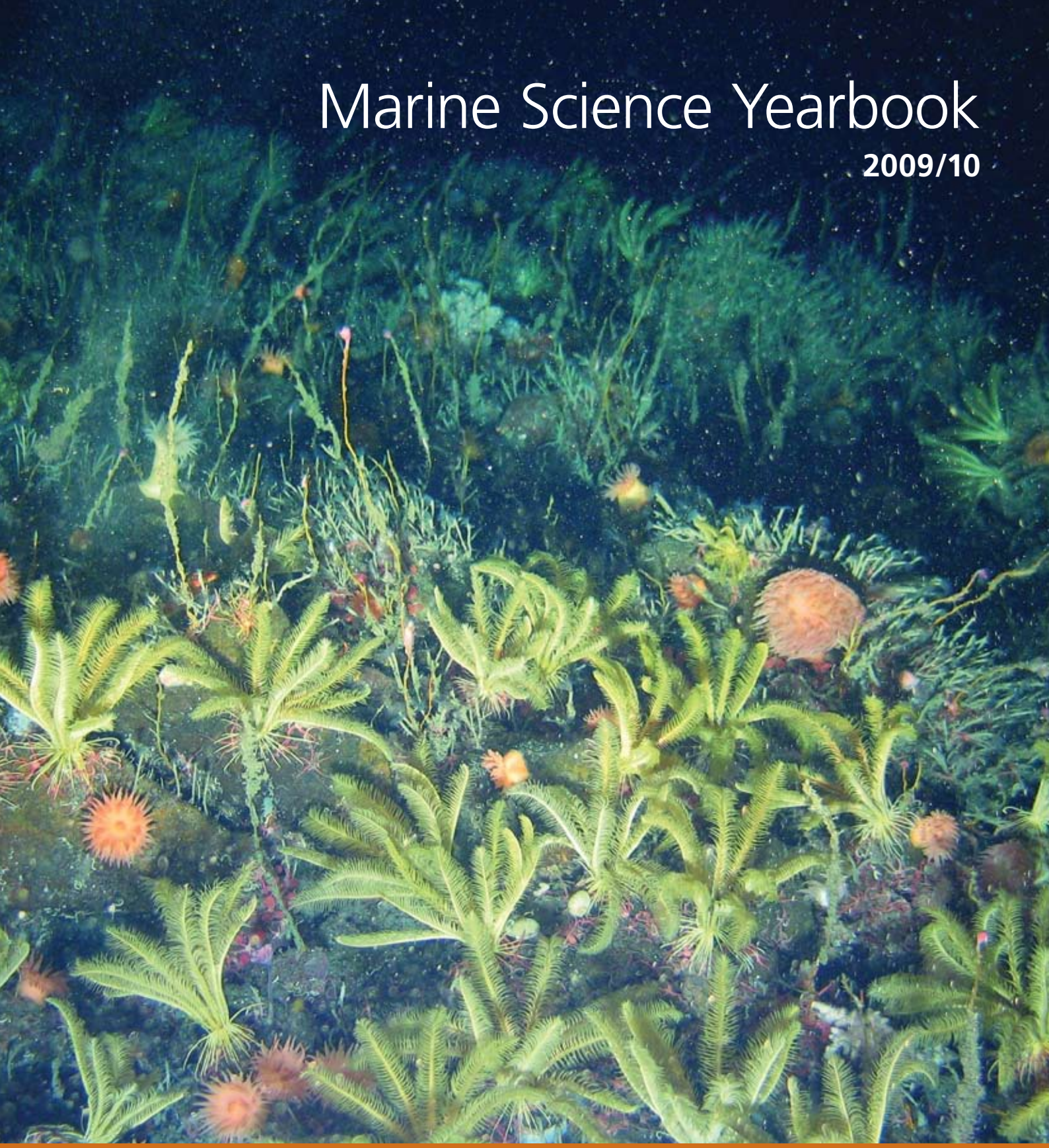
# Marine Science Yearbook

**2009/10**



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# Contents


4 **Introduction**

6 **Research themes**

7 Economic and social research in the marine environment

10 Human pressures and impacts on the marine environment

15 State of the marine environment

19 Science for integrated marine management

22 **Projects completed in 2009/10 and current projects**

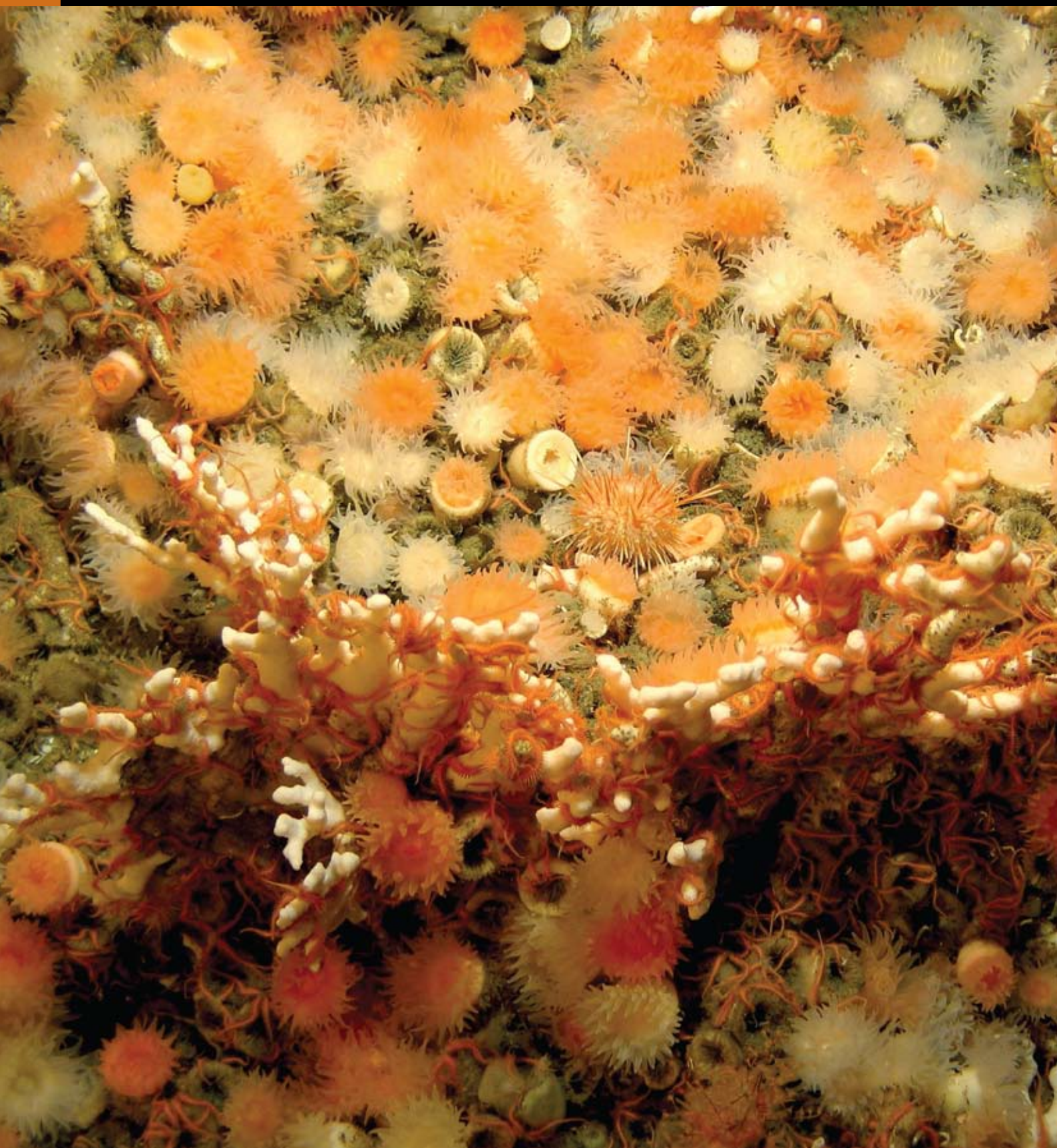
23 Economic and social research in the marine environment

27 Human pressures and impacts on the marine environment

34 State of the marine environment

43 Science for integrated marine management

# Introduction



This yearbook covers all our marine research, bringing together projects on marine biodiversity, the marine environment and marine fisheries. Previously these research projects were reported in our *Marine Environment Science Yearbook 2008/09* and our *Marine Fisheries Science Yearbook 2008/09* (see: ww2.defra.gov.uk/environment/marine/science/).

Twelve of our marine research projects, illustrating the range of our research, are reported in this yearbook under four themes:

- Economic and social research in the marine environment (analysing economic and social use of the marine environment, including fish stocks);
- Human pressures and impacts on the marine environment (analysing pressures and impacts of human activity, including fishing, contamination by hazardous substances, release of substances and nutrient enrichment);
- State of the marine environment (understanding essential characteristics of the marine environment, including physical, chemical and biological features and habitat types, and fish stock dynamics); and
- Science for integrated marine management (identifying measures to help achieve or maintain Good Environmental Status and developing long-term management plans for fish stocks).

*Defra's marine research programme* provides more detail on these themes, as well as the policy drivers behind them and our research commissioning process. *Defra's role in marine science* explains how we are working with other marine science funding organisations both nationally and internationally. It also outlines the work of the UK's key players in marine science which include Cefas (Centre for Environment, Fisheries and Aquaculture Science), Research Council Institutes and universities. Both publications are at: ww2.defra.gov.uk/environment/marine/science/

All projects completed in 2009/10 and current projects are listed in this yearbook. Each entry reports the objectives of the project and how the findings have been, or will be, applied. Using the project codes in the lists, you can search: http://randd.defra.gov.uk/Default.aspx?Location=None&Module=FilterSearchNewLook&Completed=0 for more information on projects.

The *Marine Environment Science Yearbook 2008/09* includes a glossary of terms (pages 41-45), many of which are also used in this yearbook. The *Marine Fisheries Science Yearbook 2008/09* includes an explanation of fish stock monitoring and assessments (pages 49-50).

In addition to marine research projects, Defra also funds the Fisheries Science Partnership and the Fisheries Challenge Fund.

The Fisheries Science Partnership encourages scientists and fishermen to work together. It charters commercial fishing vessels for surveys of particular fish stocks or other scientific investigations, which are carried out on the normal commercial fishing grounds using the normal gear of the chartered vessels. The *Marine Fisheries Science Yearbook 2008/09* reports on these projects up to March 2009. Further information on all projects including those completed in 2009/10 and current projects is at: www.cefas.co.uk/our-science/fisheries-information/marine-fisheries/fisheries-science-partnership.aspx

The Marine Management Organisation runs the Fisheries Challenge Fund for short-term scientific projects, as well as economic and social projects, suggested by organisations with an interest in fisheries. There is information on the Fund at: www.marinemanagement.org.uk/fisheries/funding/fcf.htm and project reports are at: www.marinemanagement.org.uk/fisheries/funding/fcf_projects.htm

There is a brief overview of Marine Fisheries Science 2009/10, including the Fisheries Science Partnership and Fisheries Challenge Fund projects in the *Fishing Focus Supplement* at: www.defra.gov.uk/foodfarm/fisheries/documents/fisheries/fishfocus18-supp.pdf

# Research themes

# Economic and social research in the marine environment

## Information needs and approaches for assessing the socio-economic impacts of MCZ networks (MB0104)

Through the Marine and Coastal Access Act, Marine Conservation Zones (MCZs) will be designated in English territorial waters and offshore waters of England, Wales and Northern Ireland. The Act states that the design of MCZ networks may have regard to any economic or social consequences of designation, which is being interpreted as 'seeking to minimise any economic and social impacts where this is consistent with the achievement of conservation goals'. Defra commissioned a review of how socio-economic factors have been taken into account in other marine protected areas and other planning initiatives and of socio-economic data requirements to recommend best practice in designating MCZs.

The process of network design adopted in the marine protected area case studies was generally iterative: network proposals were developed, tested and refined against ecological and socio-economic criteria with the involvement of stakeholders. The review recommended a staged approach with a high level of stakeholder involvement for including socio-economic considerations in the development of MCZ networks (Figure 1).

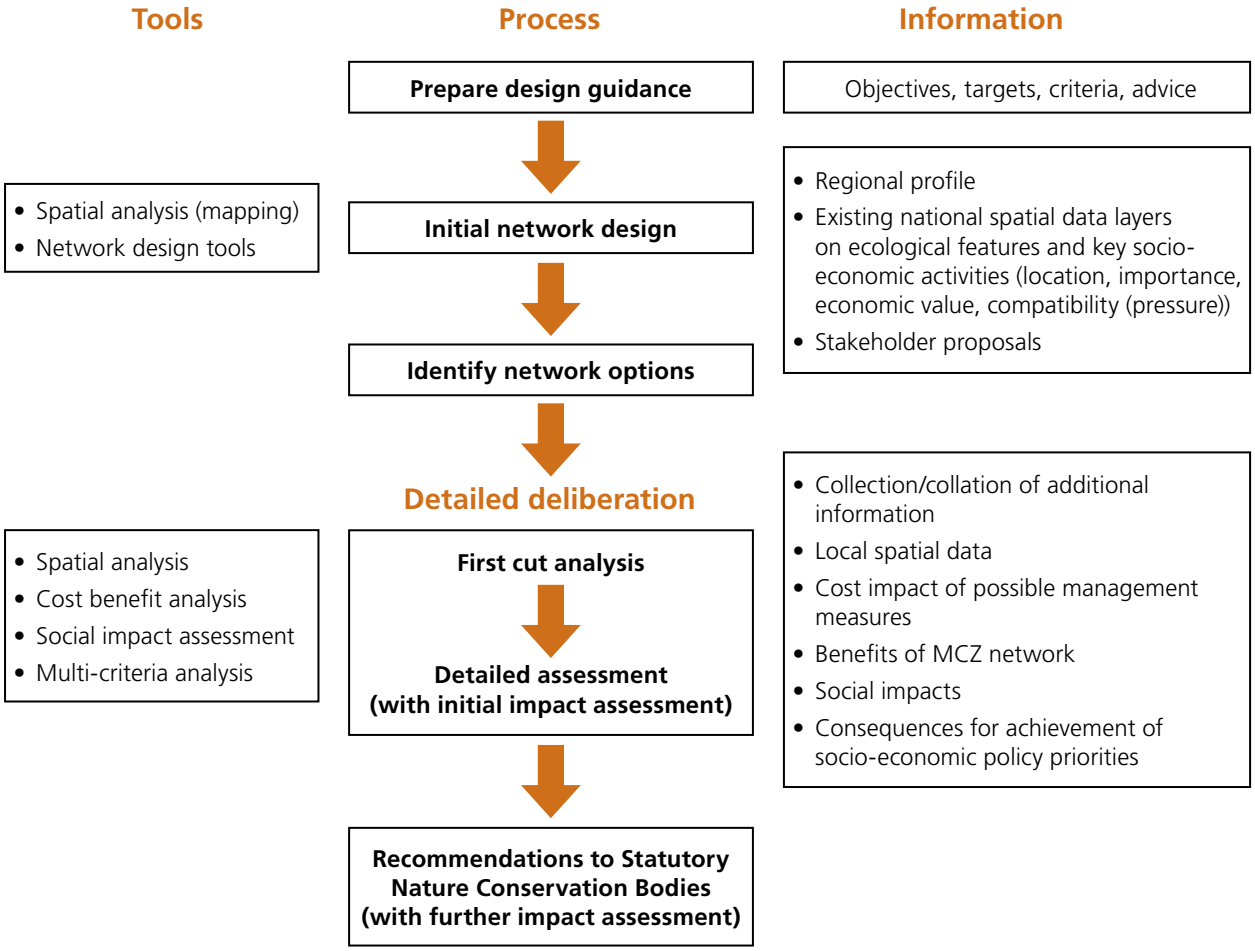



**Figure 1: Possible process for including socio-economic factors in MCZ planning.**

At initial stages, the project recommended mapping the location of socio-economic activities and using simple spatial analysis tools to compare and evaluate the options, identifying the extent and severity of possible interactions. In later stages, it recommended including a wider range of socio-economic data, for example, market structure, operational regimes, dependencies and interactions, economic value, pressures and impacts and the costs of restriction measures to support achievement of conservation objectives. A variety of assessment tools was recommended, including cost benefit analysis and social impact assessment. These analyses could generate information leading to final iterations of network design.

