

EXECUTIVE SUMMARY

McNeill (1994) pointed out that marine parks and protected areas around Australia generally have been established with little attention to monitoring their biological (resource) status, or formal assessment of the effectiveness of their management. Both tasks require structured monitoring studies tailored to test the effectiveness of protection from human use and potential environmental impacts. This report is the second in a series intended to provide empirical bases for the development of such monitoring programmes for the Great Barrier Reef Marine Park.

In this report we have concentrated on the description of variation in abundances of several coral reef organisms in the Cairns Section of the Great Barrier Reef (GBR) Marine Park. Our focus was on the implications of spatial variation for the design of sampling and monitoring programmes and the inference of spatial pattern. Patterns of interest might arise, for example, from effects of area-based management strategies or human impacts on the reef environment. The data we present indicate that spatial variation is large at most scales for most organisms. Consequently, it is unlikely that small or even moderate spatial patterns caused by management strategies, human use, or natural perturbations will be detectable reliably without considerable expense.

Our results have important implications for the design and interpretation of future studies, especially with respect to the role and scope of pilot studies. Our data do not provide the sought-after prescription of a 'best' allocation of sampling effort across different spatial scales, or a clear and unequivocal guide to the replication needed to assess either management strategies or human impacts on the GBR environment. Indeed, the analyses we present demonstrate that such messages are likely to be unavailable or flawed in ecological field studies. At best, we can provide some guidelines on the scales that are (empirically) likely to require least emphasis in future sampling programmes, and insights into the reliability of predictions of required sample sizes to detect nominated effects. Whilst there were some taxa that were conspicuously poor candidates for monitoring studies, there were no clear candidates that would provide sensitive measures of impacts, based on their sampling characteristics alone. It is clear, however, from this and a companion report that for almost all organisms we analysed (42 taxa), the common strategy of sampling only 'representative' sub-sections of reefs will result in inaccurate depictions of patterns in abundances among reefs. Sampling should be well distributed over major within-reef strata in future studies if results are to be truly relevant to whole reefs.

It is clear also that the hitherto recommended approach of doing small pilot studies to fine-tune sampling strategies for larger programmes should be reconsidered. We do not suggest that prior information is unnecessary for designing major sampling programmes. Rather, we suggest that pilot estimates should be treated more cautiously than they have been previously. We have demonstrated that predictions of 'optimum' allocations of effort, sample sizes, and statistical power are highly variable. The careful design of future field studies from pilot data will require explicit consideration of that uncertainty.

The implications of these conclusions are two fold. Firstly, the conventional approaches to sampling or funding strategies may need re-thinking, particularly where strong inferences will be made from either 'positive' or 'negative' results. It may be better in future studies to do (and fund) large 'pilot' studies to gain sound impressions of the merits of proceeding with subsequent studies, given that those subsequent studies are likely to be constrained by *reduced* funding. If the substantive pilot studies indicate that the proposed future project is weak, then funding should be refused or the approach modified. Secondly, it is likely to be inefficient to adopt a strategy for assessing management strategies in which the effects of management are compared only periodically, and where inferences of success or failure rely on the detection of spatial pattern alone. Such an approach is likely to detect only dramatic effects of management, and fail to provide insights to more subtle strengths or weaknesses of management strategies. Further attention is needed toward the development of monitoring strategies that can provide sensitive assessments of the progress (or otherwise) of management strategies for the Great Barrier Reef.