NUSANTARA BIOSCIENCE ISSN: 2087-3948
Vol. 3, No. 1, pp. 36-43 E-ISSN: 2087-3956
March 2011 DOI: 10.13057/nusbiosci/n030106

Site suitability to tourist use or management programs South Marsa Alam, Red Sea, Egypt

MOHAMMED SHOKRY AHMED AMMAR[1,♥], MOHAMMED HASSANEIN[2], HASHEM ABBAS MADKOUR[1], AMRO ABD-ELHAMID ABD-ELGAWAD[2]
[1]National Institute of Oceanography and Fisheries (NIOF), Suez, P.O. Box 182, Egypt. Tel. (Inst.) 0020 62 3360015. Fax. (Inst.) 0020 62 3360016.
♥email: shokry_1@yahoo.com
[2] Tourism Development Authority, Cairo, Egypt

Manuscript received: 3 February 2011. Revision accepted: 3 March 2011.

Abstract. *Ammar MSA, Hassanein M, Madkour HA, Abd-Elgawad AE. 2011. Site suitability to tourist use or management programs South Marsa Alam, Red Sea, Egypt. Nusantara Bioscience 3: 36-43.* Twenty sites in the southern Egyptian Red Sea (Marsa Alam-Ras Banas sector) were surveyed principally for sensitivity significance throughout the period 2002-2003. Sensitivity of the study area was derived from internationally known criteria, the keywords of each criterion and a brief description of its use was described. The present study assigned for the first time a numerical total environmental significance score that gives a full sensitivity significance evaluation for any site to decide to select either for tourist use or management purposes. However, the results of the study still have the availability to arrange sites with respect to one criterion or only two or many of the used criteria whichever needed. Sites selected for protection are categorized as belonging to the following protected area categories: sites 7, 10 (category vi), site 18 (category ib), site 5 (category iv), sites 16, 17 (category ii). Sites selected for tourist uses are suggested to be classified into 2 categories: first category sites (sites 1, 3, 8, 11, 13, 15) which are recommended as tourist use sites with management of the sensitive resources beside non consumptive recreational activities like swimming, diving, boating, surfing, wind-surfing, jet skiing, bird watching, snorkelling, etc.; second category sites (sites 2, 4, 6, 9, 12, 14, 19, 20) which are recommended as tourist use sites with both non consumptive and managed consumptive recreational activities like fishing.

Keywords: sensitivity significance, selection criteria, tourist use, management programs, Marsa Alam, Red Sea, Egypt

Abstrak. *Ammar MSA, Hassanein M, Abd-Elmegid AE. 2011. Kesesuaian untuk lokasi wisata atau program manajemen Marsa Alam Selatan, Laut Merah, Mesir. Nusantara Bioscience 3: 36-43.* Dua puluh situs di Laut Merah bagian selatan Mesir (sektor Marsa Alam-Ras Banas) disurvei terutama untuk signifikansi sensitivitas sepanjang periode 2002-2003. Sensitivitas suatu daerah penelitian merupakan kriteria yang dikenal secara internasional, kata kunci setiap kriteria dan deskripsi singkat tentang penggunaannya dijelaskan. Penelitian ini dilakukan untuk pertama kalinya berupa skor nilai total signifikansi lingkungan yang memberikan arti evaluasi sensitivitas penuh untuk situs apapun untuk memutuskan memilih baik untuk tujuan wisata atau tujuan pengelolaan lainnya. Namun, hasil penelitian ini masih memiliki ketersediaan untuk mengatur situs-situs yang berkaitan dengan satu kriteria, hanya dua atau banyak dari kriteria yang digunakan mana yang diperlukan. Situs dipilih untuk perlindungan dikategorikan sebagai milik kategori kawasan lindung sebagai berikut: situs 7, 10 (kategori vi), situs 18 (kategori ib), situs 5 (kategori iv), situs 16, 17 (kategori ii). Situs yang dipilih untuk keperluan wisatawan disarankan harus diklasifikasikan menjadi dua kategori: situs kategori pertama (situs 1, 3, 8, 11, 13, 15) yang direkomendasikan sebagai situs menggunakan wisata dengan manajemen sumber daya sensitif di samping kegiatan rekreasi non konsumtif seperti berenang, menyelam, berperahu, berselancar, wind-surfing, jet ski, mengamati burung, snorkeling, dan lain-lain; situs kategori kedua (situs 2, 4, 6, 9, 12, 14, 19, 20) yang direkomendasikan sebagai tempat wisata baik kegiatan non konsumtif atau kegiatan rekreasi non konsumtif yang dikelola seperti memancing.

Kata kunci: signifikansi sensitivitas, kriteria seleksi, kegunaan wisata, program manajemen, Marsa Alam Selatan, Laut Merah

INTRODUCTION

South Marsa Alam's diverse coastal and marine environments are valuable community resource which may be good sites providing recreation and pleasure for visitors and tourists or scientific materials for scientists to do monitoring and conservation programs. There is no getting around the fact that tourism is huge, already categorized as the world's largest industry and will continue to be the dominant developing force in the 21st century (Hill 1998). As environmental conservation and protection is critically important in some sites, sustainable tourism is critically important as well since it may provide source of finance for parks and conservation, serve as an economic justification for park protection, offer local people economically sound and sustainable alternatives to natural resource depletion or destruction, promote conservation and build support with commercial constituencies (Hawkins 1998).

