Biodiversity & Endangered Species

Rouphael et al., J Biodivers Endanger Species 2013, 1:1
http://dx.doi.org/10.4172/jbes.1000102

Research Article Open Access

Do Marine Protected Areas in the Red Sea Afford Protection to Dugongs and Sea Turtles?

Tony Rouphael[1], Ameer Abdulla[2], Omar Attum[3], Nadine Marshall[4] and Usama Ghazali[5]

[1]*DARE, PO Box 634, Como, Western Australia.*
[2]*Senior Research Fellow, Centre of Biodiversity and Conservation Science, University of Queensland, Brisbane, Australia.*
[3]*Assistant Professor of Biology, Indiana University Southeast, USA.*
[4]*Senior Social Scientist, CSIRO, Townsville, Australia.*
[5]*Senior Ranger, Egyptian Environmental Affairs Agency, Cairo, Egypt.*

Abstract

Dugongs (*Dugong dugon*) and most sea turtles are threatened by gill nets and other human activities worldwide. In the Red Sea these animals are potentially isolated from populations in other areas of the world. This isolation would make recovery following major population decline in the Red Sea unlikely. Protected areas are promoted as a management tool to safeguard these animals from human activities. Elba National Park, Egypt, supports populations of dugongs and sea turtles, as well as a growing fishing industry. We undertook a survey of fishers to determine if dugongs and sea turtles formed bycatch in Elba National Park. Specifically, we quantified the proportion of fishers operating in Elba National Park who had caught these animals as bycatch in fishing nets and the proportion of fishers who perceived that sea turtle eggs were still collected. This study indicates that at least one protected area in the Red Sea is not achieving conservation objectives relating to these animals. Nine and eighty percent of fishers reported having caught dugongs and sea turtles in nets, respectively. Seven percent of fishers perceived that people still collected turtle eggs. Elba National Park is failing to protect these animals for reasons including: it is managed solely as an IUCN Category VI Protected Area; fishers lack awareness of laws pertaining to these animals; and fishers are highly resource dependent. Potential management strategies to reduce bycatch include the establishment of IUCN Category 1a Protected Areas in important dugong and sea turtle habitat, encouraging fishers to adopt fishing gear that poses less risk to megafauna and raising awareness among fishers of the protected status of dugongs and sea turtles.

Keywords: Bycatch; Dugongs; Egypt; Fishing nets; Protected areas; Sea turtles; Red Sea

Introduction

As a result of targeted hunting, net fishing, vessel strikes and human induced habitat change, the dugong (*Dugong dugon*) and most sea turtle species are vulnerable to extinction [1,2]. Of these threats, entanglement in fishing nets is among the most serious given the widespread nature of this activity [3-5]. Animals caught incidentally in nets are usually referred to as bycatch, although this term maybe misleading because bycatch may be retained as a consumable or tradable commodity [2]. The vulnerability of these animals, particularly sea turtles, is exacerbated by threats across different life history stages. Sea turtle eggs are collected for consumption [6], hatchlings can be disorientated by artificial light [7] and juveniles and adults sea turtles can die from ingesting plastics [3,8].

Dugongs and sea turtles are found throughout the semi-enclosed Red Sea [9,10] and have been exploited there since at least the First Century AD [11]. However, threats to these animals in the Red Sea have received little recent attention, probably due to the paucity of information in relation to their abundance and interactions with fishers [2]. The lack of detail about current threats to dugongs and turtles in the Red Sea is of international concern given that these animals are threatened worldwide and that populations in the Red Sea may be isolated from other populations. The closest dugong populations are in southern Somalia and Arabian Gulf, both about 1600 km from the Red Sea [2]. Due to this isolation, population declines of dugongs and sea turtles in the Red Sea are unlikely to be reversed rapidly or could even result in local extinction.

Protected areas are recognised globally as an important tool to conserve megafauna [12,13] by separating threatening processes, such as net fishing, from critical megafauna habitat. In the Red Sea there are approximately 75 existing or proposed marine protected areas [14]. However, there is no quantitative data on whether protected areas in the Red Sea are affording dugongs and sea turtles protection from human activities.

In this study we describe a social survey of fishers in Elba National Park, Egypt, aimed at understanding the negative interactions between fishers and megafauna. Specifically, we wanted to determine what proportion of fishers had caught these animals in gill nets and determine whether people still collect sea turtle eggs. We also wanted to assess the risk of plastics to turtles by undertaking a field survey to describe densities of plastic material found on beaches in Elba National Park. We use plastic material on beaches as a proxy for the potential amount of plastic material available in adjacent waters. Ultimately, we wanted to use these approaches to assess if Elba National Park is affording these animals protection from human activities and, if not, hypothesize as to the causes of management failure and potential solutions. We also discuss the relevance of our findings to other marine protected areas in the Red Sea.

