In: Marine Research and Conservation in the Coral Triangle ISBN 978-1-61668-473-0
Editors: Julian Clifton, Richard Unsworth and David Smith, pp.

Chapter 1

INTRODUCTION

Julian Clifton(1) and Richard K.F. Unsworth(2)
1. School of Earth and Environment, University of Western Australia, Crawley, WA 6009 Australia
2. Marine Ecology Group, Northern Fisheries Centre, Department of Employment, Economic Development and Innovation, Queensland Government, PO Box 5396, Cairns, QLD 4870, Australia

Marine and coastal habitats comprise some of the most biologically productive ecosystems on the planet (Geider *et al.*, 2001), and in south-east Asia these ecosystems rank foremost in terms of global marine biodiversity (Allen and Werner, 2002; Price, 2002; Bell and Smith, 2004; Briggs, 2005; Hoegh-Guldberg *et al*., 2009). This great diversity of marine life reflects the range of marine habitats which include fringing, barrier and atoll reefs along with seagrass meadows, mangroves, mud flats and algal beds. Although coral reefs cover less than 0.2% of the world's oceans, they contain more species per unit area than any other ecosystem (Ahmed *et al.*, 2004). However, the majority of coral reefs are now impacted by anthropogenic activities (Pandolfi *et al.*, 2003; Bellwood *et al.*, 2004; Wilkinson, 2008). Estimates indicate that around 19% of the world's coral reefs have already been destroyed, whilst a further 35% are at risk of being lost by 2030 (Wilkinson, 2008). This projection, furthermore, does not include the potential detrimental impacts of climate change or ocean acidification. Protecting these biodiverse and productive systems from the adverse impacts of human activities for future generations is one of the major environmental challenges of our time.

In south-east Asia, approximately 350 million people live within 50 km of the coast, and in many countries of this region, marine products comprise a high proportion of the protein requirements of the population (Dutton, 2005; Cullen, 2007). This high dependence upon coastal and marine resources is manifest in widespread overfishing and unsustainable resource usage that threaten this global centre of marine biodiversity (McManus, 1997; Burke *et al.*, 2002; Newton *et al.*, 2007). Although over-exploitation is one of the major drivers of change affecting south-east Asian coral reefs, pollution events are also of concern. The tropical monsoons and their associated flood events have the potential to export a range of autochthonous material far out to even the remotest of coral islands (Risk and Erdmann, 2000). Such floods can disrupt the nutrient balance, smother reefs with sediments and deposit chemicals such as herbicides directly onto sensitive marine systems. In addition, marine and coastal ecosystems throughout the region are impacted by continued deforestation, water and atmospheric pollution and coastal development (Brown *et al.*, 1990; Terrados *et al.*, 1998; Burke *et al.*, 2002; Bellwood *et al.*, 2004; Freeman *et al.*, 2008). Seagrass meadows and mangroves are also critical components of tropical coastal and marine waters, providing some of the most economically important ecosystem services of any marine habitat (Costanza *et al.*, 1997; Orth *et al.*, 2006; Nagelkerken *et al.*, 2008). Similarly, they are now experiencing unprecedented rates of damage and deterioration associated with over-exploitation, coastal development and marine pollution (Alongi, 2002; Orth *et al.*, 2006; Waycott *et al.*, 2009).

Humanity faces stark choices about the future it provides for the planet. Across all of the major ecosystems of the world there is now strong evidence of changing climate that is principally the result of anthropogenic production of greenhouse gases (McCarthy, 2001; IPCC, 2007). Within south-east Asia and the Coral Triangle, sea surface temperatures are increasing at between 0.1°C and 0.4°C per decade and oceans are becoming more acidic, resulting in increased incidences of coral bleaching (Wilkinson, 2008), modified animal behaviour (McCarthy, 2001) and reduced coral reef development (De'ath *et al*., 2009). Atmospheric temperatures are also increasing, and rainfall patterns are changing, with weather more variable and extreme. Throughout the 21st century it is expected that temperatures will increase, and as polar ice caps melt sea-level will rise between 1 and 5m in the next century. A best case scenario of decisive political, industrial, social and economic intervention to mitigate these processes during the 21st century suggests that tropical oceans will increase in temperature by an average of 0.8-2.7°C (Hoegh-Guldberg *et al*., 2009). This will result in widespread damage to marine ecosystems, but some resilient well-managed systems may survive. A failure to make these changes will result in an increasingly bleak future for the natural resources of the planet, and in particular those of the Coral Triangle (Hoegh-Guldberg *et al*., 2009).