Tourist uses includes a diversity of activities that take place in both coastal zone and coastal waters (Watson et al. 2000), which involve the development of tourism capacities (hotels, resorts, second homes, restaurants, etc.)

and support infrastructures (ports, marinas, fishing, diving shops and other facilities). Coastal recreation activities include two main types: consumptive and non-consumptive ones: Activities such as fishing, , and shell collection, etc. belong to the consumptive recreational uses while the non consumptive activities include swimming, diving, boating, surfing, windsurfing, jet skiing, bird watching, snorkeling, etc .(Porter and Bright 2003). Tourist uses is based on a unique resource combination at the interface of land and sea offering amenities such as water, beaches, scenic beauty, rich terrestrial and marine biodiversity, diversified cultural and historic heritage, healthy food and good infrastructure.

Management programs are the programs that are used for preserving an area to provide lasting protection for part or all of the natural marine environments therein. IUCN (1994) defined the protected area as an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means. To help improve understanding and promote awareness of protected area purposes, IUCN has developed a six category system of protected areas identified by their primary management objective (IUCN 1994) as follows**:**

I. Strict Nature Reserve/Wilderness Area: Protected area managed mainly for science or wilderness protection.
Ia. Strict Nature Reserve: Protected area managed mainly for science.
Ib. Wilderness Area: Protected area managed mainly for wilderness protection.
II. National Park: Protected area managed mainly for ecosystem protection and recreation.
III. Natural Monument: Protected area managed mainly for conservation of specific natural features.
IV. Habitat/Species Management Area: Protected area managed mainly for conservation through management intervention.
V. Protected Landscape/Seascape: Protected area managed mainly for landscape/seascape conservation and recreation.
VI. Managed Resource Protected Area: Protected area managed mainly for the sustainable use of natural ecosystem

Carrying capacity is important to discuss dealing with sustainable coastal tourism. The term "carrying capacity" is the number of organisms the resources of a given area can support over a given time period (MPA NEWS 2004). Adapted to tourism management, it has a similar meaning: the number of people who can use a given area without an unacceptable alteration in the physical environment. Carrying capacity can differ from site to site. Dixon et al. (1994), on analyzing coral cover, they estimated that the diver carrying capacity threshold for the Bonaire Marine Park is between 4000 and 6000 dives per site per year. Surveying the percent of damaged coral colonies in the Red Sea Ras Mohammed National Park, Hawkins and Roberts (1997) suggest 5000 to 6000 dives per site per year in the absence of a site-specific data. Sampling a suite of invertebrates (hard corals, soft corals, sea fans, branching hydrocorals, and erect sponges), Chadwick-Furman (1996) found the threshold for diving sites in the US Virgin Islands to be only 500 dives per site per year and attributed this significantly lower estimate to the fragility of the various reef organisms in the study area. However, effective diver education programs can allow coral reef managers to increase carrying capacities (Medio et al. 1997). Mooring buoys and the management of the number of vessels using mooring buoys with respect to time and location are other effective tools coral reef managers use in reducing the anchor and diver damage to coral reefs.

The purpose of this study is not to replace existing criteria with a new set, but to use existing frameworks for site selection to classify south Marsa Alam sites either for tourist use or management programs in order to assign sites either to EEAA (Egyptian Environmental Affairs Agency) for management purposes or to TDA (Tourism Development Authority) for tourist uses. It is also aimed to develop a total numerical value of sensitivity significance (by scoring and summing techniques) that can be used for site selection (tourist use or management programs), then using single criteria scoring for particular management or tourist use.

MATERIALS AND METHODS

Twenty sites in the southern Egyptian Red Sea (between Marsa Alam and Ras Banas) were surveyed principally for sensitivity significance. The survey was conducted throughout the period 2002-2003. The sites were determined by fixing more or less equal distances between them, however determining the position of sites was done during the preliminary survey. The area of study is shown in Figure 1.

The ecological survey was performed using Scuba diving. For corals and other benthic fauna and flora, the transect line method applied by Rogers et al. (1983) was used by using a 30 m long tape for surveying the percent cover. The intercepted lengths of every individual coral and any other benthic organism or habitat were measured; these lengths are then used to calculate the percent cover using the formula:

% cover = (intercepted length/transect length) * 100

Three transects were used per depth zone and the average was calculated for all transects.

For fishes, the stationary fish census applied by Bohnsack and Bannerot (1986) was used by using a 50 m long transect for the survey. Transects were laid parallel to the shore at 4 m depth in the deep reefs or just above the reef patch in case of the patch reefs. The survey was basically done at 4m depth since it is the area of maximum fish abundance.

Sensitivity significance of the study area is derived from internationally known criteria, however, the keywords of each criterion and a brief description of its use can be described as follow:

Diversity (Ratcliffe 1977; IEEM 2006): large numbers of species, particularly when represented by large populations are to be valued. A high species diversity is usually also reflected by a high diversity of different communities which show variation in environmental conditions.

Rarity (Tubbs and Blackwood 1971; Wittig et al. 1983; Edwards-Jones et al. 2000): Applied to habitats or species where areas are limited, population numbers low or the habitat or species limited in distribution.

Fragility (Ratcliffe 1977; IEEM 2006): Habitats or species vulnerable to disturbance and loss because of small area, low population or reliance on a single key resource.

Ecological functions (IEEM 2006): Loss of ecological function of the physical conditions can be measured by calculating the area of vegetation that is removed or the area of nearshore habitat that is covered by the pier structure.

Typicalness (Fandiño 1996; Edwards-Jones et al. 2000): A measure of how well a site reflects all the habitats that are expected to occur in that geographical region.The more representative a site is of a region, the better.

Naturalness (Ratcliffe 1977; IEEM 2006): Habitats largely unmodified by human activity (e.g., salt marsh, blanket bog).