***Corresponding author:** Tony Rouphael, DARE, PO Box 634, Como, Perth, Australia, E-mail: tony.rouphael@gmail.com

Received January 14, 2013; **Accepted** February 20, 2013; **Published** February 22, 2013

Citation: Rouphael T, Abdulla A, AttumO, Marshall N, Ghazali U (2013) Do Marine Protected Areas in the Red Sea Afford Protection to Dugongs and Sea Turtles? J Biodivers Endanger Species 1:102. doi:10.4172/jbes.1000102

Method

Study area context

Elba National Park is situated in the southeast of Egypt adjoining Sudan (Figure 1). Established in 1986, the Park covers 35,600 km^2, of which about 2,000 km^2 covers marine waters [15]. The Park includes dugong habitat, and green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) turtle nesting beaches [16,17]. In Egypt, National Parks are established under Law No 102 of 1983 for Natural Protectorates. This Law states that it is forbidden to kill or disturb wildlife; or to damage or remove any living organisms or natural features, resources, such as shells, corals, rocks, or soil for any purpose. However, in practice Elba National Park is managed as an IUCN Category VI Protected Area because fishing is permitted throughout its marine boundaries. Fishers operate from a number of coastal villages inside the Park including Shalateen, Abu Ramad and Halaib (Figure 1). Shalateen is located about 70 km south of the northern border of Elba National Park. With 10,000 inhabitants, it is the largest village, with an estimated 89 fishers [16], and it is reported that 16% of these fishers use nets [18].

Elba National Park was chosen for this study for five main reasons. First, Egypt is recognised as a regional leader in the establishment and management of marine protected areas in the Red Sea [19]. Second, Elba National Park has no marine based tourism activity and associated coastal infrastructure and tourist resorts. Third, Elba National Park has been established for almost 25 years, making it one of the oldest in the Red Sea. Fourth, fishers using gill nets appear to represent a small proportion of all fishers [18]. Lastly, it has a protected area office and management staff funded by the Egyptian Government. For these reasons we predicted that human impacts to dugongs and sea turtles in Elba National Park would be rare.

Social survey

The social survey was conducted in Shalateen. Where practical, interviewees were selected at random to ensure the representativeness of the sample and reduce the risk of non-independence among responses from interviewees. We used a structured questionnaire including closed-ended questions (such as: If you use fishing nets, have you ever accidentally caught a dugong or sea turtle in a net?). We also used open-ended questions to enable more detailed interpretation of these threats. We did not distinguish between turtle species so as to avoid difficulties in recalling with certainty species caught and exact time of capture.

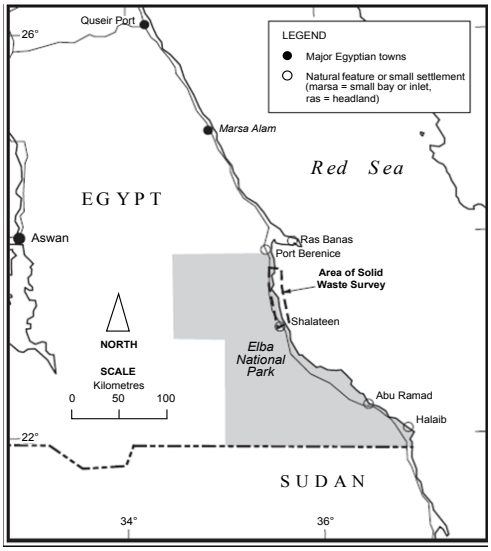

Figure 1: Elba National Park, Egypt, and location of towns and other key features mentioned in the text.

The survey was pilot–tested with five fishers to ensure that the survey was unambiguous and reflected local circumstances. A fluent Arabic speaking person acted as the interviewer, and the survey was conducted as a face-to-face survey at boat ramps, fishing ports and in homes from 12 to 17 December 2006. Forty-five people were interviewed, representing about 45% of the fishers based in Shalateen [18]. All fishers agreed to participate in the survey. The survey was conducted in the local language (Arabic) and a bilingual member of the field team translated responses into English.

