



## Contribution of a large no-take zone to the management of vulnerable reef fishes in the South-West Indian Ocean

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### ABSTRACT

A key element of an ecosystem-based approach to fisheries management is the use of marine protected areas (MPAs) as part of a holistic management strategy. This study, based in the South-West Indian Ocean, evaluated the benefits of area closure to vulnerable fishery species, which have been depleted by overfishing. A controlled fishing survey was conducted seasonally between 2006 and 2011 in the Pondoland MPA on the East Coast of South Africa. The MPA includes a 400 km<sup>2</sup> no-take zone where all forms of vessel-based exploitation are prohibited. Three endemic sparids (slinger *Chrysoblephus puniceus*, Scotsman *Polysteganus praeorbitalis* and poenskop *Cymatoceps nasutus*) and one widely distributed serranid (yellowbelly rockcod *Epinephelus marginatus*) were chosen as study species. These are slow growing, high trophic level species, which are prominent on rocky reefs in the Pondoland area and have been depleted by overfishing. Relative abundance was estimated using catch-per-unit-effort (CPUE) and length frequency distributions were used to determine the size structure of fish populations. The relative abundance and the mean length of all four species were significantly greater in the no-take zone. Over the 5-year study period, CPUE of *C. puniceus* and *C. nasutus* in the no-take zone increased as did the mean length of all species, except *C. nasutus*. This study presents clear evidence that the Pondoland MPA no-take zone is providing insurance against the depletion of vulnerable fishery stocks in fished areas, thereby establishing the basis for the enhancement of adjacent fisheries.

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### 1. Introduction

Fishing typically reduces the abundance of target species and selects larger individuals (Pauly et al., 2002), causing a reduction in mean size and age of fished species (Pauly and Watson, 2005). Globally, marine fisheries are in a state of crisis (Pauly, 1995) and in 2000, the South African government declared an emergency in the line-fishery. Falling catch rates of targeted reef fishes and repeated switching to less desirable species are hallmarks of overfishing (Roberts, 2000), which also characterise the South African line-fishery (Penney et al., 1999; Griffiths, 2000). Fisheries management on a global scale is undergoing a shift towards an ecosystem-based approach (Halpern et al., 2010; Pomeroy et al., 2010) including the use of marine protected areas (MPAs) or marine reserves (Sink and Attwood, 2008; Botsford et al., 2009; McLeod and Leslie, 2009).

Recovery of overexploited species has been reported numerous times from MPAs across the globe, in tropical (Roberts, 1995; McClanahan and Kaunda-Arara, 1996; Russ and Alcala, 1996) and temperate ecosystems (Willis et al., 2003). There are also many examples of conservation success in South Africa's growing MPA network (Buxton and Smale, 1989; Bennett and Attwood, 1991, 1993; Buxton, 1993; Garratt, 1993; Cowley et al., 2002; Götz et al., 2009).

Reports of MPA success in areas of poor fishery management have led to their widespread implementation in many parts of the world (Gell and Roberts, 2003). Yet, opposition from local communities remains the principal barrier to area closure (Gell and Roberts, 2003; T. McClanahan, Wildlife Conservation Services, Kenya, 2010, pers. comm.) and persistent poaching may hinder conservation efforts (Gell and Roberts, 2003). Reasons for opposition include loss of fishing grounds, removal of livelihood, lack of involvement of local people and dissatisfaction with past failures (Gell and Roberts, 2003). Proof of MPA benefits is fundamental to obtaining support from local communities, which increases the chances of successful protection.

