland Enterprise / North Atlantic Fisheries College |
| **Principal Investigator:** | Dr Suz Henderson / Dr Sue Marrs |
| **e-mail or contact (if different from above):** | |

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<tr>
<th><strong>Objective/ Goal (100 words max.).:</strong></th>
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<tbody>
<tr>
<td>To investigate the differences in fisheries biology (moulting period, catch damage, sex ratio, berried females period, crab sizes) of velvet crab stocks around Shetland, using a research vessel survey and laboratory work.</td>
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<table>
<thead>
<tr>
<th><strong>How are the results communicated?</strong></th>
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<tbody>
<tr>
<td>Poster display at public open day at NAFC</td>
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<tr>
<td>Published Fisheries Development Note (NAFC publication)</td>
</tr>
<tr>
<td>Articles in local newspapers and in NAFC newsletter.</td>
</tr>
<tr>
<td>Direct communication to shellfish fishermen at Shellfish Organisation meetings</td>
</tr>
<tr>
<td>Scientific Journal articles</td>
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<tr>
<th><strong>Can the results be used to support resource management, and if so how?</strong></th>
</tr>
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<tbody>
<tr>
<td>Provided data required to allow the local Shellfish Management Organisation to implement regulations on closed fishery periods.</td>
</tr>
<tr>
<td>Also provided additional information on the fisheries biology of resource stocks, and pinpointed areas where future research could be beneficial to management decisions.</td>
</tr>
</tbody>
</table>
INSTITUTION: North Atlantic Fisheries College
DEPARTMENT/ UNIT: Fisheries Section, Marine Sciences Dept.
Address: Port Arthur, Scalloway, Shetland, ZE1 0UN
Contact person: Dr Suz Henderson
e-mail and/or webpage: suz.henderson@nafc.uhi.ac.uk

Research Activity: Shellfish monitoring programme
Duration: ongoing
Cost: no fixed budget
Funding: North Atlantic Fisheries College / Shetland Enterprise (£25,000 in 2003/04)
Principal Investigator: Dr Suz Henderson / Dr Sue Marrs
e-mail or contact (if different from above):

Objective/ Goal (100 words max.):
To coordinate, collect and collate a continual series of fisheries data on all commercially fished shellfish (brown edible crabs, velvet swimming crabs, lobsters, King scallops, Queen scallops, Common whelk) around Shetland to allow the status of the stocks to be monitored.
In addition various fisheries research projects (eg lobster tagging studies) are undertaken to provide additional information on shellfish biology.

How are the results communicated?
Direct communication to shellfish fishermen at Shetland Shellfish Management Organisation meetings
Stock Status reports (NAFC publication)
Poster display at public open day at NAFC
Articles in local newspapers and in NAFC newsletter.
Scientific Journal articles

Can the results be used to support resource management, and if so how?
This data is essential to the management of shellfish stocks in Shetland, providing the Shetland Shellfish Management Organisation with information on the current state and future predictions of stock status.
**INSTITUTION:** Plymouth Marine Laboratory / Proudman Oceanographic Laboratory / MET Office  
**DEPARTMENT/ UNIT:** Address: PML, Plymouth; POL, Liverpool; MET Office, Exeter  
Contact person: Icarus Allen  
e-mail and/or webpage: jia@pml.ac.uk

<table>
<thead>
<tr>
<th><strong>Research Activity:</strong></th>
<th>Shelf seas ecosystem modelling</th>
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<tbody>
<tr>
<td><strong>Duration:</strong></td>
<td>Ongoing</td>
</tr>
<tr>
<td><strong>Cost:</strong></td>
<td>300k per year</td>
</tr>
<tr>
<td><strong>Funding:</strong></td>
<td>NERC, EU</td>
</tr>
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</table>

**Principal Investigator:** Icarus Allen  
e-mail or contact (if different from above):

**Objective/ Goal (100 words max.):**  
We are developing high resolution coupled hydrodynamic shelf seas ecosystem models for the NW European Shelf. The models are a combination of ERSEM and POLCOMS. They are nested with the FOAM N Atlantic model. The objectives are:

1. To hindcast and understand the processes controlling the seasonal cycle of the lower trophic levels (upto mesozooplankton)  
2. To make nowcast simulations of the NW European shelf ecosystem.  
3. The make long term hindcast simulations of the CRP to understand the processes driving observed changes in ecosystem function.  
4. To assess via simulation ecosystem response to anthropogenic changes e.g. changing nutrient loads, changing patterns of demersal trawling.

In the longer term we would like to address put the higher trophic levels (to fish) back into ERSEM to try and understand the mechanistic links between environmental change and fish populations.

**How are the results communicated?**  
Via peer reviewed publication, international conference, websites.

**Can the results be used to support resource management, and if so how?**  
Yes  
The model give us insight into environmental processes which can inform policy. The models allow complex ‘what if’ scenario testing to inform management decisions.
### INSTITUTION: Plymouth Marine Laboratory

**DEPARTMENT/ UNIT:**
Address: Prospect Place, Plymouth PL1 3DH
Contact person: Mel Austen
e-mail and/or webpage: mcva@pml.ac.uk    www.cost-impact.org

### Research Activity: COST-IMPACT – COSTing the IMPACT of demersal fishing on marine ecosystem processes and biodiversity: a holistic framework linking environment, fisheries and socio-economics

**Duration:** 3 years

**Cost:**

**Funding:** DEFRA, EU

**Principal Investigator:** Mel Austen

### Objective/ Goal (100 words max.):
COST-IMPACT’s objectives were to help decision makers integrate fishing and environmental policy by determining:

1. How demersal fishing impacts the biodiversity of marine benthos and the ecosystem goods and services they provide (meta-analysis of existing data, effects on pelagic-benthic coupling through nutrient cycling);
2. How these impacts influence other marine ecosystem processes (ecosystem modeling);
3. What the likely economic values of marine ecosystem goods and services are and how these values are affected by fishing (economic valuation).

COST-IMPACT has provided a tool (decision support system) to help determine whether a balance can be achieved between the impacts of fishing on marine ecosystems and the economic value of the goods and services they provide and the economic value of a fishery.

### How are the results communicated?
Scientific papers (1 published, 6-10 in preparation); web site; reports to EU; through projects reference user group consisting of policy makers, managers, representatives of fishermens organisations; through valuation workshops with EU users; at policy workshops with representatives from DGs Fish, Environment and Research; through presentations to DEFRA, English Nature, at EU stakeholders workshop on EU Marine Strategy; plan to publish articles in fishermens news magazines; press release

### Can the results be used to support resource management, and if so how?
**Yes!** C-I has been held up by English Nature and the DG Environment as an example of implementing an ‘ecosystem approach’ framework to integrate fisheries and environmental management within a socio-economic context. The holistic C-I ‘ecosystem approach’ could equally be used for other anthropogenic impacts on the marine systems. From the outputs of the natural scientists the effects of different fishing regimes on fishery productivity and other ecosystem services have been modelled. Where possible, changes in their economic value (monetary and non-monetary) have been calculated. From these results a decision support tool has been developed for incorporating trade-offs within management between fishing effort and ecosystem services. Stakeholder and RUG input into valuation estimates and development of the decision support tool has been enabled through targeted workshops. This tool is largely driven by socio-economic considerations (cost to society) supported by strong, underlying fisheries and ecology science and developed with the input of the users – fishermen, management and policy makers.
**Objective/ Goal (100 words max.):**

Ongoing zooplankton research at the Plymouth Marine Laboratory has established a weekly time series of zooplankton species since 1988, and a time series for a range of physical, chemical and biological measurements, including phytoplankton species composition since 1992 at L4, a coastal station off Plymouth. The objective is to monitor seasonal and interannual variability as well as long-term trends in the planktonic ecosystem of the western English Channel. In addition to long-term ecological research the L4 programme is an integral part of the PML Core Research Programme and a variety of experimental and process studies are carried out.

**How are the results communicated?**

L4 data are made freely available to the scientific community via the internet; Results are communicated through scientific publications (see web-site for list) as well as within appropriate research groups, for example the Marine Environmental Change network (MECN), ICES Working Group on Zooplankton Ecology and GLOBEC.

**Can the results be used to support resource management, and if so how?**

Results give important information on interannual variability and long-term trends in biodiversity. Current work is relating plankton dynamics to fish eggs and larval of the western English Channel. This is a unique high-frequency time-series in so far as it covers both zooplankton and phytoplankton (450+ taxa).
INSTITUTION: Queen's University Belfast
DEPARTMENT/ UNIT: School of Biology & Biochemistry
Address: MBC, 97 Lisburn Road, Belfast BT9 7BL

Contact person: Christine Maggs
e-mail and/or webpage: c.maggs@qub.ac.uk

Research Activity: Coralline algal studies

Duration: ongoing, for 2 more years
Cost: £200,000
Funding: EU, local government (Environment & Heritage Service)

Principal Investigator: Christine Maggs
e-mail or contact (if different from above):

Objective/ Goal (100 words max.):
Calcified coralline algae are slow-growing but are a valuable natural resource, previously as a low-cost soil ameliorator but now as a high-value scaffold for bone and dental implants. We have interlinked projects exploring both conservation and exploitation of the resource e.g. by aquaculture. The goal of the different subprojects is (1) to determine growth rates (hence sustainable harvesting figures) (2) assess associated biodiversity and (3) provide material to partners to explore the best material for bioengineering.

How are the results communicated?
In scientific papers and at conferences

Can the results be used to support resource management, and if so how?
Yes, by determining sustainable harvesting rates
INSTITUTION: SAHFOS
DEPARTMENT/UNIT: n/a
Address: The Laboratory, Citadel Hill, The Hoe, Plymouth, PL1 2PB

Contact person: Martin Edwards
e-mail and/or webpage: maed@sahfos.ac.uk, www.sahfos.org

Research Activity: The Continuous Plankton Recorder IV: Environmental Change and Biodiversity

Duration: 5 years (Apr 2002- Apr 2007)  
Cost: £88,000 (per ann.)

Funding: DEFRA,

Principal Investigator: All of SAHFOS contributes

e-mail or contact (if different from above):

Objective/Goal (100 words max.):
Primary objectives:

i) To utilise data collected by SAHFOS to interpret marine ecology and to try to distinguish between anthropogenic, climatically forced and natural plankton variability.

ii) To apply CPR data to investigations to the effects of pollution and enhanced inorganic nutrient loading on pelagic ecosystems.

iii) To use the CPR data to monitor changes in marine biodiversity and to help in the development of an index that can assess the ecological health of UK regional seas.

How are the results communicated?

Predominantly through peer-reviewed journals, although SAHFOS participates in some ICES Working Groups. There have also been many TV and radio appearances recently, as well as newspaper articles.

Can the results be used to support resource management, and if so how?

Primarily used as an overall assessment of the response of marine ecosystems to environmental change.
**Research Activity:** The Continuous Plankton Recorder Survey: Fisheries Investigations

**Duration:** 5 years (Apr 2002- Apr 2007)  
**Cost:** £685,000  
**Funding:** DEFRA

**Principal Investigator:** All of SAHFOS contributes  
**e-mail or contact (if different from above):**

**Objective/ Goal (100 words max.):**

This project has two main goals: the first is to provide core funding for the CPR survey (encompasses 7 scientific objectives), and the second is to conduct fisheries investigations with CPR data (encompasses 3 objectives). In terms of the fisheries objectives, the first is a literature review (completed). The second involves applying statistical models to understand links between CPR data and long-term changes in fish stocks. There has been considerable effort and scientific output in this. The third is promoting the use of CPR data in new approaches to fisheries assessment within ICES. This is proving to be more difficult.

**How are the results communicated?**

Predominantly through peer-reviewed journals, although SAHFOS participates in some ICES Working Groups. There have also been many TV and radio appearances recently, as well as newspaper articles.

**Can the results be used to support resource management, and if so how?**

Not in an annual sense (SAHFOS data is usually released 1 year after collection), but with new approaches for multi-annual assessment, the CPR can provide frequent (monthly), large-scale (North Atlantic) assessment of the food environment for young fish.
INSTITUTION: Scottish Agricultural College  
DEPARTMENT/ UNIT: Land Economy  
Address: kings buildings, West Mains Rd, Edinburgh  
Contact person: Dr Dominic Moran  
e-mail and/or webpage: sac.ac.uk

Research Activity: Economic analysis of notifiable fish diseases

Duration: Cost:
Funding: SEERAD, EU, DARDNI

Principal Investigator: Dr Dominic Moran, Dr Abdulai Fofana  
e-mail or contact (if different from above):

Objective/ Goal (100 words max.):  
Cost benefit analysis of surveillance levels for fish diseases in the UK  
The objective of this study is to evaluate current spending on disease surveillance for three notifiable fish diseases: infectious salmon anaemia (ISA), viral haemorrhagic septicaemia (VHS) and infectious haemorrhagic necrosis (IHN). In simple terms this objective requires the assessment of whether the UK is currently investing enough in surveillance relative to the costs that might accrue in the event of a disease outbreak. As part of this objective, the study provides a rationale for government involvement in fish disease surveillance and provides recommendations relating to future spending on surveillance.

How are the results communicated?  
Final report just submitted to SEERAD/DEFRA

Can the results be used to support resource management, and if so how?  
Definitely – basically the results tell us about the optimal level of spending on disease control
INSTITUTION: Scottish Executive  
DEPARTMENT/UNIT: FRS Marine Laboratory  
Address: 375 Victoria Road, ABERDEEN, AB11 9DB  

Contact person: Robin Cook  
e-mail and/or webpage: cookrm@marlab.ac.uk

Research Activity: Modelling the behaviour of nutrients in the coastal waters of Scotland  
Duration: October 2000-June 2002  
Cost: £750 in 2004/05  
Funding: SEERAD

Principal Investigator: Mike Heath  
e-mail or contact (if different from above): heathmr@marlab.ac.uk

Objective/Goal (100 words max.):  
The project had two purposes. Firstly, to establish whether Scottish waters suffer from eutrophication as defined by the UWWT and Nitrate Directive. Secondly, to determine the fate of nutrients emanating from Scottish sources, and in particular to determine whether they make a significant contribution to eutrophication in the waters of Scottish or other Member States. The study was carried out using the ERSEM ecosystem model configured to represent the whole European shelf, in collaboration with Hamburg University and the MacAulay land Use Research Institute.  

How are the results communicated?  
Oral presentations, reports and peer reviewed publications

Can the results be used to support resource management, and if so how?  
Yes, the project provided SEERAD with information on the scale of impact of various nutrient sources.
INSTITUTION: Scottish Executive  
DEPARTMENT/UNIT: FRS Marine Laboratory  
Address: 375 Victoria Road, ABERDEEN, AB11 9DB  
Contact person: Robin Cook  
e-mail and/or webpage: cookrm@marlab.ac.uk

Research Activity: Population dynamics models of European cod stocks  
Duration: July 2000 – July 2005  
Cost: £58,251 in 2004/05  
Funding: SEERAD

Principal Investigator: Mike Heath  
e-mail or contact (if different from above): heathmr@marlab.ac.uk

Objective/Goal (100 words max.):  
The purpose of this project is to build population models of important UK cod stocks incorporating the accumulated knowledge of the biology of the species and the environmental influences on it, in order to investigate sustainable harvesting strategies. Such models will be used to:  
• define appropriate safe biological limits in terms of exploitation rate and reproductive potential, and  
• investigate the possible response of the stock to environmental change.  
Partners on the project are CEFAS (lead), Strathclyde University and FRS. FRS has worked most closely with Strathclyde on the transfer of modelling technology developed in C263/C702 for spatially resolved modelling of Calanus finmarchicus population dynamics in ocean basins, into a form where it can be used to model cod dynamics in shelf seas. However most of the work is being done at Strathclyde.

How are the results communicated?  
Oral presentations, reports and peer reviewed publications

Can the results be used to support resource management, and if so how?  
Yes, the project is developing models of cod populations incorporating spatial structure at various scales. It is intended that these could replace existing management models and be used to predict the consequences of different spatial management schemes.
Research Activity: Recruitment and mortality of Calanus eggs and nauplii

Funding: NERC, SEERAD

Principal Investigator: Steve Hay
e-mail or contact (if different from above): haysj@marlab.ac.uk

Objective/ Goal (100 words max.):
Mortality as well as fecundity and growth control the spatial-temporal patterns in copepod abundance and biomass. Quantifying mortality rates, determining the underlying causes, and explaining their variability is a crucial step towards understanding population dynamics of Calanus finmarchicus and C. helgolandicus. This project’s focus is on eggs and early nauplii as these are the stages in which the vast majority of the life-cycle mortality occurs, and it is also in these stages that mortality is most variable. The aim is to map and explore factors determining control in growth, development, fecundity, hatch-success and mortality of these two species. The work in the northern North Atlantic Irminger Sea will be aboard RV Discovery on cruises in the spring, summer and winter. In addition at Plymouth and Aberdeen, two long-term monitoring sites (L4 in the English Channel, and Stonehaven in the northern North Sea) we further explore seasonal dynamics of these two species.

How are the results communicated?
Oral presentations, reports and peer reviewed publications

Can the results be used to support resource management, and if so how?
Indirectly, results will help to develop better models of how climate has changed the structure and function of the food web
INSTITUTION: Scottish Executive
DEPARTMENT/ UNIT: FRS Marine Laboratory
Address: 375 Victoria Road, ABERDEEN, AB11 9DB

Contact person: Robin Cook
e-mail and/or webpage: cookrm@marlab.ac.uk

Research Activity: Development and Testing of Ecological Indicators and Models to Monitor and Predict the Ecosystem Effects of Fishing (IMPACT)

Duration: 1 April 2002 to 31 March 2007  Cost: £8,200 in 2004/05
Funding: SEERAD, EU

Principal Investigator: Simon Greenstreet
e-mail or contact (if different from above): greenstreet@marlab.ac.uk

Objective/ Goal (100 words max.):

The main objectives of this research are to develop indicators of the ecological effects of fishing and to develop validated models that help to predict the impacts of fishing, and changes in fishery management practices, on the marine ecosystem. The indicators will be suitable for tracking fishery-induced changes in diversity, productivity, trophic structure and functional processes in marine ecosystems, and will be validated using historic and experimental data collected in the areas impacted by the main North Sea cod, haddock, whiting and saithe fisheries. The project will focus on the development of a minimum number of indicators that reflect the main properties of the marine ecosystem and could be monitored on a range of scales in space and time. Models to predict the impacts of fishing on the ecosystem will describe how catch controls, effort controls and technical measures (with emphasis on closed areas) affect spatial and temporal patterns of fishing effort, and the potential effects of these patterns of effort redistribution on diversity, productivity, trophic structure and functional processes. Models will be validated with field data.

How are the results communicated?

Oral presentations, reports and peer reviewed publications

Can the results be used to support resource management, and if so how?

Yes, the project will provide ecosystem indicators of change in the fisheries food web which can be used to gauge the effectiveness of management measures.
Research Activity: C264 Zooplankton demography and trophic interactions in the sub-antarctic North Atlantic, and their coupling to physical oceanography: 40-years on from the NAO minimum

Funding: NERC, SEERAD

Principal Investigator: Mike Heath
e-mail or contact (if different from above): heathmr@marlab.ac.uk

Objective/ Goal (100 words max.):
C264 is a UK consortium project coordinated by FRS which was funded from phase 2 of the NERC MarProd Programme. The purpose of the consortium was to conduct a campaign of seagoing measurements in the Irminger Sea and adjacent areas to discover the relationships between oceanic circulation, the life cycle dynamics and demography of three key crustacean zooplankton (Calanus finmarchicus, Thysanoessa longicaudata and Meganyctiphanes norvegica) and the structure and productivity of the pelagic food web. The impact of climate variability on these relationships is being examined by means of a comparative analysis of the data collected during the campaign with comparable measurements made in 1963 during the NORWESTLANT surveys, and with data from the Continuous Plankton Recorder surveys.

How are the results communicated?
Oral presentations, reports and peer reviewed publications

Can the results be used to support resource management, and if so how?
Yes, results show how climate has changed the structure and function of the food web
INSTITUTION: Scottish Executive
DEPARTMENT/ UNIT: FRS Marine Laboratory
Address: 375 Victoria Road, ABERDEEN, AB11 9DB

Contact person: Robin Cook
e-mail and/or webpage: cookrm@marlab.ac.uk

Research Activity: Integrated Approach to the Biological Basis of Age Estimation in Commercially Important Fish Species (IBACS)

Duration: December 2001 – November 2005  Cost: £49,188 in 2004/05
Funding: SEERAD, EU

Principal Investigator: Peter Wright
e-mail or contact (if different from above): wrightp@marlab.ac.uk

Objective/ Goal (100 words max.):
This project aims to improve the biological basis of age estimation for commercial fish species. The project will integrate modelling, laboratory and field observations to provide an objective basis for interpreting the macrostructures of otoliths used for estimation of fish age. The project will establish a new age estimation protocol and enable training through a data base hosted in a web site accessible by fisheries laboratories and fishermen's organisations.
FRS interest in this project is primarily concerned with being able to infer the growth history, behaviour and environmental experience of wild fish from their otoliths. As such the project will provide a tool for investigating the factors affecting the distribution and growth of cod.