Solid waste survey

Plastic bags and other solid waste were recorded using two replicate belt transects (each 5 m wide x 30 m long) laid along the strandline at each of five locations in Elba National Park. The position of the first replicate transect per location was selected randomly. The two replicate transects per location were approximately 50 m apart. The sampling locations were Haudien Shagra, El Rehaba, Gilf El Rehaba, Abu-Mad Bay and Abu-Mad Channel. These locations represented different coastline types ranging from sheltered inlet to exposed shoreline. They also varied in terms of their distance from human habitation. All were located within the National Park and 60 km to the north of Shalateen (Figure 1).

Results and Discussion

We found that dugongs and sea turtles are part of the bycatch of gill net fishers in Elba National Park suggesting that conservation objectives relating to megafauna are not being met. Eighty percent (n=36) of fishers interviewed reported having caught sea turtles in nets. It remains unknown what species or class sizes were involved and what proportions were returned alive to the sea. Turtle bycatch has previously been reported in the Egyptian Red Sea [20], but not in relation to protected areas. There is some evidence that the introduction of mono and multi-filament gill nets to Egypt has contributed to an increase in the incidental bycatch of turtles [20]. Up to 7000 green and loggerhead turtles are captured (but not necessarily killed) per year by Egyptian fishers in the Mediterranean Sea [21]. Although turtles can drown within 10 minutes of forced submergence [22], entanglement in nets doesn't necessarily always result in mortality [23]. For example, most green turtles caught in gill net fisheries in North Carolina, USA, were released alive, as reported by Government observers on fishing vessels [24]. Egypt does not require Government observers to monitor bycatch in any fisheries in the Red Sea, so it is unclear what proportion of turtles caught in nets in the Red Sea are released alive. Adding to this uncertainty is the tradition of eating and trading of turtle meat in some parts of Egypt [21], which may encourage some fishers to retain animals caught in nets in Elba National Park. Our study also suggests that sea turtle eggs were still being exploited in Elba National Park. Seven percent (n=3) of those interviewed reported that people still collected sea turtle eggs and another 49% were unsure or did not want to report such activities.

Nine percent of fishers (n=4) interviewed in our study reported having caught dugongs in nets. Our study is one of the few documenting this form of disturbance to dugongs in Egypt and, to our understanding, the first in a formally declared protected area in the Red Sea. Five dead dugongs, purportedly due to nets, were reported from the Egyptian Red

Sea from 1999 to 2004 [25], but the specific location where the animals were caught was not described. Unfortunately, Egypt is not the only nation in the Red Sea where dugongs have been caught in nets. Dugong bycatch has been reported in Yemen and Saudi Arabia [26,27] and in Sudan [28]. Although coastal people once used by-products of dugongs for items such as sandals and war shields [10], few people may now deliberately hunt these animals in the Red Sea [26].

Our estimate of people who have caught megafauna in nets is disconcerting given the survey was conducted in a single village and that our results are probably underestimated because some fishers may have avoided reporting bycatch [5,29]. If our estimates reflect those from other coastal villages in Elba National Park, then fishing related megafauna mortality could be high even if only a small proportion of animals caught in nets are not released alive. Low levels of mortality can have long-term influences on populations of species that are long-lived and have low fecundity and if the populations are already depleted or have declined. For dugong populations in central Queensland to remain stable it was estimated that 90% of all females over four years of age needed to remain alive each year [30]. Importantly, this prediction was based on near optimal reproductive criteria (e.g. short calving intervals and females give birth at 10 years of age), which is unlikely to apply to Egypt. In Egypt, this species occurs at the outer limit of its distribution [9], potentially in marginal habitat due to limitations in seagrass resources and seasonally low water temperature [25].

Direct mortality of sea turtles and eggs are not the only threat. A potential indirect threat to sea turtles in Elba National Park is ingestion of plastic material. Plastic and other solid waste along beaches varied greatly in Elba National Park. Total abundance of solid waste among locations ranged from 0 to 0.66 items/m^2, with an average of 0.25 items/m^2 per location. Of the 378 items counted, plastic represented 57% of the material. Plastic debris affects 267 species worldwide, including 86% of all sea turtles, up to 36% of seabirds, and up to 28% of all marine mammals [31]. Plastic bags, which have been found in sea turtles [3,8,32], represented 90% of all plastic material found during our study. Compared with our study, higher densities of solid waste have been reported from beaches in the northern Red Sea (2.8 items/m^2) [33], but plastics did not represent such a large proportion of the waste. It is unclear as to the source of the plastic we found on beaches during our study. Some plastic debris is likely to have drifted in via the sea after disposal from vessels [34], but other material was similar to that observed discarded outside coast guard stations and at Shalateen (authors, pers. observ.).