Scientific value (Wright 1977; Edwards-Jones et al. 2000): The degree of interest of a natural area in terms of current or potential research. It may also be related to the extent to which a site has been used for past research. Sites with good histories (e.g., description of ecosystems' dynamics in the past 50 years) are more valuable to science because they enhance our understanding of ecology

Environmental significance (IEEM 2006): Significance of the site to the environment where that significance is global, natural or local

Scenic value (Ratcliffe 1977): The combination of landforms and habitats is identified as having high scenic value in the context of surrounding landscape

Size (Ratcliffe 1977; IEEM 2006): In general, nature conservation value increases with size. Large sites, in general, contain more species and larger populations of animals and plants than small ones. Chance extinction of species, either as a result of natural or man-made factors, is reduced if a species is present in large numbers.

Estimating sensitivity significance (developed by the author)

An optimal sensitivity score (the optimal score) was supposed for each criterion; this was the score at which the site could be optimal. In addition, an estimated score was assigned to each criterion depending on how much the site meets the conditions of the optimal score, then all sensitivity scores for each site were summed to get the total sensitivity significance. Methods of how values have been assigned to each site per each criterion is described as follows (developed by the author) (Table 1).

Diversity: Diversity value of 1 (according to Shannon-Wiener 1948 formula) was assigned a sensitivity significance score of 5, so .diversity value of 1.2 = estimated score of 6 (1.2*5) and so on.

Rarity: Each 1% of rare biota, relative to the total abundance, was assigned a sensitivity significance score of 10, so 0.2% rare biota or habitats = an estimated score of 2 (0.2*10) and so on.

Fragility: Each 1% fragile habitats (nesting, feeding, breeding), relative to the total cover, was given an optimal score of 10, so each 0.3% fragile habitats = an estimated score of 3 (0.3*10) and so on.

Ecological function: Each 6.66% vital ecological function (vegetation or habitats not removed by physical conditions) was assigned a score of 1 (6.66/6.66), thus a vital ecological function of 26.64% will have an estimated score of 26.64/6.66 = an estimated score of 4 and so on.

Typicalness: A site representing 80% of the number of the characteristic ecosystems of a geographical area was assigned a score of 10% (80/8), thus a site having 24% characteristic ecosystems will have an estimated score of 24/8=3% and so on.

Naturalness: A 10% virgin area (with no human-caused alteration) was assigned a score of 1 (=10/10), thus a 30% virgin area has an estimated score of 30/10=3 and a virgin area of 50% has an estimated score of 50/10=5 and so on.

Scientific value: A site used for scientific research for the past 10 years was assigned a score of 1 (=10/10), thus a site used for the past 30 years will have an estimated score of 3 (=30/10), a site used for the past 50 years will have an estimated score of 5 (=50/10) and so on.

Environmental significance: Global significance was assigned a score of 3, each of national and local significance was given a score of 1.

Scenic value: Scenic value of the landscape depends on the value of the following dimensions: 1-visual dimension 2-geology 3-topography 4-soils 5-ecology 6-landscape history 7-Anthropology 8-architecture 9-culture associations 10-public places. A site that fulfills the scenic value with respect to those 10 items was assigned a score of 5 (=10/2), thus a site that fulfill 4 items will have an estimated score of 4/2=2, a site that fulfills 2 items will have an estimated score of 2/2=1 and so on.

Size: Each 5000m^2 habitats was assigned a score of 1 (=5000/5000), so size of 10000m^2 will have an estimated score of 2 (10000/5000) and so on.

List of sites and their positions

Site 1. Marsa Nakry: 24º55`35.476"N, 34º57`40.993"E

Site 2. between Marsa Nakry and Gabal Dorry: 24º54`36.428"N, 34º58`25.453"E

Site 3. 1 km south of Gabal Dorry: 24º47`33.942"N, 34º59` 14.139"E

Site 4. South Host Mark: 24º 47`33.942"N, 35º01`58.197"E

Site 5. Northern Sharmel Fokairy:

Transect 1: 24º45`16.192"N, 35º03`55.792"E

Transect 2: 24º45`22.126"N, 35º03`50.218" E

Site 6. Southern Sharmel Fokairy: 24º38`20"N, 35º04`51" E

Site 7. Sha'b North Ras Baghdadi:24º40`25``N,35 º05`38``E

Site 8. Northern Ras Baghdadi: 24º40`05.900"N, 35º05`52.625"E

Site 9. Southern Ras Baghdadi: 24º39`16.800"N, 35º05`54.200"E

Site 10. North Sharmel Loly: 24º36`50.460"N, 35º06`59.248"E

Site 11. Southern Sharmel Loly: 24º36`39.2666"N, 35º07`08.795"E

Site 12. North Hankourab: 24º34`49.624"N, 35º08`40.185"E

Site13. South Hankourab: 24º33`23.20"N, 35º09`02.405"E

Site 14. North Ummel Abas: 24º30`44.200"N, 35º08`16.927"E

Site 15. Middle Ummel Abas: 24º30`46.024"N, 35º08`16.300"E

Site 16. South Ummel Abas: 24º30`24.642"N, 35º08`31.717"E

Site 17. Wadi El-Mahara: 24º24`27.674"N, 35º13` 41.471" E

Site 18. a mangroove area: 24º16`32.400"N, 35º3`15.815"E

Site 19. South Hamata city: 24º 16` 32.400" N, 35º23` 15.815" E

Site 20: Lahmy; South El-Gharabawy: 24º12`09.494"N, 35º25`37.744"E

RESULTS AND DISCUSSION

Site priorities for management and protection

Dealing with the total assigned value of sensitivity significance and considering sensitivity significance score ≥ 50 to be suitable for management purposes, the following site priorities are suggested for management purposes: sites 10, 7, 18, 17, 5 and 16 having significant scores of 86, 77, 73, 61, 57 and 54 respectively. However, dealing with each criterion separately, site 10 has first priority for managing diversity and rarity; site 18 for fragility; sites 7, 10, 18 for ecological functions, scientific value, and environmental significance; sites 7, 10 for typicalness and size; site 10 for naturalness; site 18 for scenic value. Moreover, if we used many few of the used criteria, we'll have different site priorities according to the criteria selected for comparison.