How are the results communicated?
Oral presentations, reports and peer reviewed publications

Can the results be used to support resource management, and if so how?
Yes, the projects is developing better estimates of fish age which relate directly to fisheries advice.
Research Activity: IMPRESS Interactions between the Marine environment, PREdators, and prey: implications for Sustainable Sandeel fisheries

Duration: December 2000 – November 2004  Cost: £33,852 in 2004/05
Funding: SEERAD, EU
Principal Investigator: Simon Greenstreet
e-mail or contact (if different from above): greenstreet@marlab.ac.uk

Objective/ Goal (100 words max.):
The specific objectives of MSIG in the project are to determine the biomass and distribution of sandeels in the sediment of the Firth of Forth study area in Spring, Summer and Autumn, 2001 and 2002. To determine the biomass and distribution of sandeels and other pelagic fish in the water column, and the numbers and distribution of seabirds in flight and on the sea surface of the Firth of Forth study area in Summer 2001 and 2002. To examine spatial, seasonal and between year variation in the hydrography of the Firth of Forth study area in 2001 and 2002.

How are the results communicated?
Oral presentations, reports and peer reviewed publications

Can the results be used to support resource management, and if so how?
Yes, the projects is will give better scientific basis for linking sandeels and seabird, and basing sandeel fishery closures in the breeding success of seabirds
INSTITUTION: Scottish Executive  
DEPARTMENT/UNIT: FRS Marine Laboratory  
Address: 375 Victoria Road, ABERDEEN, AB11 9DB  

Contact person: Robin Cook  
e-mail and/or webpage: cookrm@marlab.ac.uk

Research Activity: BECAUSE

Duration: 1 March 2004 – 28 February 2007  
Cost: £23,610 in 2004/05  
Funding: SEERAD, EU

Principal Investigator: Simon Greenstreet  
e-mail or contact (if different from above): greenstreet@marlab.ac.uk

Objective/Goal (100 words max.):  
The principle objective of this program is the identification and quantification of critical biological interactions between and within commercial target fish species and non-commercial top predators leading to a description of food web structures and the derivation of precautionary reference points for ecosystem oriented fisheries management. These precautionary reference points and limit values accounting for interacting mechanisms with the environment are necessary for the development of adaptive strategies in fisheries management.

How are the results communicated?

Oral presentations, reports and peer reviewed publications

Can the results be used to support resource management, and if so how?

Yes, the project will provide ecosystem indicators of change in the benthos which can be used to gauge the effectiveness of demersal fisheries management measures.
INSTITUTION: Scottish Executive  
DEPARTMENT/UNIT: FRS Marine Laboratory  
Address: 375 Victoria Road, ABERDEEN, AB11 9DB  
Contact person: Robin Cook  
e-mail and/or webpage: cookrm@marlab.ac.uk  

Research Activity: Towards accreditation and certification of age determination of aquatic resources (TACADAR)  
Duration: December 2001 – November 2005  
Cost: £12,000 in 2004/05  
Funding: SEERAD, EU  

Principal Investigator: Peter Wright  
e-mail or contact (if different from above): wrightp@marlab.ac.uk  

Objective/Goal (100 words max.):  
TACADAR is a network of excellence with the overall objective to increase reliability of age estimation procedures in the European Community, compatible with the possibility of the future establishment of European wide international fisheries laboratories. TACADAR aims to increase the adoption of procedures that include quality assurance and quality control mechanisms, for the improvement of stock assessment and environmental management techniques. The ultimate objective is to stimulate the achievement of a higher level of quality within and integration between the member institutions of TACADAR, concerning fish age determination.  

How are the results communicated?  
Oral presentations, reports and peer reviewed publications  

Can the results be used to support resource management, and if so how?  
Yes, the projects is designed to achieve accreditation for age determinations in fish which are essential for management advice
**Research Activity:** MF0754 Ecosystem effects on fisheries productivity

**Duration:** April 2002 - March 2006  
**Cost:** £102,516 in 2004/05  
**Funding:** SEERAD

**Principal Investigator:** Mike Heath  
e-mail or contact (if different from above): heathmr@marlab.ac.uk

**Objective/ Goal (100 words max.):**

The overall objective of the project is to establish the relationship between trends in the abundance of key species, and changes in the balance of productivity between pelagic, demersal round-fish, and benthic (shellfish and flatfish) fisheries, and hence of changes in the sustainable structure of regional fisheries.

The project has a number of sub-objectives, which define a set of Tasks:
1. To estimate the regional pattern and long-term trends in annual new primary production for European waters.
2. To estimate trends in the productivity of the pelagic, demersal round-fish and benthic fish communities in the North Sea and west of Scotland from fishery and survey data, and relate these to trends in the key species and in exploitation intensity.
   and, linked to a set of external contracts funded by the NERC Marine Productivity Thematic Programme (MarProd):
3. To establish the connection between oceanographic climate and the trends in Calanus finmarchicus and other key species in the North Sea and west of Scotland waters.

**How are the results communicated?**

Oral presentations, reports and peer reviewed publications

**Can the results be used to support resource management, and if so how?**

Yes, results show how fisheries and climate have changed the structure and function of the food web
**Research Activity:** MF0753 and C735 Managing Fisheries to Conserve Groundfish and Benthic Invertebrate Species Diversity (MAFCONS)

**Duration:** April 2002 - March 2006

**Cost:** £249,631 in 2004/05

**Funding:** SEERAD, EU

**Principal Investigator:** Simon Greenstreet

**Objective/Goal (100 words max.):**

The primary aim of MAFCONS is to provide the scientific advisors to fisheries managers with the mathematical models that would allow them to quantify the consequences to groundfish and benthic invertebrate species diversity of achieving particular fisheries objectives (eg. specific species Total Allowable Catches, TAC). The major outcome of this project will be the development of mathematical tools to the point where they could be used in the current ICES fisheries stock assessment procedure. This would present ICES (the scientific advisory body) with the opportunity of providing the EC and fisheries ministers with advice regarding the impact of fisheries policy on the wider marine ecosystem, as well as on the fish stocks themselves.

**How are the results communicated?**

Oral presentations, reports and peer reviewed publications

**Can the results be used to support resource management, and if so how?**

Yes, results show how fisheries have changed the structure and function of the demersal food web, and provide models to predict future consequences of fisheries measures
INSTITUTION: Scottish Executive  
DEPARTMENT/ UNIT: FRS Marine Laboratory  
Address: 375 Victoria Road, ABERDEEN, AB11 9DB  
Contact person: Robin Cook  
e-mail and/or webpage: cookrm@marlab.ac.uk

Research Activity: NEW 1 Developing Benthic Habitat Mapping Methodology (HABMAP)  
Duration: April 2005 - March 2007  
Funding: SEERAD  
Principal Investigator: Simon Greenstreet  
e-mail or contact (if different from above): greenstreet@marlab.ac.uk

Objective/ Goal (100 words max.):  
This project seeks to assess the different methods needed to carry out seabed habitat mapping in Scottish waters. The role of habitat mapping in the development of an ecosystem approach to management will be explored by classifying seabed habitat in a series of 3NM by 3 NM boxes across the North Sea and west of Scotland using acoustic mapping techniques. Each of the sites chosen for seabed habitat classification will be the area immediately surrounding and including the trawl track of tows collected for the North Sea and west coast IBTS surveys. Sites will also be selected so as to include stations previously sampled for benthic community analysis. Habitat type and heterogeneity will then be related to fish and benthic species composition and diversity. Acoustic data and ground truthing sediment samples will be collected and, on completion of analysis, these data will be used to produce maps. Interpretation of these maps, along with reference to benthic and groundfish data collected as part of other projects, will allow FRS to assess the role of habitat mapping in the development of an ecosystem approach to fisheries management.

How are the results communicated?  
Oral presentations, reports and peer reviewed publications

Can the results be used to support resource management, and if so how?  
Yes, the projects will develop and assessment of fish habitat distribution, which will advise fisheries managers on the appropriate spatial scale for management measures.
Research Activity: MF0756 Understanding the role of population structuring in the maintenance of cod stocks under changing fishing and climatic pressures (CODPOP)

Funding: SEERAD

Principal Investigator: Peter Wright
e-mail or contact (if different from above): wrightp@marlab.ac.uk

Objective/ Goal (100 words max.):
The overall objective of this project is to develop the basis for advising on how fisheries management measures might be framed to conserve and restore population diversity of cod stocks around Scotland. To do this, requires an understanding of the relative contributions of fishing and climate to changes in the population structure and dynamics of cod.

How are the results communicated?
Oral presentations, reports and peer reviewed publications

Can the results be used to support resource management, and if so how?
Yes, the projects is developing models of cod population dynamics incorporating spatial structure at various scales. It is intended that these could replace existing management models and be used to predict the consequences of different spatial management schemes.
Research Activity: MF0464 Metapopulation structuring within gadoids in the north east Atlantic (METAGADOID)

Duration: April 2003 - March 2007  
Cost: £118,230 in 2004/05

Funding: SEERAD

Principal Investigator: Peter Wright

Objective/ Goal (100 words max.):

The project aims to establish the degree of reproductive isolation of haddock and whiting spawning congregations within the North Sea and Vla using newly developed micro-satellite DNA markers for these species. Population structuring will be examined within the context of spatial population theory to consider how differing local dynamics and responses to environmental variability may help in sustaining the overall productivity of the fished stocks. The potential impacts of structuring on current management strategies and the benefits of spatially explicit approaches will be examined.

How are the results communicated?

Oral presentations, reports and peer reviewed publications

Can the results be used to support resource management, and if so how?

Yes, the projects is developing models of gadoid population structure, which will advise fisheries managers on the appropriate spatial scale for management measures.
INSTITUTION: Scottish Executive
DEPARTMENT/ UNIT: FRS Marine Laboratory
Address: 375 Victoria Road, ABERDEEN, AB11 9DB

Contact person: Robin Cook
e-mail and/or webpage: cookrm@marlab.ac.uk

Research Activity: MF0463 Ecosystem approach to defining the sustainable level of fishing for sandeels
Duration: April 2000 - March 2004
Cost: Completed March 2004
Funding: SEERAD

Principal Investigator: Simon Greenstreet/Mike Heath
e-mail or contact (if different from above): greenstreet@marlab.ac.uk

Objective/ Goal (100 words max.):
The project has three main objectives.
1. Establish the source area of young-of-the-year sandeels arriving at Wee Bankie in May, and the relationship between climatic conditions and growth, survival and dispersal of larvae.
2. Determine the spatial and temporal variability in the mortality rate of sandeels due to fishing and predation by seabirds and piscivorous fish, and how this is influenced by weather conditions and oceanographic features.
3. Develop a population dynamics model for the sandeel population on Wee Bankie, including the multi-species interactions with piscivorous fish and seabirds.

How are the results communicated?
Oral presentations, reports and peer reviewed publications

Can the results be used to support resource management, and if so how?
Yes, the projects is developing models of sandeel population structure, recruitment and mortality due to fish and seabird predation, which will advise fisheries managers on the appropriate spatial scale for management measures.
INSTITUTION: Scottish Executive  
DEPARTMENT/ UNIT: FRS Marine Laboratory  
Address: 375 Victoria Road, ABERDEEN, AB11 9DB

Contact person: Robin Cook  
e-mail and/or webpage: cookrm@marlab.ac.uk

Research Activity: C737 CODYSSEY

Cost: £58,251 in 2004/05  
Funding: SEERAD, EU

Principal Investigator: Peter Wright  
e-mail or contact (if different from above): wrightp@marlab.ac.uk

Objective/ Goal (100 words max.):

This project aims to improve understanding of the horizontal migrations and vertical movements of cod and the influence of environmental and biological factors on them in order to provide management relevant information as to the horizontal availability, vertical accessibility and individual vulnerability of cod to fishing activities. The fulfilment of this objective will provide tools for the evaluation of stock assessment methodology, management and conservation of cod stocks in European waters and will be highly relevant to future stock assessment and the management of cod stocks. In order to achieve this aim the project tests the hypotheses that patterns of horizontal and vertical movement of individual cod vary systematically, and that the variation is the consequence of behavioural responses to environmental factors.

How are the results communicated?

Oral presentations, reports and peer reviewed publications

Can the results be used to support resource management, and if so how?

Yes, the projects is developing models of cod populations incorporating spatial structure at various scales. It is intended that these could replace existing management models and be used to predict the consequences of different spatial management schemes.
**INSTITUTION:** Scottish Executive  
**DEPARTMENT/ UNIT:** FRS Marine Laboratory  
**Address:** 375 Victoria Road, ABERDEEN, AB11 9DB  
**Contact person:** Robin Cook  
**e-mail and/or webpage:** cookrm@marlab.ac.uk

**Research Activity:** The role of sub-stock structure in the maintenance of cod metapopulations (METACOD)

**Duration:** December 2001 – November 2005  
**Cost:** £119,735 in 2004/05  
**Funding:** SEERAD, EU

**Principal Investigator:** Peter Wright  
**e-mail or contact (if different from above):** wrightp@marlab.ac.uk

**Objective/ Goal (100 words max.):**
The overall objective of this project is to develop the conceptual and mathematical basis for advising on how fisheries management measures might be framed to conserve or restore not only stock biomass, but also sub-stock diversity of cod. This shall be accomplished by studying and developing models based on the cod stocks off Iceland and the west and north of Scotland. The aim will be to establish the extent of genetic sub-structure in these stocks, how it is maintained, and the extent to which overall population dynamics are dependent on the sub-stocks.

**How are the results communicated?**  
Oral presentations, reports and peer reviewed publications

**Can the results be used to support resource management, and if so how?**  
Yes, the projects is developing spatially resolved models of cod population dynamics which will improve the assessment and strategic advice on cod.
**Research Activity:** An operational model of the effects of stock structure and spatio-temporal factors on recruitment. (STEREO – Stock effects on recruitment relationships). EU-FAIR-CT98-4122

**Duration:** December 1998-February 2002  
**Cost:** £

**Funding:** SEERAD, EU

**Principal Investigator:** Mike Heath  
e-mail or contact (if different from above): heathmr@marlab.ac.uk

**Objective/ Goal (100 words max.):**

The overall objective of the project was to produce a scheme for refining fisheries stock-recruitment relationships. This was to be achieved by incorporating biological, spatial and temporal information on the stock structure. The aim was to provide the information necessary for improving the scientific basis of limit reference points in fisheries management. These are the biological criteria against which the state of the stocks are judged and form the basis for management. The methodology was developed for cod and haddock stocks around Iceland, Norway and in the North Sea as case studies. The specific objective was to build a modelling system that would predict the probability of contributions by different spatial, temporal and parental components of the spawning stock of a species to the juvenile pre-recruit population some months after spawning.

**How are the results communicated?**

Oral presentations, reports and peer reviewed publications

**Can the results be used to support resource management, and if so how?**

Yes, the projects provided a better understanding of the processes affecting recruitment haddock fisheries.
INSTITUTION: Scottish Executive
DEPARTMENT/ UNIT: FRS Marine Laboratory
Address: 375 Victoria Road, ABERDEEN, AB11 9DB

Contact person: Robin Cook
e-mail and/or webpage: cookrm@marlab.ac.uk

Research Activity: The Benthic Ecology of the Western North sea

Duration: December 2001 – December 2004  Cost: £750 in 2004/05
Funding: DEFRA, SEERAD

Principal Investigator: Simon Greenstreet
e-mail or contact (if different from above): greenstreet@marlab.ac.uk

Objective/ Goal (100 words max.):

The main objective of this project is to provide a strategic evaluation of the status of the benthic communities of the western North Sea in relation to natural and anthropogenic influences as a contribution to the 2004 DEFRA “State of the Seas” assessment for UK waters. This will be achieved through the generation of information on the occurrences and densities of benthic species in the northern North Sea by capitalising on sampling effort in 2001 by FRS accompanied by the completion of a grid of benthic stations off the English east coast sampled by CEFAS. The generation of these data will have the additional benefit of contributing to an ongoing international evaluation of benthic community status in the North sea under the auspices of ICES

How are the results communicated?

Oral presentations, reports and peer reviewed publications

Can the results be used to support resource management, and if so how?

Yes, the project will provide ecosystem indicators of change in the benthos which can be used to gauge the effectiveness of demersal fisheries management measures
INSTITUTION: Scottish Executive  
DEPARTMENT/ UNIT: FRS Marine Laboratory  
Address: 375 Victoria Road, ABERDEEN, AB11 9DB  
Contact person: Robin Cook  
e-mail and/or webpage: cookrm@marlab.ac.uk

Research Activity: C623: Data-driven, basin scale, modelling of the impact of climate variability on plankton productivity and the abundance and demography of Calanus finmarchicus in the North Atlantic.  
Duration: February 2001-March 2005  
Cost: £4417 in 2004/05  
Funding: NERC, SEERAD  
Principal Investigator: Mike Heath  
e-mail or contact (if different from above): heathmr@marlab.ac.uk

Objective/ Goal (100 words max.):  
C263 was funded in phase 2 of the NERC MarProd Programme with the following aims: To elucidate the relationship between oceanic circulation and the abundance of Calanus finmarchicus over its whole North Atlantic range. Capitalising and extending on the phase 1 spin-up project (C702) the project aims to use automatic optimisation to fit a series of process-based demographic models to existing and projected abundance data. Formal statistical methods will be used to evaluate the relative goodness of fit generated by models embodying competing hypotheses, thus allowing us to distinguish between them. PI: William Gurney, U. Strathclyde. Co-Is: Simon Wood (U. St Andrews),;Michael Heath (FRS Aberdeen);

How are the results communicated?  
Oral presentations, reports and peer reviewed publications

Can the results be used to support resource management, and if so how?  
Yes, results show how climate has changed the structure and function of the food web
**INSTITUTION:** Scottish Executive  
**DEPARTMENT/UNIT:** FRS Marine Laboratory  
**Address:** 375 Victoria Road, ABERDEEN, AB11 9DB  

**Contact person:** Robin Cook  
**e-mail and/or webpage:** cookrm@marlab.ac.uk

<table>
<thead>
<tr>
<th>Research Activity:</th>
<th>AE1190 Oceanic transport around Scotland</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Duration:</strong></td>
<td>April 2003 - March 2005</td>
</tr>
<tr>
<td><strong>Cost:</strong></td>
<td>£40547 in 2004/05</td>
</tr>
<tr>
<td><strong>Funding:</strong></td>
<td>SEERAD</td>
</tr>
</tbody>
</table>

**Principal Investigator:** Bill Turrell  
**e-mail or contact (if different from above):** turrellb@marlab.ac.uk

<table>
<thead>
<tr>
<th>Objective/Goal (100 words max.):</th>
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<tbody>
<tr>
<td>To quantify the supply of warm oceanic water flowing around Scotland and determine whether this is reducing. Follows up on earlier work showing that the deep outflow from the Nordic Seas has reduced in concert with climate change</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>How are the results communicated?</th>
</tr>
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<tbody>
<tr>
<td>Oral presentations, reports and peer reviewed publications</td>
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<table>
<thead>
<tr>
<th>Can the results be used to support resource management, and if so how?</th>
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<tbody>
<tr>
<td>Indirectly, provides scientific explanation for many changes that we see in the biology of the North Sea.</td>
</tr>
</tbody>
</table>
**INSTITUTION:** Scottish Executive  
**DEPARTMENT/ UNIT:** FRS Marine Laboratory  
**Address:** 375 Victoria Road, ABERDEEN, AB11 9DB  
**Contact person:** Ian Tuck  
**e-mail and/or webpage:** tucki@marlab.ac.uk

<table>
<thead>
<tr>
<th><strong>Research Activity:</strong></th>
<th>Inshore habitat use by juvenile fish</th>
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</thead>
<tbody>
<tr>
<td><strong>Duration:</strong></td>
<td>3 years</td>
</tr>
<tr>
<td><strong>Cost:</strong></td>
<td>£827,982</td>
</tr>
<tr>
<td><strong>Funding:</strong></td>
<td>SEERAD</td>
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<tr>
<td><strong>Principal Investigator:</strong></td>
<td>Ian Tuck</td>
</tr>
<tr>
<td><strong>e-mail or contact (if different from above):</strong></td>
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**Objective/ Goal (100 words max.):**

The objective of this project is to improve our understanding of the ecology of juvenile fish in inshore waters, addressing issues important for formulating policy in general Coastal Zone Management and more specifically in the ‘ecosystem approach’ to fisheries management. The work aims to identify potential nursery grounds, investigate the spatial and temporal distribution of juvenile fish in relation to habitats in inshore waters, and develop a pilot GIS for inshore fish, incorporating fish and habitat distribution.

**How are the results communicated?**

Results will be published as either FRS reports or International journals.