Management challenges

Superficially, Elba National Park would appear to have a number of characteristics that would make it ideal for conserving dugongs and sea turtles. The Park is remote from large human populations and is currently without marine tourism infrastructure [19]. Civilian activities are regulated, and the Park has a permanent presence of national park rangers in Shalateen. Further, dugongs and sea turtles are protected throughout Egypt under Environmental Law 4/1994 [21]. This Law states "killing, capturing, transportation, selling, nest destruction and display of an endangered species either dead or alive is prohibited when Egypt is signatory to an International Convention" [21]. Egypt is a signatory party of the Convention on Migratory Species, which lists dugongs and sea turtles within its Annexes. Finally, Egypt is signatory to the Jeddah Convention which includes a Regional Action Plan for the conservation of marine turtles and their habitat in the Red Sea [35]. For these reasons it would be reasonable to assume that dugong and sea turtle bycatch, and collection of sea turtle eggs would be rare in Elba National Park.

Unfortunately, our study suggests otherwise as dugongs and sea turtles are being caught in nets, sea turtles eggs may still be collected for food and plastic waste is widespread. We believe that dugongs and sea turtles in Elba National Park are not being fully protected because of the Park's protected area classification, minimal government investment, lack of community awareness and high resource dependency among fishers.

Elba National Park is managed as an IUCN Category VI Protected Area, which offer minimal protection to marine megafauna [36]. The objective of this category of protected area is "to protect natural ecosystems and use natural resources sustainably, when conservation and sustainable use can be mutually beneficial" [37]. Under this broad definition, Category VI Protected Areas permit a range of human activities including potentially destructive harvesting activities such as gill netting [36]. A reason for the apparent contradiction of allowing destructive activities in protected areas may relate to the fact that people define sustainably differently [38]. For instance, fishers and many government officials will define sustainability in terms of socio-economic, not biodiversity values.

The effectiveness of Egyptian protected areas may have diminished greatly since the 1990s due to underinvestment by the Egyptian government [39]. Indeed, funding for Egyptian protected areas is less than other African states [15] despite many Egyptian protected areas supporting resources critical to attract and maintain marine based tourism [40,41]. Although some Egyptian protected areas, such as Ras Mohamed National Park, could be financially independent from entry fees, a large proportion of entry fees are transferred to the government treasury in Cairo [15]. Despite the best intentions of the protected area staff, underinvestment in Elba National Park has translated to a lack of vessels, vehicles and other resources needed to enforce regulations pertaining to dugongs and sea turtles.

Exploitation of megafauna may also relate lack of knowledge by the local fishers of regulations relating to Elba National Park, and to the legal protection afforded dugongs and turtles. For example, only 11.4% of fishers in Shalateen were aware of the protected status of the area despite Elba National Park having been established for about 25 years [18]. Unfortunately, even if the people are aware of the protected status of sea turtles and dugongs, poverty or lack of economic opportunities may make it difficult for fishers not to utilise these animals for food or income [18]. Without alternative sources of income it will be difficult to persuade fishers to stop using or adopting damaging fishing practices [42]. These issues are particularly pertinent to Elba National Park, where many fishers are highly dependent on natural resources to earn a living [18].

There are other challenges that make it difficult for protected area staff to reduce impacts to dugongs and sea turtles in Elba National Park. About 80% of fishers in Shalateen originated from other locations in Egypt [18]. Thus the incentive to preserve resources for future generations may not be a priority for these fishers [42]. Finally, there might be longstanding cultural reasons why fishers capture these animals. Fishers in the Egyptian Mediterranean town of Alexandria have a tradition of consuming and trading turtle meat [21] and this may be one tradition that has been brought to Elba National Park by fishers originating elsewhere in Egypt.

In the long term, these challenges are likely to compound with

increasing human population. Egypt's population, now 81 million [43], is predicted to grow to 114 million before 2065 [44]. Internal migration within Egypt is witnessing people moving from densely populated areas to the Red Sea coast [45], most likely to participate in the tourism or construction industries. Fishing is another important cause of migration to Red Sea towns [46]. As fish stocks decline due to greater competition, more fishers may adopt damaging fishing practices [42].

