A survey across MarBEF participants

Theme 2: Research on the link between Marine Biodiversity and Ecosystem Functions in Europe: a survey across MarBEF participants

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ELUCIDATING THE ROLE OF marine biodiversity in regulating ecosystem functions is a central component of the MarBEF prog- ramme, specifically addressed within Theme 2 "Marine Biodiversity and Ecosystem Functioning" (see Theme 2 section under 'research' in the main menu of www.marbef.org).

MarBEF will address this central question through integration of ongoing efforts across the partnership as well as through promoting targeted research efforts. The former requires an overview of the research activities in place, whereas the latter requires the development of appropriate metrics.

As a first step towards addressing these two requirements, a survey was conducted within the membership to generate an inventory of ongoing research projects within the MarBEF partnership, and the metrics of the functions of marine ecosystems targeted in these projects. The questionnaire was distributed prior to the Theme 2 kick-off meeting in Palma de Mallorca, Spain (17-18 May 2004). A total of 27 responses was received, most reporting on current research at a particular MarBEF member organisation, and some reporting on the activities of individual groups within organisations. The responses received represent a return rate of about 30%, which, though satisfactory for this type of activity, implies an underestimation of the total effort on Theme 2-related ongoing activities by independent resources within the consortium. However, a number of organisations participating in MarBEF do not conduct independent research relevant to Theme 2, as they may largely contribute to either of the other two themes addressed by the programme.

In total, 56 funded projects were described in the reports, and financial information was provided for 21 of these. Total funding for these projects amounted to €6.01 million. 85% of the funding was contributed by national funds, and 15% by funding received from the EC via Framework Programmes and, to a lesser extent, other instruments.

Extrapolation from these figures to the 56 identified projects – assuming the average funding of the projects for which this information was lacking was similar to that of those where data were provided – suggests that the present expenditure, by independent sources, on research into the link between marine biodiversity and ecosystem function within the MarBEF consortium is likely to be in the order of €16 million. This figure, large as it is, represents an underestimate of the total funding as (1) only direct costs were reported (e.g. "additional costs," not total costs), and (2) there must have been additional projects conducted by organisations and scientists that failed to return their questionnaires. Most of the effort was contributed by projects conducted by participants in the UK, the Netherlands and Spain, with an important contribution from participants in France and Italy and additional efforts from scientists in a number of other countries (Fig 1).

All of these projects were active in 2004, but they faded out at a rate of about 40% per year (Fig 2), with a very small fraction (<10%) of the projects still ongoing by the end of the MarBEF NoE. The maintenance of the level of effort represented by these projects depends, therefore, on the continuous recruitment of new projects and the maintenance of marine biodiversity as a funding priority across Europe.

The capacity of MarBEF to achieve its goals would be greatly enhanced if the solid base represented by these projects could be used to deliver the comparative analyses and syntheses sought by the project. This requires, however, that the metrics of ecosystem function used in these projects and those to be adopted within MarBEF, are comparable and, eventually, standardised.
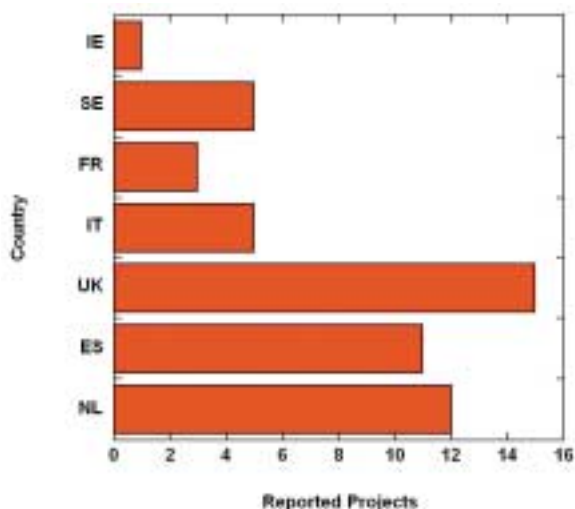

Fig 1. Distribution of projects, funded by independent sources, to assess marine biodiversity and ecosystem function per country within the MarBEF consortium, as identified by the Theme 2 survey.
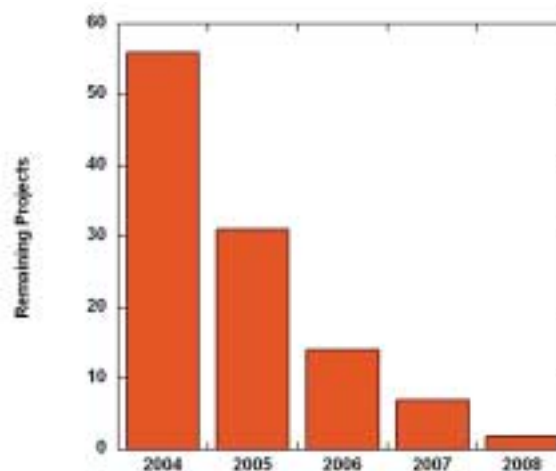

Fig 2. Number of active ongoing projects across the life-span of the MarBEF NoE, as identified by the Theme 2 survey.