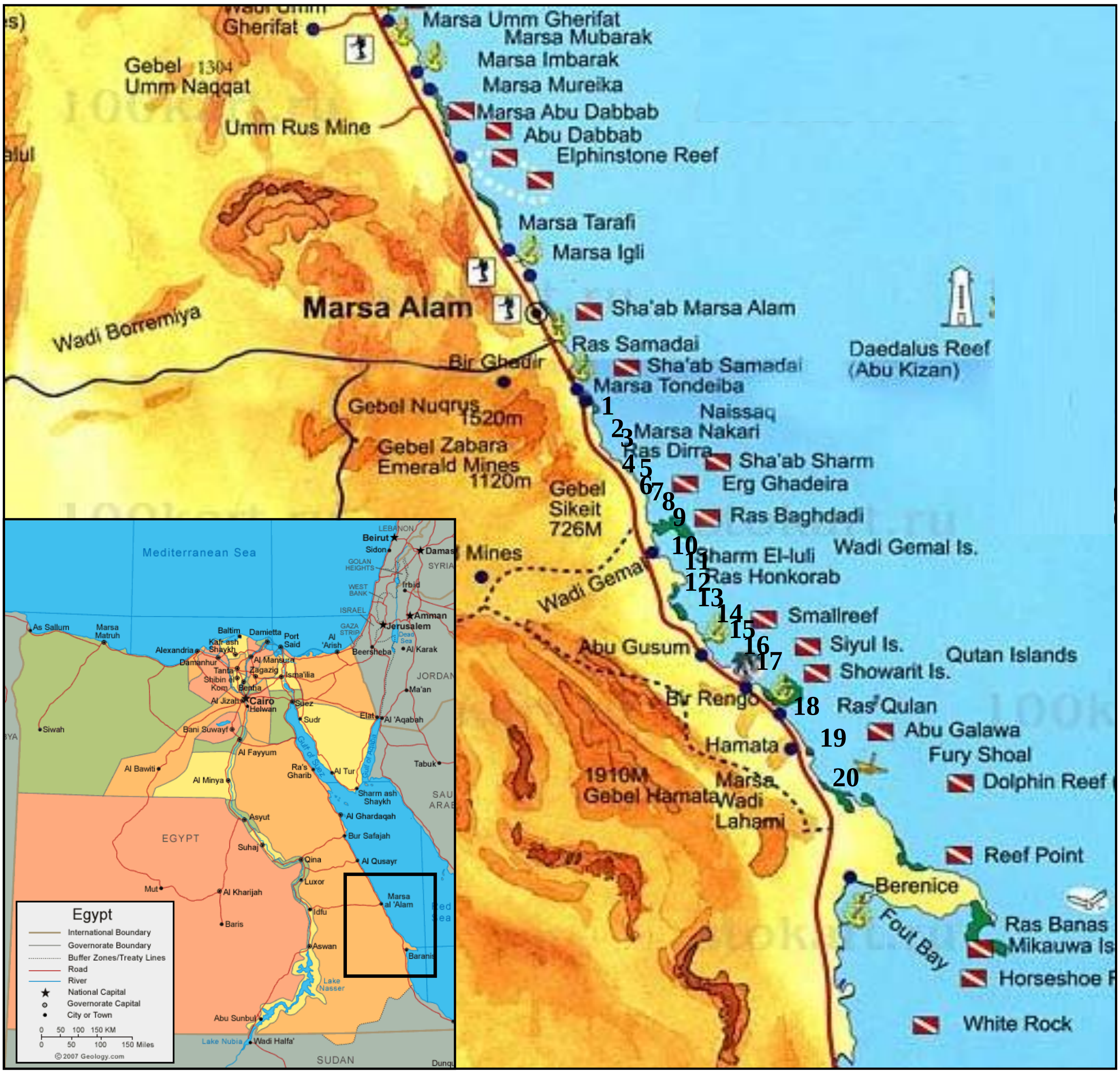

Figure 1. Location of the study area South Marsa Alam (from Marsa Alam to Ras Banas) on the Egyptian Red Sea.

Also, choosing a higher number of criteria used for comparison gives rise to shifting the priority into the site that is appropriate to most of the used criteria.

Site priorities for tourist uses

According to the total assigned sensitivity significance and considering a sensitivity significance score < 50 to be suitable for touristic use, 16 sites were selected are suggested for tourists uses. As many of these sites have some sensitive resources, these sites are suggested to be divided into two categories: first category sites include sites with some sensitive resources and with 30 ≤ sensitivity significance < 50, second category sites include sites without sensitive resources and with sensitivity significance < 30. First category sites are sites 1, 3, 8, 11, 13, 15. Second category sites are sites 2, 4, 6, 9, 12, 14, 19, 20. Sensitive habitats for first category sites are rarity for site 1, diversity and rarity for site 3, fragility for site 8, diversity for site 11 and typicalness for site 13.

