

## Assessment of Present Status and Future Needs of Four Coral Reef Sites Along the Gulf of Aqaba, Egypt

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**Abstract:** The present status and future needs of four coral reef sites (Taba, Nuweiba, Dahab and Sharm El-Sheikh) along the Gulf of Aqaba, Egypt were evaluated. A total of 60 quadrats, distributed at different depths or different patches were surveyed at each site during the year 2007. Three mooring buoys were reported only in Ras Umm Seid but nothing was found in other sites, however excessive boating and diving pressure were recorded only in Ras Umm Seid. Highest amount of garbage was recorded in Nuweiba, patrolling efficiency was best in Taba but no patrolling activities were recorded in other sites. Ras Umm Seid (Sharm El-Sheikh) had the highest amount of dead corals (13%) due to increased boating and diving pressure compared to other sites, however Dahab had the lowest amount of dead corals (4%) due to the rough conditions (strong wind and waves) causing difficulties in accessing that site. Nuweiba and Taba had high percent cover of sands (10% and 11%, respectively) playing a key role in the considerable amount of dead corals in both sites. Lowest % new coral recruits in Taba (0.5%) was associated with the soft sandy bottom, the opposite was true in Sharm El Sheikh due to the rocky bottom. Future needs of the studied sites include decreasing the number of divers to the diver carrying capacity (DCC), repair of existing buoys and incorporation of 5 more buoys in Ras Umm Seid. Other sites have no future needs in these regards as they are far beyond the DCC. Nuweiba needs first of all to be cleaned, then being protected for giving the chance of recovery. Except for Taba which has efficient patrolling, the other 3 sites need efficient terrestrial and marine patrolling as well as enforcement of EEAA regulations. However reef access points which were absent in all sites need to be established to minimize reef damage on accessing deeper water. Also, the environmental awareness field signs which were absent in all sites need to be established and managed. Taba is recommended as a protected area as it has the food for threatened species beside being useful as a nesting site. Ras Umm Seid is recommended to have an established artificial reef to draw the attention of divers and snorklers from the natural reefs and prepare artificial shelters for fishes thus promoting the fish resources.

### INTRODUCTION

Coral reefs of South Sinai are among the most important reef communities all over the world. Moreover, they are ecosystems providing shelters for a big variety of fishes and so many other organisms, including urchins, cucumbers, molluscs, as well as other benthos, forming together what the scientist call the underwater forest. Coral reefs are very important as they are a source of a big quantity of protein, besides, many of them have medical and scientific value [1]. Some reef forms, the fringing reef, protect the shore from being eroded [2].

These very important corals are strictly sensitive to the hydrodynamic action of water, which might be increased by boats and divers [3], as well as to the water quality [4], this quality is affected by some factors, like temperature, salinity, dissolved oxygen, nutrients as well as pollution [5-7].