Potential solutions to reduce bycatch

Of the threats to dugongs and sea turtles identified in our study, bycatch from gill nets may be the more serious given the number of adult animals at risk of mortality. Although it remains unknown if the level of bycatch reported in our study is having an adverse impact at a population level, a precautionary approach should be adopted with a concerted effort to reduce all bycatch involving dugongs and sea turtles, especially in a marine protected area. There are at least five broad approaches that may be suitable for reducing bycatch in Elba National Park: establish permanent or seasonal fishery closures; phase-out net fishing through a fishing gear exchange programme; reduce resource dependency; grant tenure over marine resources and; education and awareness raising. These approaches should be introduced in a way that has minimal social impact to local communities and can be experimentally assessed to determine their effectiveness [47]. But as discussed below, implementation of these approaches, individually or collectively, will not be straightforward without commitment of long-term government intervention and community participation.

Establishing permanent or seasonal fishery closures

A no-take zone, equivalent of an IUCN Category Ia 'Strict Nature Reserve', is a spatially defined area where all forms of harvesting are prohibited [37]. This type of protected area may be declared in isolation, but more commonly is found in larger protected areas comprising a mosaic of different protected area categories. A no-take zone is a key management tool because it can prevent negative interactions between fishers and megafauna [12,13,36], but is potentially contentious because it excludes fishers from areas where they may have previously fished. An adaption of this type of closure is a net-exclusion zone, which still permits other forms of fishing that pose less risk to megafauna. No-take and net exclusion zones can also be implemented seasonally in order to protect resources that may be more vulnerable during particular times, such as during the sea turtle nesting season. Seasonal closures have minimised bycatch of loggerhead *Caretta caretta* and Kemp's ridley *Lepidochelys kempii* turtles in North Carolina, USA [24].

For closures to be successful there are at least three prerequisites: appropriate placement, community support and compliance monitoring [36]. As yet none of these prerequisites can be fully met in Elba National Park, but there are potential solutions to overcome this in the medium term. Identifying appropriate location of no-take zones to protect dugongs and sea turtles is not straightforward without long-term quantitative data on the abundance and distribution of these animals. There is no quantitative data on the abundance and distribution of dugongs and sea turtles in Elba National Park. A potential solution is to identify surrogates of dugong and sea turtle distribution that are more easily measured. In the case of dugongs and green turtles, a potential surrogate of their distribution would be meadows of seagrasses in which they feed. This approach could be complemented with interviews of fishers to determine the relative abundance and distribution of dugong and sea turtles in areas where fishers commonly operate [48].

Even if suitable locations could be identified, there would still need to be community support for the establishment of no-take zones [49]. Without this support, fishers are unlikely to comply with zone regulations. In regards to Elba National Park, only about 37% of fishers in Shalateen felt that they would not benefit from establishing no-take zones to protect fish stocks [18]. However, the establishment of net-exclusion zones, rather than no-take zones, might be more favourable to a greater proportion of fishers. Lastly, even if formally designated by law, no-take and net-exclusion zones may be unsuccessful without compliance monitoring [50]. Presently, the lack of boats and vehicles will make it difficult for rangers to effectively regulate no-take zones in Elba National Park. However, the use of community rangers and cross-authorisation with other government agencies, such as the coast guard, may assist park rangers to provide broad coverage of surveillance and enforcement. Intra-government agency cooperation has been utilized for monitoring against illegal actives in terrestrial Egyptian protected areas, including the land component of Elba National Park [19].

Reduce net fishing through a gear exchange programme

Excluding net fishing entirely from Elba National Park is another potential approach to reduce bycatch, but encouraging fishers to give up this activity may not be straightforward. Without compensation or alternative sources of income fishers are unlikely to give up this practice [18]. One way to encourage fishers to give up destructive fishing practices is to facilitate an exchange of their equipment with more benign fishing tools [29]. In Elba National Park, this could include exchanging gill nets for handlines thus allowing local net fishers to remain active in the fishing industry while posing less risk to megafauna.

Reducing dependency on fisheries

If people are highly dependent on harvesting natural resources with few alternative options, they are unlikely to comply with laws relating to protected areas and wildlife protection [18,51]. Based on a study in Tanzania, fishers participating in alternative income generating activities were less likely to use destructive fishing methods [29]. Ecotourism based on megafauna watching could provide fishers with an alternative source of income [5]. Such an approach could have the added benefit of fostering local stewardship over the fauna supporting such industries. We are aware of two examples in Egypt where local people have been provided with alternative sources of income in attempt to reduce their dependency on natural resources. The first is the Egyptian protected area agency employing local people as community rangers [19] and the second is marine tourism operators employing local Bedouin to reduce these peoples dependency on marine resources that are important to the tourism industry (authors, pers. observ.). Although these initiatives were not undertaken specifically to protect marine megafauna, they demonstrate that local people's dependency on natural resources can be managed to some degree. However, appropriate safeguards and management measures need to be put in place if eco-tourism is going to be fostered and grown in the region.