Site description

Site 1 (Marsa Nakry) is characterized by a 95% degraded reef flat, 38% dead corals with increase in the hydrocoral *Millepora dichotoma* at 1-5m zone. However, one threatened manta ray (*Taeniura lymm*a) was observed. Site 2 is very poor and far from the shore with increased algae, sands and dead corals. Site 3 has 45% dead corals and one threatened stingray *(T. lymma*). Site 4 is dominated with algae while site 5 is characterized by two main ecosystems: a coral reef ecosystem and a seagrass ecosystem, 38.5% live corals, 66.5% dead corals and one threatened Manta Ray (*Himantura uarnak*). Site 6 has the shoreline heavily condensed with quite a lot amount of plastic bags, glass, and plastic bottles, wood pieces, steel pieces, robes, old shoes, small and big canes with a very poor marine life. Site 7 has 65% live corals, 14% dead corals and one endangered reptile, (the green turtle *Chelonia mydas*. Site 8 has 20% live corals and 55% dead corals, site 9 has 46.5% live corals and 50% dead corals while site 10 has 91% live corals and 5% dead corals. Sites 11 and 12 have a poor marine life except for some algae and spots of corals while site 13 is a clean sandy beach with few small coral patches having 47% dead corals and 35% live corals. Site 14 is mostly sand with few patches of algae, and a well-developed reef. Site 15 has a seagrass patch, a small reef patch suffering from old dynamite fishing and a lot of deep crab niches on the shoreline while site 16 has a fringing reef, a patch reef and a barrier reef with a seagrass bed in between. Site 17 has a degraded reef flat, with 40% live corals, 30% dead corals with juveniles of the threatened organ pipe coral *Tubipora musica* attaching rocks, dead corals and rubble on the reef crest, fishes were mostly of large sizes. while site 18 has heavily condensed mangrove trees on both land and water beside having seagrasses (10% of the

Table 1. Environmental sensitivity of each of the studied sites

Zone	Div (15)	Rar (15)	Frag (15)	EcFu (15)	Typ (10)	Nat (10)	SciVa (5)	EnSi (5)	SceVa (5)	Size (5)	Tot (100)
Site 1	1	1	0.3	26.64	24	30	30		4		
	5	10	3	4	3	3	3	3	2	2	38
Site 2	1.2	0.2	0.2	13.32	24	30	20		4		
	6	2	2	2	3	3	2	2	2	4	28
Site 3	1.6	1	0.3	19.98	24	30	20		4		
	8	10	3	3	3	3	2	2	2	4	40
Site 4	0.4	0	0	6.66	0	0	10		4		
	2	0	0	1	0	0	1	2	2	1	9
Site 5	1.2	0.9	1	59.94	64	50	30		4		
	6	9	10	9	8	5	3	2	2	3	57
Site 6	1	0.2	0.2	6.66	0	30	20		2		
	5	2	2	1	0	3	2	1	1	2	19
Site 7	2.4	1	0.9	86.58	80	70	40		6		
	12	10	9	13	10	7	4	4	3	5	77
Site 8	1.4	0	0.9	39.96	48	30	30		4		
	7	0	9	6	6	3	3	3	2	3	42
Site 9	1	0	0	33.3	32	20	10		2		
	5	0	0	5	4	2	1	1	1	3	22
Site 10	3	1.4	1	86.58	80	80	40		6		
	15	14	10	13	10	8	4	4	3	5	86
Site 11	1.4	0.4	0.4	26.64	24	30	30		4		
	7	4	4	4	3	3	3	3	2	3	36
Site 12	0.6	0	0	0	16	30	20		6		
	3	0	0	0	2	3	2	2	3	3	18
Site 13	1	0.6	0.5	39.96	40	30	20		4		
	5	6	5	6	5	3	2	2	2	2	38
Site 14	0.6	0.1	0.3	19.98	24	10	10		2		
	3	1	3	3	3	1	1	1	1	1	18
Site 15	1.2	0.3	0.9	59.94	24	30	20		4		
	6	3	9	9	3	3	2	2	2	2	41
Site 16	1.6	0.3	1	79.92	48	20	30		6		
	8	3	10	12	6	2	3	3	3	4	54
Site 17	1.4	1.3	0.9	66.6	48	40	30		4		
	7	13	9	10	6	4	3	3	2	4	61
Site 18	2.6	0.4	1.3	86.58	64	60	40		8		
	13	4	13	13	8	6	4	4	4	4	73
Site 19	1.6	0	0	0	24	40	40		4		
	8	0	0	0	3	4	4	2	2	3	26
Site 20	0.8	0	0	0	16	30	20		2		
	4	0	0	0	2	3	2	2	1	2	16

Note: Div = diversity, Rar = rarity, Frag = fragility, EcFu = Ecological function, Typ = typicalness, Nat = naturalness, SciVa = scientific value, EnSi = environmental significance, SceVa = scenic value, Tot = total. Site 2 = between Marsa Nakry and Dorry. Values in parenthesis are the optimum score for each criterion. **Diversity**: upper value in the table is the Shannon estimate of diversity, lower value is the estimated score. **Rarity**: upper value in the table is the percent rare biota or habitats, lower value is the estimated score. **Fragility**: upper value is the percent fragile habitats, lower value is the estimated score. **Ecological function**: upper value is the percent non removed vegetation or habitats, lower value is the estimated score. **Typicalness**: upper value is the percent of characteristic ecosystems of a geographical area, lower value is the estimated score. **Naturalness**: upper value is the percent of area of no human-caused alteration, lower value is the estimated score. **Scientific value**: upper value is the number of past years the site has been used for scientific researches, lower value is the estimated score. **Environmental significance**: values in the table are the estimated scores. **Scenic value**: upper value is the number of items the site fulfill for scenic value, lower value is the estimated score. **Size**: values in the table are the estimated scores.

bottom cover). Site 19 is characterized by a dirty shoreline full of plastic bags, robs, bottles and canes with a very poor reef while site 20 is a typical example of sandy beach having also a trace of an old reef completely degraded and buried with sand.