This work has provided guidance for the regional MCZ projects on how to take account of socio-economic factors in MCZ planning and has indentified data requirements. It is also useful for marine planning in considering trade-offs between social, economic and environmental factors.

## The effectiveness of the Economic Link in UK fisheries management (MF1207)

Only UK-registered vessels can fish UK quota stocks and any vessels fishing these stocks are required to demonstrate an Economic Link with the UK to ensure that the value obtained from these stocks benefits the UK. They must meet one of a range of conditions relating to landings of quota stocks in UK ports: residency of the crew in UK coastal areas; operating expenses spent in UK coastal areas; or benefits to populations dependent on fisheries, usually by donating quota to the UK under 10 metre fleet pool. After a decade of operation, it was time to assess the value of the contribution of UK-registered foreign-owned vessels to the UK economy, identifying the proportion of this attributable to the Economic Link; and to evaluate options for reform of the Economic Link.

The Economic Link has the greatest impact on 75 UK-registered, foreign-owned vessels which are responsible for more than half of the overseas landings of UK stocks. Of these, the most economically important are the Anglo-Dutch, fishing demersal species in the North Sea, landing their catch almost entirely in the Netherlands and complying with the Economic Link through quota donations; and the Anglo-Spanish, fishing to the west of the British Isles (Figure 2).

| Port | Percentage of landings by UK-registered foreign-owned vessels in 2007 | Nationality |
|---|---|---|
| Hull | 99% | Anglo-Icelandic |
| Milford Haven | 63% | Anglo-Spanish |
| Lochinver | 37% | Anglo-Spanish |
| Ullapool | 26% | Anglo-Spanish |
| Grimsby | 20% | Anglo-Icelandic (14%) Anglo-Dutch (6%) |
| Scrabster | 12% | Anglo-Icelandic (9%) Anglo-Spanish (6%) |

**Figure 2: Landings at some UK ports by UK-registered foreign-owned vessels.**

Between 1999 and 2007, by comparing landings before the introduction of the Economic Link, Anglo-Spanish vessels appear to have landed more catch in the UK than they would have without the link. These landings were estimated at about £5-8 million sales value a year. Quota donations were valued at £1-3 million a year. The additional UK crew income through the Economic Link was estimated at about £0.4-2.2 million a year. Using standard

multipliers (indicating how the economic benefits from landings and resident-crew earnings ripple through the local economy), the annual benefit to the UK economy of the Economic Link was estimated at about £5-10 million, with quota gifting and crew residency being the most effective contributions.

The project has provided Defra with options for reform including extending the landings condition to include a requirement to both land and sell, or process, a certain proportion of the catch in the UK; revising the Economic Link conditions to favour UK residency of crew and quota gifting; testing whether crew residency is sufficiently enforceable; and introducing levies on all landings to fund both enforcement and monitoring activities as well as the provision of infrastructure.

## North East England Sustainable Fisheries Community Interest Company (MF1215)

The Sustainable Access to Inshore Fisheries (SAIF) Advisory Group indicated that significant reform of the current fleet system may be required to ensure the sustainability of inshore fisheries and combat market failure where overcapacity was depleting stocks. Defra decided to explore the options for setting up a self-sustaining structure (possibly a Community Interest Company) to help address the barriers that businesses in the inshore fleet and related sectors face in North East England.

Interviews with fishermen and information from fisheries organisations and other UK projects indicated two preferred models: a social enterprise model with voluntary membership based around a quota trust; and a statutory model based around membership being given free to current fishing enterprises and direct management of the pool quota. These two options were considered against four scenarios: that the current management system and environment continues; that better balance is obtained across the inshore fleet; that there is a rigid demarcation between inshore and offshore fisheries; and that shellfish management measures may be introduced. The conclusion of the report was that, currently, it does not seem feasible to establish a Community Interest Company for the inshore fleet in the North East of England. However, the principle of a quota trust would be viable under certain scenarios and although the options may not be viable in themselves, a combination could provide a feasible solution but would require significant public funding as well as grants from the European Fisheries Fund.

This work is helping the Sustainable Access to Inshore Fisheries (SAIF) project to explore practical options and ensure that any proposed changes to management of the inshore fleet are based on a sound footing.

**Figure 3: North Shields harbour.**

# Human pressures and impacts on the marine environment

## **Harmful algal blooms as an indicator of nutrient enrichment caused by human activities** (ME2208)

Phytoplankton are microscopic plant-like organisms living in marine and freshwater habitats, which photosynthesise to produce energy. The rapid growth of one or more species is called a 'bloom', many of which are, natural events that are important, for example for the productivity of our coastal waters. The enrichment of coastal waters with plant nutrients from human activities such as fertiliser run-off from agricultural land can fuel phytoplankton growth and under the right conditions stimulate blooms. Occasionally, such blooms have harmful effects on marine ecosystems (such as deoxygenation of water as algal matter settles to the sea-bed and is broken down) or prevent our use of coastal waters (e.g. for aquaculture). Evidence of a link between enrichment and the occurrence of harmful species and harmful algal blooms in some coastal waters has led to the view that a link exists in a wide range of coastal regions and that the occurrence of harmful algal blooms diagnoses eutrophication (undesirable accelerated growth of algae and other plant caused by nutrient enrichment). Defra wanted clear evidence of whether harmful algal blooms could to be used an indicator of eutrophication.

Scientists agree that excessive addition of nutrients from human activities can result in eutrophication, unless conditions (such as the light available for growth and physical characteristics of mixing and dispersion) restrict growth and the build-up of algal biomass. They also agree that harmful algal blooms can occur naturally. There is, however, no scientific agreement on an explanation for changes in the frequency of harmful algal blooms. Trends in blooms were found to be affected by several factors, including accidental transport of species between coastal regions and natural changes in climate related to ocean currents. This makes the use of harmful algal blooms as a reliable indicator of eutrophication difficult. Data sets from coastal waters of the UK and the Republic of Ireland were used to

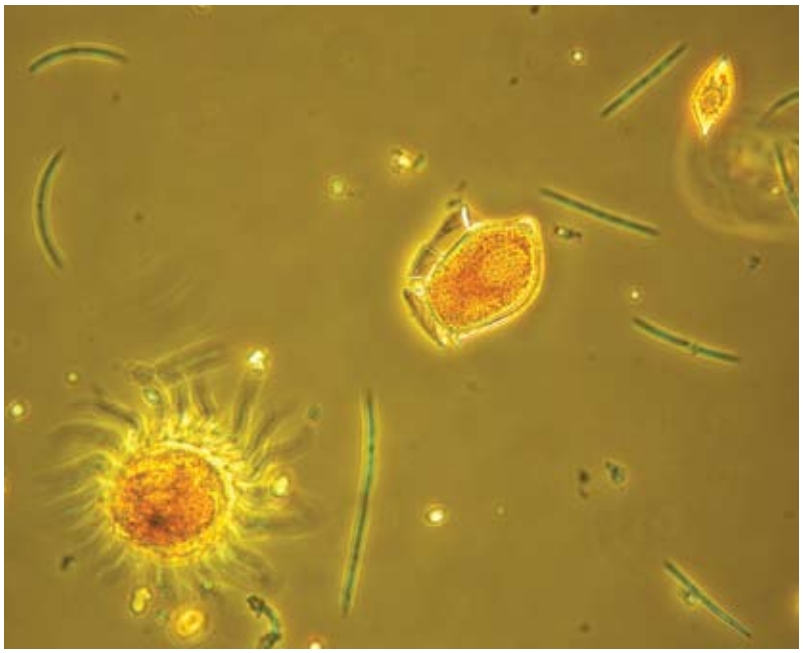


**Figure 4: *Dinophysis acuta*, a species of phytoplankton which produces chemical toxins. When filtered by shellfish, the toxins can be transferred through the food chain to humans and cause 'shellfish poisoning'.**

test whether the abundance of bloom species increases with nutrient enrichment caused by human activities. The results did not confirm an increase. It was concluded that the occurrence of blooms and the abundance of bloom species should not be used to diagnose eutrophication in UK waters unless a link to human activity causing nutrient enrichment can be demonstrated. Also, evidence of links in one coastal region should not be taken as evidence of links in other coastal regions.

The findings are being used by Defra to promote scientifically sound and ecologically relevant indicators of marine ecosystem health. They will help to determine whether blooms and bloom species should be used to decide the eutrophication status of OSPAR maritime areas as part of its assessment process. The findings will help to improve the classification of the eutrophication status of coastal and marine waters in OSPAR, and the EU Water Framework Directive and the Marine Strategy Framework Directive.

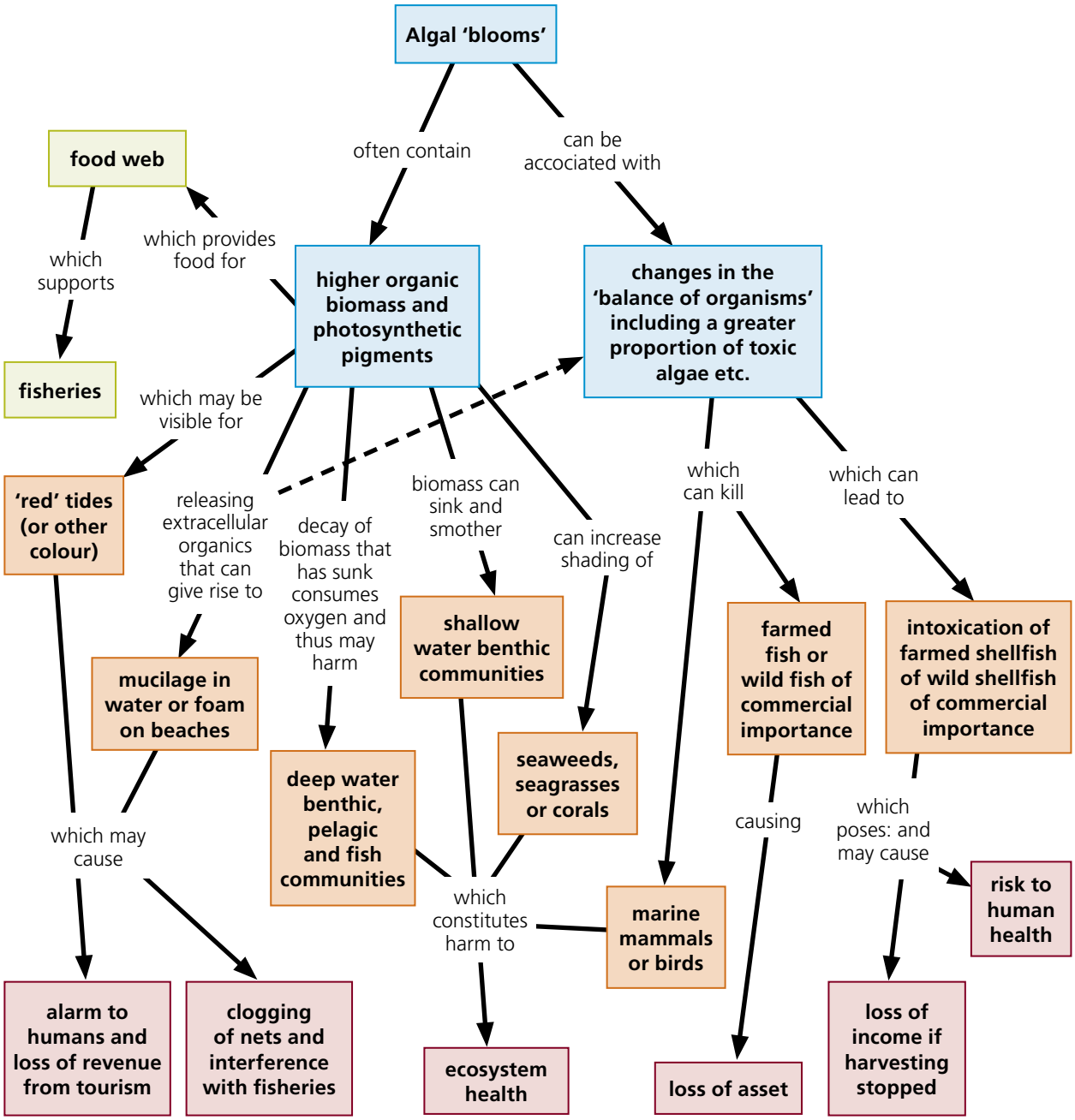



**Figure 5: Algal blooms and their effects on ecosystem health and the human use of the marine environment.**

## Impact of climate change on fish stocks and implications for marine ecosystems and sustainable fisheries (MF0434)

Climate change has already altered marine ecosystems around the UK, where the rate of climate change over the past 25 years has been among the highest in the world, with Atlantic surface waters adjacent to the UK warming by between 0.5 and 1°C since the mid-1980s. Climate change is an additional pressure that interacts with fishing, habitat disturbance and other human pressures. Measures for achieving sustainable fisheries (e.g. precautionary reference points) and for clean, healthy and productive marine ecosystems (e.g. the descriptors of Good Environmental Status in the Marine Strategy Framework Directive) will change as the climate changes. The size and rate of future climate driven changes therefore have to be taken into account to ensure robust management measures. Defra funded this project as part of the ICES/GLOBEC Cod and Climate programme, which brings together scientists from around the North Atlantic.

Comparisons of cod stocks across the whole North Atlantic showed that their growth, recruitment and role in the ecosystem is influenced by temperature and other climate-related factors (e.g. salinity in the Baltic Sea). Scientists found that the resilience of fish species and ecosystems depends on all the pressures acting on them and "blame" for species decline cannot be allocated to single causes. They advised that while fisheries continue to be the main pressure on fish stocks and marine ecosystems, management efforts to reduce the level of fishing should have the highest priority. They also advised that climate and other environmental changes which alter the productivity of ecosystems and species must be taken into account in setting the targets and reference levels (e.g. fishing levels) for

**Figure 6: Transition from cool (left side) to warm (right side) fish community that is beginning to take place in the southern North Sea and the Baltic Sea.**

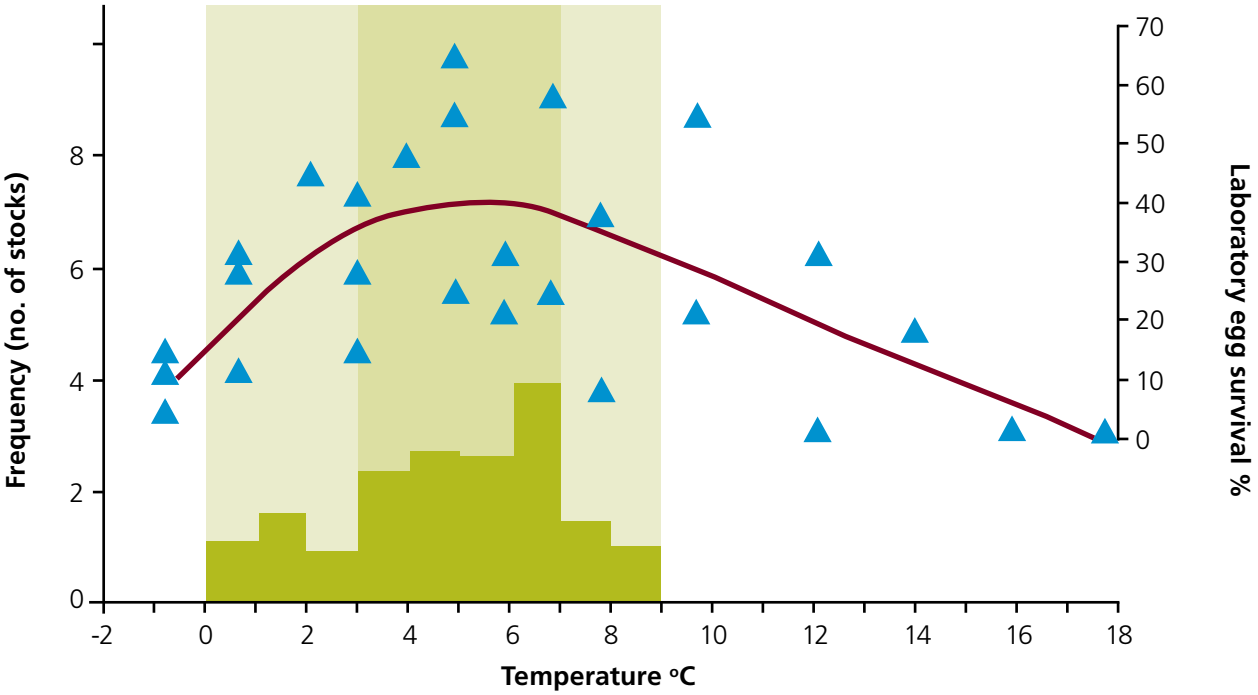



**Figure 7: Temperature at which North Atlantic cod spawn and survival of the eggs.**

management to avoid stock collapses. They reported that fisheries are causing evolutionary changes in fish stocks that may reduce long-term yields. The rate of these changes is quite slow, but management measures to halt undesirable genetic changes (or induce desirable changes) should be supported.