Granting tenure over marine resources and education

Granting tenure over fishing grounds and education are two potential approaches to reduce the prevalence of destructive fishing practices [52]. Although not recommend in context of reducing bycatch, the two approaches could be used to help minimise the impact of gill netting on dugongs and sea turtles. Providing local fishers with tenure over their fishing grounds might give them an incentive to resist the temptation of adopting destructive fishing practices and may encourage them to report fishing activities by poachers [29,52]. Also, many fishers do not have an appreciation for why destructive fishing practices are

unsustainable and thus raising awareness among fishers of the negative consequences of destructive fishing practices could be a simple method for reducing these activities [52].

Are these results representative of other Red Sea protected areas?

Managers of marine protected areas are now required to assess objectively how well they are achieving their conservation management objectives [53-56]. It has been suggested that most marine protected areas in the Red Sea are not achieving their conservation objectives in relation to dugongs because existing laws and regulations are not implemented [2]. As yet, this dire prediction cannot be confirmed because most protected areas in the Red Sea have not been formally assessed scientifically to determine if they are achieving their conservation objectives in relation to dugongs and sea turtles. For this reason it is impossible to reliably conclude if our results from Elba National Park are anomalous or, alternatively, are representative of the majority of protected areas in the Red Sea. Unfortunately, given Elba National Park has protected area staff and civilian activity is greatly controlled and it is one of the oldest in the Red Sea it does not provide confidence that other protected areas in the Red Sea are providing a better level of protection. Studies such as the one described in this paper are urgently required to determine the scale of human impact to dugongs and sea turtles in protected areas in the Red Sea.

Conclusion

Elba National Park is not affording complete protection to dugongs and sea turtles because these animals form bycatch to local fishers. In addition, some fishers suggested that sea turtles eggs may continue to be collected and we found a major threat to sea turtles, plastics bags, to be common on representative beaches in Elba National Park. There are a number of management actions available to reduce bycatch of dugongs and sea turtles. These actions include establishing ICUN Category 1a Protected Areas in habitat critical to maintaining populations of these animals and adopting fishing practices that pose less risk to dugongs and marine turtles. Undertaking these actions will not be straightforward as fishers operating in Elba National Park are highly dependent on marine resources. Also, some fishers are from northern Egypt where people have traditionally eaten and traded turtle meat. Consequently, the actual strategy or suite of strategies employed in Elba National Park need to have community support in order to maximise compliance and minimise social impacts.

Acknowledgements

Funding for this project was gratefully received from the IUCN Global Marine Programme and the project was generously supported by USAID. Staff from Elba National Park provided invaluable support to undertake this study. Dr. Fareed Krupp kindly sent the first author a copy of *Fauna of Saudi Arabia* (Vol. 13, 1993), which includes an in depth synthesis of knowledge pertaining to sea turtles in the Arabian region. Lastly, the authors are sincerely appreciative of the dedicated field efforts of Salwa El Halawany and to the fishers who generously gave their time to be interviewed.