**Can the results be used to support resource management, and if so how?**

Results will be used to advise managers on a range of issues relevant to CZM and inshore fisheries.
| INSTITUTION: **Scottish Executive**  
| DEPARTMENT/ UNIT: FRS Marine Laboratory  
| Address: 375 Victoria Road, ABERDEEN, AB11 9DB  
| **Contact person:** Ian Tuck  
| **e-mail and/or webpage:** tucki@marlab.ac.uk  
|  
| **Research Activity:** Exploration of fishing capacity and fishing activity and their utility for effort management control of fishing mortality.  
| **Duration:** 3.5 years  
| **Cost:** £806,732  
| **Funding:** SEERAD  
| **Principal Investigator:** Ian Tuck / Dick Ferro / Dave Reid  
| **e-mail or contact (if different from above):**  
|  
| **Objective/ Goal (100 words max.):**  
| The development of fisheries management systems based on effort controls are a priority for SEERAD. This pilot project investigates factors influencing fishing capacity, to establish relationships between fishing activity, fishing capacity and fishing mortality for part of the Scottish demersal and pelagic fleets, to provide preliminary estimates and guidelines for designing a more comprehensive study. Fishing capacity will be investigated in relation to vessel and gear characteristics. Using this information, the relative contributions to overall fishing mortality from each component fleet can be investigated, enabling the exploration of various methods of effort management in order to control fishing mortality.  
|  
| **How are the results communicated?**  
| Results will be published as either FRS reports or International journals.  
|  
| **Can the results be used to support resource management, and if so how?**  
| The results will provide preliminary estimates of the relationships between fishing activity, fishing capacity and fishing mortality which can be used to advise on the implications of effort control approaches. The results will also be used to develop more comprehensive studies, to further develop effort management tools.  
|
INSTITUTION: Scottish Executive
DEPARTMENT/ UNIT: FRS Marine Laboratory
Address: 375 Victoria Road, ABERDEEN, AB11 9DB

Contact person: Dr H Anne McLay
e-mail and/or webpage: mclaya@marlab.ac.uk

Research Activity: PKFM - Policy and Knowledge in Fisheries Management; the North Sea cod case
Duration: 2.5 years (2003 – June 2005) Cost: 0.9 million Euro (Total EC contribution
Funding: EC funded under the Fifth Framework Programme, Quality of life and management of living resources. Q5RS – 2002-01782

Principal Investigator: Project Co-ordinator - Poul Degnbol, Institute of Fisheries Management, Denmark
e-mail or contact (if different from above): pd@ifm.dk

Objective/ Goal (100 words max.):
To identify and understand specific shortcomings in the European fisheries policy and its implementation which have contributed to the problems evident in several European fisheries and devise means for their rectification. The project focuses on the knowledge production and decision making within the fisheries management system, the interrelationships between these processes and the role played by stakeholders, taking fisheries for North Sea cod as a case study.

How are the results communicated?
The results of research components within the project will be published in international peer review journals and will contribute to the development of a framework for performance evaluations of fisheries systems being developed by ICES (International Council for the Exploration of the Seas). The outcome of the project includes a policy brief (to be presented to the European Commission which will include an evaluation of options to improve fisheries management.

Can the results be used to support resource management, and if so how?
The project directly addresses fisheries resource management. It’s finding will hopefully be useful to managers / improve the performance of the management system.
**Research Activity:** FISBOAT project

**Duration:** 3 years  
**Cost:** € 1.5 million  
**Funding:** SEERAD, EU, (10 other European institutes contribute 50% of costs allocated to them)

**Principal Investigator:** Paul Fernandes  
e-mail or contact (if different from above):

**Objective/ Goal (100 words max.):**

The purpose of this project is to develop fish stock assessment tools based on survey data only and evaluate how these perform in producing advice within defined management procedures. The project spans several disciplines (i.e., population biology, survey methods, stock assessment, management), with the objectives of (1) producing a comprehensive diagnostic of population status using survey-based population demography and biological indices and (2) evaluate its performance in a management context.

**How are the results communicated?**

Through publication in annual reports, conferences, and the scientific literature. The project also has a website at [http://www.ifremer.fr/drvecohal/fisboat/index.htm](http://www.ifremer.fr/drvecohal/fisboat/index.htm).

**Can the results be used to support resource management, and if so how?**

Current fish stock assessment is based primarily on fisheries data (catches/landings) and models of population demography (cohort analysis). Collapse of important fish stocks in the past (e.g. cod in Canada) have revealed that fisheries based demographic indices suffer from a number of limitations, most notably illicit fishing activity such as black landing, discarding and misreporting. Fisheries surveys, used to determine the abundance and distribution of marine resources, do not suffer from such problems, but are less precise due to the relatively small sample size. This project aims to evaluate how the less precise but unbiased (or consistent bias) survey method can be used to evaluate fish stocks.
Research Activity: SIMFAMI project

Duration: 3 years  Cost: €2.3 million
Funding: SEERAD, EU (plus IFREMER, France; IMR, Norway; and IEO, Spain contribute 50% of costs allocated to them)

Principal Investigator: Paul Fernandes
e-mail or contact (if different from above):

Objective/Goal (100 words max.):
The goal of the project is to enable identification of fish species using acoustic methods, using data from a number of frequencies (e.g. 18, 38, 120 & 200 kHz) to characterise the frequency specific response of fish and plankton. Ultimately the project aims to:

- Improve existing acoustic surveys for stock assessment.
- Allow data to be obtained on the abundance and distribution of some non-target species for consideration of an ecosystem approach.
- Allow for the implementation of mackerel acoustic surveys.
- Allow data on fish abundance and distribution to be obtained from other ocean going platforms.

How are the results communicated?
Through publication in annual reports, conferences, and the scientific literature. The project also has a website at http://simfami.marlab.ac.uk.

Can the results be used to support resource management, and if so how?
Fisheries acoustic surveys are used to determine the abundance and distribution of a wide variety of pelagic marine and freshwater resources throughout the world, such as herring, anchovy, pollack, and krill. Vertical echosounders are used to collect echoes from the fish, as echotracers: these are then attributed to species. This attribution is based on verification by some other sampling method such as a pelagic trawl. However, trawling on every echotrace is not possible, such that subjective judgements often have to be made to identify the species. This project aims to provide more information to assist in that process and so enhance the precision of acoustic surveys.
Research Activity: Experimental Investigation

Project Title: SURVIVAL - An assessment of mortality in fish escaping from trawl codends and its in fisheries management.

Duration: 3 years Cost: 2,659,318 Euros
Funding: funded jointly by EU and each partner institute (including FRS/SEERAD)

Principal Investigator: Mike Breen

Objective/ Goal (100 words max.):
This project will provide estimates of mortality in gadoid fish escaping from towed fishing gears. It will utilise and test recently developed technology, to improve currently used protocols and overcome sampling errors. Furthermore, it will give an estimate of the seasonal variation in survival estimates and a method for inclusion of these estimates in stock assessment models for haddock (*Melanogrammus aeglefinus*) and cod (*Gadus morhua*). This project will provide knowledge on survival in high intensity fisheries and in fish escaping at the surface in side trawling fisheries.

How are the results communicated?

Via several different channels to meet the needs of the scientific community, the fishing industry, fisheries management and the public. Peer review publications for the scientific literature will be written at the end of each work-package. Folders presenting the project and the results will be produced for distribution to the fisheries organisations of the EU and to the fishing industry and the public in all partner countries. At the end of the project a video will be produced to facilitate the communication with the fishing fleet.

Can the results be used to support resource management, and if so how?

A work-package in the project has been dedicated to this particular problem. It will focus on the inclusion of mortality data in Virtual Population Analysis (VPA) models. The key problems of including selectivity and mortality data, which has been historically length based, in these age based stock assessments and predictive models will be addressed. The validity of these approaches will then be assessed by performing sensitivity analysis on the key parameters within the models, including measures of selectivity and escape mortality. In this way the significance of each of the data inputs in the models (ie. Landed catch, discard mortality, escape mortality, natural mortality, etc) can be assessed and their relative importance in the management of a fishery recognised.
INSTITUTION: Scottish Executive  
DEPARTMENT/UNIT: FRS Marine Laboratory  
Address: 375 Victoria Road, ABERDEEN, AB11 9DB  

Contact person: Dr RST Ferro  
e-mail and/or webpage: ferro@marlab.ac.uk

Research Activity: Fishing gear and fish behaviour studies  
Duration: 3 years  
Cost: €210919 for FRS work  
Funding: SEERAD, EU

Principal Investigator:  
e-mail or contact (if different from above):

Objective/Goal (100 words max.):  
To develop a species selective fishing gear to reduce the by-catch of juvenile cod in whitefish trawls used in the North Sea whitefish fishery

How are the results communicated?  
EU Periodic and Final reports, industry liaison group meetings, fishing industry press, peer-reviewed publications, scientific fora such as ICES

Can the results be used to support resource management, and if so how?  
The development of a gear which reduces the fishing effort on cod will help cod recovery plans in the North Sea
INSTITUTION: Scottish Executive  
DEPARTMENT/UNIT: FRS Marine Laboratory  
Address: 375 Victoria Road, ABERDEEN, AB11 9DB  

Contact person: Dr RST Ferro  
e-mail and/or webpage: ferro@marlab.ac.uk

Research Activity: Development of a new mesh measurement gauge

Duration: 3 yrs  
Cost:  
Funding: SEERAD, EU

Principal Investigator: Dr FG O’Neill  
e-mail or contact (if different from above): oneillb@marlab.ac.uk

Objective/Goal (100 words max.):  
To design, build and test an instrument which provides an objective method of measuring the mesh opening in fishing nets for use by fishing industry, enforcement officers and scientists

How are the results communicated?  
EU Periodic and Final reports, Video film, publish a protocol on use of instrument, demonstration project to obtain acceptance of use

Can the results be used to support resource management, and if so how?  
Improved enforcement for technical conservation measures regulating fisheries operations.
| **INSTITUTION:** Scottish Executive |
| **DEPARTMENT/ UNIT:** FRS Marine Laboratory |
| **Address:** 375 Victoria Road, ABERDEEN, AB11 9DB |
| **Contact person:** Dr RST Ferro |
| **e-mail and/or webpage:** ferro@marlab.ac.uk |

**Research Activity:** Fishing gear and fish behaviour studies

**Duration:** 3 yrs  
**Cost:** €182822 for FRS work  
**Funding:** SEERAD, EU

**Principal Investigator:** Dr RST Ferro  
**e-mail or contact (if different from above):**

**Objective/ Goal (100 words max.):**

To develop a species selective fishing gear to reduce the by-catch of juvenile whitefish in *Nephrops* trawls used in the West of Scotland *Nephrops* fishery  
To assess the effect of the improved selection on stocks, landings and discards using estimated selection parameters from commercial trials

**How are the results communicated?**

Fishing industry liaison group meetings, EU Periodic and Final reports, Peer-reviewed publications, Fishing industry press

**Can the results be used to support resource management, and if so how?**

Results aim to improve stocks of whitefish by reducing discarding in prawn fishery
**INSTITUTION:** Scottish Executive  
**DEPARTMENT/ UNIT:** FRS Marine Laboratory  
**Address:** 375 Victoria Road, ABERDEEN, AB11 9DB  

Contact person: Dr RST Ferro  
e-mail and/or webpage: ferro@marlab.ac.uk

<table>
<thead>
<tr>
<th>Research Activity: Fishing gear and fish behaviour studies</th>
</tr>
</thead>
</table>
| **Duration:** 3 years **Cost:** £494000  
**Funding:** SEERAD, EU  
**Principal Investigator:** Dr RST Ferro  
e-mail or contact (if different from above): |

<table>
<thead>
<tr>
<th>Objective/ Goal (100 words max.):</th>
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</table>
| To investigate physical and behavioural principles governing separation of species within mobile fishing gears  
To develop methods of separating species in 2 major UK fisheries  
To assess the biological effects of improved exploitation patterns on fish stocks |

<table>
<thead>
<tr>
<th>How are the results communicated?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual reports to SEERAD, EU reports, industry meetings, articles in fishing press, peer-reviewed scientific papers</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Can the results be used to support resource management, and if so how?</th>
</tr>
</thead>
<tbody>
<tr>
<td>New species selective gears should reduce mortality in by-catch species in the fisheries studied. Selection parameters for the selective devices developed will allow prediction of the effect of their introduction on stocks, landings and discards</td>
</tr>
</tbody>
</table>
**Objective/ Goal (100 words max.):**

The EU project PREMECS-I developed a predictive model of cod-end selection. This model is deterministic in character and based on an understanding of the fundamental mechanical, hydrodynamic and biological processes that govern cod-end selection. The overall objective of this project is to further developed this predictive selectivity model, so that it can predict the selectivity of commercially used cod-ends fished in commercial conditions. The influence of (i) netting materials made from thicker and stiffer twines, (ii) the dynamic effects of the interaction of sea state-fishing vessel-trawl gear and codend and (iii) fish morphology and fish escape behaviour will be investigated and included in the model.

**How are the results communicated?**

Scientific publications and presentations. Through the project web-site.

**Can the results be used to support resource management, and if so how?**

The outcome from this project will be an innovative model which will assist fisheries managers to assess the impact of proposed technical measures that are introduced to reduce the catch of undersized fish.
Objective/ Goal (100 words max.):
The COMMIT project aims to provide a sound scientific basis for producing long term plans and management strategies, whilst also identifying any short term biological and socioeconomic consequences. The project combines real data with computer models to simulate scenarios for testing management strategies using mixed North Sea fisheries stocks as case studies, although the methods developed will be generic and applicable to other stocks. The project will also identify the level of commitment needed to ensure that these strategies support a sustainable fishing industry that is economically viable and provides a fair standard of living.

How are the results communicated?
Through project reports, scientific papers, and plenary meetings and workshops with fisheries managers.

Web site is ftp://ftp.dfu.min.dk/efimas/COMMIT/index.htm

Can the results be used to support resource management, and if so how?
The project has the potential to change the way fisheries are managed in Europe. The tools and methods that are in development will allow robust management strategies to be formulated that provide greater security to fishers, enabling them to make the most appropriate investment or disinvestments decisions, and ensure sustainability of the resource at a higher level. This, in turn, will allow greater stability in communities dependent upon fisheries.
INSTITUTION: **Scottish Executive FRS Marine Laboratory**  
DEPARTMENT/ UNIT: Pelagic Resources Group  
Address: PO Box 101, Victoria Road, Aberdeen AB11 9DB

Contact person: Dr Emma Hatfield  
e-mail and/or webpage: www.hull.ac.uk/hergen

<table>
<thead>
<tr>
<th>Research Activity:</th>
<th>Conservation of diversity in an exploited species: spatio-temporal variation in the genetics of herring (Clupea harengus) in the North Sea and adjacent areas.</th>
</tr>
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<tbody>
<tr>
<td><strong>Duration:</strong></td>
<td>3 years</td>
</tr>
<tr>
<td><strong>Cost:</strong></td>
<td>€2,170,467</td>
</tr>
<tr>
<td><strong>Funding:</strong></td>
<td>EU</td>
</tr>
</tbody>
</table>

Principal Investigator: Dr Daniel Ruzzante  
e-mail or contact (if different from above): Daniel.ruzzante@dal.ca

| Objective/ Goal (100 words max.): | The project's overall goal is to provide guidelines for the conservation and management of biodiversity of Atlantic herring in the North Sea and adjoining waters by identifying its genetic population structure, and by quantifying relative stock contributions to the fishery. Within the project there are 6 major objectives: Estimation of genetic differentiation among spawning aggregations; Determination of temporal stability of population differentiation; Determination of composition of mixed feeding aggregations; Determination of temporal (seasonal and annual) variability in contributions to mixed aggregations; Proposal for incorporation of findings in management of herring stocks; Dissemination of results and guidelines. |

How are the results communicated?  
Annual reports to the EC. Peer reviewed and ICES papers. A targeted theme session will be held at ICES ASC 2005.

Can the results be used to support resource management, and if so how?  
Yes. The most appropriate management units and data collection requirements to monitor selected populations will be recommended, taking into account genetic diversity and practical management issues. The potential of mixed stock analysis in the management and conservation of herring will be examined. A number of the members of this consortium are members of the ICES Herring Assessment Working Group and in 2005 a working document on recommendations from the project was presented to the HAWG.
**Research Activity:** Multi-disciplinary approaches to the stock identification of herring west of the British Isles

**Duration:** 3 years  
**Cost:** €1,799,335  
**Funding:** EU  

**Principal Investigator:** Dr Emma Hatfield  
**e-mail or contact (if different from above):**

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**Objective/ Goal (100 words max.):**

WESTHER's overall goal is to describe the population structure of herring stocks in western European waters, distributed from the south-west of Ireland and the Celtic Sea to the north-west of Scotland. This will be achieved by integrating the results from several techniques, both innovative and established, including genetic markers and biological tags. The proposed research will therefore set up and improve multidisciplinary tools for herring stock identification, providing a more holistic approach. WESTHER will optimise the determination of stock structure of Atlantic herring in the western area creating a unified database of individual herring characteristics using all techniques.

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**How are the results communicated?**

Annual reports to the EC. Peer reviewed and ICES papers. A targeted theme session will be held at ICES ASC 2005.

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**Can the results be used to support resource management, and if so how?**

Yes. The results of the project will be used to provide guidelines for the conservation and management of biodiversity through input to the ICES assessment working group structure and ultimately to management of these stocks. A number of the members of this consortium are members of the ICES Herring Assessment Working Group and this will ensure that the project results are applied quickly to the assessment and available to the fishery managers.
**Research Activity:** EFIMAS (EU FP6 project)

**Duration:** 4 years  
**Cost:** 7.5 million euros  
**Funding:** EU

**Principal Investigator:** Rasmus Nielsen (DIFRES, Denmark)  
e-mail or contact (if different from above): rn@dfu.min.dk

**Objective/ Goal (100 words max.):**

The main aim is to build an inclusive operating-model simulation of the entire fisheries management process, simulating biological processes, data sampling and collation, stock assessment, management advice, management implementation, and the fisheries. This will result in an analysis tool, available to all interested stakeholders, which will facilitate the evaluation of different types of management strategies and approaches. Case studies include North Sea roundfish, Baltic Sea stocks, and Mediterranean swordfish (amongst others).

**How are the results communicated?**

Project reports and peer-reviewed publications in (mostly) fisheries journals, as well as more direct dissemination to fisheries stakeholders (scientists, industry, governments, NGOs) through public workshops and seminars.

**Can the results be used to support resource management, and if so how?**

Yes – the aim of the project (as stated above) is to improve the application of fisheries management, by allowing managers (and others) the freedom to explore the likely consequences of different management actions without necessarily endangering the resource.
Research Activity: Whole Gear Selectivity

Duration: 3 years  
Cost: c. €1,000,000

Funding: SEERAD

Principal Investigator: Dr D. Reid

e-mail or contact (if different from above):

Objective/ Goal (100 words max.):

Quantify the behaviour and catchability of fish in the standard North Sea bottom trawl survey gear. The broad aim was to use a combination of methods (sonars, TV systems and net modifications) to determine selectivity of the whole survey net, from doors to cod end. The approach was to use the different techniques at appropriate points, (e.g. TV in the net and sonar in front of the net) to observe and quantify the behaviour of the fish – how they entered the net, how many fish escaped and where, what species or size etc. Twin trawls were used to examine gear changes such as ground gear choice. The ultimate aim of this work was to allow the use of bottom trawl surveys to provide absolute abundance estimates.

How are the results communicated?

Annual reports to the SEERAD. Peer reviewed and ICES papers. Presentation at International Conferences and ICES FTFB WG

Can the results be used to support resource management, and if so how?

The aim of the project was broadly to improve the quality of the abundance indices generated by bottom trawl surveys, and ultimately to provide absolute values for these. But the results can also show where indices are compromised by differential catchabilities. As such they could provide better and more accurate and comparable indices for assessment. The work is expensive and time intensive however, and general conclusions require the assumption that catchabilities determined under a small range of conditions can be applied universally.
**Research Activity:** CATEFA – Combining Acoustic and Trawl Data to Enhance Fish Assessment  
**Duration:** 3 years  
**Cost:** c. €250,000  
**Funding:** EU  
**Principal Investigator:** Dr D. Reid  
**e-mail or contact (if different from above):**

**Objective/ Goal (100 words max.):**
Explore the links between acoustic survey data and bottom trawl data collected during a series of bottom trawl surveys in the North Sea. The aim was to determine if there were correlations between the acoustic observations of fish and the catches in the bottom trawl. Links were then planned to be used to improve the accuracy and precision of the survey estimates. Data exploration was done using linear and additive modelling, geostatistics, fuzzy logic and neural nets. New survey designs to optimise the approach were part of the objective.

**How are the results communicated?**
Annual reports to the EC. Peer reviewed and ICES papers. A targeted theme session was held at ICES 2005.

**Can the results be used to support resource management, and if so how?**
In theory results could have been used to generate new abundance indices for key demersal species. Actual results showed very weak relationships between trawl and acoustic data. Although acoustic data did show a consistent pattern on and between trawl stations. It was concluded that the noise in both methods precluded the development of useable indices.
The European Commission’s reforms of the CFP include a refocus of management away from annual quotas to a multi-annual approach to securing sustainable fisheries using harvest control rules. This project is a first step towards the development of specific tools for use in the Scottish context and seeks to provide immediate benefits to Scotland. The main objective is to develop a simulation framework to evaluate and compare alternative fishery management strategies with application to Scottish fish stock case studies. The project is closely linked to two EU funded projects: EFIMAS and COMMIT.

The results will be communicated through internal reports, peer-reviewed papers, conference presentations, articles in fisher’s publications and industry liaison meetings.