The overall implications of this ongoing degradation and loss of coastal ecosystems and the services they provide are of great concern with regard to the vast number of people who depend, both directly and indirectly, upon these resources to maintain their livelihoods (Davies *et al.*, 2009). These are further exacerbated when the potential impacts of climate change on marine productivity are considered (Duarte, 2002; Hoegh-Guldberg *et al.*, 2007; Gilman *et al.*, 2008). If marine systems are well-managed and protected from high levels of anthropogenic disturbance, they will be more resilient to the effects of climate change (Hughes *et al.*, 2007; Björk *et al.*, 2008). Conservation and management of these key habitats will therefore be of great importance throughout the current century, both in terms of supporting biodiversity and maintaining food security.

THE CORAL TRIANGLE INITIATIVE

The launch of the Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security, hereafter referred to as the Coral Triangle Initiative (CTI), at the Manado World Oceans Conference in May 2009 represented the culmination of sustained efforts to achieve an integrated conservation policy amongst Coral Triangle countries to address these common concerns. The Coral Triangle Initiative aims to achieve biodiversity conservation and sustainable use of marine resources through an ecosystem-based management approach, involving the establishment of marine protected area (MPA) networks, detailed regional management plans, agreements on tuna fishing and live reef fish trading, and the implementation of measures designed to facilitate adaptation to climate change over the next ten years (CTI Secretariat, 2008). Partner countries will be responsible for implementing programmes that address these goals, with international co-operation where necessary. This initiative represents a unique model of collaboration amongst countries within the developing world and is therefore of paramount significance with regard to conservation in this global hotspot of marine biodiversity. The current coverage of nationally designated protected areas which incorporate a marine component within the Coral Triangle countries is detailed in Table 1. Figure 1 illustrates the location of some of the larger and well-known existing marine protected areas within the Coral Triangle region.

THE WAKATOBI NATIONAL PARK

The Wakatobi National Park (WNP) encompasses the waters surrounding the four major islands of the Tukang Besi archipelago in south-east Sulawesi and was gazetted in 1996, covering a total area of 1.4 million hectares (Figure 2). With a resident community of around 100,000 people, the WNP is Indonesia’s third largest and most heavily populated marine national park. Located centrally within the Coral Triangle, it includes approximately 50,000 ha of coral reefs, including fringing reefs around the four main islands, large offshore atolls, extensive platform reefs and a barrier reef off the north coast of Wangi-Wangi (Pet-Soede and Erdmann, 2003).

Coral reefs, seagrass meadows and mangrove forests are the dominant marine shallow water habitats in the park. The reefs within the WNP provide wide niche diversity which support rich marine communities (Turak, 2003). These reefs harbour over 390 species of hard coral belonging to 68 genera and 15 families (Turak, 2003). The fish assemblages of the reefs are very rich, with 590 fish species from 52 families having been recorded (Halford, 2003). These levels of diversity are among the highest recorded in any coral reef ecosystem.

Seagrass meadows are a major feature of the intertidal and subtidal coastal waters of the WNP. To date, no comprehensive survey of the spatial extent of seagrass ecosystems of the WNP has been conducted but research has determined that these meadows are extremely productive and provide a critical role in supporting fisheries productivity within the park (Unsworth, 2007). Mangroves within the WNP have received little research attention in the past, but recent studies have begun to document the range of fauna utilizing these habitats and provide greater insight into their ecological role within the broader marine environment of the WNP.