Approaching a total mathematical sensitivity significance score

Evaluation of sensitivity significance criteria in the previous studies dealt just phonetically with each criterion separately like for example Ratcliffe (1977), IEEM (2006) for evaluation of diversity as high, medium or low, fragility as reversible or irreversible, naturalness as virgin, semi-virgin or altered, size as large, medium or small. Other criteria were phonetically evaluated like Tubbs and Blackwood for evaluation of rarity; IEEM (2006) for ecological functions; Fandiño (1996) and Edwards-Jones et al. (2000) for typicalness; Wright (1977) and Edwards-Jones et al. (2000) for scientific value; IEEM (2006) for environmental significance; Ratcliffe (1977) for scenic value. Such phonetic evaluation can only deal with each criterion separately making it difficult to compare several sites for a group of criteria together, in turn making it difficult to arrange those group of sites according to their importance with respect to several criteria. The present study solved that problem by assigning for the first time a numerical score for each criterion (explained in the material and methods section), then summing all mathematical scores to give a total sensitivity significance score. However, the study still has the availability to arrange the sites with respect to one criterion or only two or many of the used criteria whichever needed according to the management purpose. Although Croom and Crosby (1998), mentioned that scoring and summing techniques were used to minimize the personal bias, he used scoring and summing techniques with respect to only one separate criterion e.g. rarity. Approaching a total sensitivity significance score in the present study is important to select a site that is much appropriate with most of the used criteria. Salm and Clark (1984) and Ray and Legates (1998) expected that extremely complicated scoring and summing techniques may seem the most objective and defensible way to choose a priority site. They further related the reason of using a simple assessment system to the fact that it is easier to use, requires fewer resources and can be evaluated by a diverse group of individuals with varying levels of expertise.

Site priorities for management purposes

Since priorities for site selection with respect to a single criterion differ from those given on using another criterion and from those given on using the total sensitivity significance; it is important, after selecting sites for management purposes, to use the appropriate criterion for selecting the appropriate site for the appropriate management. Parkes (1990), favored the rating of individual assets but differed in how multiple values at a site should be reconciled. He suggested that, where a site has several assets of varying levels of biological significance, the site rating should be based on the value of the dominant asset at the site or the majority of assets at the site. Selection criteria can be used to order candidate sites according to priority in the selection process (Nilsson 1998). However, the present study has been directed mainly to solve the struggle between EEAA (Egyptian Environmental Affairs Agency) and TDA (Tourist Development Authority) for attaining as many sites as possible to EEAA for management purposes or to TDA for tourist uses. Therefore, it was important to think in developing a numerical total environmental significance score by which we can decide either to assign the site for EEAA or for TDA. Latimer (2009) stated that the use of precise numerical criteria or indices for the evaluation of size, diversity or rarity could provide a guideline reference scale, he further mentioned that professional judgment is also important. According to the purpose of the study and considering a total sensitivity significance ≥50 to be significant and appropriate for assigning the site for management (protection) purposes, priorities of site selection assigned for management purposes are site 10, site 7, site 18, site 17, site 5 and site 16, other sites are assigned for touristic uses.

Categorization, carrying capacity and management objectives of sites selected for management purposes

Although sites 7 and 10 have high sensitivity significance with respect to all criteria, they are recommended as managed resource protected areas (category VI) since they contain fishing communities and fishing activities. It is important to sustain fishery resources by restricting fishing activities seasonally or temporarily to let the areas recover. Areas managed to sustain fisheries are very rarely promoted to MPAs, but there are exceptions like the fish habitat reserves in Australia. Site 18 having the highest sensitivity significance with respect to fragility and ecological functions, and being inhabited with mangrove trees, is recommended as wilderness area (category Ib) which is managed mainly for wilderness protection. Sites 7, 10 and 18 having fragile habitats should have a diver carrying capacity threshold of 500 dives per site per year according to Chadwick-Furman (1996). However, site 5 has considerable sensitivity significance with respect to fragility and ecological functions, being inhabited with the fragile seagrasses, it is recommended as habitat/species management area (protected area, category IV). Similar to sites 7, 10, 18; site 5 should have a diver carrying capacity of 500 dives per site per year. Sites 16 and 17 through having considerable sensitivity significance with respect to diversity, rarity, fragility, ecological functions, and typicalness, they are recommended as a national park (protected areas, category II) since they have a significant size which will increase their diver carrying capacity to tolerate recreation. According to Dixon et al. (1994) in Bonaire Marine Park and Hawkins and Roberts (1997) in Ras Mohammed National Park, sites 16 and 17 should have a diver carrying capacity of 4000-6000 dives per site per year. A matrix of management objectives in the sites assigned as protected areas is explained (Table 2) according to IUCN (1994).