The aim of the project is to support resource management through the development of predetermined rules to apply to fish stocks. These rules should ensure that more rapid remedial action is applied in the event of stock difficulties. Prior agreement on the rules between stakeholders and management should reduce disagreement when remedial action is required.
INSTITUTION: University of Aberdeen  
DEPARTMENT/ UNIT: School of Biological Sciences  
Address: Lighthouse Field Station  
Contact person: Paul Thompson  
e-mail and/or webpage: lighthouse@abdn.ac.uk  
www.abdn.ac.uk/zoology/lighthouse  

Research Activity: Environmental impacts of offshore wind farms  
Duration: 2005-2008  
Cost: £167K  
Funding: EU, Industry – Talisman Energy (UK) Ltd  
Principal Investigators: Paul Thompson  

Objective/ Goal (100 words max.):  
DOWNVinD is an EU Sixth Framework project that aims to develop the technology required to construct wind farms in deep water. As part of this larger project, we aim to use the development of these demonstration facility to study some of the potential impacts of construction and operation of offshore turbines. In particular, we aim to:  

1. Test the performance of acoustic propagation models for estimating levels of noise resulting from construction activity.  
2. Determine whether cetacean behaviour or distribution is affected by construction noise.  
3. Develop techniques for estimating the probability of collisions between seabirds and the wind turbines, and the extent to which seabirds change their flight and foraging behaviour to avoid active turbines.  

How are the results communicated?  
Through formal EU reporting procedures. Early results will be integrated into EA procedures and become available to regulatory and stakeholder groups; peer-reviewed journal articles.  

Can the results be used to support resource management, and if so how?  
The project has been developed specifically to support industries and agencies involved in planning the development of offshore renewable energy projects.
Research Activity: Time series analysis of cod bioenergetics with application to fish stock management

Duration: 2004-2007  Cost: ca. £52,500
Funding: BBSRC PhD Studentship

Principal Investigator: L. Sandeman, Supervisor: Dr. C. Tara Marshall
e-mail or contact (if different from above): nhy303@abdn.ac.uk

Objective/ Goal (100 words max.):
Temporal variation in lipid reserves of fish impacts stock biomass, yield, mortality, maturation, fecundity, and possibly recruitment. In cod, lipids are stored in the liver. This study aims to: 1) conduct a time series analysis of the temporal variation in the liver weights of cod in the Barents Sea using a highly resolved Russian database; 2) identify biotic and abiotic influences on cod liver weights using environmental data having a similar degree of temporal resolution, e.g., temperature and feeding success; 3) develop practical guidelines for the optimal design of sampling programs that will routinely monitor the lipid reserves of cod.

How are the results communicated?
In addition to publishing scientific articles, the student will participate in relevant Working or Study Groups that meet regularly to discuss practical issues related to fisheries management. This will be an effective means for disseminating the results of the project and will enhance the student’s training in applied fisheries management.

Can the results be used to support resource management, and if so how?
Yes. Liver reserves of cod impact the proportion that will mature. Additional research will be undertaken to determine if a predictive model that could be used to project maturity in the upcoming year can be developed.
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<tr>
<th><strong>INSTITUTION:</strong></th>
<th>University of Aberdeen</th>
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<tr>
<td><strong>DEPARTMENT/ UNIT:</strong></td>
<td>School of Biological Sciences</td>
</tr>
<tr>
<td><strong>Address:</strong></td>
<td>Tillydrone Avenue, Aberdeen, UK, AB324 1TZ</td>
</tr>
<tr>
<td><strong>Contact person:</strong></td>
<td>Dr. C. Tara Marshall</td>
</tr>
<tr>
<td><strong>e-mail:</strong></td>
<td><a href="mailto:c.t.marshall@abdn.ac.uk">c.t.marshall@abdn.ac.uk</a></td>
</tr>
<tr>
<td><strong>webpage:</strong></td>
<td><a href="http://www.abdn.ac.uk/biologicalsci/staff/tara_marshall.shtml">http://www.abdn.ac.uk/biologicalsci/staff/tara_marshall.shtml</a></td>
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**Research Activity:** Testing for developmental thresholds in herring maturation

<table>
<thead>
<tr>
<th><strong>Duration:</strong></th>
<th>2005-2007</th>
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<tbody>
<tr>
<td><strong>Cost:</strong></td>
<td>£15,000 (current)</td>
</tr>
<tr>
<td><strong>Funding:</strong></td>
<td>University of Aberdeen</td>
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</table>

**Principal Investigator:** Dr. C. Tara Marshall

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<tr>
<th><strong>Objective/ Goal (100 words max.):</strong></th>
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<tr>
<td>To determine whether maturation in herring depends on the magnitude of stored energy (a developmental threshold) the null hypothesis that will be tested is: is the somatic lipid content in individual herring is uncorrelated with their probability of being mature after controlling for the effects of body size. In 2005 herring will be sampled onboard the annual acoustic survey of the North Sea conducted by the FRS Marine Laboratory. This study will use novel technology to instantaneously measure the somatic lipid content of herring thus, allowing lipid content of North Sea herring to be mapped. Logistic models will be fit to these data to assess whether somatic lipid content contribute to variation in maturity.</td>
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<tr>
<th><strong>How are the results communicated?</strong></th>
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<tbody>
<tr>
<td>The project results will be published and presented at conferences. In addition, collaboration with scientists at the FRS Marine Laboratory is an essential part of the project. A good working relationship is developing between my lab and a local pelagic fishing company who provides herring for related research.</td>
</tr>
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<tr>
<th><strong>Can the results be used to support resource management, and if so how?</strong></th>
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</thead>
<tbody>
<tr>
<td>Yes. The variability in the proportion of age 2 and age 3 herring becoming mature creates difficulties when predicting biomass for the upcoming fishing year. Developing a predictive model of maturation would have immediate applications to annual stock assessment undertaken by International Council for the Exploration of the Sea.</td>
</tr>
</tbody>
</table>
**INSTITUTION:** University of Aberdeen  
**DEPARTMENT/ UNIT:** School of Biological Sciences  
**Address:** Tillydrone Avenue, Aberdeen, UK, AB324 1TZ  
**Contact person:** Dr. C. Tara Marshall  
**e-mail:** c.t.marshall@abdn.ac.uk  
**webpage:** [http://www.abdn.ac.uk/biologicalsci/staff/tara_marshall.shtml](http://www.abdn.ac.uk/biologicalsci/staff/tara_marshall.shtml)

**Research Activity:** UNCOVER: UNderstanding the mechanisms of stock recovery  
(submitted Feb 1 2005 for STREP-SSP4 call)  
**Duration:** 2006-2009  
**Cost:** ~ £120,000 (requested for WP4.1)  
**Funding:** EU  
**Principal Investigator:** Dr. C. Tara Marshall (co-leader WP4.1)  
**e-mail or contact (if different from above):**

**Objective/ Goal (100 words max.):**

WP4.1 *Synthesis of process information and models for implementation in management evaluation tool.* The objective of UNCOVER is to apply all available and relevant data in order to identify changes experienced during the stock decline and the consequences for the prospects of stock recovery. The goal of sub-task WP4.1 is to collate the data, information and models necessary to simulate the rates of stock recovery for a variety of strategic questions. Information will then be formatted so that it can be fed forward into the management evaluation tool (a suite of software developed at CEFAS using the statistical program R).

**How are the results communicated?**

As is customary for EU projects, the results of the sub-task are a series of deliverables that will be communicated directly to other sub-tasks and, in this way, contribute to the ultimate deliverable of the project: a 2-3 page document summarizing recommendations related to the design and implementation of recovery programs.

**Can the results be used to support resource management, and if so how?**

Yes. The project is expected to provide a general discussion of the mechanisms of stock recovery and identify the features of effective recovery plans. For selected case study stocks the results of the project must indicate the following: evaluation of the potential for recovery, identification of unforeseen problems relating to existing recovery plans.
INSTITUTION: **University of Aberdeen**  
DEPARTMENT/ UNIT: Zoology / School of Biological Sciences  
Address: Tillydrone Avenue, Aberdeen, UK, AB324 1TZ  

Contact person: Dr. Graham Pierce  
e-mail and/or webpage: g.j.pierce@abdn.ac.uk

**Research Activity:** marine biology and fisheries  
**Duration:**  
**Cost:**  
**Funding:** NERC, Others  

**Principal Investigator:**  
e-mail or contact (if different from above):  

**Objective/ Goal (100 words max.):**  
General aims: studies on interactions between marine mammals and fisheries and factors affecting distribution and abundance of resource species  
Currently involved in range of projects the most relevant being:  
- Cephalopod Stocks in European Waters: Review, Analysis, Assessment and Sustainable Management (CEPHSTOCK). CEC Framework 5 Concerted Action [Coordinator]  
- Bio-diversity processes in heterogeneous environments. NERC  
- Changing distribution patterns and behaviour of bottlenose dolphins off the North East coast of Scotland. [TotalFinaElf Exploration UK, Talisman Energy (UK), Kerr-McGee North Sea (UK)]  
- Promoting higher added value to a finfish species rejected to sea (ROCKCOD). [CEC DG Fisheries CRAFT project.]  
- Collaborative research into the occurrence, distribution and habitat preferences of cetaceans on the west coast of Scotland. Dstl Commercial Services. Ministry of Defence An Overview of Cephalopods Relevant to the SEA5 area and a study of spawning areas and contaminant burdens in squid. [GEOTEK]

**How are the results communicated?**  
EU reports, peer-reviewed papers, conferences

**Can the results be used to support resource management, and if so how?**  
Yes. EU projects geared towards directly applicable research
INSTITUTION: University of Aberdeen
DEPARTMENT/UNIT: Oceanlab, School of Biological Sciences
Address: Main Street, Newburgh, Aberdeenshire. AB41 6AA

Contact person: Dr. Martin Solan
e-mail and/or webpage: http://www.oceanlab.abdn.ac.uk/

Research Activity: Coastal Ocean Benthic Observatories
Duration: 36 months          Cost: 192,000 Euro
Funding: EU

Principal Investigator: Dr. Martin Solan
e-mail or contact (if different from above): m.solan@abdn.ac.uk

Objective/Goal (100 words max.):
To integrate emerging and innovative technologies from different disciplines (physics, chemistry, biology) to provide in situ monitoring of sediment ecosystems, a key subsystem of the coastal marine environment, in order to understand the complex interactions between the biota (their functioning and diversity) and their chemical environment. The combination of innovative interdisciplinary instruments will provide powerful tools to significantly advance our understanding of organism-sediment relations under dynamic coastal conditions and enhance predictive capability. The current project represents a logical steppingstone towards the development of permanently operating benthic observatories for coastal management in order to give economic, scientific and societal gains.

How are the results communicated?
The project website, along with links to similar clustered projects, will showcase activity and progress to the public. Open days at partner institutes will promote technical developments and key issues to the wider public along with new developments aired at international committees on ocean science. Use of media where appropriate.

Engineering and ecological scientific papers.

Can the results be used to support resource management, and if so how?
Yes. The ability to carry out realistic, in situ experiments with dedicated multi-disciplinary technology will provide critical input into the development of predictive models to forecast the responses of marine coastal ecosystems to a changing environment.
INSTITUTION: University of Aberdeen
DEPARTMENT/ UNIT: School of Biological Sciences
Address: Lighthouse Field Station
Contact person: Paul Thompson
e-mail and/or webpage: lighthouse@abdn.ac.uk
www.abdn.ac.uk/zoology/lighthouse

Research Activity: Response of marine top predators to natural and anthropogenic changes in the marine environment.

Duration: Ongoing
Cost: currently c 50-100K p.a.
Funding: Various sources over the years, including all but DARDNI, as well as environmental charities, industry and Leverhulme Trust.

Principal Investigator: Paul Thompson

Objective/ Goal (100 words max.):
To understand the relative role of bottom-up (eg. climate variation and changes in food availability) and top-down (eg. predation and by-catch) influences on the dynamics of marine top predator populations. Furthermore, we aim to understand the relative influence of natural and anthropogenic environmental change on these populations.

Our research is based upon a suite of long-term ecological studies of populations of seabirds (1950-present), harbour seals (1987-present) and bottlenose dolphins (1989-present). Building upon this core programme of population monitoring, we aim to explore causal links between environmental variation and population change through interdisciplinary studies at molecular and whole animal levels.

How are the results communicated?
Through peer-reviewed journal articles; close collaboration with environmental and government organisations; extensive links with the media; active engagement with stakeholder groups

Can the results be used to support resource management, and if so how?
Much of the work has been supported by organisations interested in the conservation or management of these populations; informing management of seal-fisheries interactions, mitigation of human activities with EU Special Areas of Conservation.
| INSTITUTION: | University of Aberdeen |
| DEPARTMENT/ UNIT: | School of Biological Sciences |
| Address: | Lighthouse Field Station |
| Contact person: | Paul Thompson |
| e-mail and/or webpage: | lighthouse@abdn.ac.uk |
| e-mail and/or webpage: | www.abdn.ac.uk/zoology/lighthouse |

**Research Activity:** A Bayesian framework for integrating science and marine resource management

**Duration:** 2003-2006  
**Cost:** £84K  
**Funding:** Leverhulme Trust  
**Principal Investigators:** Paul Thompson (+ Steve Brooks, Cambridge; Phil Hammond, St Andrews; John Armstrong, FRS)

**Objective/ Goal (100 words max.):**
To develop a Bayesian framework to integrate multiple sources of uncertain and evolving data into models that can inform current marine conservation and management issues. The project uses two case studies to develop a series of related modelling frameworks.

1. Interactions between seals and Scottish salmon fisheries; where the focus is upon accounting for uncertainty in complex ecological models.
2. Conservation of UK dolphins and the EU Habitats Directive; which aims to illustrate how one can incorporating evolving datasets into conservation monitoring and reporting.

**How are the results communicated?**
Through peer-reviewed journal articles; close collaboration with environmental and government organisations; active engagement with stakeholder groups

**Can the results be used to support resource management, and if so how?**
The case studies have been selected to ensure that they can directly support the work of SNH and SERAD, and inform other management related for a such as the NERC SCOS.
INSTITUTION: **University of Aberdeen**  
DEPARTMENT/ UNIT: School of Biological Sciences  
Address: Tillydrone Avenue, Aberdeen, UK, AB32 1TZ  
Contact person: Dr. Beth Scott  
e-mail and/or webpage: b.e.scott@abdn.ac.uk

**Research Activity:**

Duration: 2000-2004  
Cost: (£188,000 of WP, ~ £2 Million total)  
Funding: EU  
Principal Investigator: B. Scott of WP - Kees Camphuysen for EU Project  
e-mail or contact (if different from above): (EU project - camhuys@nioz.nl)

**Objective/ Goal (100 words max.):**
Interactions between the Marine environment, PRedators and prey: implications for the Sustainable Sandeel fisheries: IMPRESS

The objective of the Work Package (5) was to determine how oceanographic features (mixed-layer depth, onset and breakdown of stratification, seasonal progress of primary production) should be used to define seabird foraging habitats, and whether variability in any of these features could be causative in controlling variability in prey availability. The work provided a first-order picture of the 3-dimensional structure of the study area such that predictions of structure and primary production at specified positions and on specified time scales can be made both historically and forward in time under defined climatic conditions.

**How are the results communicated?**
For Work Package (5) only  
Primary literature: 4 published or in press, 1 in review and 4 in preparation  
Conferences: oral presentations at 6 international conferences and 2 workshops  
EU reports: 4 annual progress reports and 1 final report.

**Can the results be used to support resource management, and if so how?**
YES. With the use of long-term population and a detailed 1-D physical-biological model we have shown how integrated and biologically meaningful region- and year-specific oceanographic variables can provide new insights into the mechanisms which link multiple meteorological conditions with seabird breeding success. In particular, we have used the timing of stratification and the spring bloom as possible indicators of sandeel availability. Our approach allows us to separately quantify fishing and climate effects and indicates that the presence of a local sandeel fishery decreases breeding success of Isle of May kittiwakes by 0.66 chicks/pair whereas every 5 day delay in the date of the spring bloom increases breeding success by 0.13 chicks/pair. In a system where experimental manipulation is impossible, this type of approach is extremely promising in the search for causal relationships among ecosystem components.
Research Activity: Quantifying fishermen’s spatial and temporal knowledge

Duration: 2004
Funding: EU
Principal Investigator: B. Scott

Objective/ Goal (100 words max.):
The interactive use of a spatial and temporally explicit model of North Sea cod and haddock by fishermen and social scientist such that behavioural knowledge of fishes and fisherman can be quantified. A ‘user friendly’ version of a model which explicitly represents seasonal and spatial locations of length classes of cod and haddock is now available (due to ongoing work that originated from an EU project that finished in 2003). The population and local effect of choices in the location, timing and degree of effort of fishing can be viewed graphically and spatially on maps. Modelling studies on the effectiveness of closing areas at critical times could be one of uses of such a model. It is also envisioned that such a model could be enhanced to be even more interactive and could be used to enable interaction with fisherman, biologist and social scientist to quantify fisherman’s knowledge.

How are the results communicated?
Primary literature, national and inter-national conferences, local and national press.

Can the results be used to support resource management, and if so how?
YES. The use of such a model has shown that annual mean egg size (via the size and location of female spawners and the number of females not killed during the spawning season – using spatial fishing effort information) is a far better predictor of recruitment than SSB. The use of a spatially and temporally explicit model could be very helpful in predicting when and where it is best to encourage or control fishing effort and to help quantify fishermen’s knowledge.
Research Activity: Stock identification of herring using parasites as tags.
Duration: 3 years (2003-05)  Cost: £193,330
Funding: EU (Contract QLRT-2001-01056).

Principal Investigator: Dr Ken MacKenzie
E-mail or contact (if different from above): K.MacKenzie@abdn.ac.uk

Objective/ Goal (100 words max.):
Determining the identity and integrity of stocks should be the fundamental first step in any management plan. Along with partners at the University of Liverpool, we are currently working improving understanding of stock structure, recruitment and movements in herring (*Clupea harengus*) in the seas to the west of the British Isles, a project known as WestHer. To this end, we are collaborating in a multidisciplinary project, using classical parasitological study to identify species that are good indicators of population movement and developing new techniques to study the population genetics of fish parasites with a view to applying this tool to future studies.

How are the results communicated?
Results are communicated through various media, in order to reach the broadest possible audience. Results have been communicated to the European Commission via annual reports, to the wider scientific community via peer-reviewed publication, presentations to ICES and to parasitological fora, and to the stakeholder community via our website, the combined project website (www.clupea.net/westher), and articles in the lay-press.

Can the results be used to support resource management, and if so how?
The results we produce are strongly oriented towards incorporation in management actions. The results for the previous project we were involved in, HOMSIR (QLRT-PL1999-01438, www.homsir.com), looking at stock identity in the Atlantic horse mackerel, *Trachurus trachurus*, were presented to the ICES working group on Mackerel, Horse Mackerel and Sardine. Our results supported current management of the fishery as two stocks in European Atlantic waters, but that the position of the demarcation between “western” and “southern” stocks was wrong. This advice was taken onboard by the working group and changes were made in the methods of stock assessment.
INSTITUTION: University of Hull  
DEPARTMENT/ UNIT: Scarborough Centre for Coastal Studies  
Address: Filey Rd, Scarborough, YO11 3AZ

Contact person: Dr Magnus Johnson  
e-mail and/or webpage: m.johnson@hull.ac.uk; http://coastal-studies.org

<table>
<thead>
<tr>
<th>Research Activity: Socioeconomic and ecological interactions of static gear fishers and their prey.</th>
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<tr>
<td>Duration: 3Yrs</td>
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<tr>
<td>Funding: University funded PhD</td>
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</table>

Principal Investigator: Dale Rodmell  
e-mail or contact (if different from above): d.rodmell@hull.ac.uk

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<tr>
<th>Objective/ Goal (100 words max.):</th>
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<tr>
<td>To develop an understanding of interactions of inshore fishing communities, conflicts with other marine resource users and the relationship between fishers and their prey. The structure of fishing communities is being investigated using network analysis and case studies of current conflicts are contributing to an understanding of management issues for inshore fisheries. The understanding of fishing grounds is being investigated by asking fishers to highlight areas of particular interest on fishing charts.</td>
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<th>How are the results communicated?</th>
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<tr>
<td>Close liaison with fishing communities that are collaborating with presentations at meetings, publication of proceedings from the “Who Owns the Sea Conference”, regular publication of “The Forum” (newsletter for fishermen off the NE coast) and publications in peer reviewed journals (eventually)</td>
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<tr>
<th>Can the results be used to support resource management, and if so how?</th>
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<tbody>
<tr>
<td>We hope that an understanding of how information is transmitted through fishing communities will be useful in helping institutions communicate effectively with fishers and that some of the results will demonstrate effective ways for collaborating with inshore fishers to manage coastal resources</td>
</tr>
</tbody>
</table>
**INSTITUTION:** University of Hull  
**DEPARTMENT/ UNIT:** Scarborough Centre for Coastal Studies  
**Address:** Filey Rd, Scarborough, YO11 3AZ  
**Contact person:** Dr Magnus Johnson  
**e-mail and/or webpage:** m.johnson@hull.ac.uk; http://coastal-studies.org

| Research Activity: | Investigation into ecological interactions between economically important crustacean on the Yorkshire Coast  
| Duration: | 1 yr  
| Cost: | £2000  
| Funding: | BES/University of Hull  

**Principal Investigator:** Magnus Johnson  
**e-mail or contact (if different from above):**

| Objective/ Goal (100 words max.): | To conduct some preliminary investigations into the ecological relationships between economically important reptant crustacean on the Yorkshire coast. Particular attention being paid to the impact of the invasive velvet swimming crabs on traditionally important species such as the lobster and edible crab.  

| How are the results communicated? | There will be a conference presentation at the BES in 2006, dissemination of results to fishermen at association meetings, hopefully publication of results in a peer reviewed journal  

| Can the results be used to support resource management, and if so how? | An understanding of the impact of velvet fiddler crabs may assist in planning the future of the inshore static gear fishery in this area.  