Indonesia is notorious for its overlapping, contradictory and confusing policies involving numerous government ministries and departments relating to marine resource usage (Dirhamsyah, 2006). These have been exacerbated through the devolution of power and authority away from central government to district levels of government under the *reformasi* programme initiated following the Suharto era (Thorburn, 2002). Coupled with the financial crisis of the late 1990s, it is perhaps unsurprising that the WNP has historically been characterized by a lack of sufficient funding, ineffective enforcement, minimal community participation in management activities and inappropriate zonation of the park (Elliott *et al*., 2001; Clifton, 2003).

Table 1. Coverage of legally mandated marine protected areas within the Coral Triangle countries. Sources: Birdlife International (2007); White (2008); UNEP-WCMC (2009).

	Total number of marine protected areas [1]	Area protected within Coral Triangle (km^2)
Indonesia [2]	140	106,829
Malaysia	147	6,776
Papua New Guinea	24	3,358
Philippines	212	31,315
Solomon Is. [3]	21	453
Timor Leste [4]	1	556
TOTAL	545	149,287

Note: [1] 'Marine protected areas' refers to all IUCN categories of protected area including a marine component. [2] Includes the Savu Sea MPA (35,000 km^2) designated in May 2009. [3] Excludes informal community-managed MPAs lacking government recognition common in the Solomon Islands. [4] Timor Leste's first national park (Nino Konis Santana) was designated in 2007 and includes a marine component.

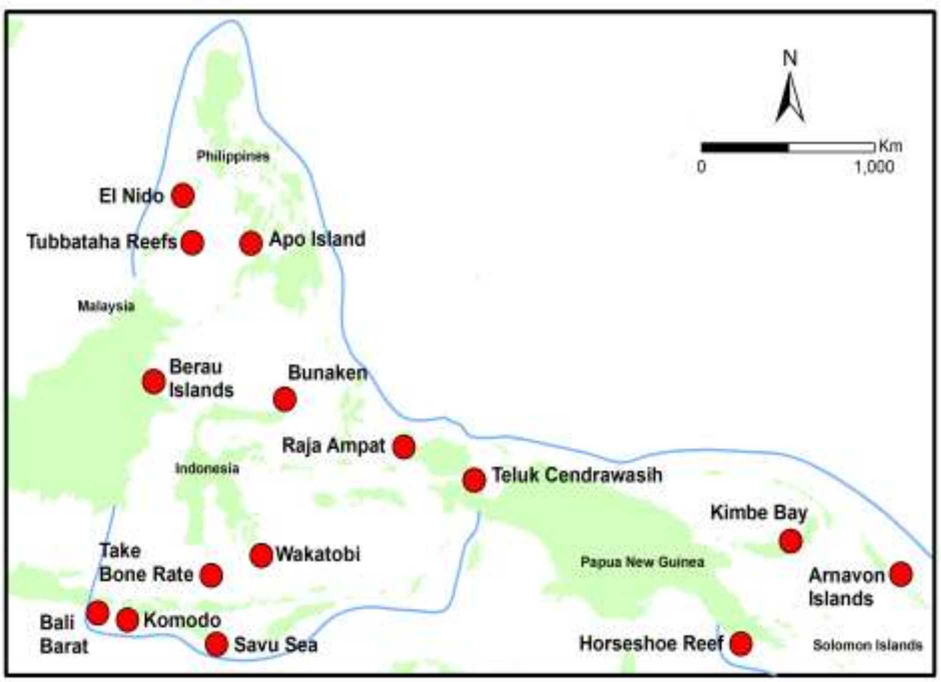

Figure 1 Marine protected areas within the Coral Triangle region.