Table 2. Management objectives of sites selected for management purposes

Management objective	Sites 7, 10 Category VI	Site 18 Category Ib	Site 5 Category IV	Sites 16, 17 Category II
Scientific research	3	3	2	2
Wilderness protection	2	1	3	2
Preservation of species and genetic diversity (biodiversity)	1	2	1	1
Maintenance of environmental services	1	1	1	1
Protection of specific natural/cultural features	3	–	3	2
Tourism and recreation	3	2	3	1
Education	3	–	2	2
Sustainable use of resources from natural ecosystems	1	3	2	3
Maintenance of cultural/traditional attributes	2	–	–	–

Note: 1 = Primary objective; 2 = Secondary objective; 3 = Potentially applicable objective; – = not applicable.

Site priorities for tourist uses

Sites classified as first category sites (sites 1, 3, 8, 11, 13 and 15) are recommended as tourist use sites with management of the sensitive resources and non-consumptive recreational activities like swimming, diving, boating, surfing, windsurfing, jet skiing, bird watching, snorkeling, etc. Locations of recreational activities could have a carrying capacity of up to 6000 dives per site per year (Hawkins and Roberts 1997) while in the sensitive locations, it should not exceed 500 dives per site per year (Chadwick-Furman 1996). However, effective diver education programs can allow coral reef managers to increase carrying capacities (Medio et al. 1997), also mooring buoys and the management of the number of vessels using mooring buoys with respect to time and location are other effective tools coral reef managers use in reducing the anchor and diver damage to coral reefs. Management of sensitive habitats in first category of tourist use sites includes protection of rarity for sites 1, diversity and rarity for site 3, fragility for site 8, diversity for site 11 and typicalness for site 13. Second category sites (sites 2, 4, 6, 9, 12, 14, 19 and 20) are recommended as tourist use sites with non-consumptive and managed consumptive recreational activities like fishing. Diver carrying capacity of these sites could approach 6000 dives per site per year. Site 4 having the lowest sensitivity significance and most minimum values with respect to every sensitivity criterion is suggested to allocate a part of it for building an artificial reef to restore the damaged ones (Ammar 2009a).

Site description

Damaged reef flat in site 1 is due to the absence of reef access points to deep water. Ammar (2009b) indicated the importance of reef access points in his assessment of some coral reef sites along the Gulf of Aqaba, Egypt. Increased algae and sands in site 2 with increased dead corals agree with Pearson (1981) and Nezali et al. (1998) that algae are among the most important factors which can influence coral recolonization. The high percentage cover of the hydrocoral *Millepora dichotoma* at 1-5m depth in Marsa Nakry as well as in other sites having that species, agrees with the finding of Ammar (2004) that, *Millepora* sp. (a hydrocoral) prefers high illumination and has a strong skeletal density to tolerate strong waves. The relatively low sensitivity significance in spite of the presence of the threatened species (blue spotted stingray *T. lymma*) in sites 1 and 3, indicates the importance of using a particular criterion when dealing with a particular management purpose. The green turtle *Chelonia mydas* found in site 7 is categorized as a taxon having an observed, estimated, inferred or suspected reduction of at least 80% over the last 10 years or three generations, whichever is the longer (IUCN 2002). The lower recorded amount of dead corals in site 10 (Sharm El Loly) though it is highly used by fishing boats, is due to the fact that these boats anchor on the inlet terminal, away from the reef and go to open water through the middle of the inlet. Reporting juveniles of the vulnerable organ pipe coral *Tubipora musica* in site 17 (Wadi El-Mahara) is the reason for increased sensitivity significance with respect to rarity in that site. Ammar (2005) categorized the organ pipe coral *Tubipora musica* as vulnerable according to IUCN (2001), as there is an estimated population size reduction of ≥ 50% over the last 10 years, based on the index of abundance and the decline in area of occupancy. Site 18 having a mangrove ecosystem, a seagrass ecosystem and a coral reef ecosystem integrating together helped to increase most of the selection criteria, in turn increases the overall sensitivity significance. Broody (1998) stated that selection criteria help to provide a rational basis for choosing among potential sites.

CONCLUSIONS

The present study approached for the first time a numerical total sensitivity significance score for each site to select a site that is much appropriate with most of the used criteria. This is important to classify a group of sites to be suitable either for tourist use or management purposes. Since priorities for site selection differ from one sensitivity criterion to the other and from the total sensitivity significance, it is important, after selecting a site for management (using the total sensitivity significance), to specify the appropriate criterion for deciding the appropriate management purpose per site. Sites selected for management (protection) purposes are categorized as belonging to the following protected area categories: sites 7, 10 (category vi), site 18 (category ib), site 5 (category iv), sites 16, 17 (category ii). Sites selected for tourist uses are classified into 2 categories: 1- First category sites (sites 1, 3, 8, 11, 13, 15) which are recommended as tourist use sites with management of the sensitive resources and non consumptive recreational activities like swimming, diving, boating, surfing, windsurfing, jet skiing, bird watching, snorkelling, etc. Second category sites (sites 2, 4, 6, 9, 12, 14, 19, 20) which are recommended as tourist use sites with non consumptive and managed consumptive recreational activities like fishing.

REFERENCES

Ammar MSA. 2004. Zonation of coral communities and environmental sensitivity offshore a resort site at Marsa Alam, Red Sea, Egypt. Egypt J Zool 42: 67-18.

Ammar MSA. 2005. An alarming threat to the red organ pipe coral Tubipora musica and suggested solutions. Ecol Res 20: 529-535.

Ammar MSA. 2009a. Coral reef restoration and artificial reef management, future and economic. Open Environ Eng J 2: 37-49.

Ammar MSA. 2009b. Assessment of present status and future needs of four coral reef sites along the Gulf of Aqaba, Egypt. Open Environ Poll Toxicol J 1: 34-42.