Research Activity: MF0215 ‘Use of age pigments for age determination of lobster (Homarus gammarus)
Duration: 5 years, 5 months + Cost: £210,806
Funding: DEFRA
Principal Investigator: M.R.J. Sheehy and P.M.J. Shelton
e-mail or contact (if different from above):

Objective/ Goal (100 words max.):
The objectives are to (i) determine the usefulness of lipofuscin age pigment for age determination of European lobster, Homarus gammarus, (ii) progress the development of rapid lipofuscin quantification procedures and (iii) assess the implications of the lobster ages obtained for stock assessment.

How are the results communicated?
To date:
International journal papers, mostly available online at the above website (7)
International and national conference/workshop presentations (6)
International and national invited seminars (4)
Departmental seminar (1)
Undergraduate lecture (1)
Postgraduate research training (3)
National and international popular media including newspaper, magazine, newsletter, TV and radio (15+)
Formal and informal oral and written reports to Policy Customer, DEFRA project officers and Fishing Industry representatives (numerous). Main project report available online at the above website.

Can the results be used to support resource management, and if so how?
The results are of direct relevance to DEFRA for improving stock assessment and management. Accurate ageing of lobsters has not only highlighted deficiencies in traditional models dependent on size and steady state but also permitted refinement of population assessment parameters. It has yielded unique insights on growth, longevity, refugia, selective fishing impacts, yield forecasting, the effects of global climate change, arguments about spawner protection or restocking, and the spawner–recruit relationship. In external review, the project obtained the highest possible score: ‘Outstanding Results Achieved’.
Research Activity: MF0225 ‘Age structure and population parameters of the edible crab, *Cancer pagurus*: data for resource management’
Duration: 4 years, 4 months + Cost: £364,314 
Funding: DEFRA 
Principal Investigator: M.R.J. Sheehy 
e-mail or contact (if different from above):

Objective/ Goal (100 words max.):
The objective is to obtain demographic information for edible crab in the main regional fisheries that can be used for new stock assessments, thus strengthening the basis for management. The acquisition of such information has been identified as a scientific priority. Because crabs cannot be aged by conventional procedures this project will employ a novel lipofuscin age pigment-based approach, as successfully applied to lobsters in MF 0215. The proposal is highly relevant to Policy because crab stocks support the most valuable crustacean fishery in England and Wales and DEFRA is responsible for crab management under both EU and national legislation.

How are the results communicated?
To date: 
International journal papers, mostly available online at the above website (2) 
International and national conference/workshop presentations (2) 
International and national invited seminars/lectures (2) 
Postgraduate lecture (1) 
Postgraduate research training (1) 
National print media (2) 
Formal and informal oral and written reports to Policy Customer, DEFRA project officers and Fishing Industry representatives (numerous).

Can the results be used to support resource management, and if so how?
The unique spatially and physiologically-resolved demographic data produced by the project are of direct relevance to DEFRA for refining population parameters and thus improving regional stock assessment and management of crabs. The project was included in DEFRA’s four year programme review in 2003, and the results to date and techniques were noted by the reviewer (a former Director of FAO’s Marine Resources Division) to be ‘state of the art’, ‘revolutionizing crustacean stock assessment’ and ‘likely to become widely used’.
<table>
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<th><strong>INSTITUTION:</strong></th>
<th>University of Leicester</th>
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<tr>
<td><strong>DEPARTMENT/ UNIT:</strong></td>
<td>Biology</td>
</tr>
<tr>
<td><strong>Address:</strong></td>
<td>University Road, Leicester, LE1 7RH</td>
</tr>
<tr>
<td><strong>Contact person:</strong></td>
<td>Matt Sheehy</td>
</tr>
<tr>
<td><strong>e-mail and/or webpage:</strong></td>
<td><a href="mailto:mrjs2@le.ac.uk">mrjs2@le.ac.uk</a> <a href="http://www.le.ac.uk/biology/staff/blmrjs.htm">http://www.le.ac.uk/biology/staff/blmrjs.htm</a></td>
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**Research Activity:** Use of lipofuscin for aging Caribbean spiny lobster, *Panulirus argus*.

**Duration:** 3 years **Cost:** US $115,281  
**Funding:** United States Department of Commerce - National Oceanic and Atmospheric Administration (NOAA)

**Principal Investigator:** T. Matthews, C. Derby, M.R.J. Sheehy

**Objective/ Goal (100 words max.):**

The first objective is to make accurate age determinations of Caribbean spiny lobster. The second is to develop a complete growth curve and age-length key to understand the general growth parameters for use in fisheries modelling. Specifically, by understanding the age-growth relationship we can evaluate the cause of the size distribution and size at reproductive maturity differences between lobster in the Dry Tortugas National Park and in the fishery to characterize the actual reproductive contribution of female lobster by age in the Dry Tortugas Marine Protected Area and non-protected areas.

**How are the results communicated?**

- International journal papers
- International and national conference/workshop presentations
- Postgraduate research training

**Press release**

Formal and informal oral and written reports to sponsor, fishery managers and other participants.

**Can the results be used to support resource management, and if so how?**

This project will provide critical information on the age and growth of the spiny lobster. Age and growth are the most basic population parameters required for effective fishery management. By better understanding these parameters, fishery managers will be able to evaluate current fishing-effort limitation programs and better understand the actual reproductive contribution of female lobster by age in a Marine Protected Area.
Research Activity: 'Factors affecting the accumulation of arthropod neurolipofuscin and its use as an ecological tool for age determination'

Duration: 4 years  
Cost: c. US$100,000
Funding: CNPq (Brazilian National Council for Scientific and Technological Development)

Principal Investigator: DB Fonseca (PhD candidate), MRJ Sheehy & PMJ Shelton (supervisors)

Objective/ Goal (100 words max.):

Age pigments have proved to be a useful tool for studying the biological ageing process, for age determination, and for understanding the population dynamics of crustaceans, particularly with regard to the assessment of commercially important stocks. However, further expansion of, and refinements to, the application of the ageing method are desirable and much remains to be discovered in regard to the endogenous and external factors that may affect lipofuscin accumulation. The project will explore these areas.

How are the results communicated?

Thesis  
International journal papers  
Conference presentations  
Departmental seminars  
Reports to sponsor and supervisors  
International technology transfer by overseas student return to home country

Can the results be used to support resource management, and if so how?

The results indirectly support ecosystem-wide resource management by developing, validating and refining the lipofuscin ageing method as tool for understanding the population dynamics of important exploited and keystone species.
**Research Activity:** Conservation effects of a closed area off the south Devon coast

**Duration:** 3 years  
**Cost:** ~£30,000  
**Funding:** DEFRA, Isle of Man Government

**Principal Investigator:** R E Blyth, M J Kaiser  
**e-mail or contact (if different from above):** reb-s@esfjc.co.uk; Michel.Kaiser@bangor.ac.uk

**Objective/ Goal (100 words max.):**

The inshore fishery off south Devon catches crabs and a variety of fin fish. The inshore area was partitioned in the late 1970s to segregate mobile and static gear. This created an area of about 450Km² that was never trawled. This project examined the influence of these no trawling areas on the diversity of the benthic community, the sizes of the major fishes species caught in the area and the reproductive potential of the scallop populations within and without of the closed area. Sport anglers were surveyed to examine their attitudes towards a willingness to pay for the maintenance of closed areas which have a conservation effect.

**How are the results communicated?**

Papers in refereed journals.


**Can the results be used to support resource management, and if so how?**

Yes. The results show that closed areas have important conservation effects on the biodiversity of both exploited and unexploited species.
INSTITUTION: University of Leicester
DEPARTMENT/ UNIT: Biology
Address: University Road, Leicester LE1 7RH

Contact person: Paul J B Hart
e-mail and/or webpage: pbh@le.ac.uk; http://www.le.ac.uk/biology/staff/blpbh.htm

Research Activity: The effects of climate change on the western English Channel; a study using Ecopath with Ecosim

Duration: 4 years    Cost: ~£60,000
Funding: CAPES Brazil who are funding a PhD student who is doing the work

Principal Investigator: Julio Araujo
e-mail or contact (if different from above): jna3@mail.cfs.le.ac.uk

Objective/ Goal (100 words max.):
An ecosystem model of the western English Channel has been built for 1973 and for 1995. These years represent a relatively cold and a relatively warm period. The model is being used to examine possible mechanisms for species changes in the fish community as shown by an analysis of long term trawl data collected by the Marine Biological Association of the UK. Further studies will examine the likely changes in the ecosystem as a result of global warming and how these changes will influence the fishing industry in the south west of England.

How are the results communicated?
There will also be papers in refereed journals and a PhD thesis.

Can the results be used to support resource management, and if so how?
The results can be used to support resource management and will suggest consequences of climate change and different management strategies.
INSTITUTION: University of Leicester/ University of Hull  
DEPARTMENT/ UNIT: Biology/ Coastal Studies Unit, Scarborough  
Address: University Road, Leicester LE1 7RH  

Contact person: Paul J B Hart/ Magnus Johnson  
e-mail and/or webpage: pbh@le.ac.uk, http://www.le.ac.uk/biology/staff/blpbh.htm; m.johnson@hull.ac.uk; http://www.coastal-studies.org

Research Activity: Economics and behaviour of the south Yorkshire inshore fishery.  
Duration: 3-5 years  
Cost: ~£30,000  
Funding: University of Hull  

Principal Investigator: Dale Rodmell  
e-mail or contact (if different from above): D.Rodmell@hull.ac.uk

Objective/ Goal (100 words max.):  
The inshore crab and lobster fishery off the Yorkshire coast between Scarborough and the Wash is carried out in the face of many other uses of the sea area. Gas caverns, pipe lines and the prospect of wind farms are all developments that are making it harder for the inshore fishers to make a living. This study will document the way in which the fishers are reacting to the disruption of their activities and will hope to make recommendations as to how the various uses of the inshore area can be reconciled.

How are the results communicated?  
They will be published in refereed scientific journals

Can the results be used to support resource management, and if so how?  
The results will be used to assist in developing management strategies for the area and will help the small scale inshore fishers defend their livelihood against intrusion from more powerful economic units, such as power companies.
INSTITUTION: University of Liverpool  
DEPARTMENT/ UNIT: Port Erin Marine Laboratory  
Address: Breakwater Rd, Port Erin, Isle of Man IM9 6JA

Contact person: Dr Bryce Beukers-Stewart  
e-mail and/or webpage: brycebs@liv.ac.uk / www.liv.ac.uk/peml/staff/bbs.htm;  
www.liv.ac.uk/peml/projects/scallop.htm

Research Activity: Scallop Fisheries Biology and Impacts

Duration: 1981 - 2006  
Cost: Currently £120k pa

Funding: Isle of Man Government

Principal Investigator: Dr Andy Brand and Dr Bryce Beukers-Stewart  
e-mail or contact (if different from above): arbrand@liv.ac.uk

Objective/ Goal (100 words max.):
1. Continue long-term assessment of scallop stocks and the impact of fishing around the Isle of Man
2. Maintain and analyse long-term datasets on commercial fishing effort and catch rates around the Isle of Man
3. Develop predictive models aimed at generating short to medium term forecasts of stock abundance
4. Examine long-term trends in by-catch composition, determine mechanisms of dredge-induced damage and assess the consequences for benthic communities
5. Examine the utility of closed area management for balancing the needs of fisheries and conservation

How are the results communicated?
Peer-reviewed publications  
Conference and workshop presentations (national and international)  
Annual Research Report to the Isle of Man Government  
Bi-annual Research Newsletters to the Manx Fishing Industry  
Presentations and meetings with stakeholders and the general public  
Local and national newspaper articles and radio interviews

Can the results be used to support resource management, and if so how?
Yes. Monitoring stocks and commercial catch and effort allows assessment of current regulations aimed at sustaining the fishery. The ability to make short to medium-term forecasts provides potential for adaptive management. By-catch research provides an assessment of the wider ecosystem affects of the fishery and information for the design of more “environmentally friendly” fishing gear. Work on closed area management suggests scallop fisheries are particularly suited to this approach. Within protected areas there has been substantial recovery of scallop stocks and benthic communities and improvements in commercial CPUE on surrounding fishing grounds.
### Research Activity: Isle of Man Scallop Re-seeding Project

**Duration:** 2003-2006  
**Cost:** £100k  
**Funding:** Bord Gáis Éireann

**Principal Investigator:** Dr Andrew Brand  
e-mail or contact (if different from above): arbrand@liv.ac.uk

**Objective/ Goal (100 words max.):**
1. To investigate the potential of stock enhancement and rotational seabed closure for improving scallop fishery yields
2. To compare the cost-effectiveness of two different methods of stock enhancement a) direct seeding of juvenile scallops on the seabed, b) suspended culture of scallop spat followed by seeding of juveniles
3. To involve and train Isle of Man fishermen in the techniques of scallop stock enhancement

**How are the results communicated?**
- Peer reviewed publications
- Conference and workshop presentations (national and international)
- Annual Research Reports to Bord Gáis Éireann and the Isle of Man government
- Bi-annual Research Newsletters to the Manx Fishing Industry.
- Presentations and meetings with stakeholders and the general public
- Local and national newspaper articles and radio interviews

**Can the results be used to support resource management, and if so how?**
Yes. Rotational closure and stock enhancement has revolutionised and revitalised scallop fisheries in other parts of the world (eg. China, Japan, New Zealand). However, the effectiveness of this method has rarely been tested in European waters. Along with the potential for improving fishery yields, this management method may reduce the negative environmental impacts of scallop fishing. Ideally stock enhancement and rotational harvesting will concentrate fishing effort on small, but highly productive areas, leaving other areas relatively undisturbed.
INSTITUTION: University of Liverpool
DEPARTMENT/ UNIT: Port Erin Marine Laboratory;
School of Biological Sciences
Address: Breakwater Rd, Port Erin, Isle of Man IM9 6JA;
Biosciences Building, Crown St, Liverpool L69 7ZB

Contact person: Dr Bryce Beukers-Stewart
e-mail and/or webpage: brycebs@liv.ac.uk / www.liv.ac.uk/peml/staff/bbs.htm;
www.liv.ac.uk/peml/projects/scallop.htm

Research Activity: Isle of Man: Conservation and Fishery Replenishment Effects of a Mobile Fishing Gear Closure

Duration: 2003-2006 Cost: £18k to Liverpool University (£149950 total)
Funding: Esmée Fairbairn Foundation

Principal Investigator: Dr Callum Roberts (University of York)
e-mail or contact (if different from above): cr10@york.ac.uk

Objective/ Goal (100 words max.):
Part of a consortium project “Towards a network of marine protected areas in the British Isles” The Isle of Man / Liverpool University component has three main objectives
1. To develop genetic markers to distinguish imported scallops (see Isle of Man Scallop Re-seeding Project) from local Irish Sea stocks, and use them to investigate dispersion of scallops and export of larvae from a closed area.
2. To translate scientific results on the fishery and conservation benefits of a closed area into a form that can be used to promote No-Take Zones locally and more widely in Britain.
3. To involve the local community in developing a network of protected areas around the Isle of Man.

How are the results communicated?
Peer reviewed publications
Conference and workshop presentations (national and international)
Annual Research Reports to the Esmée Fairbairn Foundation and Isle of Man government
Bi-annual Research Newsletters to the Manx Fishing Industry
Presentations and meetings with stakeholders and the general public
Local and nationally targeted displays, posters and leaflets
Local and national newspaper articles and radio interviews

Can the results be used to support resource management, and if so how?
Yes. Investigating and quantifying the dispersal and larval export of commercial species from closed areas is essential for evaluating their utility as fisheries management tools. However, almost no empirical studies have addressed this issue to date. Bridging the gap between the scientific community, government and stakeholders in the management process is seen as a key component of the ecosystem-based approach. This project will serve as a valuable learning experience for moving this process forward.
INSTITUTION: University of London (associated with Glasgow University)  
DEPARTMENT/ UNIT: University Marine Biological Station Millport  
Address: Millport, Isle of Cumbrae, Ayrshire, SCOTLAND, KA28 0EG  
Contact person: Dr. Rupert Ormond (Director)  
e-mail and/or webpage: www.gla.ac.uk/Marine/Acad

Research Activity: Marine Conservation and No Take Zones (NTZs)  
Duration: long-term  
Cost: approx £100k  
Funding: EU, British Council, Esmee Fairburn Trust

Principal Investigator: Dr. Rupert Ormond, Dr. Philip Smith  
e-mail or contact (if different from above):

Objective/ Goal (100 words max.):  
To provide a scientific basis for the management of Marine Protected Areas (MPAs), to investigate key issues in MPA management and to assess the extent to which NTZs may provide an effective tool for fisheries management. Issues under investigation include the effects of coral damage by visitors (in Egypt), of scallop dredging (in Scotland), and public attitudes towards MPAs (in Egypt and Scotland). Research on NTZs has been investigating the mechanisms of increased fish catch in adjacent waters, behavioural mechanisms underlying density-dependent population processes in MPAs, the application of NTZs to Norway lobster fisheries, and the potential for establishing NTZs in Scotland.

How are the results communicated?  
through project reports and scientific papers e.g.  

Can the results be used to support resource management, and if so how?  
Yes, the results are of direct relevance to the search for better ways of achieving sustainable exploitation of inshore fish stocks. Related work is directed at securing effective management of MPAs, a critical tool for the sustainable management of marine biodiversity and renewable resources.
**INSTITUTION:** University of London (associated with Glasgow University)  
**DEPARTMENT/ UNIT:** University Marine Biological Station Millport  
**Address:** Millport, Isle of Cumbrae, Ayrshire, SCOTLAND, KA28 0EG  
**Contact person:** Dr. Rupert Ormond (Director)  
e-mail and/or webpage: www.gla.ac.uk/Marine/Acad

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**Research Activity:** Large Marine Vertebrates  
**Duration:** 2002 – 2008  
**Cost:** current grants etc. about £350k  
**Funding:** Darwin Initiative, Save Our Seas Foundation, British Council etc.

**Principal Investigator:** Dr. Mauvis Gore, Dr. Rupert Ormond  
e-mail or contact (if different from above): Mauvis.Gore@millport.gla.ac.uk

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**Objective/ Goal (100 words max.):**

To research the ecology and behaviour of large marine vertebrates, with a view to both understanding their role within marine ecosystems and securing their long-term management and conservation. The research area includes projects on whales and dolphins (in the west of Scotland, the North East Indian Ocean, Red Sea and Caribbean), seals (in Scotland) and large sharks (in Scotland, the Red Sea and Indian Ocean), especially the largest planktivorous species – Whale Shark (in Seychelles) and Basking Shark (in Scotland).

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**How are the results communicated?**


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**Can the results be used to support resource management, and if so how?**

Yes. Directly findings are relevant to the management and conservation of species of high conservation interest and resource value (e.g. Humpback Whale, Basking Shark, Grey Seal). Indirectly, there is recent support for the view that top predators play key roles in structuring marine ecosystems, and that in their absence population effects cascade to lower trophic levels.
### Research Activity:
Shellfish Fisheries Biology

**Duration:** long-term  
**Cost:** of order of £500k over 10 years

**Funding:** NERC, SEERAD, EU, SNH, The Highland Council, Food Industry

**Principal Investigator:** Professor R.J.A. Atkinson  
e-mail or contact (if different from above): gbfa03@udcf.gla.ac.uk

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### Objective/ Goal (100 words max.):

Shellfish research at UMBSM has focused on Norway lobster (Nephrops norvegicus) which is of major economic importance to Scotland. Crabs (Necora puber), squat lobsters (Munida spp.), razor clams (Ensis spp.) and scallops (Pecten maximus, Aequipecten opercularis) have also received attention. Topics under current or recent investigation include refinement of methods for stock assessment, analysis of fishery discards, evaluation of capture methods, analysis of creel fisheries, assessment of the environmental impact of fishing gear, and investigation of population dynamics. For Nephrops, aspects of product quality are also under investigation, including disease- and stress-moderated phenomena using molecular, microbiological, and other methods.

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### How are the results communicated?

- project reports and scientific papers e.g.

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### Can the results be used to support resource management, and if so how?

Of obvious direct relevance to fisheries; also of wider relevance especially in relation to ecosystem impacts of fishing.
Objective/ Goal (100 words max.):

At UMBSM much research has been carried out on the ecology, biodiversity and conservation of various benthic habitats, in particular of Maerl beds formed by coralline algae. This habitat has been found to support an exceptionally high diversity of invertebrates, and serve as a key nursery ground for commercial fish and mollusc species. More recently habitat mapping has featured both as a component of conservation work and in fishery-related studies. Thus, UMBSM staff undertook the extensive NCC-funded Sealochs Survey and have recently undertaken RV-based mapping studies for SNH at sites in both the outer and inner Hebrides. Much recent research has also been undertaken on the ecology, behaviour and physiology of burrowing megafauna.

