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## Conservation planning for resilient coral reefs.



Lead researcher: **Dr Eddie Game (TNC, formerly UQ)**

Collaborators: Dr Eve McDonald-Madden (UQ), Dr Scott Wooldridge (AIMS), Dr Marji Puotinen (Uni. of Woollongong), Mr Matt Watts (UQ), Dr Michael Bode (Uni. of Melbourne), Mr Hedley Grantham (UQ), Professor Hugh Possingham (UQ).

**Project Description:** Chronic anthropogenic disturbance has left many marine systems at risk of degrading into undesirable states. In many cases, ecosystem shifts are triggered by catastrophic disturbance events that are beyond the control of local management, such as coral bleaching or cyclones. Recognition of this risk has instigated what has been referred to as a new paradigm for marine stewardship; managing areas with the explicit goal of maintaining ecosystem resilience. Despite this, there has been little synthetic influence of resilience theory on marine conservation planning. The focuses of this research is on how to make good decisions regarding the selection of marine protected areas (MPAs) with the goal of maintaining resilient reef systems in the face of catastrophic disturbance events. There have been three main components to this research.

- 1) We formulated a new conservation planning problem that aims to minimize the probability of missing conservation targets as a result of catastrophic events. To illustrate this approach we tackled the problem of minimizing the impact of large-scale coral bleaching events on a reserve system for the Great Barrier Reef, Australia. We show that by considering the threat of catastrophic events as part of the reserve design problem it is possible to substantially improve the likely persistence of conservation features within reserve networks for a negligible increase in cost. In the case of the Great Barrier Reef, a 2% increase in overall reserve cost was enough to improve the long-run performance of our reserve network by 60
- 2) It is thought that recovery of marine habitats from uncontrollable disturbance may be faster in marine reserves than in unprotected habitats. But which marine habitats should be protected, those areas at greatest risk or those at least risk?. We applied solutions to this problem to a situation of cyclone disturbance of coral reefs on Australia's Great Barrier Reef. With regard to the risk of cyclone disturbance, the optimal reef to protect differed dramatically, depending on the expected speed of reef recovery of both protected and unprotected reefs. This work demonstrates that an adequate consideration of risk is fundamental to all conservation actions and can indicate surprising routes to conservation success.
- 3) Marine Protected Area networks are usually a system of static, permanently closed areas. There are, however, both social and ecological reasons to believe that the dynamic movement of protected areas may be preferable. On coral reefs, the periodic movement of protection may improve the resilience of the reef network and prevent unprotected reefs from undergoing phase-shifts to undesirable states. We establish a theoretical example to explore whether dynamic closures can promote the resilience of reefs systems. We discover that, at current levels of reservation (10-30%), the dynamic movement of this protection across all reefs in a system is unlikely to enhance resilience.

### Recent publications:

- Game, E. T., E. McDonald-Madden, M. L. Puotinen, and H. P. Possingham. 2008a. Should we protect the strong or the weak? Risk, resilience and the selection of marine protected areas. *Conservation Biology* in press.
- Game, E. T., M. Watts, S. Wooldridge, and H. P. Possingham. 2008b. Planning for persistence in marine reserves: a question of catastrophic importance. *Ecological Applications* 18:670-680.
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