The project findings are informing fisheries management, the conservation of biodiversity, and indicators of Good Environmental Status under the Marine Strategy Framework Directive. They are also being fed into OSPAR, the reform of the Common Fisheries Policy, and climate impact reports, including the UK Marine Climate Change Impacts Partnership report cards.

## Environmentally responsible fishing – quantifying the environmental footprint of inshore fisheries (MF1005)

The inshore fleet is of socio-economic, cultural and historical value to local communities and some of these under 10 metre vessels are generally thought to have a lower environmental footprint than large offshore trawlers. There was, however, a gap in information on where these vessels fish, what they catch, what they land and discard, and the costs of their fishing activity. This information was needed to assess the biological and economic components of their environmental footprint.

The project collected data on the fishing position, catches and discards from each tow or haul of gear of 31 under 10 metre vessels from the Hartlepool, Lowestoft and Thames Estuary areas, targeting finfish. Vessels were fitted with a satellite monitoring system and skippers completed log books on their fishing activity. To provide information on the full catching capacity of the inshore fleet and as an incentive for providing significant quantities of data, they were allowed to land all catches outside quota regulations under derogation from the European Commission. All costs were also recorded. Indicators of the environmental footprint of the fishing operations were estimated through, for example, analysing the weight of fish caught in relation to fuel consumption or $CO_2$ emissions.

There was no real difference in the fishing profit margin of the vessels when grouped by area or by gear type. A wide variation among vessels was likely to relate to the experience, skill and motivation of the skipper. The project vessels, unrestricted by quota, had higher catch rates and higher landings volume (Figure 8) than comparable vessels with uncapped licences, illustrating that there is more catching capacity in the inshore fleet than is needed to land the currently permitted volumes of fish. The success of the project was based on the diligence with which the participants completed their log books and provides an excellent example of the level of data collation that can be achieved through close collaboration between scientists and fishermen.

The project filled gaps in the evidence base of Defra's Sustainable Access to Inshore Fisheries project, which aims to develop a strategy for long-term sustainability in English inshore fisheries. The substantial imbalance between permitted fishing opportunities and catching capacity in the English under 10 metre fleet has implications for future management. The detailed data can also be useful for marine planning and for assessing the impact of marine protected areas.

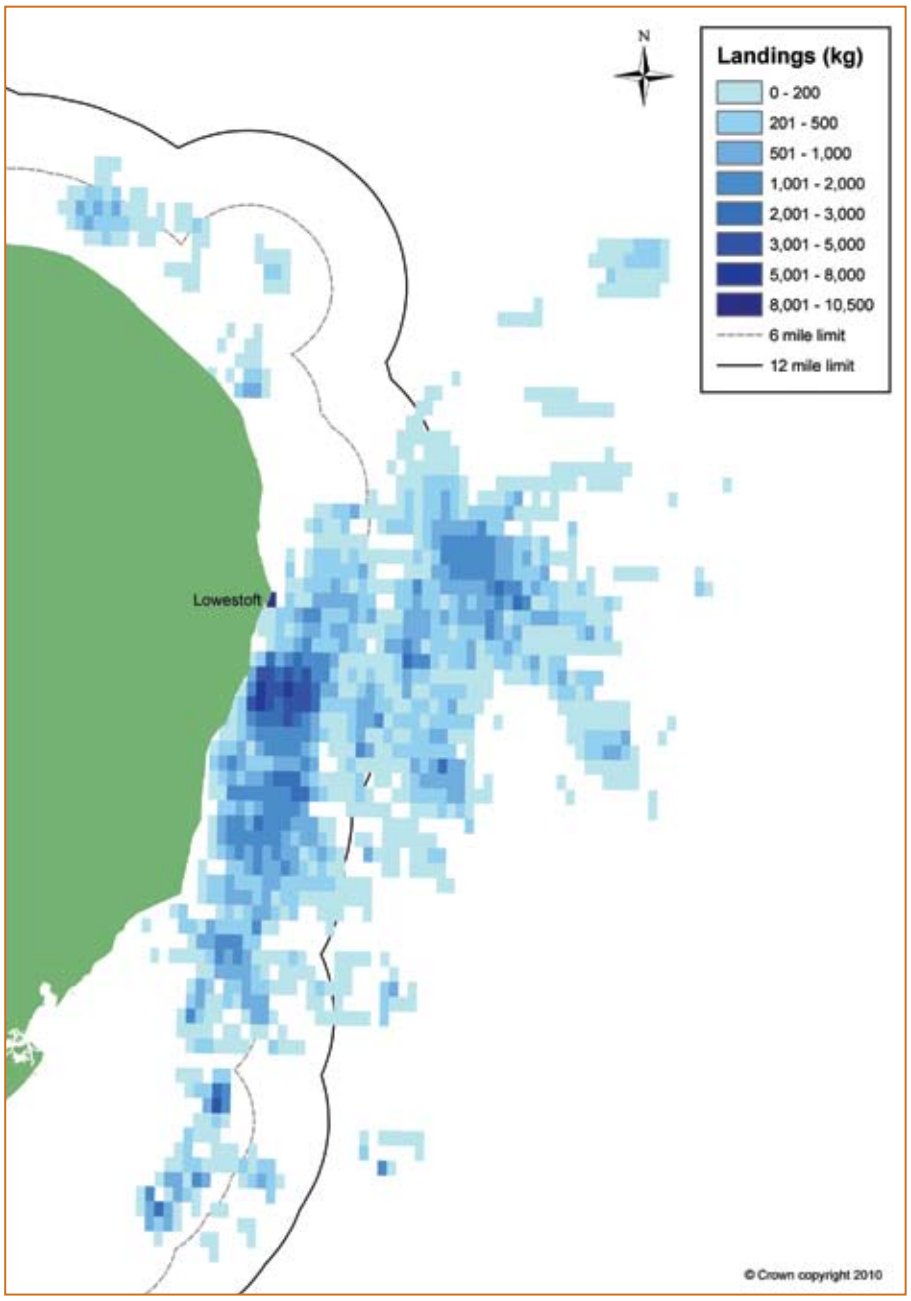



**Figure 8: Distribution of landings from Lowestoft vessels – highest densities are shown in darker shades of blue.**

# State of the marine environment

## **Areas of rock in UK marine waters** (MB0103)

Rock habitats are important for conservation as they are often home to a wide variety of plants and animals (Figure 9). We need to understand the distribution of rocky habitats to meet the requirements of the EU Habitats Directive and the Marine Strategy Framework Directive and for marine planning and the selection of sites for marine conservation. National geological maps of the seabed however may not identify some areas where rock habitat is covered by a very thin layer of sediment.

The British Geological Survey was commissioned to prepare a map of the distribution of rock at, or near, the seabed surface. It re-analysed over 75,000 samples and examined 152,986km$^2$ of new data from Multibeam Echosounder Systems to highlight areas where rock outcrop is likely to occur. Using this information, it prepared the first clear, comprehensive map of the distribution of seabed rock across all areas of the United Kingdom Continental Shelf. It also completed a confidence assessment displayed in the form of a layer (information represented graphically on a map) to accompany the seabed rock map. This layer highlights that in many areas of the Continental Shelf, the quality and quantity of data is limited. The results showed extensive areas of rock (usually in the form of rock platform) present offshore southern England and north-east England. Figure 10 shows rock in the south-west region and an assessment of confidence in the results based on the amount and quality of data and the range of data sources used.

The provision of seabed data by several Government Departments and agencies enabled the British Geological Survey to prepare a comprehensive map to a common standard for use by Government Departments and public bodies and marine industries. It has also used the data to update its own seabed sediment maps (e.g. DigSBS250 – see: www.bgs.ac.uk/products/digitalmaps/seabed.html).

The map is providing information for delivering the network of marine protected areas to meet existing international and national obligations and commitments. The four regional Marine Conservation Zones projects (e.g. Finding Sanctuary) are using the map particularly to identify reef habitats for possible Marine Conservation Zones under the Marine and Coastal Access Act 2009.

**Figure 9: Example of marine rocky reef habitat.**

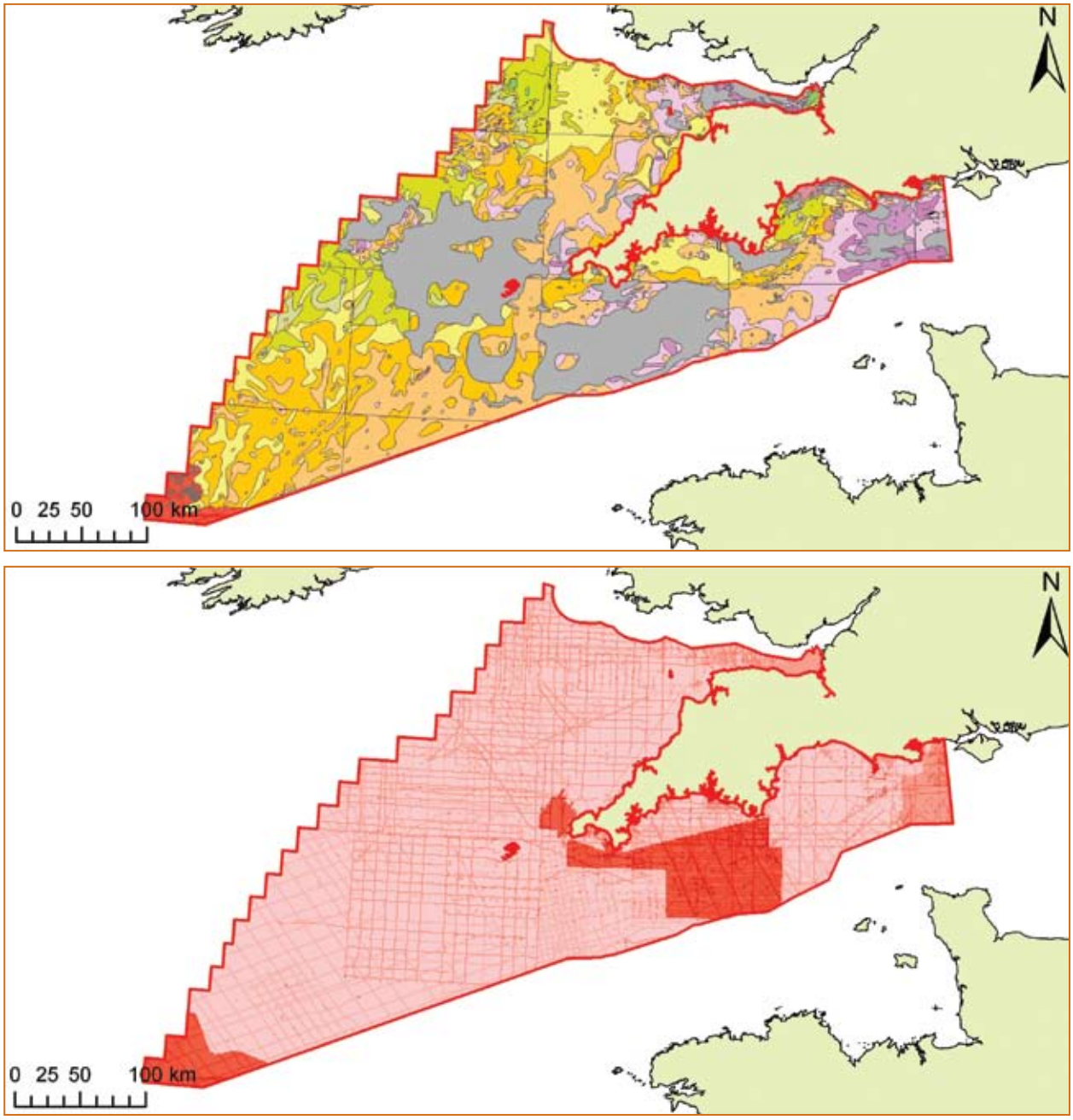



**Figure 10: Upper map shows the distribution of rock at the seabed in dark grey, overlain on the sea bed sediments for the Finding Sanctuary project area. Lower map represents the confidence levels for this data set – darker shading indicates higher confidence.**

## European marine ecosystem observatory project (ME4136)

Defra has found it resource intensive to identify, access and integrate a wide range of data from monitoring and modelling to underpin environmental assessments, for example the assessments of eutrophication required by OSPAR and also for the Nitrates Directive. This programme of work set out to address this problem.

The work built on earlier work putting in place a consortium, the European Marine Ecosystem Observatory (EMECO) to develop an integrated approach to co-ordinating and making better use of marine observations at a European scale. This project funded the development, with input from end-users, of the EMECO web-based Datatool (Figure 11),

which is available at: www.emecogroup.org/overview.aspx. The Datatool is a mechanism to integrate data from multiple sources in a transparent way to create maps of variables relating to eutrophication for the North Sea and the seas to the west of the UK. It includes over 20 variables ranging from temperature to chlorophyll and water quality. It can produce averages for variables by day, week, month or year.

The Datatool will be able to inform the UK initial assessment of Good Environmental Status for the Marine Strategy Framework Directive, as well as initiatives such as the EU/GMES MYOCEANS programme, ICES working groups, EU data initiatives (e.g. EMODNET), the OSPAR Eutrophication Committee and the National Centre for Ocean Forecasting.