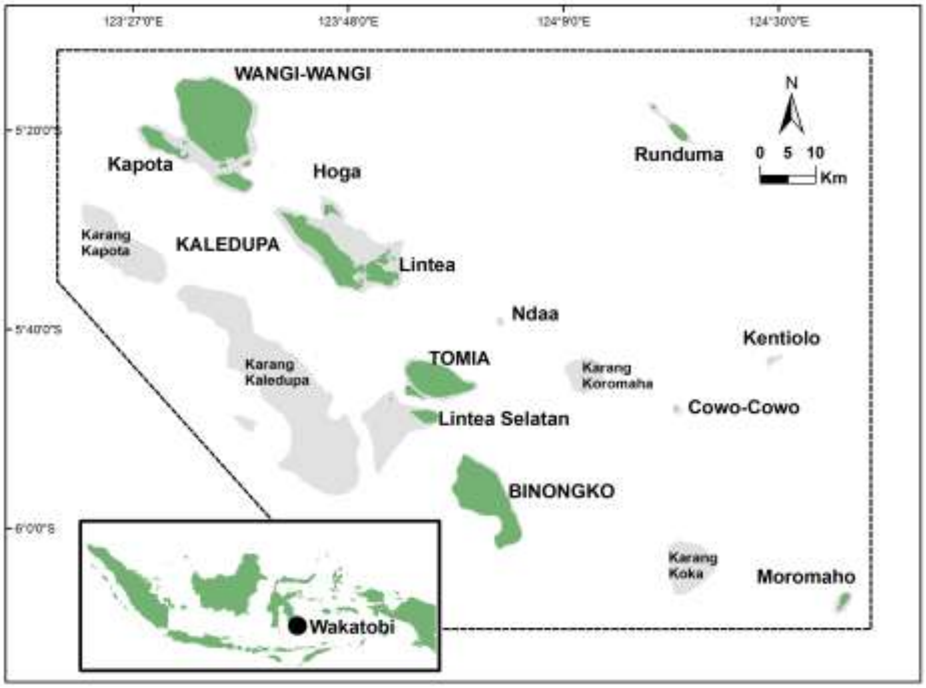

Figure 2. Location map for the Wakatobi National Park.

Figure 3 Zonation plan for the Wakatobi National Park.

More recently, the Wakatobi National Park has been the focus of considerable efforts designed to improve management and to elevate the park's profile as an example of successful interventions. These include the 15 year World Bank-funded Coral Reef Rehabilitation and Monitoring Programme (COREMAP) initiative which commenced in 1998 (Moosa, 2004). Since 2003, The Nature Conservancy (TNC) and the World Wide Fund for Nature (WWF) have assisted the park authorities in developing a new management plan for the park which received official recognition in July 2007 (Figure 3), the zonation details for which are provided in Table 2. Together with initiatives to enhance enforcement of park regulations and raise support for the WNP amongst resident communities, these organizations are promoting the WNP as a model for networks of marine protected areas elsewhere in this area as part of the wider Coral Triangle Initiative.

Table 2 Regulations governing activities in the WNP. Adapted from Coral Triangle Centre (2008)

	Core zone	Marine zone	Tourism zone	Traditional use zone	General use zone	Special land zone
Area covered (ha)	1,300	36,450	6,180	804,000	495,700	46,370
Fishing (all techniques)	x	x	x	✓	✓	n/a
Research	p	p	p	p	p	n/s
Boat transit only	[✓]	✓	✓	✓	✓	n/a
Boat transit and anchoring	[✓]	✓	✓	✓	✓	n/a
Tourism	x	p	p	p	p	n/s
Restoration and rehabilitation	x	x	✓	✓	✓	n/s
Education	p	p	✓	✓	✓	n/s
Traditional and ritual use	p	p	✓	✓	✓	n/s

Key: ✓: permitted; [✓]: permitted only in emergency; x: forbidden; p: prior permit required; n/s: not specified; n/a: not applicable.

