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Designing effective protected area networks - integration of the tropical cyclone disturbance regime in the Great Barrier Reef Representative Area Program : a GIS application

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Designing effective protected area networks – integration of the tropical cyclone disturbance regime in the Great Barrier Reef Representative Area Program: a GIS application.

By

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Sophie Debort

01 / 11 /2006

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ABSTRACT

In recognition of the scenic, ecological, and scientific values of the marine environment, attempts at conservation are increasingly recognized. In a world progressively modified by human activities, the conservation of biodiversity is essential as insurance to maintain resilient ecosystems and ensure a sustainable flow of ecosystems goods and services to society. Unfamiliarity with large disturbances that rarely occur has resulted in the neglect of this kind of event in reserve management. Cyclones are extremely powerful events that can damage coastal and marine environments like coral reefs by generating large wave forces, sediment re-suspension and subsequent smothering, influx of large volumes of freshwater and terrestrial sediment due to heavy rains, and winds and storm surge. For example, in the Great Barrier Reef (GBR), a lack of knowledge about large natural disturbances like cyclones and their effect on the marine environment has prevented managers of the Marine Park from explicitly considering such perturbations in planning.

The goal of this study was to place what is known about widespread natural disturbances (tropical cyclones) into the context of marine reserve design requirements and management decision for the conservation of the GBR, Australia. To do so, the newly implemented Representative Area Program (RAP) of the GBR Marine Park (GBRMP) was evaluated against the recently characterised tropical cyclone disturbance regime across the region (Puotinen, 2005a). Recruitment to reefs by settlement of distant larvae via a series of short steps within and between reefs is a key process towards reef recovery. It was then assumed that the reefs that are highly protected (HPR) from human activities should also be relatively cyclone-free, to allow them to act as ‘sources’ of larvae to enable recovery of less protected adjacent reefs after disturbances. The level of cyclone disturbances at HPR was characterised based on its frequency and timing, and its influence on connectivity between HPR (source) and non-HPR (sink) reefs across the GBR.

Even though most HPRs have had time to recover fully between tropical cyclone events at least once over the last 35 years, they typically had a short time to recover between subsequent cyclone events (short recovery periods). Thus, they may

not always be available as 'sources' of larvae in a given year, which reduces the effective connectivity between sources and sink reefs in that cyclone disturbance regime. Under such scenario, the RAP may not adequately protect the GBR. This is the case because HPR (potentially representing the best source for support and replenishment of adjacent areas) have not been placed to ensure infrequent exposure to cyclone damage. Because reserves are usually meant to be permanent, their design must be effective even under conditions that may be very different from current conditions. In this context, it is important to consider the history of disturbance in a region as it may determine the level of complexity or fragility that this region can develop between disturbance events. The RAP was developed with the best information available at the time, but the characterisation of the GBR cyclone disturbance regime now available (Poutinen, 2005a) suggests that the timing of the most recent cyclone event is not typical of the 1969-2003 time series. Thus, an 'insurance' factor based on Allison *et al.* (2003) was complied to identify how much additional reef area would need to be set aside to allow for the creation of a new framework accommodating the reality of cyclone disturbance in marine reserve planning. Overall, only for short recovery times (5-10 years) and ecosystem level connectivity between source and sink reefs can a sufficient additional insurance reserve be realistically set aside to provide a buffer against cyclone disturbance. One solution to this may be to create temporary dynamic reserves as needed after severe cyclones. The effectiveness of such measures over the long-term will depend not only on the occurrence and magnitude of other disturbances that may develop synergistically to create more dramatic effects on reefs but also on global climate change. Predicting effects of directional climate change will facilitate the evaluation of the long-term success of a reserve.

ACRONYMS

AML: Arc Macro Language
BOM: Bureau Of Meteorology
GBR: Great Barrier Reef
GBRMP: Great Barrier Reef Marine Park
GBRMPA: Great Barrier Reef Marine Park Authority
GIS: Geographic Information System
HPR: Highly Protected Reefs
MPA: Marine Protected Areas
RAP: Representative Areas Programme

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