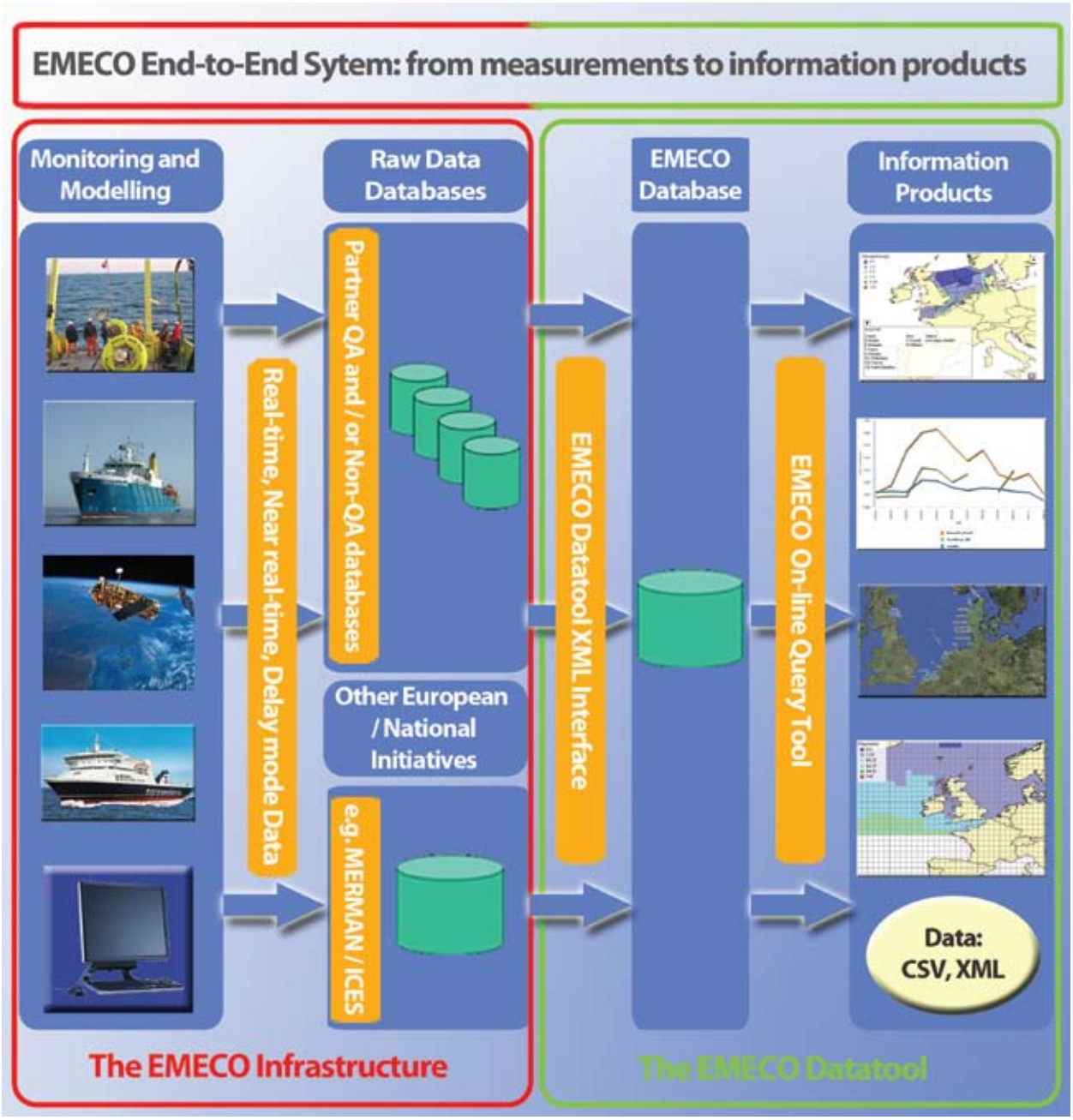



**Figure 11:** **EMECO Datatool.**

## The effect of the environment on fish stock behaviour (MF0154)

Fish behaviour is affected by a range of factors, but there is increasing attention on the role of the environment, particularly temperature, because of concerns about global and local changes in climate. Some studies have suggested that populations of cold-adapted fish, like Atlantic cod, will move north in response to warming seas, to be replaced by warm-adapted species, like European seabass. Understanding the causes of movements and behaviour of commercially exploited fish is essential to develop more accurate mathematical models to help us predict how stocks will respond to changes in the environment and fishing pressure.

Cefas collected new, and collated existing, data to obtain about 70,000 days of behavioural data to assess the behaviour of Atlantic cod, thornback rays and European seabass in the North Sea and English Channel. Scientists found that individuals in the sub-stocks of the cod population in the North Sea and English Channel share the same behavioural characteristics, such as site attachment (even in migratory individuals); rapid and long distance migration (including homing migrations); and in some cases, clearly defined feeding or spawning 'hot spots'. Cod in different sub-stocks occupied a range of different depths and temperatures for different periods of time. Winter temperatures were similar for all cod, but summer temperatures varied between sub-stocks, sometimes exceeding 18°C. Thornback rays spent more time in shallow habitats in the Thames Estuary in summer. In autumn, individual rays ranged further, occasionally to the east or central North Sea or into the English Channel; and vertical movements were large, suggesting that individuals were swimming along seabed areas where gradients were steep and in deep areas in the central estuary. Data on European seabass showed evidence of rapid long distance (up to 400km) migration and of mid-water searching and deep diving behaviour (over 100m) during migration. At other times bass generally remained close inshore.

Mathematical models based on the data can be used to inform fisheries management. For example, the site attachment behaviour of cod and rays enables more accurate assessment of the benefits of closed areas or seasons; and data on the extent and timings of migration helps in assessing the prospects for recovery of depleted stocks through immigration. Models showed that habitat choice in cod does not solely depend on water temperature but also needs to take account of factors such as food availability. The results are relevant for the reform of the Common Fisheries Policy, and implementation of the Marine Strategy Framework Directive, marine protected areas and marine planning.

**Figure 12: Atlantic cod (*Gadus morhua*).**

# Science for integrated marine management

## **Managing contaminated sediments** (ME1104)

To improve the management of contaminated sediments, Defra needed more information on the extent of contaminated marine sediments in UK waters and on options for dredging and disposal of contaminated material. Some legal and liability issues also needed clarification.

The project collated all data on sediment chemistry into a single database. This indicated contamination by multiple metals in all the major industrialised estuaries in the UK, with high concentrations typically in inshore berth and dock areas. As an example, Figure 13 shows lead contamination in coastal sediments. The project also provided a technical review of sediment treatment options and established that there is capability in the UK to process the main contaminants of concern (TBT, metals, organics). It highlighted that sustainable maintenance of ports and waterways must include the control of historical and continuing sources of contaminants to marine sediments. It provided approaches to identifying sources and pathways of contaminated sediment and reviewed practical preventive measures. It also looked at ways of recycling dredged sediments on land.

This study, funded with Natural England and The Crown Estate, is helping to support the effective management of contaminated material dredged from UK marine waters. The outputs include comprehensive guidance for licensing agencies and developers. The work has focused on England, but the approach could be adopted across the UK.

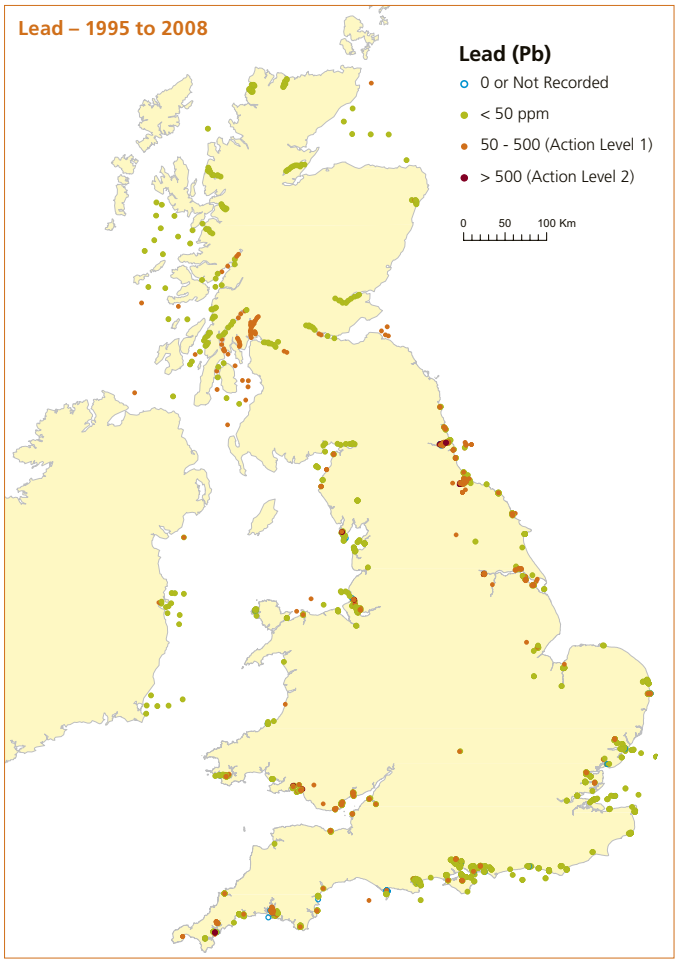



**Figure 13: Distribution of lead in UK coastal sediments generated using project GIS database. Colour dots represent metal concentrations in relation to the Cefas Action Level classification.**

## Testing procedures for oil spill dispersants (ME1309)

Chemical dispersants are the primary tool used to tackle oil spills, especially offshore (Figure 14). If applied correctly they can help minimise the damage of spills to marine habitats, but inappropriate use of dispersants can result in increased environmental impact. Therefore, the UK Government, through the Marine Management Organisation (formerly through the Marine and Fisheries Agency), regulates the use and approval of oil spill treatment products in UK marine waters through a statutory scheme requiring assessments for effectiveness and toxicity. There are periodic reviews with full stakeholder engagement to ensure that the approval scheme remains fit-for-purpose. Two outcomes of the 2007 scheme review were research recommendations to develop toxicity testing of dispersants for spills of heavier oil and to establish the differences in toxic potential of treatment when added neat rather than diluted with water.


**Figure 14: Dispersant spraying.**

**Figure 15: A Sea Test in progress.**

The UK already has a well established toxicity testing procedure for oil spill dispersants: the Sea Test (Figure 15). This compares the impact on brown shrimps of mechanically dispersed oil and of the same oil treated with a dispersant. Pass/fail criteria are based on the comparative mortality between the control (oil only) and test (oil + dispersant) treatments. Cefas modified the Sea Test for use with a representative heavy oil (a Falmouth sourced IFO180 fuel oil), selected after assessments of both dispersibility and toxicity. Cefas also investigated the toxicity of oil spill dispersants in the standard Sea Test when added as a Type 2 (water diluted) or a Type 3 (neat) and confirmed that toxicity was higher when a dispersant was added as a Type 3. The data sets generated for the new heavy oil test procedure and for the standard Sea Test using dispersant as a Type 3 were analysed to establish options for pass/fail criteria that could be implemented as part of the statutory approval scheme.

As regulator, the Marine Management Organisation can draw on the data from the project to update the UK scheme for approving oil spill treatment products and to set appropriate pass/fail criteria for use of dispersants to ensure that the scheme remains fit-for-purpose.

## **Practical tools for marine planning** (ME1420)

The Marine and Coastal Access Act introduced a marine planning system which will enable the UK Government and Devolved Administrations to move from a largely reactive licensing system to a forward-looking system to achieve sustainable development objectives. Marine Plans provide the mechanism to consider all the relevant activities in an area and make decisions based on reliable scientific data and evidence describing the impacts of activities on each other and on the environment. Tools were needed to help in the preparation of Marine Plans.

The project aimed to develop a set of tools to help with practical decision-making through the planning process. Following a review of marine planning tools and a stakeholder workshop on marine planning tasks and required tools, Cefas focused on developing prototype tools for use within a GIS to map human pressures, to assess the cumulative impacts of those pressures, and to identify conflicts of use. Cefas developed planning scenarios to assess the most suitable planning tools. Figure 16 indicates how such tools can be used to assess the potential pressure of aggregate dredging and the sensitivity of the marine resource. Cefas mapped data on human activities and pressures on the environment and developed a framework to assess cumulative impacts. These were translated into GIS software tools to enable the framework to be used in the planning process. Cefas tested the tools at national and local scales using simulated planning scenarios and different marine planning objectives. The project assessed how to prioritise efficient use of marine space by developing a set of tools that allow planners to see the level of interaction between activities when preparing regional plans and for site-specific licensing. It also developed a framework for gauging the sustainability of Marine Plans by assessing various options and proposals against previously agreed social, economic and environmental objectives/indicators.

Tools developed by this project can be used by the Marine Management Organisation (MMO) to prepare Marine Plans for English inshore and English offshore marine regions and to guide licensing decisions.

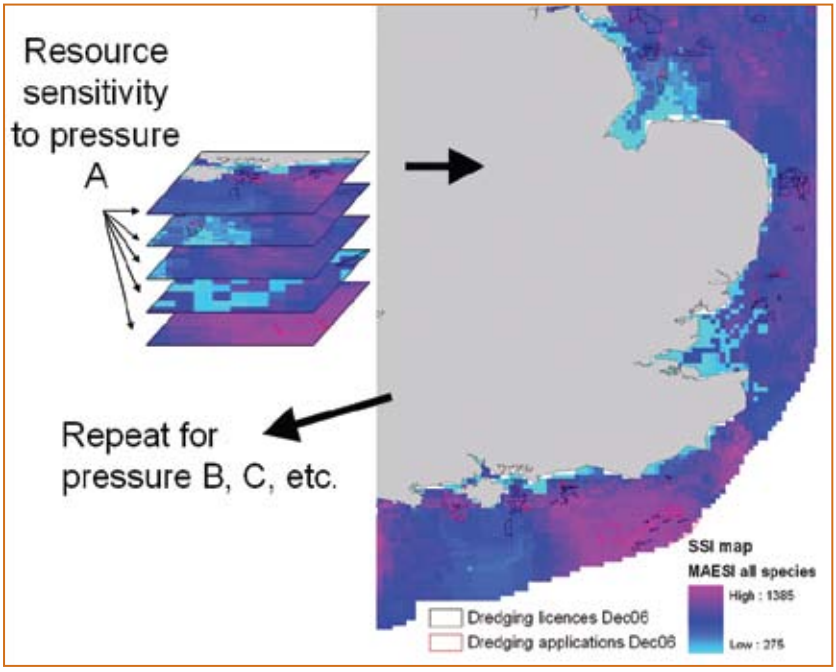



**Figure 16: An illustrative example of how a potential pressure (aggregate dredging), and the sensitivity of the resource can be assessed using 'tools'.**

# Projects completed in 2009/10 and current projects

# Economic and social research in the marine environment

## Projects completed between April 2009 and March 2010

### Fishermen's project

**(FC1301) Start date: February 2009 Completion date: December 2009**

To gain a better understanding of the attitudes, motivations and behaviours of fishermen to support policy development and to improve the way Defra engages with the fishing industry.

This project has provided a foundation for the Sustainable Access to Inshore Fisheries (SAIF) engagement strategy.

### Socio-economic data – determining how and what to take into account in the planning of marine protected area networks

**(MB0104) Start date: January 2009 Completion date: January 2010**

To understand and recommend how socio-economic data could be integrated into the planning of the UK Marine Conservation Zone network, including developing socio-economic data-layers.

This project has helped Defra to prepare guidance on how socio-economic data can be taken into account in developing Marine Conservation Zone networks and to identify the key data sets needed by regional Marine Conservation Zone projects for selecting sites.

### Scoping study for elements of the Marine Strategy Framework Directive impact assessment

**(ME5101) Start Date: March 2009 Completion date: June 2009**

To develop the evidence base for the Marine Strategy Framework Directive impact assessment.

This project outlined possible policy baselines against which the impact of the Directive could be measured. It assessed how each baseline could be used in the impact assessment, indicating their strengths and limitations. It also outlined possible scenarios, including their costs and benefits, for the measures which might be required to achieve Good Environmental Status under the Directive, beyond those already planned through other legislation and policy commitments such as the Marine and Coastal Access Act and the EU Water Framework, Bathing Water, Habitats, Birds and Nitrates Directives.

### Analysis of the effectiveness of the UK Economic Link in UK fisheries management

**(MF1207) Start Date: January 2009 Completion date: May 2009**

To evaluate the performance of the Economic Link licence condition against public interest objectives, particularly the vision of a sustainable fishing industry contributing to coastal communities in '*Fisheries 2027 – a long-term vision for sustainable fisheries*'.

This project assessed the historic performance of the condition, whether it was likely to be fit-for-purpose in the future, and it set out options for improving its operation. It contributed to thinking on the reform of the Common Fisheries Policy.