References

1. IUCN (1995) A Global Strategy for the Conservation of Marine Turtles. IUCN Species Survival Commision, Switzerland.
2. Marsh H, O'Shea TJ, Reynolds JE (2011) Ecology and Conservation of the Sirenia: Dugongs and Manatees. Cambridge University Press, Cambridge, England.
3. Carr A (1987) Impact of nondegradable marine debris on the ecology and survival outlook of sea turtles. Marine Pollution Bulletin 18: 352-356.
4. Hodgson AJ, Marsh H, Delean S, Marcus J (2007) Is attempting to change marine mammal behaviour a generic solution to the bycatch problem? A dugong case study. Animal Conservation 10: 263-273.
5. Kiszka J, Muir C, Poonian C, Cox TN, Amir OA, et al. (2009) Marine mammal bycatch in the southwest Indian Ocean: review and need for a comprehensive status assessment. Western Indian Ocean J Mar Sci 7: 119-136.
6. Prichard PCH (1980) The conservation of sea turtles: practices and problems. American Zoologist 20: 609-617.
7. Witherington BA, Martin RE (1996) Understanding, assessing, and resolving light pollution problems on sea turtle nesting beaches. Fla Mar Res Inst Tech Rep 2: 73.
8. Laist DW (1987) Overview of the biological effects of lost and discarded plastic debris in the marine environment. Marine Pollution Bulletin 18: 319-326.
9. Marsh H, Penrose H, Eros C, Hugues J (1992) Dugong Status Report and Action Plans for Countries and Territories. UNEP, Nairobi, Kenya.
10. Frazier J, Bertram GC, Evans PGH (1987) Turtles and marine turtles. Key Environments Red Sea, Pergamon Press, Oxford, England 228-314.
11. Huntingford GWB (1980) Periplus of the Erythraean Sea. Hakluyt Society, London, UK.
12. Dobbs K, Fernandes L, Slegers S, Jago B, Thompson L, et al. (2007) Incorporating marine turtle habitats into the marine protected area design for the Great Barrier Reef Marine Park. Pacific Conservation Biology 13: 293-302.
13. Dobbs K, Fernandes L, Slegers S, Jago B, Thompson L, et al. (2008) Incorporating dugong habitats into the marine protected area design for the Great Barrier Reef Marine Park, Queensland, Australia. Ocean and Coastal Management 51: 368-375.
14. Gladstone W, Krupp F, Younis M (2003) Development and management of a network of marine protected areas in the Red Sea and Gulf of Aden region. Ocean and Coastal Management 46: 741-761.
15. Samy M, Sanchez Lizaso JL, Forcada A (2011). Status of marine protected areas in Egypt. Animal Biodiversity and Conservation 34: 165-177.
16. Anonymous (2002) Egyptian Italian Environmental Cooperation Program-Phase II. NCSCB, EEPA, Cairo, Egypt.
17. Baha El Din S (2005) A Guide to the reptiles and amphibians of Egypt. The American University in Cairo Press, Cairo, Egypt.
18. Marshall NA, Marshall PA, Abdulla A, Rouphael T (2010) The links between resource dependency and attitude of commercial fishers to coral reef conservation in the Red Sea. AMBIO 39: 305-313.
19. NCS (2006) Protected Areas of Egypt: Towards the Future. Nature Conservation Sector, Egyptian Environmental Affairs Agency, Cairo, Egypt.
20. Frazier J, Salas S (1984) The status of marine turtles in the Egyptian Red Sea. Biological Conservation 30: 41-67.
21. Nada M, Casale P (2011) Sea turtle bycatch and consumption in Egypt threatens Mediterranean turtle populations. Oryx 45: 143-149.
22. Sasso CR, Epperly SP (2007) Survival of pelagic juvenile loggerhead turtles in the open ocean. Journal of Wildlife Management 71: 1830-1835.
23. Casale P (2008) Incidental Catch Of Marine Turtles In The Mediterranean Sea: Captures, Mortality, Priorities. WWF Italy, Rome, Italy.
24. McClellan CM, Read AJ (2009) Confronting the gauntlet: understanding incidental capture of green turtles through fine-scale movement studies. Endangered Species Research 10: 165-179.
25. Hanafy M, Gheny MA, Rouphael AB, Salam A, Fouda M (2006) The Dugong, *Dugong dugon*, in Egyptian waters: distribution, relative abundance and threats. Zoology in the Middle East 39: 17-24.
26. Preen A (1989) Dugongs. Volume 1: The Status and Conservation of Dugongs in the Arabian Region. MEPA, Coastal and Marine Management Series, Riyadh, Saudi Arabia.
27. Gladstone W, Tawiq N, Nasr D, Andersen I, Cheung C, et al. (1999) Sustainable use of renewable resources and conservation in the Red Sea and Gulf of Aden: issues, needs and strategic actions. Ocean and Coastal Management 42: 671-697.
28. Vine P, Schmid H (1987) Red Sea explorers. Immel Publishing, London, UK.

29. Silva P (2006) Exploring the linkages between poverty, marine protected area management, and the use of destructive fishing gear in Tanzania. World Bank Policy Research Working Paper 3831, February 2006.

30. Marsh H, Heinsohn GE, Marsh LM (1984) Breeding cycle, life history and population dynamics of the dugong, *Dugong dugon* (Sirenia: Dugongidae). Australian Journal of Zoology 32: 767-788.

31. Laist DW (1997) Impacts of marine debris: entanglement of marine life in marine debris including a comprehensive list of species with entanglement and ingestion records. Marine Debris, Sources, Impacts and Solutions, Springer-Verlag, New York, USA 99-139.

32. Tomas J, Guitart R, Mateo R, Raga JA (2002) Marine debris ingestion in loggerhead sea turtles, *Caretta caretta*, from the Western Mediterranean. Mar Pollut Bull 44: 211-216.

