Biological Conservation 167 (2013) 396–404

Contents lists available at ScienceDirect

Biological Conservation

journal homepage: www.elsevier.com/locate/biocon

Combining human preference and biodiversity priorities for marine protected area site selection in Sabah, Malaysia

Lydia C.L. Teh [a,*], Louise S.L. Teh [a], Robecca Jumin [b]

[a] Fisheries Centre, University of British Columbia, AERL, 2202 Main Mall, Vancouver, British Columbia V6T 1Z4, Canada
[b] WWF-Malaysia, Suite 1-6-W11, 6th Floor, CPS Tower, Centre Point Complex, 88000 Kota Kinabalu, Sabah, Malaysia

ARTICLE INFO

Article history:
Received 7 June 2012
Received in revised form 28 August 2013
Accepted 1 September 2013
Available online xxxx

Keywords:
Fishers' spatial preferences
Fuzzy logic
Marine spatial management
Marine protected area zoning
Sabah, Malaysia
Community consultation

ABSTRACT

High human reliance on marine resources in developing countries is a challenge for implementing marine protected areas, which usually seek to limit or restrict fishing in selected areas. Fishers' spatial preferences should be considered during the site selection process, but biodiversity considerations are generally the primary focus. The Protected Area Suitability Index (PASI) is a fuzzy logic spatial planning tool that combines human preferences and conservation criteria to assess the suitability of marine sites for being protected from fishing and other extractive use. We apply the PASI in zoning a marine sanctuary in Sabah, Malaysia, with the objectives of (i) assessing the PASI's ability to capture fishers' spatial preferences; and (ii) comparing the nuances of community based and fuzzy logic approaches in spatial planning. There was overlap in sites chosen for protection by both approaches, and multi-dimensional scaling results suggest that the PASI captures fishers' preferences. Community consultations enable direct integration of local knowledge to fill gaps in scientific knowledge, but can be time consuming and expensive. The PASI is an alternative to data and labour intensive conservation planning tools that are currently available, and can be particularly useful for zoning marine protected areas in data poor developing countries where conservation requires quick action.

1. Introduction

Marine protected areas are used for multiple purposes – they can help to mitigate human threats to the coastal ecosystem (Halpern et al., 2008), address biodiversity loss (Sala and Knowlton, 2006), restore fisheries and ecosystem processes (Sumaila et al., 2000; Russ et al., 2004; McClanahan et al., 2007; Goñi et al., 2008), and generate socio-economic benefits (Unsworth et al., 2010; Mwaipopo, 2008; Govan, 2009). The use of MPAs is rising globally (Wood et al., 2008), and in recent years, MPAs have featured prominently in marine conservation agendas for biodiversity rich areas in the developing world. For example, the Coral Triangle is a multi-national effort to establish networks of MPAs in Southeast Asia and western Oceania (CTI Secretariat, 2009).

High human reliance on marine resources in developing countries is a challenge for implementing MPAs, which specifically seek to limit or restrict fishing in selected areas. Indeed, theories on the ecological effects of marine protected areas are based on the condition that no fishing takes place within MPA borders (Ward et al., 2001). Carrying on with conservation without addressing socio-economic complexities is liable to be met with limited success (Mascia, 2003; Cinner, 2007). Community support for MPA regulations is thus seen as a key factor in achieving successful biological and socio-economic outcomes (Crawford, 2009).

Community participation in MPA planning has generally been associated with more supportive attitudes (Crawford, 2009; Versleijen and Hoorweg, 2009) towards the MPA and hence higher compliance. Zoning plans that do not get widespread support can be difficult to implement; for example, conflicts over access to resources may arise (Lewis, 1996), or fishers may ignore zoning regulations (Mora et al., 2006; Crawford, 2009). The opinions and preferences of communities are thus an important consideration when prioritising sites for protection. However, incorporating community preferences to MPA spatial planning is often an *ad hoc* process, whereas researchers tend to favour a systematic approach to planning MPAs (Ban, 2008). Typically, systematic planning involves designing MPAs to achieve specific targets in representing biodiversity, species, and habitats (Margules et al., 2002; Leslie, 2005). This process is frequently facilitated by software that is supported by academic institutions or environmental non-governmental organizations (NGO).

Community based[1] and systematic planning approaches to MPA design each have their drawbacks. Even where MPAs have been

* Corresponding author. Tel.: +1 604 822 2731; fax: +1 604 822 8934.
E-mail addresses: lydia.teh@fisheries.ubc.ca (L.C.L. Teh), l.teh@fisheries.ubc.ca (L.S.L. Teh), rjumin@wwf.org.my (R. Jumin).

[1] In this paper, 'community based approach' and 'community consultations' are used interchangeably to refer to a planning process that involved multiple stakeholders, including community members. It does not imply that the entire process was initiated and driven by community members alone.