**Provision of Sustainable Access to Inshore Fisheries project research gap analysis**
**(MF1209) Start Date: June 2009 Completion date: October 2009**

To assess the adequacy of the existing evidence base for developing, implementing and evaluating long-term policy options through the Sustainable Access to Inshore Fisheries (SAIF) project which aims to reform English inshore fisheries to deliver a thriving and sustainable inshore fleet.

This project identified weaker research areas and suggested potential opportunities for further research to strengthen those areas.

**The potential benefits of a wealth-based approach to fisheries management: an assessment of the potential resource rent from UK fisheries**
**(MF1210) Start Date: June 2009 Completion date: March 2010**

To assess how fisheries policy makers and fisheries managers can ensure that fisheries wealth is used to benefit society by contributing to economies, rather than driving fisheries overexploitation.

This project provided an estimate of the potential UK fish resource rent (the amount left after exploitation costs and normal returns have been accounted for); three detailed case studies of UK fisheries and discussed the key policy implications. It is helping to identify changes needed to achieve sustainable fisheries.

**North East England sustainable fisheries**
**(MF1215) Start Date: October 2009 Completion date: March 2010**

To explore the options, including their advantages and disadvantages, for setting up a self sustaining, community-based framework (such as a Community Interest Company) that would address the barriers that businesses in the inshore catching sector face in North East England.

This project identified options for supporting the inshore fishing industry in the North East which could be useful elsewhere in England and will feed into the development of potential reform options through the Sustainable Access to Inshore Fisheries (SAIF) project.

**Economic approach to long-term reform of access to fisheries for the inshore fleet**
**(NE0105) Start date: January 2009 Completion date: September 2009**

To provide a snapshot of the economic performance of the inshore fleet by analysing the current definition of the inshore fleet (vessels of 10 metre length and under), exploring the availability of data to measure performance, and evaluating a number of possible future management options.

This project forms a major part of the economic evidence base for the Sustainable Access to Inshore Fisheries (SAIF) project, providing a baseline for average economic activity of the inshore fleet with which to assess proposed policy options.

## Projects continuing in 2010/11

### Women in fisheries

**(FC1302) Start date: January 2010 Completion date: April 2010**

To report views from women in fishing across the country and investigate how women could play a more prominent role in fisheries management.

This project provided information and advice for the Sustainable Access to Inshore Fisheries (SAIF) project, in particular its engagement strategy. It was partially funded through the European Fisheries Fund.

### Further development of marine pressure data-layers and ensuring the socio-economic data and data-layers are developed for use in the planning of marine protected area networks

**(MB0106) Start Date: October 2008 Completion date: December 2010**

To map the distribution of human activities in UK marine waters and provide information on the pressures associated with different human activities. This project used the data being collected by project MB0102 (see page 37).

This project will provide maps (pressure data-layers) to identify where socio-economic activities interact with conservation features to support the regional Marine Conservation Zone projects in Marine Conservation Zone site selection and for wider marine planning purposes.

### Adapting to future climate change in the marine environment

**(ME5102) Start date: September 2009 Completion date: August 2012**

To investigate the extent to which existing and future management measures and legislation (e.g. Marine and Coastal Access Act, EU Habitats Directive, EU Marine Strategy Framework Directive) are robust to future climate change, by exploring 10 year variations in climate change (associated with ocean-atmosphere processes) that might mask the overall warming trend of coastal waters over the next 20 to 30 years.

This project will provide insight into the socio-economic consequences of climate change in the marine environment and will help the 'future-proofing' of marine policies. It will indicate whether statutory instruments, targets and reference points might need future revision.

### Economic and social assessment for the Marine Strategy Framework Directive

**(ME5103) Start Date: March 2010 Completion date: January 2011**

To assess current (and expected) data availability, tools and methods for regional analysis, and recommend their practical application and priorities for further development. To help OSPAR assess options for regional economic and social analysis meeting the EU Marine Strategy Framework Directive's requirements. With OSPAR's guidance, to develop a detailed specification for a regional scale economic and social analysis for the Directive.

This project will help in understanding the Directive's requirements for economic and social assessment and will contribute to co-ordination of EU member states' national programmes of measures required under the Directive by 2015.

### Development and piloting of low cost vessel monitoring technology on English inshore vessels

**(MF1214) Start Date: March 2010 Completion date: July 2011**

To address a number of the limitations of a Vessel Monitoring System (VMS) and investigate additional opportunities, including developing a sensor system to detect and record when a vessel is fishing, and piloting VMS on a voluntary basis on 30 inshore (under 15 metre) vessels in the South West.

This project will inform policy making including on CFP reform and the Sustainable Access to Inshore Fisheries (SAIF) project; enforcement of marine protected areas nationally; and development of the Marine Management Organisation's inshore fisheries enforcement procedures.

### Social impacts of fishing

**(NE 0108) Start date: August 2009 Completion date: February 2011**

To investigate the social impacts of fishing. Working together with fishing communities, to explore the tangible and non-tangible impacts fishing has on fishermen and wider fishing communities.

This project provided social evidence in relation to the inshore fleet, an area of research which had previously been identified as underexplored, and this evidence will help inform the Sustainable Access to Inshore Fisheries (SAIF) project.

## Projects starting in 2010/11

### Assessing the economic impact of changes to fishing opportunities in 2011

**(MF1218) Start date: September 2010 Completion date: November 2010**

To assess the impact of changes in fishing quota and days at sea on the economic viability of the UK fishing industry as part of a Defra impact assessment on European legislation.

This project is helping to identify changes needed to achieve sustainable fisheries and will inform the UK position for fisheries negotiations.

### Market-led sustainability programme

**(MF1219) Start date: November 2010 Completion date: December 2011**

To provide the detailed and informed insight for developing effective ways of intervening in the market for fish. To identify the barriers and the incentives needed to produce effective market-driven behaviour changes to maximise the value from the existing catches (using a broader range of species); reduce reliance on the pressure stocks and wastage of natural resources; support fishing communities; increase revenue for fishermen and promote efficiency in the supply chain.

This project will help to deliver Defra's objectives to 'promote increased domestic food production' and 'pursue a zero waste agenda'. It will also contribute to reducing discards under the Common Fisheries Policy.

# Human pressures and impacts on the marine environment

## Projects completed between April 2009 and March 2010

### Modelling the impact of UK nutrients on other member states

**(ME2207) Start date: July 2007 Completion date: December 2009**

To review the current UK capability on ecosystem modelling on eutrophication and propose strategic work to fill gaps.

This project supported Cefas in its role as convenor of the OSPAR Intercessional Correspondence Group on Eutrophication Monitoring (ICG-EMO) and helped to ensure agreement between the technical experts nominated by each member state on the best methods for addressing OSPAR's objective to combat eutrophication.

### Harmful algae, nuisance blooms and anthropogenic nutrient enrichment

**(ME2208) Start date: June 2008 Completion date: October 2009**

To examine the relationship between blooms, ecohydrodynamics and nutrient enrichment, using phytoplankton data sets from UK, Irish and Norwegian waters. To identify the characteristics of the coastal regions causing enrichment and determine the conditions under which enrichment is more likely to encourage blooms.

This project found that the occurrence of harmful algal blooms and their abundance should not be used to diagnose eutrophication (nutrient enrichment) unless a link to human causes of nutrient enrichment can be demonstrated. Furthermore, evidence of a link in one coastal region should not be taken as evidence of a general linkage in other coastal regions.

### Biological effects methods for monitoring contaminants

**(ME4127) Start date: January 2008 Completion date: October 2009**

To evaluate Defra/Environment Agency/Natural England/ Natural Environment Research Council funded research on biological effects tools, and provide a clear guide to their application for management under the EU Marine Strategy Framework Directive. To develop and validate tools to assess the effects of contaminant mixtures. To develop and apply the techniques prescribed by OSPAR to produce data compliant with Analytical Quality Control.

The project defined the role of biological effects for management, ensuring the science is fit-for-purpose and for policy. It also supported the biological effects component of the UK marine monitoring programme, undertaken by Defra to meet UK obligations under OSPAR and helped to influence and guide the uptake of biological effects methodology internationally via OSPAR.

### Strengthening trans-Atlantic research programmes on ocean acidification, commercial fish and shellfish

**(ME5202) Start date: April 2009 Completion date: March 2010**

To enable a group of UK, US and Canadian fisheries scientists to identify priority experiments needed to understand the likely impacts of increasing ocean pH and $CO_2$ levels on fish and shellfish.

The group advised ICES and other organisations on future research needs; sharing responsibilities for conducting experiments; and co-ordinating progress and results. Its work has encouraged shared use of facilities and reduced duplication of experiments.

### Impact of climate change on fish stocks and implications for marine ecosystems and sustainable fisheries

**(MF0434) Start date: April 2006 Completion date: December 2009**

To improve forecasts of the response of the marine ecosystem to global change by developing an understanding of marine ecosystem structure and functioning under varying physical conditions.

This project helped to improve resource management of the marine ecosystem, especially for cod and other commercial stocks.

### Environmentally responsible fishing – a pilot research project to quantify the environmental footprint of inshore fisheries

**(MF1005) Start date: August 2009 Completion date: March 2010**

To collect data from inshore fishing vessels targeting finfish off the east coast of England on where they fish, what they catch, what they land and discard, and the costs of their fishing activity. To use this data to assess the biological and economic components of the environmental footprint of the vessels.

This project filled gaps in the evidence base for inshore fishing and was used to inform the Sustainable Access to Inshore Fisheries (SAIF) project. The findings on the substantial imbalance between permitted fishing opportunities and catching capacity in the English under 10 metre fleet have implications for future management measures. The data are also useful for marine planning and for assessing the impact of marine protected areas.

## Projects continuing in 2010/11

### Lyme Bay: A case study – assessing recovery of benthic species, spill over effects and socio-economic impacts

**(MB0101) Start date: August 2008 Completion date: March 2011**

To measure the recovery of benthic communities using indicator species and record changes to the scallop population in the area of Lyme Bay which, in July 2008, was permanently closed to scallop dredging and bottom trawling. To assess any socio-economic effects of the restrictions on fishing.

This project will be used to assess the effectiveness of marine protected areas in achieving conservation objectives; improve understanding of the socio-economic effects of restricting fishing; indicate where fisheries management and conservation objectives could be integrated; and establish an approach for cost-effective monitoring.

### Assessing survivability of bycaught porbeagle and spurdog and furthering our understanding of movement patterns in UK marine waters

**(MB5201) Start date: September 2009 Completion date: October 2012**

To assess the survival rates of porbeagle (*Lamna nasus*) and spurdog (*Squalus acanthius*) which are caught but returned to the sea. They will be tagged with electronic and simple marker tags, the information from these tags will be used to identify the times of year or particular localities where these species may be most vulnerable to capture as bycatch in commercial fisheries; to gather data on movement patterns of these species to help build up data to identify areas where they aggregate during key life stages; and to evaluate the technical measures that could help minimise bycatch mortality.

This project will combine these findings with assessments of the survival rates of porbeagle and spurdog after being discarded to assess the vulnerability of stocks to fisheries. It will also inform conservation measures that may be necessary.

### Assessing discard mortality of commercially caught skates (*Rajidae*) – testing results concluded from laboratory experiments

**(MB5202) Start date: July 2009 Completion date: March 2012**

To identify the skate species discarded in representative UK fisheries, their condition and discard survival rates, focusing on the fisheries with a high proportion of UK skate landings and on species/stocks of greatest management concern. To improve current estimates on discard mortality to allow better stock assessments.

This project will identify the risks to stock sustainability of continuing with current fishing practices and highlight where fishing practices can be improved to reduce discard mortality.

### Determining the toxicity profile of major oils transported in the European maritime area to establish the applicability of biological effects techniques

**(ME1311) Start date: May 2008 Completion date: September 2010**

To profile by toxicity the major oil types and hazardous and noxious substances transported in EU waters using the bioassays and biomarkers recommended by the ICES Working Group on the Biological Effects of Contaminants, and to produce a guidance document on the use of biological effects techniques for oil spills.

This project is meeting the request by the OSPAR Commission in 2006 for ICES to assess the long-term impact of oil spills on marine and coastal life.

### Development and improvement of analytical methods for marine monitoring

**(ME4117) Start date: May 2005 Completion date: March 2011**

To review annually existing analytical methods, used by Defra and other organisations, which assess a range of determinants, such as sensitivity and selectivity for organic and inorganic chemicals including novel compounds. To recommend new or modified techniques for analysing environmental samples, such as fish, shellfish, seawater and sediments.

This project will underpin the UK monitoring effort (National Marine Monitoring Programme, OSPAR and EU Water Framework Directive), and ensure Defra has access to accurate, effective, economic and up-to-date methods for environmental assessment. It will also ensure that Defra remains at the forefront in method development, and can meet new demands for monitoring contaminants and combinations of contaminants in the marine environment.

### Environmental indicators

**(ME4118) Start date: May 2005 Completion date: April 2010**

To provide a consistent approach to using environmental indicators to assist the regulation of human activities at sea, focusing on the operational use of indicators.

This project will help Defra, other Government departments and industrial stakeholders in defining or meeting marine environmental quality standards and performance measures under the Driving Forces-Pressure-State-Impact-Response approach.

### Ocean acidification research programme

**(ME5201) Start date: February 2009 Completion date: March 2014**

To reduce uncertainties in predictions of carbonate chemistry changes and their effects on marine biogeochemistry, ecosystems and other parts of the Earth System. To understand responses to ocean acidification and other stresses related to climate change affecting marine organisms, biodiversity and ecosystems, including improving understanding of their resistance or susceptibility to acidification. The programme is jointly funded by Defra, the Natural Environment Research Council, and the Department of Energy and Climate Change.

The programme aims to provide data and effective advice to policy makers and managers of marine bioresources on the possible size and timescale of the risks of ocean acidification to allow for development of appropriate mitigation and adaptation strategies.

### Monitoring and assessment of contaminant-related effects in the marine environment

**(ME5203) Start date: April 2009 Completion date: March 2012**

To develop a road map for changes to the offshore biological effect monitoring programme. To apply OSPAR's integrated approach to monitoring biological effects of contaminants on fish and invertebrates in coastal and estuarine ecosystems. To develop genomic technologies (e.g. gene microarrays) to improve monitoring and analytical quality control procedures in line with OSPAR requirements.

This project will contribute to the development of a more integrated approach for monitoring biological effects of contaminants and a more fit-for-purpose biological effect UK monitoring strategy under the Clean and Safe Seas Environmental Monitoring Programme. It will also help to develop and validate biological effects techniques, fulfilling our commitments under the OSPAR Joint Assessment and Monitoring Programme and the Co-ordinated Environment Monitoring Programme. With continued development, biological effects tools will help to determine Good Environmental Status, required under the EU Marine Strategy Framework Directive, and to define environmental quality standards under the EU Water Framework Directive.

### Chemical hazards and impacts in the marine environment

**(ME5204) Start date: September 2009 Completion date: March 2014**

To review existing research and techniques, fill knowledge gaps and plan for the future in relation to chemical hazards and impacts in the marine environment. The project covers passive sampling; emerging contaminants; flood risk sediments; modifiers to chemical risk; and human exposure to chemical contaminants.

This project will contribute to the current understanding of the impacts of chemicals on the marine environment, which is a priority for Defra under its national and international commitments (EU Marine Strategy Framework Directive, EU Water Framework Directive, EU Climate Change Directive, and UK Marine and Coastal Access Act).

### Identifying a range of options to prevent avian collision with wind turbines, using a UK-based case study

**(ME5206) Start date: March 2010 Completion date: October 2010**

To inform licensing of round three wind farm developments by collating key information on the collision risk to birds from offshore wind installations; identifying the range of existing and novel ways of reducing bird collisions; estimating the extent to which these options could minimise collisions; and contributing to the development of a quantitative model for the wind energy industry to use as a tool to reduce bird fatalities.

This project will help to fill a gap in evidence on the effects of wind farms on birds. The current mitigation option of a compulsory shut down of some or all wind turbines in a wind farm during, for example, migration or breeding seasons, seriously affects the financial viability of wind farm proposals and could halt the future expansion of offshore wind farms.

