How can we integrate data and models to better understand the consequences of changes in marine ecosystems for the services they deliver to society?

Marine Theme Objective: Human Pressures and Impacts on the Marine Environment

What's the problem?

It is becoming increasingly clear that human activities and environmental change are having much wider consequences for biodiversity and ecosystem services than previously thought. The effects of change are difficult to predict because of our limited understanding of marine food webs, and how they respond to changes in pressures. Change may be driven from below ("bottom-up"), for example increased nutrients may increase plant growth, and in turn increase the amount of fish. Alternatively, change may be driven from above ("top-down") by reducing the numbers of predators, and therefore allowing larger numbers of prey to survive. In order to respond appropriately to such changes we need to improve our understanding of the UK marine ecosystem as a whole. A mechanism is needed to bring existing data together, target new data collection, and integrate data, models and ecosystem services within a common framework. The Marine Ecosystems Research Programme (www.marine-ecosystems.org.uk) is designed to provide the resources and investment needed to support this.

What are the aims of the project?

The overarching objectives of the Marine Ecosystems Research Programme are to:

1. Improve our understanding of how the regulation of key ecosystem services afforded by marine food webs, such as nutrient cycling, climate regulation, food production and recreation, are affected by 'top down' and 'bottom up' processes, the scale of these processes and the way that biodiversity influences ecosystem function at different levels of the food web.

2. Integrate the improved knowledge and understanding of how the regulation of key ecosystem services are affected by 'top-down' and 'bottom-up' processes with existing ecosystem models, in order to explore the impact of environmental change on the structure, function and services associated with marine food webs across a range of scales.

3. Apply the new model developments to test the impact of potential management solutions, such as marine conservation zones, on the structure and function of marine food webs across scales, and explore the efficacy of specific indicators of good environmental status.

Figure 1: Human interaction with the marine environment is not a one way process. It is only through improved understanding of these complex interactions that predictions of what may happen in the future can be made (Image: Peter Evans).

Which policy areas will the research inform?

Project outputs will inform the implementation of the Marine Strategy Framework Directive (MSFD), the Marine and Coastal Access Act, Marine (Scotland) Act, Common Fisheries Policy and the OSPAR Joint Assessment and Monitoring Programme as well as the work of UK government departments. The research supports an ecosystem approach to policy, regulatory and management initiatives, including the implementation of the EU Biodiversity Strategy, the Natural Environment White Paper and the further development of the Marine Protected Area network.

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What results are expected from the project and how will they be used?

The Marine Ecosystems Research Programme will:

-Enable novel integrated marine ecosystem science to increase understanding of the dynamics of ecosystem services provided by the UK marine environment. This will lead to a mechanism for providing advice on the likelihood of changes in ecosystem services in response to future changes in human activity and the environment.

-Re-organise existing data records on aspects of marine ecosystems from a wide range of sources and conduct regional macroecological analyses to identify relationships between taxa and their environment.

-Through targeted field work and experiments generate new understanding of features currently under-sampled, or not adequately represented, in existing ecosystem models and organise the information for inclusion in ecosystem models.

-Refine the ability of UK ecosystem models to forecast changes in marine ecosystem services.

-Produce an ensemble of well documented, contrasting, whole or partial simulation models of marine ecosystems together with statistical models emerging from macroecological analyses. This will be used to forecast ecosystem states with associated uncertainty under scenarios of future conditions.

-Map the outputs from the model ensemble onto an inventory of ecosystem services, by translating outputs into quantitative measures of goods and services and relevant indicators of good environmental status, in particular indicators that are defined in the MSFD.

-Create an integrated system capable of making forecasts of ecosystem status, goods and services for various scenarios of future environmental conditions.

-Improve our capacity to assess the structure of marine ecosystems by improving the way that biodiversity and ecosystem function are represented in the European Regional Seas Ecosystem Model (ERSEM).

-Use the enhanced model to explore the impacts of human-induced stresses and natural variability on the structure of marine ecosystems, and develop links to project changes in ecosystem services in response to future policy decisions.
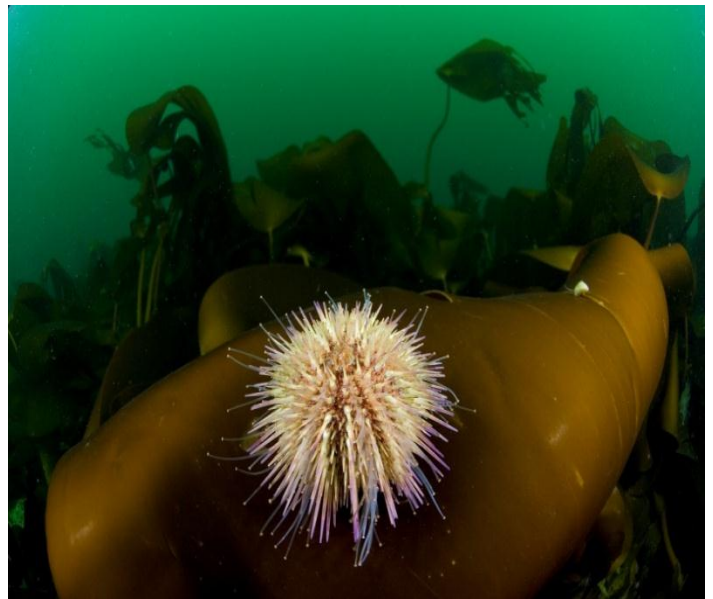

Figure 2: A diverse range of plant and animal species coexist in marine ecosystems. Understanding their interactions with each other, humans and physical drivers is the challenge of this programme (Image: Paul Naylor).

The research programme will be delivered in two work packages. The interactions between management decisions and the delivery of services from marine ecosystems will be examined via future funding applications.

Where can I find further information about this and related research?

WP1: Paul Somerfield (pjso@pml.ac.uk)
WP2: Icarus Allen (jia@pml.ac.uk)
Project officer: Jessica Heard (jessh@pml.ac.uk)
Knowledge Exchange: Kelly-Marie Davidson (kdav@pml.ac.uk)
Programme Manager: Vicki Norton (vicrto@nerc.ac.uk)
Alternatively, please contact Defra's Marine Evidence Team at marinescience@defra.gsi.gov.uk

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