SUMMARY OF FINDINGS

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Biodiversity: impacts of species loss and nutrients on biodiversity

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Ecosystems are subject to a myriad of anthropogenic activities yet the cumulative effects of these activities, and how they may vary under different environmental conditions, are difficult to disentangle. Species loss and nutrient enrichment are two of the key drivers of change in aquatic ecosystems. Experimental manipulation of simulated species loss scenarios is required to build a framework from which models can be developed to predict the effects of loss of biodiversity. It is vital that we understand the relationships between species loss and ecosystem functioning to protect the delivery and sustainability of ecosystem services such as raw materials, water purification, bioremediation, disturbance alleviation etc.

Scientists at UCD and Queen's University Belfast examined the effects of loss of species in intertidal ecosystems at ambient and enriched nutrient concentrations to test for effects of loss of species and if such effects varied with environmental context. In addition, the impacts of municipal sewage outfalls on the diversity, functioning and stability of rocky shores was examined, leading to recommendations for improved monitoring for the Water Framework Directive.

Key words: Biodiversity, species loss, eutrophication, ecosystem functioning and stability, monitoring, rocky shores, Water Framework Directive.

Background

In Ireland, the economic and social benefits of biodiversity are conservatively estimated to be at least €2.6 billion per annum, however, this figure does not include significant services such as waste assimilation by aquatic biodiversity. Ireland's National Platform for Biodiversity Research identified several knowledge gaps including human impacts on biodiversity-ecosystem functioning relationships and in Ireland there is a basic lack of baseline marine biodiversity data.

Application of ecosystem-based approaches to the management of marine resources requires that we know the functional roles of species and understand the impacts of human activities on biodiversity and ecosystem functioning. Little is known about the effects of loss of species from multiple trophic levels (predators, consumers, plants) or whether such effects are determined by environmental conditions or other activities such as eutrophication or pollution. Marine ecosystems are dynamic by nature, making it difficult to detect impacts on communities without careful monitoring with appropriate replication and scale – as required for the Water Framework Directive.

Key points

- A robust sampling strategy did not identify clear effects of sewage outfalls on benthic assemblages or diversity but did show that sewage affected ecosystem stability. This scale of this impact was identified as 50 – 2,000 m from point source (municipal outfalls in Dublin area).
- WFD metrics are based on comparison to a defined set of pristine conditions. This may not be possible for rocky shores owing to their dynamic nature.
- Experimental tests showed that the effects of loss of species could not be predicted from current biodiversity models.
- Effects of species loss varied with environmental conditions. Direct effects (e.g. grazers on algae or of predators on primary consumers) and indirect effects (e.g. predators on primary producers via primary consumers) were determined by nutrient concentration of the water column.
- The impact of species removal (e.g. mussel harvesting) and other activities that lead to eutrophication interact to determine the overall outcome of the effects of loss of species for ecosystem functioning.
- Species interactions in natural ecosystems are complex and require careful experimentation in intact communities to develop new conceptual models of the role of biodiversity maintaining ecosystem functions.

Findings/ Recommendations

- Metrics of ecological status for rocky shores for the WFD should be based on quantified sampling surveys, incorporate changes in variability of assemblages (indicative of community stability), include shifts in assemblage structure (not focus primarily on species richness) and incorporate benthic fauna and flora.
- More research is required to improve the current tools for assessment of ecological status of marine ecosystems.
- A long-term marine monitoring programme should be established to address the paucity of data in particular with regard to biosecurity and global change.
- Much more research is required to predict the effects of loss of species under predicted global change scenarios (increased ocean surface temperature, acidification, increased storminess etc). Empirical studies should be aligned with modelling approaches to accelerate advancement in this field.

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http://www.epa.ie/downloads/pubs/research/biodiversity/

Publications connected to this work Crowe, T. P., Bracken, M. E. & O'Connor, N. E. (2012). Reality check: issues of scale and abstraction in biodiversity research, and potential solutions. In *Marine biodiversity futures and ecosystem functioning: Frameworks, methodologies and integration*. Paterson, D. M., Aspden, R. J. A. & Solan, M. (Editors) Oxford University Press.