33. Abu-Hilal A, Al-Najjar T (2009) Marine litter in coral reef areas along the Jordan Gulf of Aqaba, Red Sea. J Environ Manage 90: 1043-1049.

34. PERSGA/GEF (2003) Coral Reefs in the Red Sea and Gulf of Aden. Surveys 1990 to 2000 Summary and Recommendations. PERSGA Technical Series No. 7. PERSGA, Jeddah, Saudi Arabia.

35. PERSGA/GEF (2004) Regional Action Plan for the Conservation of Marine Turtles and their Habitats in the Red Sea and Gulf of Aden. PERSGA, Jeddah, Saudi Arabia.

36. Preen A (1998) Marine protected areas and dugong conservation along Australia's Indian Ocean coast. Environ Manage 22: 173-181.

37. Day J, Dudley N, Hockings M, Holmes G, Laffoley D, et al. (2012) Guidelines for applying the IUCN Protected Area Management Categories to Marine Protected Areas. IUCN, Gland, Switzerland.

38. Morelli J (2011) Environmental sustainability: A definition for environmental professionals. Journal of Environmental Sustainability 1: 19-27.

39. Sowers J (2011) Nature reserves and authoritarian rule in Egypt; embedded autonomy revisited. The J Environ Develop 16: 375-397.

40. Hawkins JP, Roberts CM (1994) The growth of coastal tourism in the Red Sea: present and future effects on coral reefs. Biolog Conver 76: 216.

41. Marshall NA, Marshall PA, Abdulla A, Rouphael T, Ali, A (2011) Preparing for climate change: recognising its early impacts through the perceptions of dive tourists and dive operators in the Egyptian Red Sea. Current Issues in Tourism 14: 507-518.

42. Pomeroy R, Parks J, Pollnac R, Campson T, Genio E, et al. (2007) Fish wars: Conflict and collaboration in fisheries management in Southeast Asia. Marine Policy 31: 645-656.

43. UNFPA (2011) State of world population 2011. United Nations Population Fund, New York, USA.

44. United Nations (2009) Adaptation to climate change in the Nile Delta through integrated coastal zone management. United Nations Development Programme Government of Egypt Project Document.

45. Zohry A (2005) Interrelationships between internal and international migration in Egypt: A pilot study: forced migration and refugee studies program American University in Cairo, July 2005. Development research centre on migration, globalisation and poverty University of Sussex Falmer, Brighton, UK.

46. Kotb MA, Hanafy MH, Rirache H, Matsumura S, Al-Sofyani AA, et al. (2008) In Status of Coral Reefs of the World: 2008. AIMS, Townsville, Australia.

47. Underwood AJ (2000) Importance of experimental design in detecting and measuring stresses in marine populations. Journal of Aquatic Ecosystem Stress and Recovery 7: 3-24.

48. Aragones LV, Jefferson T, Marsh H (1997) Marine mammal survey techniques applicable in developing countries. Asian Marine Biology 14: 15-39.

49. Jones P (2006) Collective action problems posed by no-take zones. Marine Policy 30: 143-156.

50. Robbins WD, Hisano M, Connolly SR, Choat JH (2006) Ongoing collapse of coral-reef shark populations. Current Biology 16: 2314-2319.

51. Marshall NA, Fenton DM, Marshall PA, Sutton S (2007) How resource-dependency can influence social resilience within a primary resource industry. Rural Sociology 72: 359-390.

52. Pet-Soede L, Erdmann M (1998) Overview and comparison of destructive fishing practices in Indonesia. SPC Live Reef Fish Information Bulletin 4: 28-36.

53. Abdulla A, Gomei M, Maison E, Piante C (2008) Status of Marine Protected Areas in the Mediterranean Sea. IUCN, Malaga, Spain & WWF, France.

54. Hocking M, Stolton S, Dudley N (2000) Evaluating Effectiveness: A Framework for Assessing the Management of Protected Areas. Gland, Switzerland, IUCN.

55. Pomeroy RS, Parks JE, Watson LM (2007) How is your MPA doing? A guidebook of natural and social indicators for evaluating marine protected area management effectiveness. Gland: IUCN Press.

56. Rouphael AB, Abdulla A, Said, Y (2011) A framework for practical and rigorous impact monitoring by field managers of marine protected areas. Environ Monit Assess 180: 557-572.

Citation: Rouphael T, Abdulla A, AttumO, Marshall N, Ghazali U (2013) Do Marine Protected Areas in the Red Sea Afford Protection to Dugongs and Sea Turtles? J Biodivers Endanger Species 1:102. doi:10.4172/jbes.1000102