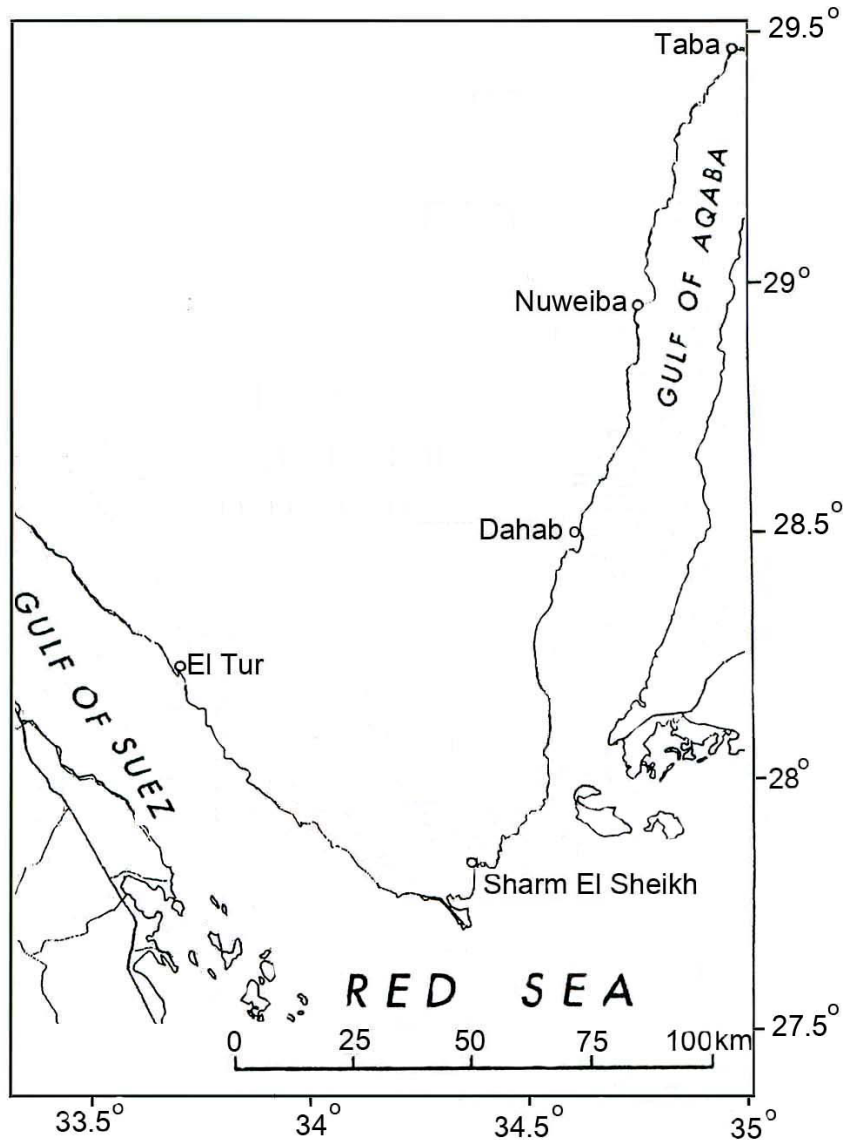
Previous studies assured a negative correlation between the number of divers, especially the unexperienced divers and the amount of coral reef damage [8]. Number of boats are also effective by leakage of petroleum oil which is toxic

and harmful to coral communities or by causing audio and hydrodynamical disturbance to the coral reef communities which is naturally a calm and sensitive ecosystem or by inputting the divers and snorklers who might be unexperienced representing a possible harm to the reef [9]. Divers may damage reefs by trampling, walking, collection or accidental damage by inexperienced divers.

Present tourism in South Sinai is predominantly concentrated on the coast from Sharm El Sheikh to Nabq where more than 70% of the hotel rooms are located receiving more than 90% of the tourist visitors (source: city council). The area will probably also be the main magnet for tourism in the future due to the location of the international airport and the international branding of the name Sharm El-Sheikh. While diving and snorkeling are listed as the major pull factors for visitors to South Sinai, it should be noted that 48% of visitors to dive locations are non-divers; snorkelling, swimming, or viewing reefs from glass bottom boats, or just on pleasure lunch excursions (mainly domestic visitors) (source: city council, dive guides). Other visitors to dive sites are SCUBA divers engaging in a wide range of dive experiences (source: city council, dive guides):

- Daily diving – two dives during the day (78%)
- Night diving – one dive at night (6%, predominantly experienced divers)

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**Fig. (1).** Location map of the study sites.

- Diving safari excursions - normally 5-6 days (16%)

Reef mooring systems are needed for the protection of reefs. Reef mooring systems in South Sinai, for use by excursion vessels, were first installed in 1994, mainly funded by the EC (European Commission), and were maintained with EC funding up to 2002 after which maintenance costs were covered by the EEAA (Egyptian Environmental Affairs Agency). However, only a third of moorings are presently in functional condition as dimensioning was aimed at far smaller vessels.

There is presently no tourism management plan for the Gulf of Aqaba/Ras Mohammed. An outline environmental plan was produced in 2003 by the Regional Organisation for the Conservation of the Red Sea and the Gulf of Aden (PERSGA), National Parks of Egypt and the EEAA.

Recreational diving can damage reefs both directly and indirectly. Several studies have looked to the adverse effect

of heavy boating pressure and the provision of facilities for tourists [10-12]. Resuspension of sediments may also stress organisms [13].

Effective management of coral reefs and the people visiting or living near them can only occur through supportive policies, enhanced capacity, sustainable financing and significant on-the-ground actions that are based on appropriate information, knowledge and awareness [9].