How are the results communicated?

through reports, scientific papers and relevant agencies


Can the results be used to support resource management, and if so how?

Understanding of the ecology and distribution of benthic habitats is essential both for the conservation and management of their resources and for the management of commercially exploited stocks that depend upon them. In the Strategy Implementation Plans 2005-2007 recently published by the Scottish Biodiversity Forum (2005) it was pointed out that “more work needs to be done on the sensitivity of habitats and species, to complement existing distribution and mapping information".
Research Activity: Environmental Impacts of Fisheries
Duration: long-term    Cost: overall order £500k
Funding: EU, Highland Council, SNH, Shellfish Association of Great Britain, etc.
Principal Investigator: Prof. P.G. Moore, Prof. R.J.A. Atkinson

Objective/ Goal (100 words max.):
Secondary effects of fisheries include impacts on vulnerable habitats, on by-catch species, the impacts of discarding practices and knock-on effects on ecosystems. At UMBSM, over the past decade, a considerable number of research projects have dealt with such issues: the impacts of demersal towed gears (otter trawls, scallop dredges, hydraulic dredges); SCUBA diver exploitation of razor-fish; discarding from Nephrops fisheries; and impacts on fragile habitats, like maerl beds and Limaria reefs. Currently research (the PARTANS project) in the North of Scotland (Caithness) is investigating the impact (biological and socio-economic) of the creel-based crab and lobster fishery.

How are the results communicated?
through project reports and scientific papers e.g.

Can the results be used to support resource management, and if so how?
If fisheries management is to be placed on a more realistic and sustainable footing, then a more holistic approach to ecosystem management needs to be forthcoming. This will need to encompass issues relating both to conservation of biodiversity and habitat integrity, and require biological data on target and non-target species and ecosystems.
Objective/ Goal (100 words max.):

Much of the classic work on the biological oceanography of phytoplankton and zooplankton was undertaken in the Clyde from UMBSM. This described for example the typical seasonal patterns in species abundance, and the dependence of Herring on copepod food (e.g. Marshall 1924, Marshall & Orr 1927). We have over the past 2-3 years recommenced routine sampling of plankton at stations near to UMBSM, and sampling of other stations through the Firth of Clyde on a more irregular basis. This is being done with a view to studying how plankton abundance and dynamics may have responded to the changes in annual temperature and in nutrient levels and distribution, which have become apparent within the Firth over the last decade as a result of both climate change and improved water quality.

How are the results communicated?

results will be communicated through project reports and scientific papers
preparation of first papers is in hand

Can the results be used to support resource management, and if so how?

Plankton abundance and dynamics are key drivers within pelagic food chains, and also influence sea-bed ecosystems, since most benthic invertebrates and demersal fish species have a larval stage that spends significant time in the plankton. Changes in timing and abundance of planktonic prey species have been imputed as a factor in the decline in UK cod stocks, and perhaps also Basking Sharks.
Objective/ Goal (100 words max.):
Studies of finfish at UMBSM have included investigations of the biology of both commercial and non-commercial species. Recent studies have been into the importance of inshore areas in Scottish waters as nursery grounds for commercially important fish species, particularly gadoids, and the energetics and migratory behaviour of salmon. Previous commercially relevant studies have looked at inshore wrasse (when species were used as cleaners by the salmon farming industry) and aspects of the diet and ecology of flatfish. The ecological role of fish in tropical environments (particularly butterflyfishes, triggerfishes, emperors, and groupers) has also received attention.

How are the results communicated?

through project reports and scientific papers e.g.

Can the results be used to support resource management, and if so how?
Yes. The studies have been largely directed at understanding the ecology and population dynamics of exploited species. Work on non-target species is critical to an understanding of ecological interactions between species and guilds.
**INSTITUTION:** University of Newcastle upon Tyne  
**DEPARTMENT/ UNIT:** School of Marine Science & Technology  
**Address:** Dove Marine Laboratory, Cullercoats, North Shields, NE30 4PZ

Contact person: Prof C.L.J. Frid  
e-mail and/or webpage: C.L.J.Frid@ncl.ac.uk

<table>
<thead>
<tr>
<th>Research Activity: European Fisheries Ecosystem Plan</th>
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<tbody>
<tr>
<td>Duration: 3</td>
</tr>
<tr>
<td>Cost: 1.4m€</td>
</tr>
<tr>
<td>Funding: EU</td>
</tr>
</tbody>
</table>

Principal Investigator: Prof C.L.J. Frid  
e-mail or contact (if different from above): 

<table>
<thead>
<tr>
<th>Objective/ Goal (100 words max.):</th>
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<tbody>
<tr>
<td>Review ecosystem management issues for North Sea fisheries, consult stakeholders on issues and acceptability and effectiveness of management regimes, develop an integrated Fisheries Ecosystem Plan for the North Sea.</td>
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</table>

<table>
<thead>
<tr>
<th>How are the results communicated?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reports to sponsors, conferences, academic publications, public presentations, press releases. Dissemination strategy including ‘glossy’ and stakeholder/focus groups.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Can the results be used to support resource management, and if so how?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes – by incorporation into CFP.</td>
</tr>
</tbody>
</table>
INSTITUTION: University of Newcastle upon Tyne
DEPARTMENT/UNIT: School of Marine Science & Technology
Address: Dove Marine Laboratory, Cullercoats, North Shields, NE30 4PZ

Contact person: Prof C.L.J. Frid
e-mail and/or webpage: C.L.J.Frid@ncl.ac.uk

Research Activity: Sustainable fisheries in Northumberland
Duration: 3 years  Cost: £ 30k
Funding: English Nature

Principal Investigator:
Contact person: Prof C.L.J. Frid
e-mail or contact (if different from above):

Objective/Goal (100 words max.):
Review existing fisheries activity in the nearshore fisheries operating in the EMS.
Consider ecological impacts of fisheries on key features
Recommend monitoring and management responses

How are the results communicated?
Reports to sponsors, conferences, academic publications, public presentations, press releases.

Can the results be used to support resource management, and if so how?
Yes – by En and NSFC in formulation of by-laws.
**INSTITUTION:** University of Newcastle upon Tyne  
**DEPARTMENT/ UNIT:** School of Marine Science & Technology  
**Address:** Dove Marine Laboratory, Cullercoats, North Shields, NE30 4PZ  
**Contact person:** Prof C.L.J. Frid  
**e-mail and/or webpage:** C.L.J.Frid@ncl.ac.uk

<table>
<thead>
<tr>
<th><strong>Research Activity:</strong></th>
<th>Use of biological traits analysis to characterise ecological functioning in marine benthos</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Duration:</strong></td>
<td>3 years</td>
</tr>
<tr>
<td><strong>Cost:</strong></td>
<td>£50k</td>
</tr>
<tr>
<td><strong>Funding:</strong></td>
<td>CEFAS</td>
</tr>
<tr>
<td><strong>Principal Investigator:</strong></td>
<td>Prof C.L.J. Frid</td>
</tr>
<tr>
<td><strong>e-mail or contact (if different from above):</strong></td>
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**Objective/ Goal (100 words max.):**  
PhD studentship  
Examine the potential use of BTA for characterising changes in infaunal and epibenthic assemblages in the face of fishing pressure.

**How are the results communicated?**  
Reports to sponsors, conferences, academic publications, public presentations, press releases.

**Can the results be used to support resource management, and if so how?**  
Yes – as part of EcoQO regime for habitat quality.
| **INSTITUTION:** University of Newcastle upon Tyne  
**DEPARTMENT/ UNIT:** School of Marine Science & Technology  
**Address:** Dove Marine Laboratory, Cullercoats, North Shields, NE30 4PZ |
| --- |
| **Contact person:** Prof C.L.J. Frid  
e-mail and/or webpage: C.L.J.Frid@ncl.ac.uk |

**Research Activity:**

<table>
<thead>
<tr>
<th>Duration: 3 years</th>
<th>Cost: £45k</th>
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<tbody>
<tr>
<td><strong>Funding:</strong> NERC</td>
<td></td>
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</tbody>
</table>

**Principal Investigator:** Prof C.L.J. Frid  
e-mail or contact (if different from above): |

**Objective/ Goal (100 words max.):**

PhD studentship – P Percival

Bio-geochemistry of fishing events. Role of physical disruption and altered bioturbation in influencing nutrient regeneration rates.

**How are the results communicated?**

Reports to sponsors, conferences, academic publications, public presentations, press releases.

**Can the results be used to support resource management, and if so how?**

Yes – as part of EcoQo regime for healthy habitats!
**INSTITUTION:** University of Newcastle upon Tyne  
**DEPARTMENT/UNIT:** School of Marine Science & Technology  
**Address:** Dove Marine Laboratory, Cullercoats, North Shields, NE30 4PZ

Contact person: Prof C.L.J. Frid  
e-mail and/or webpage: C.L.J.Frid@ncl.ac.uk

<table>
<thead>
<tr>
<th>Research Activity:</th>
<th>Discarding in the <em>Nephrops</em> fishery</th>
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<tbody>
<tr>
<td><strong>Duration:</strong></td>
<td>3 years</td>
</tr>
<tr>
<td><strong>Cost:</strong></td>
<td>£75k</td>
</tr>
<tr>
<td><strong>Funding:</strong></td>
<td>NERC, ESRC</td>
</tr>
</tbody>
</table>

Principal Investigator: Prof C.L.J. Frid  
e-mail or contact (if different from above): 

<table>
<thead>
<tr>
<th>Objective/Goal (100 words max.):</th>
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<tbody>
<tr>
<td>PhD studentship under joint awards scheme. T.L. Catchpole</td>
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Look at the ecological and socio-economic aspects of discarding in the *Nephrops* fishery.

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<tr>
<th>How are the results communicated?</th>
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<tbody>
<tr>
<td>Reports to sponsors, conferences, academic publications, public presentations, press releases.</td>
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</table>

<table>
<thead>
<tr>
<th>Can the results be used to support resource management, and if so how?</th>
</tr>
</thead>
</table>
**INSTITUTION:** University of Newcastle upon Tyne  
**DEPARTMENT/ UNIT:** School of Marine Science & Technology  
**Address:** Dove Marine Laboratory, Cullercoats, North Shields, NE30 4PZ  

Contact person: Prof C.L.J. Frid  
e-mail and/or webpage: C.L.J.Frid@ncl.ac.uk  

**Research Activity:** Ecosystem approach to benthic management  
**Duration:** 3 years  
**Cost:** £60k  
**Funding:** University of Newcastle  

**Principal Investigator:** Prof C.L.J. Frid  
e-mail or contact (if different from above):  

<table>
<thead>
<tr>
<th>Objective/ Goal (100 words max.):</th>
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<tr>
<td>PhD – L.A Robinson</td>
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<tr>
<td>Examine aspects of the scientific basis of ecosystem based management for the benthos.</td>
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</table>

**How are the results communicated?**  
Reports to sponsors, conferences, academic publications, public presentations, press releases.  

**Can the results be used to support resource management, and if so how?**  
Yes – through adoption into the EcoQO elements for benthos and habitats.
**INSTITUTION:** University of Newcastle  
**DEPARTMENT/ UNIT:** School of Marine Science & Technology  
**Address:** Ridley Building, University of Newcastle NE1 7RU

Contact person: Nicholas Polunin  
e-mail and/or webpage: n.polunin@ncl.ac.uk,  
http://www.ncl.ac.uk/marine/staff/profile/nvc.polunin

<table>
<thead>
<tr>
<th>Research Activity: Marine Protected Areas as a Management Tool for Conflict Reduction in Coastal Fisheries and Conservation</th>
</tr>
</thead>
</table>
| **Duration:** 2005-07  
**Cost:** ~€200k  
**Funding:** EU (INCO) |

Principal Investigator: (WP Coordinator) Nicholas Polunin  
e-mail or contact (if different from above):

<table>
<thead>
<tr>
<th>Objective/ Goal (100 words max.):</th>
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</table>
| Improve the basis for planning of MPAs on offshore continental shelves with a view to reconciling demands especially of fisheries, biodiversity conservation and industrial uses, based on the following specific objectives:  
- Compile data for four selected case studies of MPAs on continental shelves (Mexico, China, North Sea), compare and contrast the stated objectives, operation, and known effectiveness of the MPAs existing and planned with respect to location, resource and other factors  
- Gather model data for South China Sea, develop Ecospace models for the North Sea, South China Sea and southern Gulf of Mexico shelf systems  
- Conduct simulations of existing MPAs where feasible with respect to stock benefits/costs, and derive objective criteria for the placement of MPAs in all three case studies  
- Consider possible alternatives for design of MPA networks in the shelf systems, develop conceptual models for the planning of MPAs on continental shelves, and apply these to the China and Mexico case studies |

<table>
<thead>
<tr>
<th>How are the results communicated?</th>
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<tbody>
<tr>
<td>Workshops, scientific literature, popular media where appropriate</td>
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<table>
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<tr>
<th>Can the results be used to support resource management, and if so how?</th>
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<tbody>
<tr>
<td>Directly relevant to understanding of marine protected areas/reserves/fishery closures as resource and ecosystem management tools in the marine environment</td>
</tr>
</tbody>
</table>
Research Activity: Marine Protected Areas: A review of Lessons Learned

Objective/ Goal (100 words max.):

DEFRA is in the process of responding to the Strategy Unit Report 'Net Benefits'. A number of working groups have been established to consider the Strategy Unit recommendations. The Marine Environment Working Group (MEWG) has taken on the responsibility of those aspects of the strategy Report that relate to the environmental aspect of fisheries. One of the areas under consideration by the MEWG is the recommendation that Marine Protected Areas (MPAs) "should be established on an experimental basis, and the economic and biological impacts carefully studied...in areas which give multiple benefits to multiple uses of the marine environment" However, before considering an experimental programme of MPAs or carrying out further field based research, a review of existing MPAs is required to help establish what has worked and what has not. This review will provide the MEWG with the necessary evidence on 'lessons learned' to direct further work effectively. The review will have a wide scope to include the key concepts, processes and issues for a variety of MPA types, providing a valuable information source for policy makers.

How are the results communicated?

Meetings, reports, popular media where appropriate

Can the results be used to support resource management, and if so how?

Directly relevant to understanding of marine protected areas/reserves/fishery closures as resource and ecosystem management tools in the marine environment
INSTITUTION: University of Newcastle
DEPARTMENT/UNIT: School of Marine Science & Technology
Address: Ridley Building, University of Newcastle NE1 7RU

Contact person: Nicholas Polunin
e-mail and/or webpage: n.polunin@ncl.ac.uk,
http://www.ncl.ac.uk/marine/staff/profile/nvc.polunin

Research Activity: Ecological assessment of Yorks no-trawl areas
Duration: 2005-06
Cost: £100k
Funding: Northeastern Sea Fisheries Committee

Principal Investigator: (WP Coordinator) Nicholas Polunin
e-mail or contact (if different from above):

Objective/Goal (100 words max.):
A preliminary survey of the principal habitats will be necessary as a basis for the ecological work. Time will be needed to draft a habitat map, and this would then be used for the sampling design. The subsequent work would involve input from marine survey, marine invertebrate and marine fish specialists based in the Newcastle School of Marine Science & Technology working with the NE Sea Fisheries Committee in the period May-November 2005. Resources are needed primarily for vessel time, human resources, sample processing, report writing and minor equipment for completion of the project in the 6-month time frame. Working on the three no-trawl areas (NTAs) of Whitby, Filey and Hornsea the project will produce a map of marine habitat of the three NTAs and adjacent waters, for sampling design and use of the wider community. Compare densities and whole assemblages of soft-bottom fauna between NTAs and adjacent similar habitats. Assess whether large fish species are more abundant in NTAs compared with adjacent similar habitat.

How are the results communicated?
Scientific literature, reports, popular media where appropriate

Can the results be used to support resource management, and if so how?
Directly relevant to understanding of impacts of small-scale marine protected areas/reserves/fishery closures as resource and ecosystem management tools in the marine environment.
**INSTITUTION:** University of Newcastle  
**DEPARTMENT/ UNIT:** School of Marine Science & Technology  
**Address:** Ridley Building, University of Newcastle NE1 7RU  

Contact person: Nicholas Polunin  
e-mail and/or webpage: [n.polunin@ncl.ac.uk](mailto:n.polunin@ncl.ac.uk),  
[http://www.ncl.ac.uk/marine/staff/profile/nvc.polunin](http://www.ncl.ac.uk/marine/staff/profile/nvc.polunin)

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Research Activity:

<table>
<thead>
<tr>
<th>Duration: 2004-07</th>
<th>Cost: ~€346k</th>
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<tbody>
<tr>
<td>Funding: Italian CNR (Progetto Coordinato – Agenzia 2001)</td>
<td></td>
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</table>

Principal Investigator: Fabio Badalamenti  
e-mail or contact (if different from above): fbadala@tin.it

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**Objective/ Goal (100 words max.):**

The aim is to use an effective trawling ban to explore aspects of the dynamics of inshore food webs supporting fisheries recovering from exploitation and progress understanding of the methodological underpinnings of resource and environmental management. The detailed objectives include: Deriving size spectra and relationships between δ¹⁵N and body size of marine fishes; Testing whether these relationships can predict the trophic structure of the fish community; Describing the trophic structure of the whole fish community based on these and gut-contents data; Comparing size spectra and assemblage composition between no-trawl and trawled areas; Making detailed investigations of the food webs of key fishery species; Elucidating interaction strengths between fishery components based on before/after analyses of fishery assemblage in and out of the no-trawl zone.

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**How are the results communicated?**

Scientific papers, scientific meetings, media releases where appropriate

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**Can the results be used to support resource management, and if so how?**

The project will explore scarcely-known outcomes of management with respect to resource species and the wider community, thus improving understanding of the impacts of trawl bans.
Research Activity: Role of fishermen’s (stakeholders’) knowledge in advancing governance, management, policy and science.

Duration: 2000-2002 Cost: approx £200K
Funding: SEERAD, EU and University of Aberdeen.

Principal Investigator: Selina Stead (Co-PI, Anne McLay, FRS)
e-mail or contact (if different from above):

Objective/ Goal (100 words max.):
The main objective of this interdisciplinary study was to investigate how fishers’ knowledge can compliment developments in fisheries governance, management, policy and science in a meaningful way. During 2001 and 2002, face-to-face, semi-structured interviews of 80 skippers of demersal boats in the north east of Scotland were conducted at or near the following ports, Aberdeen, Fraserburgh and Peterhead. The interviews identified variables such as management restrictions, intuition, personal motivation and bank loans as influential in Scottish demersal skippers’ decision-making processes on fishing practices. Various multivariate statistical analyses (error and biplots, PCA, RDA, discriminant analysis and regression trees) helped to depict patterns in fishers’ decision making processes over time.

How are the results communicated?
Scientific papers, scientific meetings, FRS Aberdeen information fact sheets, informal feedback to stakeholders.

Can the results be used to support resource management, and if so how?
The findings highlighted the individuality of skippers’ views regarding their decision-making processes making the task of formulating management and policy that will be endorsed by all stakeholders more challenging. The results can be directly used to compliment existing information on resource management.
INSTITUTION: University of Newcastle  
DEPARTMENT/ UNIT: School of Marine Science & Technology  
Address: Ridley Building, University of Newcastle, Newcastle upon Tyne, NE1 7RU  

Contact person: Selina Stead  
e-mail and/or webpage: selina.stead@ncl.ac.uk, http://www.ncl.ac.uk/marine/staff/profile/selina.stead  


Duration: 2004-2007  
Cost: approx £120K  
Funding: WIOMSA, Leverhulme Trust Contribution, Wildlife Conservation Society and University of Newcastle.  

Principal Investigator: Selina Stead (Co-PI for socio-economic component)  
e-mail or contact (if different from above):  

Objective/ Goal (100 words max.):  
The overall project in which the socio-economic component forms part thereof, will evaluate the effects of coral bleaching and mortality on the coral reef communities, fish, and fisheries in the western Indian Ocean through a combination of field studies before and after the coral bleaching event in 1998. The ecological project investigators are repeating fish community surveys in four regions (Kenya, Tanzania, Seychelles, and Reunion) that were conducted before 1998 to determine the changes and the effects of coral mortality, management, and remoteness on the changes in fish communities. This ecological work is being followed by complimentary socioeconomic surveys that will provide a basis for understanding the effects of the ecological changes on people and possible ways to mitigate these effects. Furthermore, stakeholders’ views on how best to conserve coral reefs in ways complimentary to local management regimes will be explored, time permitting.  

How are the results communicated?  
Scientific papers, scientific meetings, TV, radio, press releases, feedback direct to stakeholders.  

Can the results be used to support resource management, and if so how?  
Understanding how socioeconomic factors influence resource use, the degree of dependence, and alternatives can assist resource managers in identifying root causes of environmental problems and help apply limited funds to protection, restoration and management activities based on local knowledge. Managers can use this information to demonstrate to the public and policy makers the importance of protecting the natural environment including coral reef, and to support their actions in planning new management policies.
Research Activity: Invest in Fish (SW) Bioeconomic modelling

Duration: 2004-2006  
Cost: approx £200k

Funding: DEFRA, EU

Principal Investigator: Sean Pascoe  
e-mail or contact (if different from above): sean.pascoe@port.ac.uk

Objective/ Goal (100 words max.):
The objective of the study is to assess the benefits and costs of stock recovery in the South West. A dynamic bioeconomic model is being developed that includes the main biological processes in the fishery, environmental impacts from fishing, a recreational fishing sector and the regional economy, as well as the fishing fleet that operates in the area. The model is to be used to assess the biological, environmental and economic impact of various management strategies proposed by industry and other stakeholders.