STRUCTURE OF THE BOOK

This book is organised into two sections examining aspects of the natural and human environment of the Wakatobi National Park. These include discussions of particular habitats and species, their environmental interactions and indicators of anthropogenic disturbance, along with descriptions of socio-economic and cultural characteristics of resident communities which are of relevance to conservation and the political context of resource management. The first part of the book focuses upon the marine environment, commencing with contributions from McMellor and Smith (chapter 2), and Hennige and colleagues (chapter 3). These chapters outline the biological diversity and ecological structuring of coral reefs in the Wakatobi. Unsworth (chapter 4) and Cragg and Hendy (chapter 5) examine the functional roles performed by seagrass meadows and mangrove forests respectively and their vulnerability to anthropogenic disturbance. In chapter 6, Bell and colleagues summarise the driving forces influencing the spatial and temporal distribution of sponges in the park, emphasising the potential for economic benefits to be derived from a greater understanding of sponge ecology. In chapter 7, Bennett underlines the extent of species' adaptation to unique and harsh environments through a detailed study of intertidal fish species tolerance of temperature conditions. de León and colleagues examine the significance of understanding marine habitat connectivity in order to facilitate conservation planning in chapter 8. Finally, in chapter 9, Kelly and Marples present compelling evidence for further discoveries to be made in terms of avian species evolution in terrestrial environments of the WNP.

The book then concentrates upon the characteristics of resident communities in the park and their use of maritime resources. This commences with Cullen's detailed socio-economic survey of marine resource dependence amongst Kaledupan villages in chapter 10, which links with Exton's analysis of trends in nearshore fisheries in chapter 11 to present a comprehensive picture of the links between resident communities and maritime resources. Clifton builds upon this in chapter 12 through outlining the socio-cultural characteristics differentiating the Bajau (or Bajo) ethnic group from the majority island population and the implications for conservation policy. In Chapter 13, Pilgrim presents a forceful argument for research into traditional environmental knowledge amongst resident communities and its relevance to designing resource management practices. Moving to a wider scale of analysis in chapter 14, Clifton highlights areas of concern with regard to the development of marine protected area networks within the Coral Triangle and their implications for conservation and community participation. A summary of key issues is provided by Clifton and Unsworth in chapter 15, along with areas of interest with respect to future conservation policy in the Coral Triangle.

It is the hope of the editors and authors involved in this book that its publication will stimulate awareness of what is truly a beautiful location, with elements of the natural and human environment which attract visitors from around the globe. However, the threats facing the environment are, sadly, not unique to this region and can only be addressed through conservation policy which is informed by sound knowledge. Whilst this goal is still distant, this book serves to illustrate the potential contribution which can be made by natural and social scientists sharing the same ultimate objective.

REFERENCES

Ahmed, M.; Chong, C. K.; Balasubramanian, H. In *Economic evaluation and policy priorities for sustainable management of coral reefs*; Ahmed, M., Chong, C.K., Cesar, H.; Eds.; Worldfish Centre: Penang, 2004; pp2-12.

Allen, G. R.; Werner, T. B. *Env. Biol. Fish*. 2002, *65*, 209-214.

Alongi, D. M. *Env. Cons*. 2002, *29*, 331-349.

Bell, J. J.; Smith, D. J. *Mar. Biol. Ass. UK* 2004, *84*, 581-591.

Bellwood, D. R.; Hughes, T. P., Folke, C., Nystrom, M., *Nature* 2004, *429*, 827-833.

Birdlife International (2007). Timor-Leste (formerly East Timor) declares first national park. http://www.birdlife.org/news/news/2007/08/timor-leste_np.html

Björk, M.; Short, F.; McLeod, E.; Beer, S. *Managing seagrasses for resilience to climate change*. IUCN: Gland, Switzerland, 2008; 48pp.

Briggs, J. C. *Biol. Cons*. 2005, *126*, 297-305.

Brown, B. E.; Le Tisser, M. D. A.; Scoffin, T. P.; Tudhope, A. W. *Mar. Ecol. Prog. Ser*. 1990, *65*, 273-281.

Burke, L.; Selig, E. R.; Spalding, M. *Reefs at risk in South East Asia*. World Resources Institute: Washington, DC, 2002; 76pp.

Clifton, J. *Mar. Pol*. 2003, *27*, 389-395.