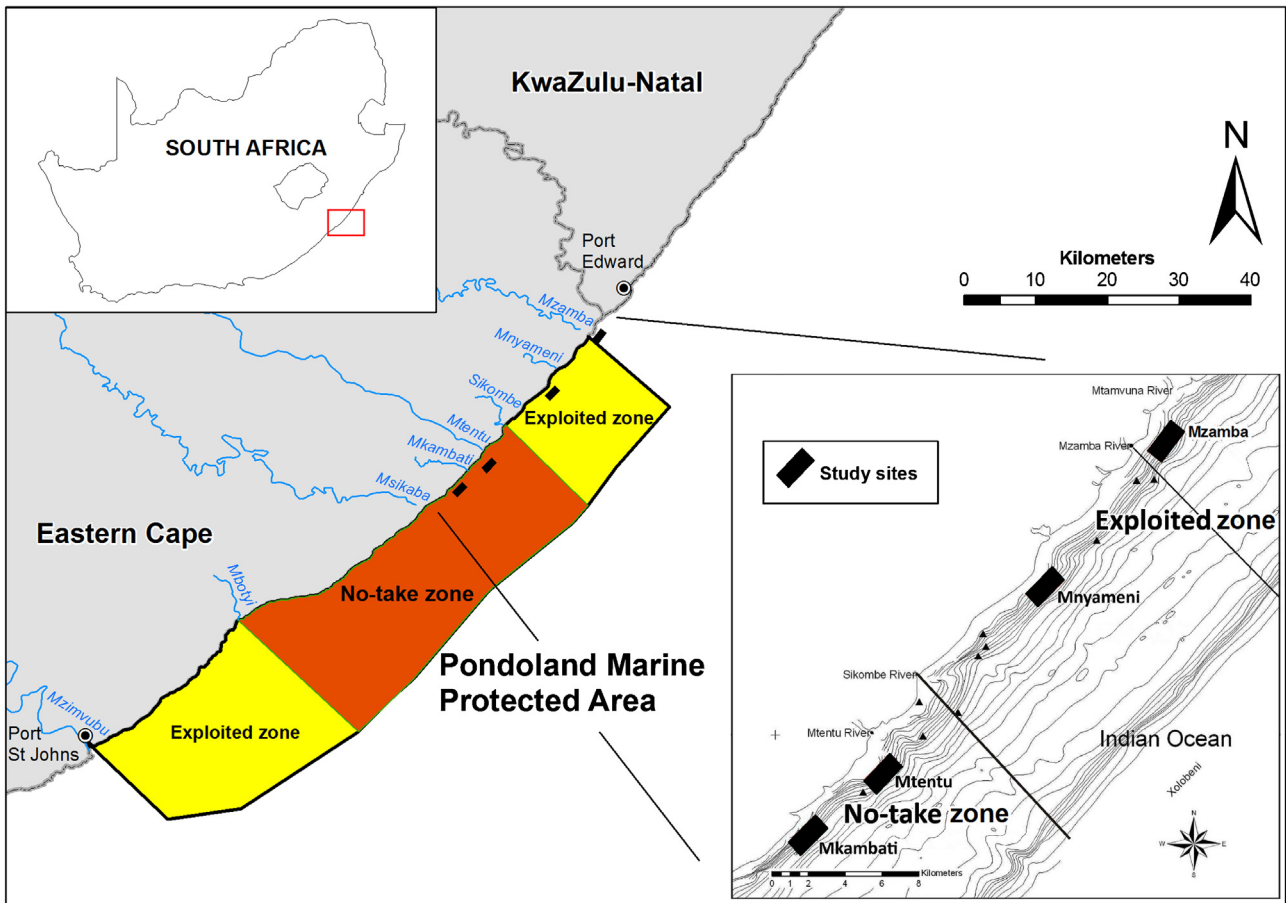
The Pondoland MPA in the South-West Indian Ocean includes a large 400 km<sup>2</sup> no-take zone fully protected from all forms of offshore (vessel based) exploitation. It was proclaimed in

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**Fig. 1.** The Pondoland MPA on the East Coast of South Africa. The no-take zone is closed to all offshore (vessel based) exploitation. Offshore line-fishing and spear-fishing are permitted in exploited zones. Four 2 km<sup>2</sup> study sites, indicated by a ■, are from north to south: Mzamba and Mnyameni (exploited), and Mntentu and Mkambati (no-take).

June 2004 making it a recent addition to South Africa's growing MPA network. The objectives of this area closure are to conserve biodiversity and rebuild important reef fish stocks, which have been depleted by overfishing. This study evaluated the effectiveness of the no-take zone for slow growing, high trophic level reef fishes using a controlled fishing survey.

Three endemic sparids (slinger *Chrysolephus puniceus*, Scotsman *Polysteganus praeorbitalis* and poenskop *Cymatoceps nasutus*) and one widely distributed serranid (yellowbelly rockcod *Epinephelus marginatus*) were chosen as study species. The three endemic sparids have a narrow distributional range along the south-east African coast. *E. marginatus* has a wider distributional range, occurring along the entire southern African coastline, the Mediterranean, north-west Africa and western South America (Heemstra and Randall, 1993). All four are prominent species on the rocky reefs in the Pondoland area and have been heavily targeted by both the recreational and commercial small-scale offshore line-fishery along South Africa's East Coast. The four species exhibit slow growth, late-maturity and are protogynous hermaphrodites, and residency within small home ranges makes them particularly vulnerable to fishing (Garratt, 1986; Buxton and Clarke, 1989; Mann, 2000; Mann et al., 2005; Fennessy, 2006).

An exploited zone adjacent to the no-take zone was used as a control to address the following key question: Are these four species more abundant and larger inside the no-take zone? The findings are discussed in terms of potential fisheries management benefits derived from increased egg and larval production and spillover to adjacent open access areas.

## 2. Materials and methods

### 2.1. Study area

The Pondoland MPA is situated in the South-West Indian Ocean on the East Coast of South Africa. It covers approximately 800 km<sup>2</sup> of scattered reef and sand habitat from the shoreline out to the edge of the continental shelf (Fig. 1). The MPA is between two bio-geographic regions, the sub-tropical Natal Bioregion to the north-east of Pondoland and the warm-temperate Agulhas Bioregion to the south-west (Emanuel et al., 1992; Turpie et al., 2000; Lombard et al., 2004; Sink et al., 2005; Mann et al., 2006). In the centre of the MPA, approximately 400 km<sup>2</sup>, or 50% of the MPA, is designated as a no-take zone, which is closed to all offshore (vessel based) exploitation. On the outer edges of the no-take zone are two controlled fishing areas (buffer zones) where offshore line-fishing and spear-fishing are permitted. No industrial fishing, such as trawling or long-lining, is permitted anywhere in the entire MPA. Management responsibility for the Pondoland MPA rests with national government, which has partially delegated authority to provincial government bodies.

### 2.2. Data collection

Standardised research fishing was conducted seasonally (quarterly) from April 2006 until June 2011. During each field trip, approximately 6 h were spent fishing in the no-take zone and another 6 h in the exploited zone. Two large areas of scattered reef in the exploited zone (Mzamba and Mnyameni) and two in the

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