Bohnsack JA, Bannerot SP. 1986. A stationary visual census technique for quantitatively assessing structure of coral reef fishes. NOAA Tech Rep NMFS 41: 1-15.

Broody SD. 1998. Evaluating the role of site selection criteria for marine protected areas in the Gulf of Maine. Report 2, Gulf of Maine Marine Protected Area Project. Maine, USA.

Chadwick-Furman NE. 1996. Effects of scuba diving on coral reef invertebrates in the US Virgin Islands: implications for the management of diving tourism. Proc. 6th Intl Coelenterate Biol Conf. Amsterdam, The Netherland.

Croom M, Crosby M. 1998. Description of dimensionless analyses and delphic priority ranking methodologies for selecting marine and coastal protected areas. In: Crosby MP, Laffoley D, Mandor C, O'Sullivan G, Geenen K (eds). Proceedings of the Second International Symposium and Workshop on Marine and Coastal Protected Areas: Integrating Science and Management. Silver Spring, MD: Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration.

Dixon JA, Scura LF, van't Hof T. 1994. Ecology and microeconomics as "joint products": the Bonaire Marine Park in the Caribbean. In: Perrings CA, Mäler KG, Folke C, Holling CS, Jansson BO(eds) (eds) Biodiversity Conservation: Problems and Politics. Kluwer, Dordrecht.

Edwards-Jones G, Davies B, Hussain S. 2000. Ecological Economics; An Introduction. Blackwell. Cornwall, UK.

Fandiño M. 1996. Framework for ecological evaluation. [PhD Dissertation]. University of Amsterdam. ITC publication 45. Enschede.

Hawkins DE. 1998. The relationship of tourism-related revenue generation to coral reef conservation. In: Hatziolos ME, Hooten AJ, Fodor M (eds). Coral reefs: challenges and opportunities for sustainable management The International Bank for Reconstruction and Development/The World Bank. New York.

Hawkins JP, Roberts CM. 1997. Estimating the carrying capacity of coral reefs. Proc 8th Int Coral Reef Symp 2: 1923-1926.

Hill C. 1998. Green globe: The tourism industry and sustainability. In: Hatziolos ME, Hooten AJ, Fodor M (eds). Coral reefs: challenges and opportunities for sustainable management The International Bank for Reconstruction and Development/The World Bank. New York.

IEEM [Institute of Ecology and Environmental Management]. 2006. Guidelines for ecological impact assessment in the United Kingdom. Institute of Ecology and Environmental Management, Winchester

IUCN. 1994. Guidelines for Protected Area Management Categories. IUCN. Gland, Switzerland.

IUCN. 2001. The IUCN red list of threatened species 2001. Categories and criteria (v. 3.1). In: CITES identification manual. IUCN. Gland, Switzerland.

IUCN. 2002. 2002 IUCN red list of threatened species. IUCN. Gland, Switzerland.

Latimer W. 2009. Assessment of biodiversity at the local scale for environmental impact assessment and land-use planning. Planning Practice & Research 24(3): 389-408.

Medio D, Pearson M, Ormond RFG. 1997. Effect of briefings on rates of damage to corals by scuba divers. Biol Conserv 79: 91-95.

MPA NEWS. 2004. Assessing the carrying capacity of marine protected areas. MPA NEWS 6 (2): August 2004.

Nezali LM, Johnstone RW, Mgaya YD. 1998. Factors affecting scleractinian coral recruitment on a nearshore reef In Tanzania. Ambio 27 (8): 717-722.

Nilsson P. 1998. Criteria for the selection of marine protected areas - an analysis. Report 4834 Research and Development Department, Swedish Environmental Protection Agency. Stockholm.

Parkes D. 1990. Guidelines for the Assessment of Biological Significance in Victoria. Department of Conservation and Environment, Flora and Fauna Survey and Management Group, Lands and Forests Division. East Melbourne.

Pearson RG. 1981. Recovery and colonization of coral reefs. Mar Ecol Prog Ser 4: 105-122

Porter R, Bright RD. 2003. Non-consumptives outdoor recreation, activity meaning, and environmental concern. Proceedings of the 2003 Northeastern Recreation Research Symposium, GTR-NE-317.

Ratcliffe DA (ed). 1977. A Nature Conservation Review. Cambridge University Press, Cambridge.

Ray C, Legates D. 1998. Range of selection approaches for marine and coastal protected areas. In: Crosby MP, Laffoley D, Mandor C, O'Sullivan G, Geenen K (eds). Proceedings of the Second International Symposium and Workshop on Marine and Coastal Protected Areas: Integrating Science and Management. Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration. Silver Spring, MD.

Rogers CS, Gilnack M, Fitz HC. 1983. Monitoring of coral reefs with linear transects: a study of storm damage. J Exp Mar Biol Ecol 66: 285-300.

Salm R, Clark J. 1984. Marine and Coastal Protected Areas: A Guide for Planners and Managers. IUCN. Gland, Switzerland.

Tubbs CR, Blackwood JW. 1971. Ecological evaluation of land for planning purposes. Biol Conserv 3 (3): 169-172.

Watson AE, Cole DN, Turner DL, Reynolds PS. 2000. Wilderness recreation use estimation; a handbook of methods and systems. general technical report RMRSGTR-56. U.S. Department of Agriculture-Forest Service, Rocky Mountain Research Station. Ogden, Utah.

Wittig R, Armitage MT, Firse MT, Moss D. 1983. A quick method for assessing the importance of open spaces in towns for urban nature conservation. Biol Conserv 26: 57-64.

Wright DF. 1977. A site evaluation scheme for use in the assessment of potential nature reserves. Biol Conserv 11: 293-305.