### Marine renewables

**(ME5208) Start date: December 2009 Completion date: December 2014**

To determine impacts and benefits of large scale marine renewable energy projects to enable Defra to demonstrate the benefits of including environmentally-focused, as opposed to technologically-driven science, in thinking about energy needs.

This project will help to answer questions on the extent to which ecosystems can continue to deliver essential life supporting services when wave energy is extracted from the marine system; on the magnitude and extent of the consequences/impacts of wave energy extraction on ecosystem services; and on whether there is a balance to be struck. It will also assist in delivering the environmental science needed to inform marine renewable energy development, while meeting EU Marine Strategy Framework Directive requirements and designating marine protected areas.

### Practical steps towards reducing discards and developing more environmentally responsible fisheries

**(MF1002) Start date: April 2008 Completion date: March 2013**

To develop technologies which minimise discarding (and therefore environmental impact) to the practicable minimum across all English and Welsh fishing fleets. To work with the fishing industry and other agencies using techniques and tools developed under research project MF0738 to reduce discards, for example gear modifications, improved onboard catch handling, and fishing pattern alterations.

This project will provide advice and tools for the industry and allow Defra to quantify the patterns and causes of discards, including assessing the effectiveness of new ways of reducing discards. It is hoped that the work will help the industry to shift towards reduced discarding and more environmentally-responsible fishing. The project is also using social research to understand fishers' discarding behaviours and help facilitate local solutions to the problem. For example, Project 50% (see: www.cefas.co.uk/our-science/fisheries-information/marine-fisheries/fishing-gear-technology/project-50.aspx) was a pilot under this project to combine social research with gear selectivity trials to help improve the long-term uptake of more selective gear designs to reduce discards.

### Mitigating cetacean bycatch

**(MF1003) Start date: April 2008 Completion date: March 2011**

To work with the fishing industry and Seafish to test and develop methods to reduce cetacean (dolphin and porpoise) bycatch in nets, particularly through the use of acoustic deterrent devices (also known as 'pingers'). To analyse data, for example collected by the observer bycatch monitoring scheme, to match bycatches of non-target species with particular fishery characteristics.

This project will build on our understanding of how certain species (notably harbour porpoises and common dolphins) become entangled in fishing gear. It will provide advice and technical solutions to industry to reduce bycatch of cetaceans.

## Projects starting in 2010/2011

### Effects of underwater noise on coastal fish and crustaceans: behavioural responses in the field

**(ME5205) Start date: September 2010 Completion date: August 2013**

To carry out experiments to obtain data on the direct effects of human-generated noise on a number of commercially important fish and crustacean stocks, including trying to define harm/disturbance and the sources and sound levels. To provide an evidence-based tool to forecast the effects of human-generated noise on marine species.

This project will increase understanding of the effects of sound on fish and shellfish behaviour. It will inform Defra policy making and provide evidence for the assessing and setting targets for Good Environmental Status under the EU Marine Strategy Framework Directive. It will also inform industry and guide regulatory and consenting agencies, such as the Marine Management Organisation, in assessing applications for activities. It may lead to more precise valuations for cost benefit exercises when conflicting interests arise from the multiple uses and users of the UK's coastal areas.

### The impact of anthropogenic noise on fish and invertebrates at the individual, population and community level

**(ME5207) Start date: September 2010 Completion date: August 2013**

To conduct experiments on how different human-generated (anthropogenic) sound sources and noise types (e.g. continuous) affect the tolerance, welfare, behaviour and development of individual organisms of a variety of species of fish or invertebrates at different life stages.

This project will feed into the model being created by project ME5205 (see page 32) and add to the information ME5205 provides. By considering the impact of noise at both individual and ecosystem levels, we should be able to predict future population sizes and community structures, which affect economic and policy decisions. It may also help to provide evidence to underpin conditions on licensing decisions, such as stopping piling work at spawning or migration times for certain marine species.

### Using northern fulmars as an ecological monitor of marine litter in line with indicators set for the MSFD descriptor 10

**(ME5209) Start date: July 2010 Completion date: December 2012**

To investigate the amount of plastic in the stomachs of northern fulmars, which are oceanic foragers, as a way of monitoring the amount of litter on the surface of the sea. To add 2006-2011 data to the 2002-2006 data which the Netherlands supplied to the UK.

This project will inform the EU Marine Strategy Framework Directive (MSFD) descriptor 10 on marine litter. It will give the UK a data set to use to indicate the presence of marine litter in the environment, and any trends over time. It will contribute to OSPAR EcoQO monitoring in the North Sea, providing a comparison between OSPAR regions.

### Monitoring ambient noise for the Marine Strategy Framework Directive

**(ME5210) Start date: October 2010 Completion date: March 2013**

To provide information on the current state of ambient (continuous low frequency) noise in UK marine waters and to identify baseline values for different environmental conditions. To collect data on ambient noise at strategic sites to assess site specific sound levels and to investigate seasonal variations in noise.

This project will provide the data needed for the ambient noise indicator for measuring Good Environmental Status under descriptor 11 in the EU Marine Strategy Framework Directive. It will be used to assess the monitoring effort needed by the Directive for underwater noise, including the location of monitoring stations, the equipment necessary and the most cost effective way of monitoring.

# State of the marine environment

## Projects completed between April 2009 and March 2010

### Developing the necessary data-layers for Marine Conservation Zone selection – distribution of rock/hard substrata in UK offshore waters and England territorial waters

**(MB0103) Start date: September 2008 Completion date March 2010**

To produce a digital data-layer (map) of the distribution of rock and hard substrata at or near the seabed surface for English and Northern Ireland territorial waters and UK offshore waters.

This project is helping regional Marine Conservation Zone projects to identify and select Marine Conservation Zones, particularly reef habitat types.

### Deep sea habitats – contributing towards the completion of a deep sea habitat classification scheme

**(MB0105) Start date: January 2009 Completion date: May 2009**

To map the seabed landscape, along with the distribution of surface sediment types, by interpreting and integrating acoustic, geological and geomorphological data sets from deep sea areas. To present the results in a form compatible with the European Nature Information System habitat classification scheme.

This project is helping the regional Marine Conservation Zone projects to identify sites by providing a coherent classification scheme for deep sea habitats.

### Mapping spawning and nursery areas of species to be considered in marine protected areas (Marine Conservation Zones)

**(MB5301) Start date: July 2009 Completion date: January 2010**

To update the current spawning and nursery ground maps with new survey data for 40 fish species, which are being considered as priority species as part of the designation of marine protected areas under the Marine and Coastal Access Act. To use data from a range of sources to develop GIS maps of spawning and nursery grounds.

This project assists Defra and the regional Marine Conservation Zone projects in selecting Marine Conservation Zones and informs fisheries management.

### Broad scale mapping of hard substrates in the central English Channel – providing an evidence base to support regional management

**(ME1102) Start date: April 2006 Completion date: September 2009**

To provide information on the distribution, extent and character of potential EU Habitats Directive Annex I reef habitat in the central English Channel to help in selecting Special Areas of Conservation (SACs). To compare communities of gravel habitats across the central and eastern Channel to underpin regulatory decisions on gravel regions likely to be affected by dredging. To help in developing adaptive survey strategies and provide guidance on best practice for surveying rocky reef habitats.

This project has provided the extra data needed to identify and locate Annex I reef habitats in UK offshore waters so they can be assessed against the SAC selection criteria in time to meet the UK's commitments in 2010 under the Habitats Directive.

### Assessment of marine biodiversity linked to ecosystems

**(ME3109) Start date: October 2004 Completion date: September 2009**

To contribute to the successful management of marine ecosystems by adopting a scientifically robust approach to monitoring environmental change, based on the ecosystem approach to environmental management.

This project has provided statistical tools to judge ecosystem improvements and give the UK a measure of biodiversity to meet the objective for assessing environmental status and change, required for implementing the ecosystem approach as agreed at the Fifth North Sea Conference, and included within the EU Water Framework Directive, the EU Marine Strategy Framework Directive, and the Marine and Coastal Access Act.

### Climate change contributions for OSPAR Quality Status Report 2010

**(ME4134) Start date: July 2008 Completion date: June 2009**

To carry out observations linked to existing marine fieldwork programmes at key locations around the UK and to enable the new information on pH (measure of acidity or alkalinity) to be set in the context of the variability in the physical characteristics of water and nutrient cycle conditions determining the observed pH.

This project has provided information for OSPAR, without which it would be impossible to assess the potential threat to UK marine waters of acidification resulting from the uptake of increased levels of $CO_2$ into the sea.

### Assessment of assessments

**(ME4135) Start date: November 2008 Completion date: October 2009**

To assemble information on scientific, social and economic assessments completed by United Nations agencies and global treaty organisations, regional organisations, national governments and other organisations. Defra and many other international sponsors funded this work, which was then critically appraised to determine how well the assessments had been communicated to international, national and regional policy makers.

This project has provided a framework for progress towards a global marine assessment, and proposed starting the first global integrated ocean assessment by 2010.

### European marine ecosystem observatory project

**(ME4136) Start date: December 2008 Completion date: March 2010**

To develop tools to generate new information by drawing together the wide variety of data from monitoring and research, including models. To use this knowledge to strengthen the evidence base for assessment of the eutrophication status in the UK.

This project provided a platform to meet the requirements of assessing Good Environmental Status under the EU Marine Strategy Framework Directive and has promoted agreement amongst national agencies responsible for providing advice to the UK Government on Good Environmental Status

### Linking the behaviour, spatial dynamics and environment of cod and ray populations to evaluate fisheries scenarios

**(MF0154) Start date: April 2004 Completion date: September 2009**

To incorporate environmental and biological data sets into a computer-based model of fish migration to help to predict how stocks will respond to changes in the environment and fishing pressure.

This project is particularly informing fisheries management under the Common Fisheries Policy.

### Spatial and genetic structuring of edible crab populations

**(MF0230) Start date: January 2005 Completion date: July 2009**

To provide genetic information on the stock structures of edible crabs (*Cancer pagurus*) in the English Channel and North Sea. To determine the population of origin of each crab by genotyping (determining the genes from DNA) individual larvae.

This project improved stock assessments of edible crabs and determined the most appropriate spatial scale for the management of crab fisheries. The project also highlighted the key role of female crabs and hydrodynamics (water movements) in determining population stability and fragmentation.

### ICES/GLOBEC project office

**(MF0429) Start date April 2006 Completion date: December 2009**

To support the ICES/GLOBEC (Global Ocean Ecosystem Dynamics) project office which exists to help with implementing the cod and climate change programme strategic plan, and other co-operative international studies on the effects of climate change on the marine ecosystem.

This project has helped to improve forecasts of the response of the marine ecosystem to global change by developing an understanding of marine ecosystem structure and functioning under varying physical conditions. It is contributing to resource management of the marine ecosystem, especially for cod and other commercial stocks.

### Detecting predation of fish eggs and larvae

**(MF0432) Start date: July 2005 Completion date: February 2010**

To develop molecular tools to detect the presence of eggs and larvae of several commercial species in the stomachs of predators. To test the reliability of these methods in laboratory experiments; and to use the methods in the field to identify the range of predators responsible for egg and larval mortality.

This project found that changes in predator-prey interactions can increase mortality in the early life history stages of commercial fish, such as cod and plaice, and damage stock viability or inhibit stock recovery. It is informing policy advice to Defra and the EU on recovery plans and long-term sustainability of stocks under climate change.

### Review of development and application of electronic tags for fish

**(MF1111) Start date: January 2010 Completion date: March 2010**

To review of all the research that has been undertaken by Cefas and supported by Defra into tag development over the last 20 years.

This project has provided a history of electronic tag development, indicating how tagging has helped to develop our understanding of fish biology to improve fisheries management.

### Ocean fluxes south of Denmark Strait – part of an integrated Arctic Ocean observing system

**(SD0440) Start date: December 2005 Completion date: November 2009**

To improve information allowing us to predict changes in the ocean-atmosphere-cryosphere system of northern seas.

This project has increased our lead time in mitigating or adapting to climate change caused by reductions in the polar reservoirs of ice and freshwater. Climate models predict that the perennial Arctic Ocean sea-ice will disappear in late summer within a few decades. This would affect the North Atlantic's thermohaline circulation which modulates climate and have socio-economic impacts.

## Projects continuing in 2010/2011

### Marine protected areas – gathering/developing and accessing the data for the planning of a network of Marine Conservation Zones

**(MB0102) Start date: October 2008 Completion date: December 2011**

To develop data-layers for identifying and designating a network of Marine Conservation Zones. To review webGIS access systems available for marine data display; assess end-user needs for webGIS; and advise on the suitability of existing systems and development of a system for planning marine protected areas.

This project will provide data for selecting Marine Conservation Zones to ensure that they are based on the best available science. It will also be useful for marine planning by the Marine Management Organisation.

### Continuous plankton recorder

**(ME3108) Start date: August 2006 Completion date: March 2011**

To maintain and increase data collected for many decades by the continuous plankton recorder over the north-west European Shelf and in the eastern and western north Atlantic. To retain and improve our survey skills in logistics, maintenance of equipment, taxonomy, identification, analysis and data processing. The data will be analysed for climatically-forced, human impact and natural plankton variability.

This project provides data for investigating the effects of pollution and increased inorganic nutrient loads on pelagic ecosystems; monitoring changes in marine biodiversity to help develop indices of ecological health of UK regional seas; and informing Defra agencies and initiatives (e.g. climate and ecosystem modellers). It will contribute to Defra's understanding of the health of marine ecosystems and provide key data for policy commitments (e.g. OSPAR Quality Status Reports and ICES, climate change, and the ecosystem approach). It will also annually update the plankton database (WinCPR).

### Marine ecosystem connections

**(ME3205) Start date: May 2005 Completion date: March 2011**

To determine key ecosystem connections that are susceptible to change through understanding the flows of carbon and nitrogen between marine ecosystem components and how changes in environmental conditions, or human disturbances, can impact on these components. To advise on the undesirable effects of nutrient enrichment, and the development of indicators for assessing these effects.

The project will advise Defra on all aspects of ecological indicator selection for the marine environment, supporting the ecosystem approach to environmental management and commitments to OSPAR and the Fifth North Sea Conference.

### Support for UK input to the OSPAR Quality Status Report and Charting Progress 2

**(ME4130) Start date: October 2007 Completion date: March 2011**

To produce the UK information for the OSPAR Quality Status Report. To develop a specification for a UK (and regional) annual report card to supplement the Charting Progress report by enabling regular reporting on data showing progress towards achieving the EU Marine Strategy Framework Directive's descriptors of Good Environmental Status.

This project will ensure the UK fulfils OSPAR requirements and is in a good position to deliver the UK report on the initial assessment of our marine environment under the Marine Strategy Framework Directive, required as the first stage of implementing the Directive. It also contributed to the production of Charting Progress 2 and will assist an annual review of progress.

### Defining the degree of acidification of UK waters and potential future changes

**(ME4133) Start date: August 2008 Completion date: January 2011**

To enable new information on acidity (pH) to be set in the context of the variability in hydrographic and biogeochemical conditions determining acidity through observations as part of existing marine fieldwork programmes at key locations around the UK.

This project will provide essential information for assessing the potential threat to UK marine waters of acidification resulting from the uptake of increased levels of $CO_2$ into the sea.

### Mapping the structure, function and sensitivity of seabed sediment habitats to support assessment of the sea-floor status and the broad scale monitoring and management of the benthic environment

**(ME5301) Start date: April 2009 Completion date: March 2013**

To develop quantitative measures of the ecological function of seabed sediments and apply these to map the sensitivity of sediment habitats which, when combined with maps of human pressures, will enable evidence-based assessments of the health of the seabed.

The project will inform the assessment of 'sea-floor integrity' under the EU Marine Strategy Framework Directive and provide measurements for setting environmental targets. It will also contribute to the development of the Directive's monitoring programme and the indicators for achieving Good Environmental Status.