How are the results communicated?
The results are to be communicated through workshops and meetings with industry and other stakeholder groups. The meetings are proposed to be interactive in that stakeholders will assess the outcomes of the different management strategies and propose variants for testing.

The results are also to be communicated through the academic and research community through journal article publication and conferences. A communications officer has been employed on the project to ensure dissemination through the popular press.

Can the results be used to support resource management, and if so how?
It is anticipated that the results will have a direct impact on resource management. One of the aims of the project is to determine a management strategy that will be adopted by government as well as stakeholder groups.
Research Activity: Assessment of excess fishing capacity in the Scottish fleet

Duration: 2003-04             Cost: approx £40k
Funding: SEERAD

Principal Investigator: Diana Tingley
E-mail or contact (if different from above): diana.tingley@port.ac.uk

Objective/ Goal (100 words max.):
The objective of the study was to assess the level of excess capacity in the Scottish fleet (on a fleet segment basis), and to estimate the economic impacts (in terms of rent generation and employment) through removing the excess capacity.

How are the results communicated?
The results were presented in a report to SEERAD. Two journal articles based on the analysis are also in submission to journals (awaiting final decision).

Can the results be used to support resource management, and if so how?
The results can be directly used to support policy in that key fleet segments that are most in need of decommissioning have been identified.
**Research Activity:** EFIMAS: Operational Evaluation Tools for Fisheries Management Options

**Duration:** 2004-2008  
**Cost:** €317k  
**Funding:** EU

**Principal Investigator:** Sean Pascoe  
e-mail or contact (if different from above): sean.pascoe@port.ac.uk

**Objective/ Goal (100 words max.):**

Generic bioeconomic models are being developed that are aimed at providing a toolbox for fisheries managers and scientists to assess a wide range of management options. The models are being tested on a range of case studies across Europe. The studies that CEMARE are involved in are: North Sea Roundfish, North Sea Flatfish and Nephrops fisheries. The project team is international and multidisciplinary.

**How are the results communicated?**

At the moment no results have been developed. The expectation is that the results will be communicated largely through publication and conference. The target audience is scientists and the more quantitative managers. The results from the case studies will be presented to fisheries managers in each member state.

**Can the results be used to support resource management, and if so how?**

The intention is that the models will be used to support rational management decision-making within Europe. The models should also be adaptable for fisheries outside Europe, so may have an international impact.
**INSTITUTION:** University of Portsmouth  
**DEPARTMENT/ UNIT:** Centre for the Economics and Management of Aquatic Resources (CEMARE)  
**Address:** Boathouse No. 6, College Road, H.M. Naval Base, Portsmouth PO1 3LJ. UK.  

Contact person: Sean Pascoe  
e-mail and/or webpage: [http://www.port.ac.uk/cemare](http://www.port.ac.uk/cemare)

<table>
<thead>
<tr>
<th>Research Activity: Commit: Creation Of Multiannual Management Plans for Commitment</th>
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</thead>
<tbody>
<tr>
<td>Duration: 2004-2007</td>
</tr>
<tr>
<td>Funding: EU</td>
</tr>
</tbody>
</table>

Principal Investigator: Sean Pascoe  
e-mail or contact (if different from above): sean.pascoe@port.ac.uk

**Objective/ Goal (100 words max.):**

The aim of the project is to consider multiannual management measures in European fisheries. A feature of the project is that the impact of the management measure on compliance (and the subsequent effectiveness of the management measure) is also to be included in the analysis. The project has been linked in with the EFIMAS project so that economies in terms of model development can be achieved. The project will also employ Bayesian belief networks to consider the probability of compliance (and effects of compliance)

**How are the results communicated?**

At the moment no results have been developed. The expectation is that the results will be communicated largely through publication and conference. The target audience is scientists and the more quantitative managers. The results from the case studies will be presented to fisheries managers in each member state.

**Can the results be used to support resource management, and if so how?**

The intention is that the models will be used to support rational management decision-making within Europe. The models should also be adaptable for fisheries outside Europe, so may have an international impact.
INSTITUTION: University of Portsmouth
DEPARTMENT/ UNIT: Centre for the Economics and Management of Aquatic Resources (CEMARE)
Address: Boathouse No. 6, College Road, H.M. Naval Base, Portsmouth PO1 3LJ. UK.

Contact person: Sean Pascoe
e-mail and/or webpage: http://www.port.ac.uk/cemare

Research Activity: Modelling fishermen behaviour under new regulatory regimes
Duration: 2002-04 Cost: €70
Funding:
Principal Investigator: Sean Pascoe
e-mail or contact (if different from above): sean.pascoe@port.ac.uk

Objective/ Goal (100 words max.):
The aim of the project was to use a cost function approach to estimate the direct of change in vessel size in the future and the potential economic benefits from fleet reduction. The direction of change was based on the assumption that, under a property rights based system, fishers would eventually adjust their vessel and quota holdings to that which would minimise their costs of production.

How are the results communicated?
To date, two conference papers and one journal article has been produced (as well as the usual reports to the EU)

Can the results be used to support resource management, and if so how?
The results are of potential interest to managers, but would probably not have an impact on management decision making.
**INSTITUTION:** University of Portsmouth  
**DEPARTMENT/ UNIT:** Centre for the Economics and Management of Aquatic Resources (CEMARE)  
**Address:** Boathouse No. 6, College Road, H.M. Naval Base, Portsmouth PO1 3LJ. UK.  
**Contact person:** Sean Pascoe  
**e-mail and/or webpage:** http://www.port.ac.uk/cemare

<table>
<thead>
<tr>
<th>Research Activity</th>
<th>Multiple Objectives in the Management of EU Fisheries</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Duration:</strong></td>
<td>3 years (Completed March 2003)</td>
</tr>
<tr>
<td><strong>Cost:</strong></td>
<td>€1,014,089</td>
</tr>
</tbody>
</table>

| **Funding:**      |                                                      |
| **Principal Investigator:** Simon Mardle |
| **e-mail or contact (if different from above):** simon.mardle@port.ac.uk |

<table>
<thead>
<tr>
<th><strong>Objective/ Goal (100 words max.):</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>To investigate the actual objective structure present within EU fisheries management from the perspectives of the different interest groups. This concentrated on resource allocation with respect to the Common Fisheries Policy (CFP). Preference elicitation from all parts of the industry was undertaken in the development of the objective structure. Attitudes and opinions from all applicable representatives were elicited, i.e. fishers, management, scientists, environmentalists etc. Multi-criteria decision analysis methods were used to elicit the necessary information. A modelling and analysis framework, based on the multiple objectives of the CFP and fisheries management, was developed to enable the investigation of many of the relevant management questions and potential effects of management controls.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>How are the results communicated?</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>The main methods for the dissemination of results was through the publication of journal articles, the attendance of conferences, and a workshop. Yearly progress reports to the EC, task reports and a final report were also completed. Further, the EC’s electronic technological implementation plan (eTIP) was also completed.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Can the results be used to support resource management, and if so how?</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>For fisheries management, multiple objective bioeconomic modelling with inclusion of interest group preferences could contribute significantly to policy design and implementation. Analysing the effects of potential management strategy on fleet and stock dynamics of given fisheries from the viewpoints of key interest groups could play an invaluable role in identifying and developing consensus amongst groups. As opinion and the effects of that opinion become more explicit, then more realistic targets can be set for achievement from management. Several subsequent benefits may arise: e.g. the inclusive nature of the process (rather than the often perceived opposite by many), and the scientific qualities that result. A more global consensus and confidence in the policy may be achievable, leading to better compliance, as a policy developed with direct input from “the ground” may be more acceptable.</td>
</tr>
</tbody>
</table>
INSTITUTION: University of Portsmouth
DEPARTMENT/UNIT: Centre for the Economics and Management of Aquatic Resources (CEMARE)
Address: Boathouse No. 6, College Road, H.M. Naval Base, Portsmouth PO1 3LJ. UK.

Contact person: Sean Pascoe
e-mail and/or webpage: http://www.port.ac.uk/cemare

Research Activity: Technological developments and tactical adaptations of important EU fleets

Duration: 3 years (Start date: Sept 2002)  Cost: €3,344,368

Funding:

Principal Investigator: Simon Mardle
e-mail or contact (if different from above): simon.mardle@port.ac.uk

Objective/Goal (100 words max.):
This project addresses the poor understanding of the links between management tools, fleet developments and the pressure exerted on fishing communities. More precisely, the aim is to supply fisheries managers with a modelling tool to allow the evaluation of the impact of regulations (i.e. TACs, MAGPs, area and season closures, subsidies) on the dynamics of fleets and fishing mortality. The carrying idea is the investigation of the dynamics of elements that cause changes in fleet dynamics: technological advances in gears and vessel equipment, and also tactical adaptation of fishing vessels.

How are the results communicated?
The main methods for the dissemination of results are through the publication of journal articles, and the attendance of conferences. Links to International Council for the Exploitation of the Sea (ICES) Working Groups have also been established. Yearly progress reports to the EC, task reports and a final report are also planned. Further, the EC’s electronic technological implementation plan (eTIP) will be completed.

Can the results be used to support resource management, and if so how?
This project will contribute to ensuring sustainability of fisheries by improving the efficiency of management tools in the regulation of fleet dynamics, fish resources and the support of fisheries socio-economics.
**INSTITUTION:** University of Portsmouth  
**DEPARTMENT/ UNIT:** Centre for the Economics and Management of Aquatic Resources (CEMARE)  
**Address:** Boathouse No. 6, College Road, H.M. Naval Base, Portsmouth PO1 3LJ. UK.  
**Contact person:** Sean Pascoe  
**e-mail and/or webpage:** [http://www.port.ac.uk/cemare](http://www.port.ac.uk/cemare)

| Research Activity: Understanding the Mechanisms of Stock Recovery |
|---------------|----------|
| **Duration:** 4 years (Start date: T.B.C.) | **Cost:** €6,368,886 |
| **Funding:** |  
| **Principal Investigator:** Simon Mardle |  
| **e-mail or contact (if different from above):** simon.mardle@port.ac.uk |  

**Objective/ Goal (100 words max.):**
The purpose of this project is to enhance the understanding of mechanisms of fish stock recovery and provide recommendations for the recovery of European Community fish stocks which are outside safe biological limits. At present, it is evident that a number of exploited fish stocks in European waters are at historically low levels and are in danger of collapse. This project will synthesise and integrate relevant information from previous and ongoing research programs to evaluate and develop strategies for the rebuilding of stocks. Thereby this project will investigate the failures and successes of previous stock recovery activities and will try to define constraints of recovery plans for the future.

**How are the results communicated?**
Four main elements are deemed essential to the dissemination of results from this project: (i) expert workshop and a final Conference; (ii) a project website; (iii) a CD-Rom and brochure synthesising the results and the final project report; and (iv) scientific publications and presentation at international scientific meetings. The final Conference is provisionally entitled “an International Conference on Stock Recovery” and is planned for the final phase of the project.

**Can the results be used to support resource management, and if so how?**
The new CFP Regulation is explicit in the requirement that the Council adopts as a priority, recovery plans for fisheries exploiting stocks which are outside safe biological limits (2371/2002). Furthermore, the EU is now committed to the contents of the Johannesburg World Summit on Sustainable Development Plan of Implementation, including targets to restore depleted fish stocks by 2015. To this end, UNCOVER advances the state of the art in development and application of recovery plans for endangered fish stocks as well as in strategic medium- to long-term fisheries management strategies.
<table>
<thead>
<tr>
<th>INSTITUTION: University of Portsmouth</th>
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</thead>
<tbody>
<tr>
<td>DEPARTMENT/ UNIT: Centre for the Economics and Management of Aquatic Resources (CEMARE)</td>
</tr>
<tr>
<td>Address: Boathouse No. 6, College Road, H.M. Naval Base, Portsmouth PO1 3LJ. UK.</td>
</tr>
<tr>
<td>Contact person: Sean Pascoe</td>
</tr>
<tr>
<td>e-mail and/or webpage: <a href="http://www.port.ac.uk/cemare">http://www.port.ac.uk/cemare</a></td>
</tr>
</tbody>
</table>

Research Activity: Project EMBioC  
Duration: 3 years (2 projects)  
Cost: £187,641  
Funding: DEFRA  
Principal Investigator: Dr. P. Wattage  
e-mail or contact (if different from above): p.wattage@port.ac.uk  

Objective/ Goal (100 words max.):  
The main objective of the project was to extend the current understanding of specific socio-economic and institutional factors and processes that mediate the relationship between humans and wetland ecosystems and the socio-economic carrying capacity of those ecosystems. The second objective was to extend current understanding of the potential held by natural wetland ecosystems to assist in addressing the challenges of population growth and consumer demand on wetland resources. The third objective was to advise and train users of mangroves on best management practices while maintaining mangrove eco-system integrity. The final objective was to estimate the human demand for wetland resources and eco-system services— the ecological footprint — functionally required in supporting human activities, specifically prawn farming, in the project area. The analysis was undertaken in Sri Lanka.

How are the results communicated?  
Series of project meetings  
Project workshops, more than 10 with all stakeholders  
International conference  
Leaflets for wetland users in local languages  
Journal articles  
Project webpage  
Project reports (available in the www)

Can the results be used to support resource management, and if so how?  
Results were used in policymaking process  
Through education of all stakeholders and school children
**INSTITUTION:** University of Portsmouth  
**DEPARTMENT/ UNIT:** Centre for the Economics and Management of Aquatic Resources (CEMARE)  
**Address:** Boathouse No. 6, College Road, H.M. Naval Base, Portsmouth PO1 3LJ. UK.  
**Contact person:** Sean Pascoe  
**e-mail and/or webpage:** [http://www.port.ac.uk/cemare](http://www.port.ac.uk/cemare)

**Research Activity:** Project PORESSFA  
**Duration:** 3 years  
**Cost:** Euro 649998  
**Funding:** EU

**Principal Investigator CEMARE:** Dr. P. Wattage  
**e-mail or contact (if different from above):** p.wattage@port.ac.uk  
**Principal Investigator Project:** Dr. Denis Bailly  
**e-mail or contact (if different from above):** denis.bailly@univ-brest.fr

**Objective/ Goal (100 words max.):**  
The general objective of the project is to address the sustainable development issues of shrimp farming activities in Asia. In particular the project aims at answering the following development policy question: Under which social, institutional and environmental conditions can shrimp farming be a reliable factor for rural development and national economic growth for Asian countries within the new globalization environment?  
To address this question, the project will carry out a comparative analysis of four major producing countries in Asia (Bangladesh, India, Thailand and Vietnam) and investigate the socio-institutional conditions and policy orientations necessary to promote the sustainable development of the shrimp farming industry in Asia within the general context of trade liberalisation.

**How are the results communicated?**  
- Series of project meetings  
- Project workshops in all participating countries  
- International conference  
- Journal articles  
- Project web page  
- Project reports (available in the www)

**Can the results be used to support resource management, and if so how?**  
Results will be used in policymaking process
INSTITUTION: University of Portsmouth
DEPARTMENT/ UNIT: CEMARE, Dept Economics
Address: Boathouse 6, HM Naval Dockyard, Portsmouth PO1 3LJ
Contact person: Aaron HATCHER
e-mail and/or webpage: aaron.hatcher@port.ac.uk

Research Activity: Fishery Regulation and the Economic Responses of Fishermen: Perceptions and Compliance (Shared-Cost RTD Project)

Duration: 36 months Cost: €1,103,640 (EU €875,030)
Funding: EU

Principal Investigator: Aaron HATCHER
e-mail or contact (if different from above):

Objective/ Goal (100 words max.):
The objective of this project was to develop a better understanding of the way in which European fishermen respond to regulations. This includes, for example, their knowledge of the regulations which apply to them, their perceptions of the economic implications of regulations, experience of enforcement and formal sanction, normative and other 'psychic' responses to regulations (such as judgements about the 'rightness' of compliance and the perceived legitimacy of regulations and of the regulatory authorities), their perceptions of the attitudes and behaviour of fellow fishermen, and how all these various factors affect their fishing behaviour, in particular their compliance with regulations.

How are the results communicated?
The results of the case-studies have been disseminated at the national level by means of formal or informal seminars arranged for administrators and/or fishermen. In addition, papers have been delivered at the 2003 conference of the European Association of Fisheries Economists, held in Brest, France, and at an International Symposium held in Bergen, Norway, held in June 2003. An article based on the Project and including the results for the UK case-study appeared in the journal "Land Economics" in February 2005. Other articles are in submission or preparation.

Can the results be used to support resource management, and if so how?
Compliance with regulations is a significant problem in most fisheries and compliance is essential if the objectives of fisheries management are to be met. There is a clear need for levels of compliance in European fisheries to be improved and this project contributes to the understanding of the factors which affect compliance. The European dimension is particularly significant due to the structure of the Common Fisheries Policy which means that fishermen from different EU Member States fish for the same stocks and often on the same fishing grounds. It is hoped that the results of this project will increase awareness of the potential importance of the way in which regulations are designed and implemented in achieving regulatory compliance. The results can therefore inform future policy design at both national and European levels.
Research Activity: Performance Evaluation of Fisheries Management Regimes (STREP Research Proposal)

Duration: 36 months  Cost: c. €1m

Principal Investigator: Aaron HATCHER

e-mail or contact (if different from above):

Objective/ Goal (100 words max.):
The project aims to develop a practical framework for evaluating the economic performance of fisheries management regimes in terms of fleet economic efficiency, costs of implementation and robustness with respect to uncertainty and changing economic and biological conditions. In conjunction with the evaluation framework the project will develop a decision support model for determining the most appropriate management regimes given a set of objectives and their importance in a given situation. The evaluation framework will be developed based on existing theoretical and empirical work supplemented by study visits to a number of important and innovative fishery management regimes outside the EU. The evaluation framework and decision support tool will be tested in a variety of EU/EEA case-studies.

How are the results communicated?
Initial dissemination of the project’s results will be by means of a final project report to the European Commission, accompanied, it is envisaged, by a presentation at DG Fish. Following acceptance of the final project report, a non-technical report summarising the project’s main conclusions will be made available to policy makers and fishery managers in the EEA and beyond. The results of the research will also be presented to the Regional Advisory Committees, including a demonstration on how to use the decision support tool. It is anticipated that the project will also yield a number of outputs suitable for publication in academic, peer-reviewed, journals. This will ensure dissemination of the research results both across the EEA and internationally. In addition, the project team will present the results of their research at international conferences to further disseminate the results.

Can the results be used to support resource management, and if so how?
The potential positive societal impact of the project is considerable if it leads to better fisheries management, i.e., management that is more cost effective and which permits the fishing industry to operate more efficiently while at the same time meeting key biological targets. These benefits will accrue both to the industry itself (in terms of profitability and competitiveness) and, more generally, to society in terms of a more efficient use of scarce resources.
**INSTITUTION:** University of Portsmouth  
**DEPARTMENT/ UNIT:** CEMARE, Dept Economics  
**Address:** Boathouse 6, HM Naval Dockyard, Portsmouth PO1 3LJ  
**Contact person:** Prem Wattage  
**e-mail and/or webpage:** p.wattage@port.ac.uk

<table>
<thead>
<tr>
<th><strong>Research Activity:</strong></th>
<th>PROTECT Project, 14 partners</th>
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<tbody>
<tr>
<td><strong>Duration:</strong></td>
<td>3 years, from Jan 2005.</td>
</tr>
<tr>
<td><strong>Cost:</strong></td>
<td>Euro 2,961,011</td>
</tr>
<tr>
<td><strong>Funding:</strong></td>
<td>EU</td>
</tr>
<tr>
<td><strong>Principal Investigator:</strong></td>
<td>Erik Hoffmann, DIFRES Denmark (project co-ordinator)</td>
</tr>
<tr>
<td><strong>e-mail or contact (if different from above):</strong></td>
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<tr>
<th><strong>Objective/ Goal (100 words max.):</strong></th>
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<tbody>
<tr>
<td>The objectives of this case study are:</td>
</tr>
<tr>
<td>- To evaluate the potential of MPAs to protect deep water coral ecosystems from the effects of fishing as a tool for ocean governance, in the context of EU fisheries and marine environmental policies.</td>
</tr>
<tr>
<td>- To outline and develop a suite of implementation, monitoring, assessment and management tools for MPAs for deep water coral ecosystems. These methods are intended to assist managers in assessing (i) the fisheries impact on coral and coral communities, (ii) the impact of introducing MPAs with varying level of protection on the ecosystem, and (iii) the impact of MPAs on the fisheries operating in deep water coral areas and related socio-economic effects.</td>
</tr>
<tr>
<td>- To improve the linkage between science and management when designing and introducing future MPAs, including guidance on (i) timing and level of stakeholder involvement required to achieve legitimacy and to ensure that the best knowledge is applied and (ii) follow-up actions after the implementation of MPAs, ensuring achievement of objectives or introduction of necessary modifications.</td>
</tr>
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<table>
<thead>
<tr>
<th><strong>How are the results communicated?</strong></th>
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<tbody>
<tr>
<td>Project meetings, project reports. Conferences, workshops and peer reviewed journal articles</td>
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<tr>
<th><strong>Can the results be used to support resource management, and if so how?</strong></th>
</tr>
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<tbody>
<tr>
<td>Project will provide an opportunity for dialogue between scientists, policy makers and stakeholders on the issues of MPA design and management.</td>
</tr>
</tbody>
</table>
INSTITUTION: University of Portsmouth  
DEPARTMENT/ UNIT: School of Earth and Environmental Sciences  
Address: Burnaby Building, Burnaby Road, Portsmouth PO1 3QL  
Contact person: Dr Clive Trueman  
e-mail and/or webpage: clive.trueman@port.ac.uk

Research Activity: Long-term records of diet in Atlantic salmon recovered from archived scale samples  
Duration: 24 months  
Cost: 24K  
Funding: DEFRA  
Principal Investigator: Dr Clive Trueman  
e-mail or contact (if different from above):

Objective/ Goal (100 words max.):  
To recover records of open ocean diet retrospectively from the stable isotope (d13C d15N) composition of archived salmon scales, and investigate driving forces behind open ocean mortality of salmon.  
Records of diet composition extending 30-50 years are recovered from stable isotope analyses of archived scales.  
Temporal patterns in diet composition of salmon are compared to population data and records of sea surface conditions, to identify mechanisms linking ocean conditions and mortality.  
Project focuses on developing analytical protocols suitable for recovery of stable isotope signals from scales, and applying them to recover long-term dietary records from the North Sea salmon.

