

# How can we assess marine biological diversity and ecosystem state in a changing world?

Marine Objective Theme: Science for Integrated Marine Management

## What's the problem?

We need to know if the seas around the UK are 'clean, biologically diverse and healthy' and large amounts of money are invested in monitoring the environment, ranging from large national schemes to targeted surveys. To be useful, the data collected must be converted into information that's statistically robust. Classical statistical analytical methods are not always useful for studying biological communities. Current methods for measuring biodiversity, particularly those based on species numbers, don't tell us much about the health of ecosystems. We need to develop new measures of biodiversity which can be linked to ecosystem state and health. Analytical methods which allow us to detect important changes in the environment against a background of constant change, which may use data of poor quality, such as historical data, and which may be widely applied in cost-effective ways are a key aim of this project.

## What are the aims of the project?

To gain a clearer understanding of what marine biodiversity looks like in relatively unimpacted conditions we are continuing work, which began in previous projects, to make an inventory of marine biodiversity in the Isles of Scilly, an area considered to be relatively unimpacted and of high conservation status. Owing to its location in the far South-West it is also an area that is likely to provide early indications of changes associated with a warming climate.

The project also aims to develop statistical analytical methods to detect meaningful change in a constantly changing world and we are enhancing and expanding methods developed at the Plymouth Marine Laboratory, using existing data, particularly marine monitoring data. The suitability of new analytical methods to detect long-term change are also being tested by applying our new methods to existing datasets which were collected over the appropriate scales of space and time. Finally, we are developing biodiversity measures which provide information on the functional makeup of communities.

The work in this project underpins various national and international collaborations, and enables the team to make an environmental statistical input into collaborations and consultations. The project commenced in 2004 and is due to complete in October 2009.



Figure 1. Red dead man's fingers, sponge and sea cucumber on rocks in the Isles of Scilly (Image: B.E Picton)

## Which policy areas will the research inform?

Findings and knowledge from this project will inform the design and analysis of monitoring programmes, such as the UK Marine Monitoring and Assessment Strategy (UKMMAS). The project will provide tools for converting data into information for assessing environmental status and change, such as are required for implementing the ecosystem approach as agreed at the 5th North Sea Conference, the Water Framework Directive, the Marine Strategy Framework Directive, the Food and Environment Protection Act and the Marine and Coastal Access Bill.

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

The project builds on more than a decade of collaborative work between the project team, Defra (and its predecessors) and scientists in the UK (e.g. at Cefas) and Europe (e.g. through the EU Network of Excellence on Marine Biodiversity and Ecosystem Functioning, see [www.marbef.org](http://www.marbef.org)). The project also makes available expertise in environmental statistics for collaborative work and consultations relevant to Defra-funded research and policy implementation.

New statistical analysis tools developed in this project include tests for the significance of links, and new methods for exploring the links between biological and environmental data; a test for significant structure in complex data; a method for detecting and reducing the influence in analyses of species which do not occur at random in the environment, and a strategy for detecting and analysing differences between changes in biological communities at locations subject to different stresses. These, along with reviews of new and existing methods for multivariate analysis, significantly improve our ability to analyse and understand complex data.

If successful, it is intended that these new methods are incorporated into the Plymouth Routines in Multivariate Environmental Research package ([www.primer-e.com](http://www.primer-e.com)). This package is a global standard in marine environmental research and analysis, and is also fast becoming a primary research tool in terrestrial and freshwater studies, as well as other areas of investigation such as ecosystem modelling and molecular ecology.

Measures of biodiversity which indicate the functional makeup (what different species do e.g. breaking down material; releasing nutrient back into the water column etc) of biological communities have also been developed. We are exploring their behaviour with data from monitoring studies to understand how functional diversity is affected by different stresses. Fundamental to calculating such measures is knowledge about the functional biology of the species involved. Such information is scarce for most marine species, even commonly observed ones, and much of that which exists is very old so the project team have worked with the Marine Life Information Network (MarLIN) to develop and populate a prototype database of biological trait information (the Biological Traits Information

Catalogue, [www.marlin.ac.uk/biotic](http://www.marlin.ac.uk/biotic)) which can be used to provide some of the necessary information.

In addition to the development of methods, the project has also collected data from the Isles of Scilly. This part of the project is focused primarily on groups of organisms that are not adequately sampled in standard assessments and these records can now be used to calibrate biodiversity assessments from elsewhere in the UK and Europe. The study provides baseline information on the extent of marine biodiversity that is poorly known, even in well-monitored areas. The database currently includes records of more than 1000 species and one published study showed that a few square meters of sand are home to more than 500 species, only a tiny fraction of which would be collected using standard methods.

The development of a statistical test from the initial idea, through testing and publication, to its widespread use, takes many years. Many of the data-analysis techniques now routinely used in biodiversity assessments, monitoring programmes and Defra's marine R & D projects were developed via this project and its predecessors.

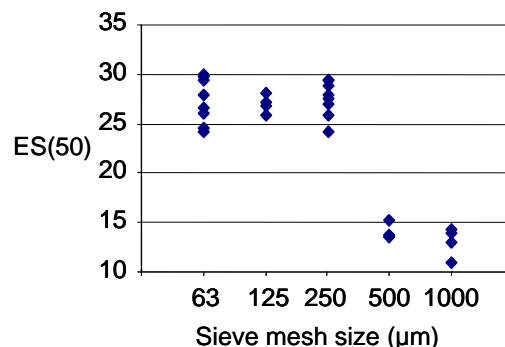


Figure 2. Most biodiversity studies of seabed animals examine animals caught on 500 and 1000 µm sieves. A carefully controlled study in the Isles of Scilly showed that there are far more species in smaller size fractions. (Image PML)

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

The project leader is Dr Paul J. Somerfield, based at the Plymouth Marine Laboratory ([www.pml.ac.uk](http://www.pml.ac.uk)). Primer-E ([www.primer-e.com](http://www.primer-e.com)) is a spin-out company from the Plymouth Marine Laboratory.

Alternatively,

Contact the Marine and Fisheries Science Unit, Defra, Nobel House, London.

## Defra Science – did you know?

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