### Research supporting improved understanding and assessment of ecosystem health

**(ME5302) Start date: April 2009 Completion date: March 2013**

To build on project ME2202 (see page 44) to improve our understanding and assessment of eutrophication through work on three themes: 1) Assessing eutrophication and ecosystem health, which is a descriptor for the EU Marine Strategy Framework Directive and addresses the requirement to reduce human-induced eutrophication; 2) Pixels to Policy, which aims to ensure Defra benefits fully from the outputs of the EU MyOcean programme, a three-year action plan to create an European 'Marine Core Service' looking at ocean monitoring and forecasting; and 3) Diversification and analysis of existing data to ensure the full range of data required for the Marine Strategy Framework Directive can be met.

This project will help to improve the monitoring, assessment and management of eutrophication in the context of wider pressures on ecosystem health, as required by the Marine Strategy Framework Directive

### The EMECO Western Shelf Observatory

**(ME5303) Start date: September 2009 Completion date: March 2011**

To enable a group of UK, US and Canadian fisheries scientists to compile a list of priority experiments that need to be conducted to understand the likely impacts of increasing ocean pH and $CO_2$ levels on fish and shellfish.

This project will provide ICES and other interested parties with information on future research needs; encourage shared use of facilities; reduce duplication of experiments; and consider how to share responsibilities for conducting experiments and co-ordinating progress and results.

### Research supporting the extended SmartBuoy network

**(ME5304) Start date: August 2009 Completion date: March 2012**

To extend the network of SmartBuoys to a further two sites in UK coastal waters, by adding biogeochemical sensors to an Irish Meteorological Buoy in the Celtic Sea. To carry out research to improve our understanding of the current environmental status of our coastal waters and of methods for improving detection of its status.

This project supports Defra`s need for an improved evidence base for assessing eutrophication to meet a range of policy drivers including OSPAR, the Urban Waste Water Treatment Directive and the Nitrates Directive.

### Evaluating shelf-wide spatial and temporal changes in fish larval distribution over the last half century in relation to environmental factors and adult distributions

**(MF1101) Start date: July 2007 Completion date: June 2011**

To analyse Sir Alister Hardy Foundation for Ocean Science (SAHFOS) Continuous Plankton Recorder (CPR) fish larval samples from UK Shelf seas from 1948 to the present day and explore changes in larval abundance, distribution, timing and size in relation to the environment, plankton and adult fish. To assess how different species of fish have responded to past environmental changes at the critically-important larval stage.

This project will help managers to understand better and take account of the impacts of environmental change on commercial stocks and therefore manage fish stocks more effectively. It will also maximise the use of the long time-series of CPR data.

### Macro-ecology of marine fish in UK waters

**(MF1102) Start date: April 2007 Completion date: March 2012**

To improve our understanding of population biology and ecology for key species of commercial fish (e.g. cod, plaice, sole) and fish of conservation interest (e.g. skates and rays). To study relationships between fish population sub-units in spawning areas, on nursery grounds and on feeding grounds, how these vary year-on-year, and the contribution of the environment to such variation.

This project will provide the biological knowledge necessary to improve the management of fish populations into the future against a broad range of policy objectives and will reduce uncertainty in management advice.

### Spatial dynamics of edible crabs in the English Channel in relation to management

**(MF1103) Start date: April 2007 Completion date: March 2011**

To provide improved knowledge of the movements of edible crabs (*Cancer pagurus*) in the English Channel at local and regional scales.

This project is providing advice to Defra on the management of crab stocks, including the scale at which management measures are likely to be appropriate and effective.

### Spatial and temporal patterns in scallop recruitment and their implications for management

**(MF1104) Start date: April 2007 Completion date: March 2012**

To investigate the key biological and hydrographical processes governing the recruitment of scallops in the English Channel, and the possible effects of climate change on these processes. To develop a computer-based forecasting model for scallop populations, which includes information on where scallops are at different stages in their lifecycle based on new insights into scallop recruitment gained during the research.

This project will improve the quality of Cefas' advice to Defra on the management of scallop stocks, especially through management plans.

### The Continuous Plankton Recorder survey: fisheries investigations (CPR VI)

**(MF1105) Start date: May 2007 Completion date: March 2012**

To monitor and analyse the changes in plankton production and biodiversity associated with hydroclimatic changes in the north Atlantic over about 70 years. To further investigate links between plankton data and long-term changes in fish stocks over the north-west European shelf and in the north-east Atlantic.

This project will help to develop new approaches to fisheries management and conservation strategies. This is a continuation of Project MF0430.

### Demersal fish recruitment processes in the Irish Sea – generating and testing hypotheses based on high-resolution data on eggs, larvae and prey collected since 1995

**(MF1106) Start date: August 2009 Completion date: July 2012**

To investigate whether changes in fish recruitment associated with mortality at early stages affect the recovery potential of cod and haddock, using existing data on eggs and

larvae of demersal fish and the zooplankton prey of the larvae in the Irish Sea. To test whether mismatches with suitable prey in location or time; or different responses to their environment; or direct interactions between species can explain the difference in productivity of Irish Sea cod and haddock stocks observed over recent years.

This project will help in the development of effective management strategies for the Irish Sea demersal fisheries.

**Trends in the inshore marine community of the east and south UK coast: 1970s to present**

**(MF1107) Start date: September 2009 Completion date: March 2011**

To assess trends in species and community indicators and evaluate the effects of environmental factors and human activities on those indicators using data on the abundance and distribution of young fish, shellfish and epibenthos (animals and plants living on the sea bottom) in inshore habitats, collected by Cefas since the 1970s as part of the Young Fish Survey.

This project will provide information on ecosystem health, indicating how the status of inshore habitats has been affected by human impacts including climate change. It will inform management of the species studied, the ecological status of these areas and future activities that could be permitted within them.

**One hundred years of change in fish and fisheries**

**(MF1108) Start date: October 2009 Completion date: September 2012**

To recover, digitise, store and make accessible long-term electronic datasets from scientific research surveys and fisheries data dating back to the beginning of the 20th century. To map changes in the distribution of catches and effort of the fishing fleet over the last 100 years and identify changes in the size and age of fish and their relative abundance. To use this data to investigate how climate change and fishing have affected the distribution of fishing effort, fish abundance and food webs.

This project will provide long-term data sets which can be used to help calibrate models which reconstruct past changes in the ecosystem and fisheries. These models can be used to predict responses to future change.

**DAPSTOM Phase 3 – Understanding trophic interactions in the Irish Sea**

**(MF1109) Start date: April 2009 Completion date: September 2010**

To use fish stomach content data to describe how fish feeding preferences have changed in the last century and understand how changes in the abundance of cod in the Irish Sea has affected Norway lobster, as cod is thought to be its most important predator.

This project will attempt to provide more accurate predictions of the potential impact that changes in cod abundance might have on Irish Sea Nephrops stocks for use in fisheries management.

### The effect of climate variability on the distribution and abundance of squid in the North Sea

**(MF1110) Start date: October 2009 Completion date: January 2011**

To investigate the effects of climate on the abundance and distribution of squid in British waters, using data from the International Bottom Trawl Survey and fisheries activity and discard database. To assess the value of squid as a commercial species and estimate their potential impact on commercial species at higher levels in the food chain.

This project will increase knowledge of the relationship between squid and the environmental and climatic factors affecting them and their effect on the ecosystem.

### Cetacean strandings around the UK coast

**(WC0601) Start date: April 2007 Completion date: June 2010**

To analyse data for all cetacean strandings around the UK coast and determine the major causes of death in stranded cetaceans, including bycatch and physical trauma. To check the incidence of disease in stranded cetaceans to identify any substantial new threats to their conservation status. To investigate possible links between feeding behaviour, fisheries and stranded cetaceans by examining their stomach contents. To develop an integrated database on strandings and post-mortem findings which allows interrogation of data via the Internet.

This project will provide a co-ordinated approach to surveillance of cetacean strandings and investigation of major causes of death of stranded cetaceans in the UK. It will assist the UK in meeting its commitments under the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS) and the EU Habitats Directive.

## Projects starting in 2010/2011

### The Marine Environmental Change Network (MECN) – phase 4

**(ME5305) Start date: September 2010 Completion date: September 2013**

To develop novel approaches for data analyses and to address issues of comparability of the marine data sets and monitoring methodologies.

This project supports the work of MECN which provides policy makers and other end-users with information enabling them to produce more accurate assessments of ecosystem state and gain a clearer understanding of factors influencing change in marine ecosystems. It will contribute to the assessment needed for the EU Marine Strategy Directive and to assessments by the UK Marine Monitoring and Assessment Strategy community and the Marine Climate Change Impacts Partnership.

### BTO range expansion for fulmar collection

**(ME5306) Start date: October 2010 Completion date: March 2011**

To extend to south-west Britain the British Trust for Ornithology's (BTO) current collection by volunteers of fulmar corpses washed up on the tide line of the Orkneys, Shetland and Eastern England.

This project is contributing to project ME5209 (see page 33).

# Science for integrated marine management

## Projects completed between April 2009 and March 2010

### Integrated science for integrated management – developing the capacity for adaptive ecosystem management

**(AE1148) Start date: September 2003 Completion date: March 2010**

To evaluate new methods and the use of ecosystem quality objectives under various environmental scenarios, using a thematic approach. To provide advice on how to obtain a significant reduction in the loss of biological diversity by 2010 and recommendations for establishing representative networks of marine protected areas by 2012.

This project has helped to support Defra's European, OSPAR and United Nations commitments to apply the ecosystem approach for the sustainable development of the marine environment.

### Developing a database to promote the exchange of marine survey data

**(MB0108) Start date: February 2009 Completion date: May 2009**

To review marine survey data and metadata held by Cefas to ensure a consistent standard so that Cefas can meet the obligations of the 2009 memorandum of understanding between a number of UK agencies to promote the exchange, without charge, of mutlibeam survey data collected since 2003.

This project has ensured that mutlibeam survey data held by Cefas can be easily exchanged with other organisations.

### Contaminated dredged marine sediments: developing a management framework

**(ME1104) Start date: February 2007 Completion date: March 2010**

To improve the management of contaminated marine sediments in the UK by developing good practice guidelines. To work with industry and other stakeholders to interpret relevant legislation and regulations and evaluate options, solutions and beneficial uses of contaminated dredged marine sediments.

This project is helping to improve the management of contaminated dredged material.

### Oil spill treatment product testing scheme – research and development activities from the 2007 scheme review

**(ME1309) Start date: August 2008 Completion date: January 2010**

To develop and validate a new test procedure (based on the Sea Test) for approving products for use on heavy oils. To investigate the relationship of toxicity in the Sea Test when dispersants are added as type 2 or 3. To establish new separate pass/fail assessment criteria for dispersant approval for these two types.

This project allowed the UK to respond to the two main recommendations of the UK Oil Spill Treatment Product Approval Scheme Review in 2007 to ensure that response procedures are in place to enable prompt action to be taken to mitigate the likely environmental impacts of, for example, spilled oil. Reviews are needed to maintain an approved list of products for

use in UK and ensure that the testing and approval process and techniques remain fit-for-purpose in light of a changing shipping and response industry.

**Ecological risk assessment information data-mining and comparison**
**(ME1310) Start date: September 2008 Completion date: August 2009**

To investigate how to incorporate new and existing biotools into risk assessment methods for chemical spills, develop operational guidelines and disseminate the results widely throughout Europe via the EU-funded Ampera research network on accidental marine pollution.

This project supplied rapid, cost-effective and fit-for-purpose methods for understanding the environmental impact of oil and chemical spills and predicting the longer-term ecological consequences. The guidelines will support better integration of research activity into spill response mechanisms. The decision-making systems will support the adoption of best operational practice across EU member states and inform future EU policy.

**Coastal developments thematic programme: guidance and methodologies for managing marine activities**
**(ME1401) Start date: August 2004 Completion date: April 2009**

To deliver more effective approaches to assessing human activities in the marine environment by improving the robustness of the assessments of the environmental impact of marine disposals and constructions.

This programme has provided advice for policy makers on the environmental impact of marine disposals and constructions and greater transparency for stakeholders on how assessments are carried out.

**Development of practical tools to support the new marine planning system**
**(ME1420) Start date: May 2008 Completion date: December 2009**

To develop a set of tools to help with practical decision-making through the planning process.

The project is supporting the Marine Management Organisation's marine planning work. The tools have the potential for use in conflict resolution between competing activities as demands for marine resources grow; and in the effective management of resources and activities.

**Research supporting the development of eutrophication monitoring and assessment**
**(ME2202) Start date: April 2004 Completion date: May 2009**

To help to identify the key factors determining ecosystem susceptibility to nutrient enrichment and the resulting undesirable ecosystem effects of eutrophication.

This project has allowed Defra to support the national and international debate about the assessment and management of eutrophication. It is helping regulators and competent authorities to meet the requirements of the Urban Waste Water Treatment, Nitrates and Water Framework Directives and OSPAR.

### Data archive for seabed species and habitats (DASSH)

**(ME3111) Start date: October 2005 Completion date: March 2010**

To set up DASSH, the UK archive for marine biodiversity data. It is the accredited Data Archive Centre under the Marine Environmental Data and Information Network (MEDIN) framework and provides access to survey data and metadata to a wide audience including Government departments, statutory agencies, consultancies and the public.

This project is providing access to data to support marine planning and environmental impact assessments and to supply the evidence base to achieve Good Environmental Status under the Marine Strategy Framework Directive. Data from DASSH have supported the preparation of Charting Progress 2 and can assist in meeting the reporting requirements of the UK Marine Monitoring and Assessment Strategy (UKMMAS), the operational needs of the Marine Management Organisation, and the data needs for designation of protected areas through the regional Marine Conservation Zone projects.

### Marine Environmental Change Network III

**(ME3116) Start date: August 2007 Completion date: March 2010**

To co-ordinate and sustain a network of long-term data sets, providing a gateway for contributors to access processed data from various organisations without high costs. To promote and expand the Marine Environmental Change Network, seek funding for new measurements and expand and develop the Network's website and database.

This project has co-ordinated monitoring undertaken by the Network partners. Long-term data on the marine environment is limited, but is needed for the Marine and Coastal Access Act, the EU Marine Strategy Framework Directive and Water Framework Directive.

### Developing output tools for the National Marine Monitoring Programme database (MERMAN – Marine Environment Monitoring and Assessment National Database)

**(ME4125) Start date: May 2006 Completion date: April 2009**

To implement and manage the MERMAN database to provide quality controlled data for national and international assessments.

This project has provided management and support for MERMAN to deliver quality assured data as an evidence base to support policy decisions in the UK and Europe.

### Developing best practice to underpin UKMMAS: Protocol Marine Monitoring Manual

**(ME4126) Start date: February 2007 Completion date: May 2009**

To implement and manage the Marine Environment Monitoring and Assessment National Database (MERMAN) to allow the provision of quality controlled data for national and international assessments. It included advising on the final stages in the completion of the MERMAN database, implementing a data management plan and transferring data to ICES and other organisations.

This project has provided management and support for MERMAN to deliver quality assured data as an evidence base to support policy decisions in the UK and Europe

### Development of the global and regional assessments of the marine environment database

**(ME4132) Start date: March 2008 Completion date: October 2009**

To develop the existing searchable database to house marine assessments and other reports at a national and regional scale for the UK marine and coastal environment.

This project has made marine science information widely available (e.g. to the UK Marine Monitoring and Assessment Strategy (UKMMAS) and OSPAR) and ensures the most efficient use of available reports. This allows better identification of information gaps and targeting of future spending on marine monitoring and supporting existing regional and global strategies and processes. It enables the UK to hold information for national assessments, such as Charting Progress, in one location.

### OSPAR Climate Change Quality Status Report

**(ME4134) Start date: July 2008 Completion date: June 2009**

To co-ordinate and draft the climate change contribution for the OSPAR Quality Status Report in 2010.