Costanza, R.; D'Arge, R.; de Groot, R.; Farber, S.; Grasso, M.; Hannon, B.; Limburg, K.; Naeem, S.; O'Neill, R. V.; Paruelo, J.; Raskin, R. G.; Sutton, P.; van den Belt, M. *Nature* 1997, *387*, 253-260.

Coral Triangle Centre (2008). New zoning system for Wakatobi NP. http://www.coraltrianglecenter.org/

CTI Secretariat (2008). Coral Triangle Initiative: a proposal for a new multilateral partnership to help safeguard the marine and coastal resources for future generations. http://www.worldwildlife.org/what/wherewework/coraltriangle/publications.html

Cullen, L. C. *Marine resource dependence, resource use patterns and identification of economic performance criteria within a small island community: Kaledupa, Indonesia*. PhD thesis, University of Essex, 2007.

Davies, T. E.; Beanjara, N.; Tregenza, T. *Fish Man. Ecol*. 2009, *16*, 279-289.

De'ath, G; Lough, J.M; Fabricius, K.E. *Science* 2009, *323*, 116-119.

Duarte, C. M. *Env. Cons*. 2002, *29*, 192-206.

Dudley, N. *Guidelines for applying protected area management categories*; IUCN: Gland, Switzerland, 2008; 106pp.

Dutton, I. M. In *The politics and economics of Indonesia's natural resources*, Resosudarmo, B.P.; Ed.; ISEAS Publications, Singapore, 2005; pp. 162-178.

Elliott, G.; Mitchell, B.; Wiltshire, B.; Manan, A.; Wismer, S. *Coast. Man*. 2001, *29*, 295-316.

Freeman, A. S.; Short, F. T.; Isnain, I.; Razak, F. A.; Coles, R. G. *Biol. Cons*. 2008, *141*, 2993-3005.

Geider, R. J.; Delucia, E. H.; Falkowski, P. G.; Finzi, A. C.; Grime, J. P.,; Grace, J.; Kana, T. M.; La Roche, J.; Long, S. P.; Osborne, B. A.; Platt, T.; Prentice, I. C.; Raven, J. A.; Schlesinger, W. H.; Smetacek, V.; Stuart, V.; Sathyendranath, S.; Thomas, R. B.; Vogelmann, T. C.; Williams, P.; Woodward, F. I. *Glob. Change Biol*. 2001, *7*, 849-882.

Gilman, E. L.; Ellison, J.; Duke, N. C.; Field, C. *Aq. Bot*. 2008, *89*, 237-250.

Halford, A. In: Pet-Soede, L.; Erdmann, M.V.; Eds. *Rapid Ecological Assessment Wakatobi National Park*. WWF/TNC Joint Publication: Denpasar, Bali; 2003, pp. 53-64.

Hoegh-Guldberg, O; Hoegh-Guldberg, H; Veron, J.E.N.; Green, A; Gomex, E.D; Lough, J; King, M; Ambariyanto; Hansen, L; Cinner, J; Dews, G; Russ, G; Schuttenberg, H.Z; Penaflor, E.L; Eakin, C.M; Christensen, T.R.L; Abbey, M; Areki, F; Kosaka, R.A; Tewfik, A; Oliver, J. *The Coral Triangle and Climate Change: Ecosystems, People and Societies at Risk*. WWF Australia, Brisbane, 2009; 276pp.

Hoegh-Guldberg, O.; Mumby, P. J.; Hooten, A. J.; Steneck, R. S.; Greenfield, P.; Gomez, E.; Harvell, C. D.; Sale, P. F.; Edwards, A. J.; Caldeira, K.; Knowlton, N.; Eakin, C. M.; Iglesias-Prieto, R.; Muthiga, N.; Bradbury, R. H.; Dubi, A.; Hatziolos, M. E. *Science* 2007, *318*, 1737-1742.

Hughes, T. P.; Rodrigues, M. J.; Bellwood, D. R.; Ceccarelli, D.; Hoegh-Guldberg, O.; McCook, L.; Moltschaniwskyj, N.; Pratchett, M. S.; Steneck, R. S.; Willis, B. *Curr. Biol*. 2007, *17*, 360-365.