0006-3207/$ - see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.biocon.2013.09.002

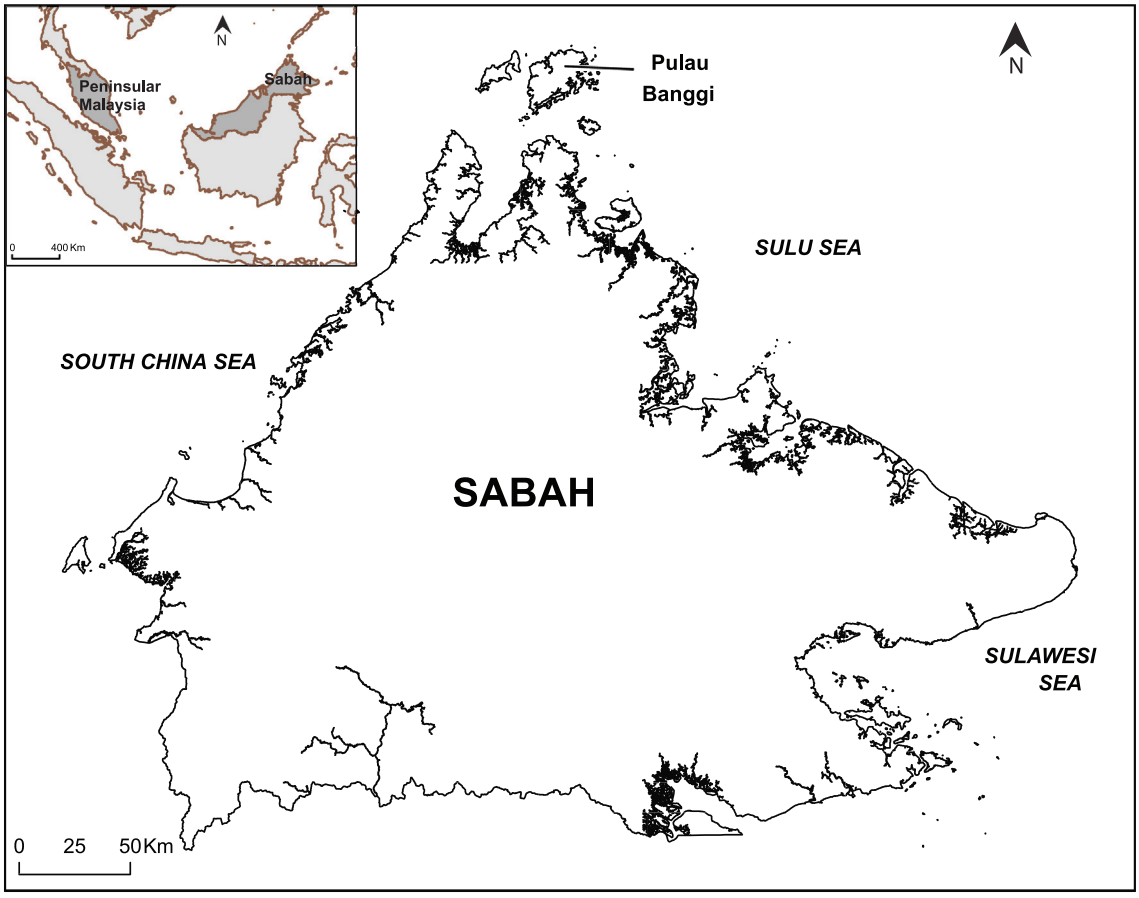

Fig. 1. Pulau Banggi lies off the northern coast of Sabah in East Malaysia.

formed with community participation, internal conflicts within the community can erode the system (Russ and Alcala, 1999). In addition, community based site selection outcomes may not capture the full range of biodiversity and ecological features that are necessary to sustain the marine ecosystem. On the other hand, systematic planning for representation relies heavily on data availability, the lack of which may delay the entire process (Grantham et al., 2009). In developing countries, this is probably the biggest challenge, notwithstanding the fact that socio-economic data are even rarer to come across than biological data; hence, systematic planning for representation may overlook social aspects that are relevant to communities.

A practical approach to prioritising sites for marine protected areas would thus be one that incorporates communities' spatial preferences within a systematic planning framework. Here, we adopt the Protected Area Suitability Index (PASI), a fuzzy logic spatial planning tool which fulfills such a role (Teh and Teh, 2011; Teh et al., 2012b). We aim to assess the PASI's ability to capture fishers' spatial preferences, and to provide insights on zoning approaches that address both human and biodiversity needs. To this extent, we compare the process and outcome of a community based approach to MPA site selection with that of applying the PASI. We explore the nuances of each approach using a case study of the Maliangin Sanctuary in Pulau Banggi, Sabah, East Malaysia, as the basis for the comparison (Fig. 1).

1.1. Background

The Malaysian state of Sabah is located within the Coral Triangle, which is one of the most biodiversity rich marine regions in the world. However, it is also one of the most threatened, as the combined stressors of overfishing, widespread use of destructive fishing methods, coastal development and pollution are putting 85% of coral reefs in the region at risk of degradation and loss (Burke et al., 2012).

In 2003, the Sabah government agreed to a proposal to gazette the Tun Mustapha Park (TMP), a multi-use marine managed area that will cover approximately 1.1 million hectares in Sabah's northern coast. This marine region is home to endangered species such as dugongs (Rajamani, 2009) and marine turtles (Harding et al., 2001), and serves as a corridor linking the South China Sea and Sulu Sea for migratory species. At the same time, roughly 80,000 people live within the proposed TMP, most of who make a full or partial living from the sea (Jumin and Kassem, undated). There is little to no management of marine resource use within the TMP, which is most clearly illustrated by Malthusian overfishing in Pulau Banggi (Teh and Sumaila, 2007). As such, the formal gazettement of the TMP by the Sabah government will provide an avenue for marine conservation and sustainable marine resource use in the region. The TMP will implement a zoning system to accommodate varied values and uses of the TMP, including biodiversity protection and sustainable fisheries.

Pulau Banggi is the main island group within the TMP, with a total area of about 700 km^2 (Anon, 2003). It is comprised of two large islands and numerous smaller outlying islands. It is sparsely populated, and fishing is the primary economic activity and provides the main source of protein for the majority of coastal households. In 2006, efforts were initiated to begin prioritising marine sites in Pulau Banggi for protection, i.e., closed to fishing. Many fishers in Pulau Banggi have limited flexibility to adapt to changes