This project has led the preparation of information for the OSPAR Quality Status Report 'Impacts of Climate Change on the North-East Atlantic ecosystem' and contributed to the drafting of Charting Progress 2.

## Projects continuing in 2010/2011

### Ecological consequences of dredging – a review of current practice

**(ME1101) Start date: October 2008 Completion date: March 2012**

To develop approaches, tools and guidelines for assessing the environmental impacts of dredging on sediments and the wider ecosystem.

This project, with the Environment Agency, will assist Defra in assessing the potential benefits from using dredged material for coastal protection and habitat conservation and enable the UK to support international and regional conventions involving dredged material disposal and biodiversity issues (e.g. OSPAR, RAMSAR, Rio Convention on Biodiversity).

### Strategic review of offshore wind farm monitoring data associated with FEPA licence conditions

**(ME1117) Start date: October 2008 Completion date: December 2010**

To review the monitoring reports on nine UK offshore wind farms prepared under the Food and Environment Protection Act (FEPA); compare findings against international information sources; report lessons learned; and make recommendations for future monitoring.

This project provided an overall picture of the effects of offshore wind farms in preparation for further development. It also provided an update to the April 2007 OSPAR report on the current state of knowledge on the environmental impacts of the location, operation and removal/disposal of offshore wind farms.

**Implementation of risk assessment methodologies for oil and chemical spills in the European marine environment**

**(ME1312) Start date: August 2008 Completion date: September 2011**

To develop fingerprinting tools for heavy oils and new products (hazardous noxious substances) and to assess their risk in spills in different European regional seas. The project will use the same data and the same protocols where necessary as project ME1311 (see page 29), to which it is linked.

This project involves multidisciplinary co-operation between leading European research groups in risk assessment of oil and chemical spills in the marine environment. It aims to define a European strategy for risk assessment of accidental marine pollution and will help support Defra's 2006 commitments to OSPAR.

**Chemspill**

**(ME1313) Start date: January 2009 Completion date: June 2010**

To provide a tool combining the best available hydrodynamic and wind field data with ecotoxicological information for modelling chemical spills, which are complex and less well understood than oil spills.

This project will provide information to allow prediction of the biological impacts of a chemical spill and increase the understanding of potential risks to humans, fisheries interests, coastal resources and the marine environment.

**Improving our understanding of climate change in relation to marine habitats and species**

**(ME3204) Start date: December 2005 Completion date: November 2010**

To run an effective Secretariat for the UK's Marine Climate Change Impacts Partnership (MCCIP).

This project assists MCCIP in providing a co-ordinating framework for Great Britain and Ireland for the transfer of high quality evidence of impacts to the marine climate and advice to policy makers.

**Combining sea and coastal planning in Europe**

**(ME5401) Start date: July 2008 Completion date: December 2011**

To achieve a seamless, integrated approach to land and sea planning and management, providing the foundation for strong, vibrant and sustainable coastal economies, which are in harmony with the environment.

This project, in partnership with the Belgian Government, will help to address pressures facing the coast from development, climate change, and competition for space between maritime sectors.

**A strategic review of environmental monitoring associated with large scale human activities in the marine environment, focusing on marine renewable energy and marine aggregates**

**(ME5402) Start date: April 2009 Completion date: May 2013**

To examine existing data (from licence conditions of consented activities) to review monitoring practices and recommend ways to improve monitoring efficiency. To assess if the

different monitoring regimes for the marine aggregate and offshore wind sectors provide appropriate information for licence decisions. To explore linkages between sector specific monitoring (e.g. of an individual offshore wind farm) and national and international data and reporting requirements (e.g. EU Marine Strategy Framework Directive, OSPAR). It builds on the review of objectives of Food and Environment Protection Act (FEPA) monitoring conditions on offshore wind farms (project ME1117 – see page 46), extending the approach to the marine aggregate sector.

The project will provide advice to industry and regulators on a consistent, coherent approach to monitoring of large scale developments within and across sectors. It will support policy and regulatory developments under the Marine and Coastal Access Act, contribute to achieving a single consistent regime, and promote consistency and efficiency in monitoring.

**R&D to support the licensing of dredging, disposal, renewable and general construction and associated monitoring under the Food and Environment Protection Act, Coast Protection Act and the Marine and Coastal Access Act**

**(ME5403) Start date: May 2009 Completion date: March 2014**

To identify methods to enable better, more transparent assessments of various human activities in the marine environment and provide guidance for stakeholders and the wider public on the approaches used to assess and manage these activities.

The project will inform Defra's policy for managing and advising on the impacts of human activities in the marine environment and will help the Marine Management Organisation to deliver its licensing activities.

**Strategic support for the Marine Strategy Framework Directive**

**(ME5405) Start date: April 2009 Completion date: March 2013**

To design a robust method for integrating the information on each Good Environmental Status descriptor to form an overall assessment of Good Environmental Status, taking account of variations in outcomes due to changes in monitoring scales and different levels of uncertainty.

This project will help the UK to meet its obligations in a co-ordinated way under the Marine Strategy Framework Directive, which requires EU member states to take measures to achieve Good Environmental Status in marine waters by 2020. It will also contribute to work for OSPAR and in Europe to deliver effective, pragmatic solutions for implementing the Directive.

**Knowledge-based sustainable management for Europe's seas**

**(ME5406) Start date: April 2009 Completion date: March 2013**

To provide an 'assessment toolbox' for developing and implementing emerging EU policy, at a regional sea scale and in member states' Exclusive Economic Zones. To develop the 'toolbox' using an ecosystem and socio-economic approach, working with regional liaison groups and a multi-sector project advisory board.

The project's 'toolbox' will be used to model the economic and social impacts of changes to ecosystem goods and services, and the costs and benefits of following options available through existing or proposed policy instruments (e.g. EU Marine Strategy Framework Directive and the Maritime Strategy Blue Book).

**Pollution response in emergencies – marine impact assessment and monitoring (ME5407) Start date: April 2009 Completion date: March 2012**

To develop and maintain guidelines setting out methods and information required for impact assessment in the short, medium and long term for responding to an oil or chemical spill in English and Welsh marine waters. To establish and maintain a network of national and regional experts, samplers, fisheries contacts, analytical providers and facilities that may be required at short notice to respond after an incident.

This project will put in place the expertise, resources, networks and logistical planning needed for prompt and effective impact assessment and monitoring of marine pollution, drawing on the national contingency plans and environmental advice mechanisms of the national authorities responsible for marine spill response in English and Welsh waters.

**Ecosystem approach to fisheries management (MF1001) Start date: April 2007 Completion date: March 2013**

To develop, test and report on indicators that allow managers and stakeholders to assess the status of the ecosystem and the impacts of fishing, and to develop decision tables that allow managers and stakeholders to see the effects of different management options and to choose from among them.

This project is conducting a pilot of an ecosystems approach to fisheries management in the south-west of England, providing information for policy makers on developing this type of approach.

**Bottom vulnerable marine ecosystems (VMEs) in the NAFO Regulatory Area (MF1004) Start date: January 2009 Completion date: March 2011**

To map potential vulnerable marine ecosystems which may occur in the Northwest Atlantic Fisheries Organisation (NAFO) Regulatory Area at depths less than 2000 metres. To study the distribution of fishing effort in the Regulatory Area.

This project will allow fishery managers to propose the closure of sensitive areas to bottom fisheries. Studies of vulnerable marine ecosystems are an important aspect of Regional Fisheries Management Organisations' compliance with United Nations General Assembly Resolution 61/105.

**A risk analysis framework for fisheries management (MF1201) Start date: April 2007 Completion date: March 2012**

To investigate how to adapt risk analysis theory, as currently developed and applied in a variety of fields, into a common framework for the identification, assessment, management and communication of risk for UK and European fisheries. To cover the full process from stock assessment, projection and advice, via management decisions, to the practical implementation of the management measures. To apply this to selected case studies working with others including Defra and EU project teams, ICES, Regional Fisheries Management Organisations and Regional Advisory Councils.

This project will provide a framework which will increase our capacity to understand and incorporate uncertainty and risk into fisheries management decisions. It will help to evaluate management choices on the trade-offs between biological, ecological, economic and social objectives.

### A strategic evaluation of ecosystem models in support of fisheries management (MF1202) Start date: April 2008 Completion date: March 2011

To assess how important the interactions are between predators and their prey in comparison with other sources of uncertainty in fisheries models, and help to predict knock-on, ecosystem implications of future management actions. To test and evaluate the usefulness of different modelling approaches for exploring wider ecosystem considerations of fisheries in the marine environment. To focus on two case study regions: the North Sea and the Western Approaches.

This project will provide clear guidance for applying multispecies and fisheries-related ecosystem modelling approaches which feed into fisheries management decisions.

### Improved understanding and management of recreational sea angling (MF1203) Start date: April 2008 Completion date: March 2011

To analyse and evaluate existing management measures and current recreational activity through case studies of species (bass, cod, tope, grey mullet and salmon), both in the UK and elsewhere (e.g. striped bass in the U.S.A.). To develop and pilot methods to estimate the level of recreational participation and catches in bass fisheries. To evaluate costs and benefits of potential management options for bass fisheries and to develop assessment and modelling techniques.

This project will allow fisheries managers to understand the impacts of the different sectors on fish populations and the implications of management on biological sustainability. It will support Defra's aim to improve the management of fisheries in relation to recreational sea angling in the UK, particularly in England.

### Improved understanding and management of shellfish fisheries (MF1204) Start date: April 2007 Completion date: March 2012

To model the possible responses of shellfish stocks and shellfish fishing fleets to different management options, using satellite monitoring data and catch and effort returns from the shellfish licensing scheme. To assess relationships between inshore and offshore shellfish populations and their response to exploitation, and assess the impact on the breeding potential of crustacean stocks of exploitation patterns which differ between sexes.

This project will give fisheries managers a better understanding of the way in which shellfish stocks and fleets respond to exploitation and will improve the evidence base for advice on the sustainable management of shellfish stocks.

### Development of tools for estimation of stock status under uncertainty (MF1205) Start date: April 2008 Completion date: March 2012

To develop and evaluate alternative methods for stock assessment and management focusing on stocks with limited data available. To develop approaches for generating robust management and assessment methods for a wide variety of stocks, fisheries and management regimes.

This project will help fisheries managers to develop management measures including providing them with better estimates of uncertainty in stock assessments.

### Developing fisheries management indicators and targets (project 1)

**(MF1206) Start date: October 2009 Completion date: June 2012**

To develop the tools to determine the economically optimal level of exploitation of European ecosystems under changing climatic conditions, while ensuring that the pressure exerted on both commercial stocks and susceptible fish species is biologically sustainable.

This project will provide information for policy makers and fisheries managers.

### Using fishery observer data to investigate technical interactions and management options for mixed fisheries

**(MF1208) Start date: April 2009 Completion date: August 2010**

To investigate alternative approaches to managing mixed fisheries using highly detailed data on fishing activity collected by Cefas observers. To identify the conditions that would need to be met for these measures to be effective in a mixed fishery.

This project will provide information for policy makers and fisheries managers.

### Bycatch and discards: management indicators, trends and location

**(MF1211) Start date: August 2009 Completion date: August 2012**

To describe the species and size composition of total catches and to analyse the factors determining the amount of discards. To investigate fishers' behaviour to understand if discarding is part of their fishing strategy.

This project will give fisheries managers an understanding of the general patterns and causes of discards. It will provide key information for developing operational indicators and propose ways of reducing discards.

### Developing fisheries management indicators and targets (project 2)

**(MF1212) Start date: October 2009 Completion date: June 2012**

To produce operational models of fish stock dynamics, taking into account the ecosystem changes caused by climate change and commercial fisheries harvesting. To combine these models with economic models taking into account broad social goals when applying values to fisheries production and management.

This project will develop fisheries resource indicators that combine economic, social and biological indicators that can be fed into the wider model produced by the project.

### Developing fisheries management indicators and targets (project 3)

**(MF1213) Start date: October 2009 Completion date: June 2012**

To produce the tools to determine the economically optimal level of exploitation of European ecosystems under changing climatic conditions, while also ensuring that the pressure on both commercial stocks and susceptible fish species is biologically sustainable. Work will include evaluating management options for protecting non-target species.

This project will reveal the trade-offs in performance across a range of management objectives. It will provide fisheries managers with the information on which to make rational decisions, given their objectives, preferences, and attitudes to risk.

### Food security, governance and FPA desk study

**(MF1216) Start date: March 2010 Completion date: April 2010**

To study food security, governance and Fisheries Partnership Agreements (FPAs) to describe the links between the Common Fisheries Policy and international fisheries governance. To identify aspects that could be included in Common Fisheries Policy reform to have a positive impact on international elements and those that need to be dealt with through other channels.

This project will inform the UK input to the reform of the Common Fisheries Policy.

### Management of marine finfish fisheries and monitoring under the EU data collection regulation

**Cefas fish stock monitoring contract – ongoing**

To provide the best scientific advice on the status of finfish stocks of interest to the UK, through monitoring and assessment of the most important commercial stocks.

## Projects starting in 2010/2011

### A fit-for-purpose plan to deliver key aspects of contaminant science under the Marine Strategy Framework Directive

**(ME5404) Start date: April 2010 Completion date: March 2014**

To deliver a flexible, fit-for-purpose monitoring strategy for UK contaminants that directs and supports current and future monitoring activities, providing state and trend data as needed.

This project is feeding into the data and evidence collection in UK offshore waters to support OSPAR and the EU Marine Strategy Framework Directive, which requires assessment of Good Environmental Status at a broad, regional scale. This approach contrasts with the scale of traditional site-based (Habitats Directive) or water body (Water Framework Directive) assessments and requires comprehensive judgements on a wide range of ecosystem components.

### Database development to increase the capacity for collection and analysis of marine litter data and the development of a training programme

**(ME5412) Start date: September 2010 Completion date: March 2011**

To develop a new Marine Conservation Society database, meeting Marine Environmental Data and Information Network (MEDIN), OSPAR and EU Marine Strategy Framework Directive requirements. To train Marine Conservation Society officers to follow the OSPAR beach litter monitoring manual to ensure the collection and recording of high quality data, following the revised OSPAR protocol.

This project will enable the Government to meet its responsibility under the Marine Strategy Framework Directive to monitor marine litter on the surface and in pelagic, benthic and beach/coastal zones. It will also enable the Marine Conservation Society to report to OSPAR on behalf of the UK.

### Microplastics in the marine environment – literature review

**(ME5413) Start date: October 2010 Completion date: March 2011**

To build up our evidence base to understand what constitutes harm from microplastics in the marine environment for the EU Marine Strategy Framework Directive.

This project will set out the benchmark of current scientific research and indicate if there are evidence gaps which may need to be addressed.

### Rame Head environmental impact study

**(ME5414) Start date: September 2010 Completion date: December 2010**

To review whether the original conditions under which the licences were granted to the Rame Head disposal site remain valid and environmental effects remain tolerable. To assess whether the existing evidence is fit-for-purpose and to advise the Marine Management Organisation on the nature of the sedimentary materials previously found at the site. To establish the range of local views on the disposal activities at the site.

This project will inform the independent review of the Rame Head disposal site being led by the Marine Management Organisation. It will also highlight unexpected consequences and future social, economic and environmental risks likely to be linked to the disposal site, including a sense of local scale and impact.

### Low cost VMS data analysis: assessment and applications

**(MF1217) Start date: July 2010 Completion date: September 2011**

To review and analyse the data collected by the 30 vessels equipped with the low cost Vessel Monitoring System (VMS). The analyses include assessment of the ability to discriminate fishing versus non-fishing events; comparison of the low cost VMS versus the over 15 metre boat VMS; and the benefits of additional environmental data collection.

This project builds on the project MF1214 (see page 26). It will inform the future development or implementation of a low cost inshore Vessel Monitoring System.

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