Benefits of marine protected areas beyond boundaries: an evaluation for two coral reef fishes

Thesis submitted by
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in 2008

For the research degree of Master of Science
in Marine Biology
within the School of Marine and Tropical Biology
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Abstract

Increases in the numbers and sizes of predatory fishes in well established no-take marine protected areas (MPAs) on coral reefs are well-known. However, few studies have investigated whether adult spillover or recruitment subsidies lead to higher adult and juvenile densities in fished areas adjacent to MPAs, compared with fished sites further away from MPAs. Our understanding of these phenomena has been limited because most MPA studies have been restricted to comparisons of MPAs and fished areas, and do not consider fished areas that do not benefit from MPAs. On the Great Barrier Reef, adults of two recreationally important coral reef fish (*Plectropomus maculatus* and *Lutjanus carponotatus*) have been observed to increase in numbers in inshore no-take areas ("green zones"). In this thesis I made a preliminary investigation of the potential for adult spillover and recruitment subsidies by comparing fished areas, near to and distant from green zones. Firstly, I examined the early age and growth of juvenile fishes at the Keppel Islands, in order to define the size of young-of-the-year (0+) and estimate settlement and spawning periods. I used this information to estimate the densities of adults and 0+ year fish within green zones, fished areas within 1km from green zones and at sites greater than 5km from the nearest protected area.

The size-age relationships for the 0+ year cohorts were determined by studies of sectioned sagittal otoliths. Juveniles were collected between October and November in 2006, and May and June in 2007. The youngest *P. maculatus* and *L. carponotatus* recruits caught were 63 (53mm FL) and 66 days old (49mm FL) respectively, but ages extended to 334 days (220mm FL) for *P. maculatus* and 345 days (183mm FL) for *L.*

carponotatus. Juvenile growth was rapid in both species, with *P. maculatus* and *L. carponotatus* averaging 0.96 mm d^{-1} and 0.72 mm d^{-1} respectively. The estimated PLD of *P. maculatus* was 28.6 days, while *L. carponotatus* was 33.6 days. Based on the observations from this study, recruitment surveys approximately two months after spawning would be sufficient, however, in order to include additional 0+ age cohorts, surveys would ideally take place 160 days after initial spawning.

The potential for local benefits of MPAs were examined by comparing adult and recruit densities outside MPAs, both near to and distant from the MPA boundary. Adults and juveniles of *P. maculatus* and *L. carponotatus* were surveyed at both the Keppel Islands and Palm Islands, two inshore networks of no-take MPAs on the Great Barrier Reef. Within each region, the abundance and biomass of adults and recruits were compared for three treatments: (1) Within MPAs; (2) Nearby fished areas (< 1km from MPA boundaries) and (3) distant fished areas (> 5km from MPA boundaries). Site variation accounted for the majority of differences in both adult and recruits of *P. maculatus* and *L. carponotatus*. Hence, no significant differences were found for any of the treatments. Low densities of juveniles and patchiness in their distribution appear to combine to make detecting recruitment subsidies extremely difficult. I suggest refinements of the sampling technique, as well as alternative approaches to solving this problem.

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This thesis includes some collaborative work with Prof. Geoff Jones and Dr. Craig Syms. While undertaking these collaborations, I was instrumental in the project concept and responsible for the project design, analysis and interpretation, as well as the final synthesis of results into a form suitable for publication. Data from 2006 was provided by Richard Evans and David Williamson. My collaborators provided intellectual guidance, financial support, technical instruction and editorial assistance.

Financial support for the project was provided by my supervisor Prof. Geoff Jones, MTSERF and ARC Centre of Excellence.

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Signature **Date**

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ACKNOWLEDGEMENTS

This study was funded by MTSERF and ARC Centre of Excellence. I am indebted to Geoffrey Jones and Craig Syms for their help in planning this study and comments on the thesis; to Richard Evans, Jacob Johansen, Heidi Luter, Yui Sato, Niklas Taylor and David Williamson for their assistance in the field and to Dong Lou for showing me how to prepare and examine otoliths.