IPCC. *Climate Change 2007: The Physical Science Basis: Summary for Policymakers*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. IPCC: Geneva; 2007, 21pp.

McCarty, J.P. *Conserv. Biol.* 2001, 15, 320-331

McManus, J. W. *Coral Reefs* 1997, *16*, S121-S127.

Moosa, M.K. In *Economic evaluation and policy priorities for sustainable management of coral reefs*; Ahmed, M., Chong, C.K., Cesar, H.; Eds.; Worldfish Centre: Penang, 2004; pp172-182.

Nagelkerken, I.; Blaber, S. J. M.; Bouillon, S.; Green, P.; Haywood, M.; Kirton, L. G.; Meynecke, J. O.; Pawlik, J.; Penrose, H. M.; Sasekumar, A.; Somerfield, P. J. *Aq. Bot*. 2008, *89*, 155-185.

Newton, K.; Côté, I. M.; Pilling, G. M.; Jennings, S.; Dulvy, N. K. *Curr. Biol*. 2007, *17*, 655-658.

Orth, R. J.; Carruthers, T. J. B.; Dennison, W. C.; Duarte, C. M.; Fourqurean, J. W.; Heck, K. L.; Hughes, A. R.; Kendrick, G. A.; Kenworthy, W. J.; Olyarnik, S.; Short, F. T.; Waycott, M.; Williams, S. L. *BioScience* 2006, *56*, 987-996.

Pandolfi, J. M.; Bradbury, R. H.; Sala, E.; Hughes, T. P.; Bjorndal, K. A.; Cooke, R. C.; McArdle, D.; McClenachan, L.; Newman, M. J. H.; Paredes, G.; Warner, R. R.; Jackson, J. B. C. *Science* 2003, *301*, 955-958.

Pet-Soede, L.; Erdmann, M.V.; Eds. *Rapid Ecological Assessment Wakatobi National Park*. WWF/TNC Joint Publication: Denpasar, Bali; 2003, 187pp.

Price, A. R. G. *Mar. Ecol. Prog. Ser*. 2002, *241*, 23-27.

Risk, M. J.; Erdmann, M. V. *Mar. Poll. Bull*. 2000, *40*, 50-58.

Terrados, J.; Duarte, C. M.; Fortes, M. D.; Borum, J.; Agawin, N. S. R.; Bach, S.; Thampanya, U.; Kamp-Nielson, L.; Kenworthy, W. J.; Geertz-Hansen, O.; Vermaat, J. *Est. Coast. Shelf Sci*. 1998, *46*, 757-768.

Thorburn, C. *Soc. Nat. Res*. 2002, *15*, 617-628.

Turak, E. In: Pet-Soede, L.; Erdmann, M.V.; Eds. *Rapid Ecological Assessment Wakatobi National Park*. WWF/TNC Joint Publication: Denpasar, Bali; 2003, pp.33-52

UNEP-WCMC (2009). World database on protected areas. http://www.wdpa.org

Unsworth, R. K. F (2007) *Aspects of the ecology of Indo-Pacific seagrass systems*. PhD thesis, University of Essex, U.K.

Waycott, M.; Duarte, C. M.; Carruthers, T.; Orth, J. J.; Dennison, W. C.; Olyarnik, S.; Calladine, A.; Fourqurean, J. W.; Heck, K. L.; Hughes, R.; Kendrick, G. A.; Kenworthy, W. J.; Short, F.; Williams, S. L. *Proc. Nat. Acad. Sci. USA* 2009, doi: 10.1073/pnas.0905620106.

White, A. (2008). Scaling up to MPA networks in the Coral Triangle: lessons from the MPA Learning Network. http://www.icriforum.org/EARW/4-1-2.Alan_White.PPT.pdf

Wilkinson, C. R.; Ed. *Status of Coral Reefs of the World: 2008*. Global Coral Reef Monitoring Network and Reef and Rainforest Research Centre: Townsville, Australia, 2008; 296pp.