The main goal of the study is to evaluate the present status and future needs of four coral reef communities along the Gulf of Aqaba, Egypt as it is the key element affecting sustainable development in South Sinai, Egypt.

## MATERIALS AND METHODS

Four sites were chosen along the Gulf of Aqaba to study coral reefs and associated fauna and flora. These sites were Taba, Nuweiba, Dahab and Sharm El-Sheikh representing a transect along the Gulf of Aqaba (Fig. 1). Latitudes and lon-

**Table 1. Percent Cover of Different Coral Growth Forms in the Studied Sites**

	Taba	Nuweiba	Dahab	Ras Umm Seid
Branching Corals	14	10	8	18
Massive Corals	7	5	18	10
Encrusting Corals	4	4	26	5
Soft Corals	3	13	11	8
Hydrocorals	2	4	5	6

gitudes of the studied sites are as follows: Taba: 29° 28.369'N 034° 51.578'E; Nuweiba: 28° 59.164'N 034° 41.180'E; Dahab: 28° 31.849'N 034° 30.886'E; Ras Umm Seid (Sharm El-Sheikh): 27° 50.878'N 034° 18.956'E.

A preliminary visual survey of the studied sites showed that the site at Taba lies few hundred meters to the north of Pharaoh's island and characterized by the shallowness and sandy bottom with abundance of algal turf, seagrasses, Turkey fish, sea anemone and molluscs while the site at Nuweiba lies just at the southern border of Domina Elaria hotel and characterized by long intertidal zone that reaches several hundred meters with abundance of algae and seagrasses, followed by the coral reef zone with abundance of the soft corals. Dahab is an open site with deep and steep reef slope with abundance of gorgonians, massive and encrusting corals as well as the presence of moray. Ras Umm Seid is characterized by a deep slope with the abundance of the soft corals and the presence of considerable amount of the yellow spots disease, molluscs, the feather star and algae. The study was performed throughout the period Spring 2007 – Winter 2007.

Using SCUBA diving and a 1 m<sup>2</sup> quadrat with a quadrat grid, coral reef communities were assessed with respect to percent cover of live corals, dead corals, new coral recruits and coral diseases. A total of 60 quadrats, distributed at different depths or different patches were surveyed at each site. In each of the deep sites (Nuweiba, Dahab and Ras Umm Seid), the 60 quadrats were distributed equally in an order of 10 quadrats at each of the depths 1m, 5m, 10m, 20m, 30m and 35m. However, in Taba (the shallow site), the 60 quadrats were distributed equally into 6 shallow reef patches in an order of 10 quadrats per patch. Sample photos with a high resolution underwater camera beside collection of small pieces of samples were conducted to help in later identification of species.

Percent cover was estimated as follow:

$$\left( \frac{\text{Number of grid squares overlying coral or other feature}}{\text{Total number of squares}} \right) * 100.$$

Percent cover of other living features like sea anemones, molluscs, echinoderms, sponges, sea grasses and algae in addition to the non living features like dead corals, bare rocks, rubbles and sands/sediments were also assessed in the same way. Human impacts (like number of boats, number of divers, number of snorklers, number of existing buoys, number of interlacing angle fishing threads, garbage, patrolling efficiency, presence of reef access points) on these coral

reef sites were assessed during the survey. In addition future needs depending on the status and impact on each site were provided.

## RESULTS

The percent cover of different coral growth forms at the studied sites is shown in Table 1. The highest percent cover (18%) of branching corals was found in Ras Umm Seid while that of massive and encrusting corals reached its maximum (18% and 26%, respectively at Dahab. Soft corals attained a maximum (13%) at Nuweiba whereas hydrocorals were found having a maximum percent cover of 6 at Ras Umm Seid.

