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An ecosystem-scale predictive model of coastal seagrass distribution

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ABSTRACT

1. Maintaining ecological processes that underpin the functioning of marine ecosystems requires planning and management of marine resources at an appropriate spatial scale.

2. The Great Barrier Reef World Heritage Area (GBR) is the world's largest World Heritage Area (approximately 348 000 km^2) and second largest marine protected area. It is difficult to inform the planning and management of marine ecosystems at that scale because of the high cost associated with collecting data. To address this and to inform the management of coastal (approximately 15 m below mean sea level) habitats at the scale of the GBR, this study determined the presence and distribution of seagrass by generating a Geographic Information System (GIS)-based habitat suitability model.

3. A Bayesian belief network was used to quantify the relationship (dependencies) between seagrass and eight environmental drivers: relative wave exposure, bathymetry, spatial extent of flood plumes, season, substrate, region, tidal range and sea surface temperature. The analysis showed at the scale of the entire coastal GBR that the main drivers of seagrass presence were tidal range and relative wave exposure. Outputs of the model include probabilistic GIS-surfaces of seagrass habitat suitability in two seasons and at a planning unit of cell size 2 km $\times$ 2 km.

4. The habitat suitability maps developed in this study extend along the entire GBR coast, and can inform the management of coastal seagrasses at an ecosystem scale. The predictive modelling approach addresses the problems associated with delineating habitats at the scale appropriate for the management of ecosystems and the cost of collecting field data. Copyright © 2010 John Wiley & Sons, Ltd.

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INTRODUCTION

Safeguarding the delivery of marine ecosystem services requires the maintenance of ecological processes that underpin the functioning of marine ecosystems (Agardy, 1994; Daily, 1997; Roberts *et al*., 2003). Marine productivity is heterogeneous and highly variable over space and time (Agardy, 1994). The transport of materials, nutrients and organisms by the convective forces of ocean waves and currents extends the spatial scale of many ecological processes (Carr *et al*., 2003). Maintaining ecological processes that underpin the functioning of marine ecosystems requires the management of marine resources to occur at appropriate spatial scales. The data necessary to inform management at these scales are far less organized and available for most marine environments than for terrestrial environments (Carr *et al*., 2003). Spatial information on the distribution of habitats and species is difficult to collect in marine environments at the scale of ecosystems as it is expensive and logistically difficult (Ban, 2009).

Data on the occurrence of species are commonly available in two forms: point localities and predicted distributions. Point locality data are more readily available, easy to use and have low rates of commission errors (Rondini *et al*., 2006). However, using point locality data to delineate the occurrences of species is challenging when: (1) data sets are incomplete; (2) species occur over broad spatial scales; and (3) species respond both spatially and temporally to

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