Function	Variable	Units	Projects
Ecosystem metabolism	Gross primary production	mmol C m^{-2}d^{-1}, mmol C m^{-3}d^{-1}	9
	Community respiration	mmol C m^{-2}d^{-1}, mmol C m^{-3}d^{-1}	12
	Net community production	mmol C m^{-2}d^{-1}, mmol C m^{-3}d^{-1}	5
	Net primary production	mmol C m^{-2}d^{-1}, mmol C m^{-3}d^{-1}	2
	Export production	mmol C m^{-2}d^{-1}	1
	Dissolved organic carbon production	mmol C m^{-2}d^{-1}	1
	Gas (CO$_2$ and O$_2$) flux	mmol element m^{-2}d^{-1}, mmol element l^{-1}d^{-1}	3
Ecosystem stability	Abundance*,**	number m^{-2}, number m^{-3}	12
	Biomass*,**	g C m^{-3} c C m^{-2}	14
	Cover*,**	%	3
	Pigment concentration*,**	mg m^{-3}, mg m^{-3}	1
	Growth**	d^{-1}	5
	Mortality**	d^{-1}	5
	Recruitment**	d^{-1}	6
Nutrient flux	Nutrient flux	mmol element m^{-2}d^{-1}, mmol element l^{-1}d^{-1}	8
	Denitrification	mmol N m^{-2}d^{-1} mmol N l^{-1}d^{-1}	2
Calcification		mmol C m^{-2}d^{-1}, mmol C m^{-3}d^{-1}	1
Food web function	Food web level	Rank	4
	Food web efficiency	%	5
	Herbivory	%	2
	Growth efficiency	%	2
Physical effects	Bioturbation		4
	Energy dissipation		1

*Only if variable over time
**Only if referring to habitat-forming species

Table 1. Ecosystem functions and descriptors incorporated in ongoing projects, as identified by the Theme 2 survey.

Fig 3. Number of ongoing projects addressing benthic, planktonic and fish communities, as identified by the Theme 2 survey.

The majority of the projects involved observational approaches, with a significant fraction (32%) involving experimental manipulation and a few (4%) using modelling to explore the links between marine biodiversity and ecosystem function. These observations suggest that the projects may deliver a significant amount of data to feed MarBEF's datasets and, eventually, comparative analyses, but also that there is a paucity of modelling effort, which must be stimulated by the MarBEF programme. The majority of the projects focused on benthic communities, with about 20% addressing planktonic communities and a few examining fish communities (Fig 3). No projects addressing the role of marine homeotherms (birds and mammals) on ecosystem function were identified in the survey. Partially as a consequence of this distribution, most of the projects focused on the diversity of zoobenthic assemblages – a significant fraction (about 1/4) addressed that of macrophytes, while only a few (10%) focused on microbes.

The number of ecosystem functions addressed was widely diverse and included ecosystem metabolism; the variance in the abundance or biomass, and the demography, of habitat-forming species as indices of ecosystem stability, nutrient fluxes, calcification rates, and the role of biota on mixing processes such as bioturbation and energy dissipation (Table 1).

Among these, most effort was directed at addressing ecosystem metabolism, particularly community gross primary production and respiration, and ecosystem stability, as described by the stability in abundance or biomass and the demography of structural species in the communities (Table 1). Other

functions, such as calcification rates, mixing and energy dissipation, were seldom addressed, and many relevant functions, such as nutrient storage, were not addressed by any of the projects identified in the survey.

The metrics of biodiversity used as independent variables possibly affecting these functions included species richness (the trait most commonly used to represent biodiversity, diversity indices), taxonomic distinctiveness, and genetic diversity (in 16% of projects), but many of the project descriptions did not identify the metrics used to assess biodiversity.

Conclusions

The survey demonstrated that the examination of how marine biodiversity affects ecosystem functions is receiving considerable research attention, both in terms of resources and personnel, and is therefore providing a valuable substrate for synthesis and integration within MarBEF.

Present efforts within the MarBEF community are skewed towards the examination of ecosystem functions in benthic environments as affected by zoobenthos, while the role of microbial diversity in regulating ecosystem functions remains poorly addressed. The functions most commonly addressed are ecosystem metabolism and stability, and some other important functions seem to remain largely unassessed. The range of techniques used to measure any one descriptor of ecosystem function did not vary broadly across the projects, suggesting that deriving and adopting common metrics is a feasible goal. In addition, the units used, while differing, could be easily converted to achieve homogeneity across traits, except for those describing effects of marine biodiversity on mixing and energy
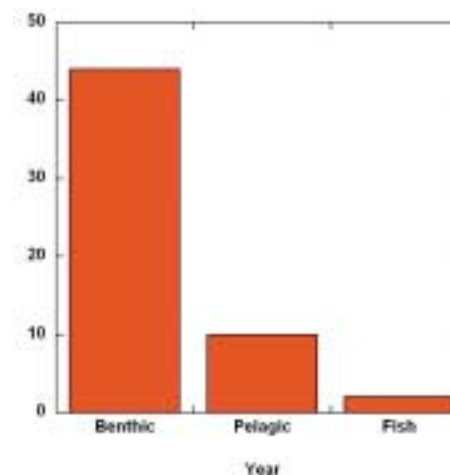
dissipation, for which a consensus on accepted units does not seem to exist. Whereas observational approaches dominate current efforts, there are still rather few modelling studies.

This survey reveals imbalances in the present coverage of the role of marine biodiversity on ecosystem function, reflected in the types of habitats and communities examined, the ecosystem functions assessed and the approaches used. Realisation of this imbalance suggests possible remediation actions that could be stirred by MarBEF, such as encouraging the development of projects on poorly studied environments or functions, and training workshops to disseminate the capacity to use models to assess the role of marine biodiversity in ecosystem function. Furthermore, the results of the survey suggest that the goal to integrate research on this important topic is within reach of MarBEF, as there is a broad empirical basis for comparative analyses and integration and a common culture of use of metrics and methods that, while requiring formal articulation, should render coordinated efforts accessible.

Acknowledgments

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