Abundant coral species and their percent cover at the four studied sites are shown in Table 2. Six abundant corals were recorded in each site. In site 1 (Taba) *Asteriophora myriophthalma*, *Acropora eurystoma*, *Lobophyllia corymbosa*, *Pocillopora damicornis*, *Milopora dichotoma* and *Acropora tenuis* have a total percent cover of 13.5 compared to 16.5 for other corals. In this site, the branching coral *Acropora eurystoma* and the massive coral *Asteriophora myriophthalma* recorded the highest percent cover, each representing 3% cover. In site 2 (Nuweiba), *Lithophyton* sp., *Acropora hemperichi*, *Acropora humilis*, *Goniastrea retiformis*, *Echinopora lamellosa* and *Turbinaria mesentrina* were found having a total percent cover of 20.5 compared to 15.5 percent cover for other corals. The soft coral *Lithophyton* sp. and the branching stony coral *Acropora hemperichi* were the most abundant corals in this site having 8 and 4 percent cover, respectively. Site 3 (Dahab) was characterized by *Pachyseris rugosa*, *Oxypora lacera*, *Mycidium elephantotus*, *Pavona varians*, *Porites lobata* and *Siphonogorgonian* sp. having a total percent cover of 29 compared to 39 percent cover for other corals. The encrusting coral *Pachyseris rugosa* and the gorgonian soft coral *Siphonogorgonian* sp. were the most abundant coral in this site having 7 and 6 percent cover respectively. Corals of site 4 (Ras Umm Seid) included *Xenia* sp., *Acropora hemperichi*, *Porites lobata* and *Acropora eurystoma* having percent cover of 29 compared to 39 percent cover for other corals. The soft coral *Xenia* sp. and the branching stony coral *Acropora hemperichi* were the most abundant coral species in this site having 6 and 5 percent cover, respectively.

The percent cover of other living organisms at the studied sites is shown in Table 3. The percent cover of the bivalve *Tridacna* sp. attained a maximum of 3 at Taba, Dahab and Ras Umm Seid and totally absent in Nuweiba. Contrary to

**Table 2. Abundant Coral Species and their Percent Cover at the Studied Sites**

Sites	Corals Species	Percent Cover	Depth of Most Dominant Species (m) in Sites 2-4 / Number of Patches Having Dominant Species in Site 1
Site 1 (Taba)	<i>Asteriopora myriophthalma</i>	3	5 patches
	<i>Acropora eurytoma</i>	3	4 patches
	<i>Lobophyllia corymbosa</i>	2.5	2 patches
	<i>Pocillopora damicornis</i>	2	3 patches
	<i>Millepora dichotoma</i>	1.5	2 patches
	<i>Acropora tenuis</i>	1.5	4 patches
	Other corals	16.5	6 patches
	Total	30	
Site 2 (Nuweiba)	<i>Lithophyton</i> sp.	8	10m, 20m
	<i>Acropora hemperichi</i>	4	20m
	<i>Acropora humilis</i>	3	1m, 5m
	<i>Goniastrea retiformis</i>	2.5	20m
	<i>Echinopora lamellosa</i>	1.5	30m
	<i>Turbinaria mesentrina</i>	1.5	35m
	Other corals	15.5	5m, 10m
	Total	36	
Site 3 (Dahab)	<i>Pachyseris rugosa</i>	7	35m
	<i>Oxypora lacera</i>	4	30m
	<i>Mycidium elephantotus</i>	3	30m
	<i>Pavona varians</i>	2	30m, 35m
	<i>Porites lobata</i>	7	20m, 30m
	<i>Siphonogorgonian</i> sp.	6	10m, 20m
	Other corals	39	1m, 5m
	Total	68	
Site 4 (Ras Umm Seid)	<i>Xenia</i> sp.	6	20m, 30m, 35m
	<i>Acropora hemperichi</i>	5	10m, 20m
	<i>Porites lutea</i>	4	30m
	<i>Porites compressa</i>	2	30m
	<i>Porites lobata</i>	1	35m
	<i>Acropora eurytoma</i>	3	1m, 5m
	Other corals (mostly hydrocorals, gorgonians and branching stony corals)	26	1m, 10m
	Total	47	

that, Nudibranch was only recorded in fewer number in Nuweiba having a maximum percent cover of 1. Values of the percent cover of the sea urchin *Diadema setosum* are similar to each other for both Taba and Ras Umm Seid with a maximum value of 2, totally absent in Nuweiba and recorded 1% in Dahab. The sea urchin *Prinocidaris baculosa* was found only in Nuweiba and totally absent in other sites. Sea cucumbers were not recorded in Taba and Dahab. Feather star were only found in Ras Um Seid (6%), not recorded in other sites. Sea grasses were not recorded in Dahab and Ras Umm Seid but they were recorded at Taba and Nuweiba having a maximum percent cover of 9 at each site. Algal turf was highly abundant at Taba (16%) than Ras Umm Seid

(1%), totally absent in Nuweiba and Dahab. Bladder blister algae were recorded only at low percent cover (3) at Ras Umm Seid. Other macroalgae were only found in Nuweiba having percent cover of 14.