How are the results communicated?  
Results will be communicated through reports to CEFAS, scientific literature and conferences.

Can the results be used to support resource management, and if so how?  
The long-term goal is to establish a predictive relationship between measurable ocean conditions, salmon behaviour and mortality.
**INSTITUTION:** University of Portsmouth  
**DEPARTMENT/UNIT:** School of Earth and Environmental Sciences  
**Address:** Burnaby Building, Burnaby Road, Portsmouth PO1 3QL  

**Contact person:** Dr Clive Trueman  
**e-mail and/or webpage:** clive.trueman@port.ac.uk

<table>
<thead>
<tr>
<th><strong>Research Activity:</strong> Validating geochemical proxies for recovery of open marine life history information in <em>Salmo salar</em></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Duration:</strong> 12 months</td>
</tr>
<tr>
<td><strong>Cost:</strong> 16K in kind</td>
</tr>
<tr>
<td><strong>Funding:</strong> NERC</td>
</tr>
</tbody>
</table>

**Principal Investigator:** Dr Clive Trueman  
**e-mail or contact (if different from above):**

<table>
<thead>
<tr>
<th><strong>Objective/Goal (100 words max.):</strong></th>
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<tbody>
<tr>
<td>An experimental controlled feeding study aimed at supporting future research using trace element chemistry as a sensitive and cost effective measure of stock identity and or migration, and stable isotope chemistry as a record of dietary composition.</td>
</tr>
<tr>
<td>Using Atlantic salmon as a target organism this project investigates the relationship between tissue (otolith, scale, muscle, liver, bone) composition and water and diet composition as a function of temperature and growth rate.</td>
</tr>
<tr>
<td>The incentive for this work is the emerging importance of otolith and scale chemistry as proxy records to track the spatial distribution, structure and dietary behaviour of marine fish stocks</td>
</tr>
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<table>
<thead>
<tr>
<th><strong>How are the results communicated?</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Results will be communicated through scientific literature and conferences.</td>
</tr>
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<table>
<thead>
<tr>
<th><strong>Can the results be used to support resource management, and if so how?</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Results will directly impact the use of otolith and scale microchemistry as alternatives to DNA fingerprinting to establish stock identity and location. Tissue microchemistry is likely to play an important role in trace-ability studies but must be validated before use.</td>
</tr>
</tbody>
</table>
INSTITUTION: University of Portsmouth
DEPARTMENT/ UNIT: School of Earth and Environmental Sciences
Address: Burnaby Building, Burnaby Road, Portsmouth PO1 3QL

Contact person: Dr Clive Trueman
e-mail and/or webpage: clive.trueman@port.ac.uk

Research Activity: Otolith elemental fingerprints as biological tracers of fish stocks and fish behaviour

Duration: ongoing  Cost: institution supported
Funding: Funded through university student projects – pending application to Leverhulme (c. £90K)

Principal Investigator: Dr Clive Trueman
e-mail or contact (if different from above):

Objective/ Goal (100 words max.):

Trace element composition of otoliths has emerged as a powerful method to identify regionally-distinct fish stocks. Resolution and utility depends upon the biology of the stocks and the geology/oceanography of their habitat region(s).

Our ongoing work revolves around investigating new elemental fingerprints, and applying techniques to distinguish between individual stocks and identify source region. Analyses are performed by state-of-the-art mass spectrometry. Our group consists principally of analytical geochemists, and I specialise in biominerals chemistry. Atlantic salmon and orange roughy are target species in current work. Pending grant focuses on North Sea, English Channel and Baltic cod.

How are the results communicated?

Results will be communicated through scientific literature and conferences.

Can the results be used to support resource management, and if so how?

Results will directly impact the use of otolith and scale microchemistry as alternatives to DNA fingerprinting to establish stock identity and location. Tissue microchemistry is likely to play an important role in trace-ability studies but must be validated before use.
**INSTITUTION:** University of St Andrews  
**DEPARTMENT/ UNIT:** Sea Mammal Research Unit  
**Address:** Gatty Marine Laboratory  
St Andrews KY16 8LB  
**Contact person:** Prof. Ian Boyd, Director  
**e-mail and/or webpage:** ilb@st-andrews.ac.uk , http://www.smru.st-and.ac.uk/

<table>
<thead>
<tr>
<th>Research Activity:</th>
<th>Marine mammals</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Duration:</strong></td>
<td>Lon-term</td>
</tr>
<tr>
<td><strong>Cost:</strong></td>
<td>£3 million annually</td>
</tr>
<tr>
<td><strong>Funding:</strong></td>
<td>NERC, DEFRA, SEERAD, EU, DARDNI, Others</td>
</tr>
<tr>
<td><strong>Principal Investigator:</strong></td>
<td>As above</td>
</tr>
<tr>
<td><strong>e-mail or contact (if different from above):</strong></td>
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**Objective/ Goal (100 words max.):**

The SMRU mission is to undertake world class research on marine mammals and to support the statutory duty of NERC to advise Government in the UK about the management of seal populations.

**How are the results communicated?**

- Scientific publication in peer-review literature.
- Reports to customers
- Report of the UK Special Committee on Seals (SCOS) ([http://www.smru.st-and.ac.uk/CurrentResearch.htm/scos.htm](http://www.smru.st-and.ac.uk/CurrentResearch.htm/scos.htm))
- Knowledge transfer and PUS activities
- Committee membership (especially IWC, ICES and SEERAD)

**Can the results be used to support resource management, and if so how?**

They are used continuously to support resource management, e.g. the SCOS process, within OSPAR and ICES.
**INSTITUTION:** University of St. Andrews  
**DEPARTMENT/UNIT:** Geography and Geosciences  
**Address:** Irvine Building, St. Andrews, Fife, KY16 9AL  
**Contact person:** Michael Bird  
**e-mail and/or webpage:** Michael.bird@st-andrews.ac.uk

<table>
<thead>
<tr>
<th><strong>Research Activity:</strong> Monitoring ecosystem health and environmental change using seabird guano</th>
<th><strong>Duration:</strong> 2 years</th>
<th><strong>Cost:</strong> £50,000</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Funding:</strong> NERC, DEFRA, SEERAD, EU, DARDNI, Others (pilot work complete, applications to Leverhulme and Carnegie Trust submitted)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Principal Investigator:** as above  
**e-mail or contact (if different from above):**

<table>
<thead>
<tr>
<th><strong>Objective/Goal (100 words max.):</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>To develop seabird guano (excrement) as a sensitive and integrative indicator of ecosystem health and ecosystem change, through the analysis of the stable carbon and nitrogen isotope composition of the guano (both the insoluble uric acid and residual ‘organic’ components) and the determination of ‘diffuse pollutants’ in the guano (trace elements and persistent organic pollutants).</td>
</tr>
</tbody>
</table>

**How are the results communicated?**  
Via publication in international journals and presentation at conferences

<table>
<thead>
<tr>
<th><strong>Can the results be used to support resource management, and if so how?</strong></th>
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<tbody>
<tr>
<td>Yes, guano potentially provides a sensitive tool for monitoring ecosystem health in terms of (i) changes in the tropic level and food sources of individual species, and (iii) changes in the levels of anthropogenic pollutants. The major advantages of guano over other materials are that seabird guano: (i) can be sampled without capturing or killing birds (ii) can be easily and rapidly sampled at regular intervals from the same locations (nests and habitual perches) without undue disturbance to the birds, allowing detailed time series to be built up (iii) broadly integrates an ecosystem-level signal (iv) is responsive to comparatively short term changes (v) there are locations where long histories of environmental change are available from guano accumulated over thousands of years, allowing recent changes to be assessed against longer-term natural variability.</td>
</tr>
</tbody>
</table>
Research Activity: Modelling the distribution and abundance of *Calanus finmarchicus* in the N. Atlantic

Duration: 6 years  
Cost: £700k

Principal Investigator: Bill Gurney  
e-mail or contact (if different from above):

Objective/ Goal (100 words max.):
To construct a physiologically and spatially structured demographic model of *Calanus finmarchicus* demography describing its distribution and abundance over the range 30N-80N and 80W-90E. To determine physical and biotic driving functions for this model from one or more General Circulation Ocean Models and from satellite and biochemical observations. To fit the model to spatially and physiologically resolved observations of *Calanus* abundance over the region of interest.

How are the results communicated?
One paper about methodology published in Journal of Animal Ecology  
One paper describing a scoping exercise applying the model to the NE Atlantic/Norwegian Sea in press (Fisheries Oceanography)  
One paper describing the full model in review (Marine Ecology Progress Series)

Can the results be used to support resource management, and if so how?
The specific insights concerning Calanus, will have strong implications for future management oriented whole ocean ecosystem models, but the model itself probably has limited resource management relevance.

The methodology is highly suited to resource management models of fish stocks (see separate sheet.)
Research Activity: Modelling the distribution and abundance of Gadus Morhua on the European continental shelf.

Duration: 3 years
Cost: £150k
Funding: DEFRA (subcontract through CEFAS)

Principal Investigator: Bill Gurney

Objective/ Goal (100 words max.): To construct a physiologically and spatially structured demographic model of Gadus Morhua (Atlantic Cod) demography describing its distribution and abundance over the range 48N-62N and 12W-12E. To determine physical and biotic driving functions for this model for the period 1969-2003 from a statistical characterisation of the Hamburg Ocean Model and from fisheries management observations tabulated by ICES. To fit the model to spatially and physiologically resolved observations of Cod abundance over the region of interest.

How are the results communicated? One paper describing the full model in review (Marine Ecology Progress Series)

Can the results be used to support resource management, and if so how? The methodology is highly suited to resource management models of fish stocks. Its computational efficiency allows a fully spatially and physiologically resolved model to be fitted to observations using numerical optimisation techniques.
**INSTITUTION:** University of Wales Bangor  
**DEPARTMENT/ UNIT:** School of Ocean Sciences  
**Address:** Menai Bridge, Anglesey, LL59 5EY

Contact person: Dr MJ Kaiser  
e-mail and/or webpage: www.sos.bangor.ac.uk/~oss405/kaiser.htm

<table>
<thead>
<tr>
<th>Research Activity:</th>
<th>Sustainable mussel cultivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration:</td>
<td>3 yr</td>
</tr>
<tr>
<td>Cost:</td>
<td>£146 000</td>
</tr>
<tr>
<td>Funding:</td>
<td>NERC</td>
</tr>
</tbody>
</table>

**Principal Investigator:** MJ Kaiser  
e-mail or contact (if different from above):

<table>
<thead>
<tr>
<th>Objective/ Goal (100 words max.):</th>
</tr>
</thead>
<tbody>
<tr>
<td>To understand the ecology of mussel cultivation in order to minimise negative environmental impacts and to maximise potential yield from limited mussel resources. The project examined the effects of cultivation on invertebrate communities, bird populations and modelled density dependent growth rates.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>How are the results communicated?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final NERC report, Shellfish News, and 6 peer reviewed publications and one PhD thesis.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Can the results be used to support resource management, and if so how?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct management advice given in relation to stocking density vs direct environmental effects. Advice given to industry re methods of improving yield and reducing losses to predators, advice taken up by industry and currently implemented. Evidence of environmental effects provided for Countryside Council for Wales. Research relevant in wider international context.</td>
</tr>
</tbody>
</table>
| **INSTITUTION:** University of Wales Bangor  
**DEPARTMENT/ UNIT:** School of Ocean Sciences  
**Address:** Menai Bridge, Anglesey, LL59 5EY |
|---|
| **Contact person:** Dr MJ Kaiser  
**e-mail and/or webpage:** www.sos.bangor.ac.uk/~oss405/kaiser.htm |
| **Research Activity:** Sustainable mussel cultivation: a multidisciplinary approach |
| **Duration:** 3 yr  
**Cost:** £297 000  
**Funding:** BBSRC |
| **Principal Investigator:** MJ Kaiser  
**e-mail or contact (if different from above):** |
| **Objective/ Goal (100 words max.):**  
To understand the interaction between physical and ecological processes that govern growth and mortality and spatial dynamics in cultivated beds of mussels. To understand the limits of carrying capacity in systems subject to mussel cultivation and hence to minimise risk of over-stocking and negative effects on other components of the system. |
| **How are the results communicated?**  
BBSRC, Shellfish News, peer reviewed publications and PhD thesis. Study currently at beginning of year two of project. |
| **Can the results be used to support resource management, and if so how?**  
Direct management advice given in relation to stocking density vs direct environmental effects. Advice given to industry re methods of improving yield and reducing losses to predators, advice taken up by industry and currently implemented. Evidence of environmental effects provided for Countryside Council for Wales. Research relevant in wider international context. |
**INSTITUTION:** University of Wales Bangor  
**DEPARTMENT/ UNIT:** School of Ocean Sciences  
**Address:** Menai Bridge, Anglesey, LL59 5EY

Contact person: Dr MJ Kaiser  
*e-mail and/or webpage:* [www.sos.bangor.ac.uk/~oss405/kaiser.htm](http://www.sos.bangor.ac.uk/~oss405/kaiser.htm)

<table>
<thead>
<tr>
<th>Research Activity:</th>
<th>Subtidal seed mussel ecology</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Duration:</strong></td>
<td>3 yr</td>
</tr>
<tr>
<td><strong>Cost:</strong></td>
<td>£62 000</td>
</tr>
<tr>
<td><strong>Funding:</strong></td>
<td>DEFRA and SEAFISH</td>
</tr>
</tbody>
</table>

**Principal Investigator:** MJ Kaiser  
e-mail or contact (if different from above):

<table>
<thead>
<tr>
<th><strong>Objective/ Goal (100 words max.):</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>To understand the ecology of ephemeral beds of seed mussels, their role in the marine ecosystem and utilisation by other biological components.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>How are the results communicated?</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry media and peer reviewed publications, attendance at aquaculture meetings, direct contact with industry, Shellfish News. Study currently at beginning of year two of project.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Can the results be used to support resource management, and if so how?</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct management advice given in relation to the ecological importance of mussel seed and opportunities to maximise potential of harvested beds by utilising alternative strategies. Evidence of environmental effects provided for Countryside Council for Wales. Research relevant in wider international context.</td>
</tr>
</tbody>
</table>
**INSTITUTION:** University of Wales Bangor  
**DEPARTMENT/ UNIT:** School of Ocean Sciences  
**Address:** Menai Bridge, Anglesey, LL59 5EY  

Contact person: Dr MJ Kaiser  
e-mail and/or webpage: www.sos.bangor.ac.uk/~oss405/kaiser.htm

<table>
<thead>
<tr>
<th>Research Activity: Essential fish habitat</th>
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</thead>
<tbody>
<tr>
<td>Duration: 3 yr</td>
</tr>
<tr>
<td>Funding: DEFRA (MF0805)</td>
</tr>
<tr>
<td>Principal Investigator: MJ Kaiser</td>
</tr>
</tbody>
</table>
e-mail or contact (if different from above): |

**Objective/ Goal (100 words max.):**

To understand the relationship between key commercial species and seabed habitats and thereby to identify those habitats that have an important role in the life history of adult stages of these fish.

**How are the results communicated?**


**Can the results be used to support resource management, and if so how?**

Direct management advice given in relation to the spatial distribution of fish in relation to habitat resources. Temporal variability in habitat use identified. Key habitats identified for some species, others more generalist and hence not a dependent upon a particular habitat. Importance of regional vs local scale in management context highlighted with respect to habitat conservation.
INSTITUTION: University of Wales Bangor  
DEPARTMENT/ UNIT: School of Ocean Sciences  
Address: Menai Bridge, Anglesey, LL59 5EY  

Contact person: Dr MJ Kaiser  
e-mail and/or webpage: www.sos.bangor.ac.uk/~oss405/kaiser.htm

<table>
<thead>
<tr>
<th>Research Activity:</th>
<th>Indicators and models of fishing disturbance</th>
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<tr>
<td>Duration:</td>
<td>3.5 yr</td>
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<tr>
<td>Cost:</td>
<td>£179 000</td>
</tr>
<tr>
<td>Funding:</td>
<td>DEFRA/CEFAS (MF0731)</td>
</tr>
</tbody>
</table>

Principal Investigator: MJ Kaiser  
e-mail or contact (if different from above):

| Objective/ Goal (100 words max.): | To understand the response of benthic communities to different regimes of fishing disturbance across different habitats in the North Sea and to determine how this affects habitat quality for demersal fish such as cod and haddock |

| How are the results communicated? | Industry media and peer reviewed publications, attendance at aquaculture meetings, direct contact with industry, Shellfish News. Study in year 2. International symposium on fish habitat in July 2005 in Bangor. |

| Can the results be used to support resource management, and if so how? | Direct management advice given in relation to scenarios of fishing disturbance that can be applied to model the outcome of imposing closed areas and displacing fishing effort to other areas of the seabed. Energetic consequences for fish identified from relating spatial distribution and habitat use to condition of fish. |
**INSTITUTION:** University of Wales Bangor  
**DEPARTMENT/UNIT:** School of Ocean Sciences  
**Address:** Menai Bridge, Anglesey, LL59 5EY  

Contact person: Dr MJ Kaiser  
e-mail and/or webpage: [www.sos.bangor.ac.uk/~oss405/kaiser.htm](http://www.sos.bangor.ac.uk/~oss405/kaiser.htm)

<table>
<thead>
<tr>
<th>Research Activity:</th>
<th>RESPONSE</th>
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<tbody>
<tr>
<td>Duration:</td>
<td>3 yr</td>
</tr>
<tr>
<td>Cost:</td>
<td>£137 000</td>
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<td>Funding:</td>
<td>EU</td>
</tr>
</tbody>
</table>

Principal Investigator: MJ Kaiser  
e-mail or contact (if different from above):

**Objective/Goal (100 words max.):**

To understand the response of benthic communities to different regimes of fishing disturbance across different habitats in the Irish Sea and to determine how this affects benthic community composition and structure including macro and meiofauna.

**How are the results communicated?**

Industry media and peer reviewed publications, attendance at aquaculture meetings, direct contact with industry, Fishing News. Study in year 3.

**Can the results be used to support resource management, and if so how?**

Direct management advice given in relation to scenarios of fishing disturbance that can be applied to model the outcome of imposing closed areas and displacing fishing effort to other areas of the seabed.
**INSTITUTION:** University of Wales Bangor  
**DEPARTMENT/UNIT:** School of Ocean Sciences  
**Address:** Menai Bridge, Anglesey, LL59 5EY  

Contact person: Dr MJ Kaiser  
e-mail and/or webpage: www.sos.bangor.ac.uk/~oss405/kaiser.htm

<table>
<thead>
<tr>
<th>Research Activity: Biological and socio-economic benefits of different inshore fisheries management regimes</th>
</tr>
</thead>
</table>
| Duration: 3 yr  
Funding: ESRC |
| Cost: ESRC funded PhD |
| Principal Investigator: MJ Kaiser  
e-mail or contact (if different from above): |

**Objective/Goal (100 words max.):**

To investigate the costs and benefits of different approaches to inshore fisheries management in inshore areas of the UK focussing on Wales. The project will integrate habitat risk assessment in relation to the negative effects of various fishing activities and relate this to benefits of differing approaches to managing inshore fisheries including recreational fishing. A socio-economic analysis will generate the outcome of the different management scenarios.

**How are the results communicated?**

Industry media and peer reviewed publications, attendance at aquaculture meetings, direct contact with industry, Fishing News. Study in year 3.

**Can the results be used to support resource management, and if so how?**

Direct management advice given in relation to scenarios of inshore fishery can be modelling to demonstrate social and economic responses and hence aid assessment of the most desirable outcome to achieve conservation, social and economic benefits.