The percent cover of non living features at the studied sites is shown in Table 4. The percent cover of dead corals and bare rocks attained a maximum of 13 and 12, respectively at Ras Umm Seid and a minimum of 4 and 7, respectively at Dahab whereas rubbles attained a maximum of 3 at Ras Umm Seid and a maximum of 1 at both Taba and Nuweiba. Sand was maximal at Taba (11%) and attained a minimum of 1% at Ras Umm Seid.

**Table 3. Percent Cover of Other Fauna and Flora in the Studied Sites**

Taxa		Taba	Nuweiba	Dahab	Ras Umm Seid
Molluscs	<i>Tridacna</i> sp.	3	-	3	3
	Nudibranch	-	1	-	-
Echinoderms	<i>Diadema setosum</i> (sea urchin)	2	-	1	2
	<i>Prinicipidaris baculosa</i> (sea urchin)	-	3	-	-
	Sea cucumbers	3	-	5	-
Feather star	-	-	-	-	6
Sea anemone	-	4	-	2	-
Sponge	-	3	6	2	3
Sea grasses	-	9	9	-	-
Macroalgae	Algal turf	16	-	-	1
	Bladder blister algae	-	-	-	3
	Other macroalgae	-	14	-	-

**Table 4. Percent Cover of Non Living Features in the Studied Sites**

	Taba	Nuweiba	Dahab	Ras Umm Seid
Dead Corals	9.5	5	4	13
Bare Rocks	8	11	7	12
Rubbles	1	1	2	3
Sand	11	10	4	1
Total	29.5	27	17	29

**Table 5. Percent Cover of New Coral Recruits and Coral Diseases in the Studied Sites**

	Taba	Nuweiba	Dahab	Ras Umm Seid
New coral recruits	0.5	2	3	5
Coral diseases	1	2	1	1

The percent cover of new coral recruits and coral diseases are shown in Table 5. New coral recruits were highest in Ras Umm Seid (5%) reached its minimum (0.5%) at Taba. Coral diseases were maximal (2%) at Nuweiba and reported 1% at each of other sites.

Data of human impacts are shown in Table 6. Average number of divers per day was 0, 15 and 20 in Taba, Nuweiba and Dahab, respectively attaining its highest value (140) in Ras Umm Seid. Similarly, average number of snorklers was 0, 20 and 25 in Taba, Nuweiba and Dahab, respectively attaining its maximum value (100) in Ras Umm Seid. Moreover, number of diving boats was 0, 2 and 3 in the same three sites, respectively having its highest value of 7 in Ras Umm Seid. Number of existing mooring buoys was 3 (with a dete-

riorated status) in Ras Umm Seid and 0 in other sites. Garbages (plastic bags, chains, cans, tyres and onshore faeces) were maximum in Nuweiba and minimum in Taba. However, number of interlacing threads of angle fishing was 7, 4 and 1 in Nuweiba, Dahab and Ras Umm Seid decreased to 0 in Taba. An interlacing fishing thread in Dahab is indicated in Fig (2). No reef access points or environmental awareness signs were recorded in any of the study sites. Patrolling was efficient only in Taba and absent in other sites.

## DISCUSSION

In Taba, abundant corals were represented by five branching and one massive coral, total percent cover of

Table 6. Data of Human Impacts in the Studied Sites

		Taba	Nuweiba	Dahab	Ras Umm Seid
Number of divers (average/day)		0	8	10	140
Number of snorklers (average/day)		0	4	5	100
Number of dive boats		0	1	0	7
Number of existing buoys		0	0	0	3
Angle fishing (number of interlacing fishing threads)		0	7	4	1
Garbage	Plastic bags	1	8	3	3
	Cans	1	6	2	1
	Chains	0	1	0	0
	Tyres	0	2	0	0
	Onshore faeces (number of pieces)	0	6	2	0
Patrolling efficiency (Number of patrolling persons)	EEAA rangers	0	0	0	0
	Coast guards/Police	4	0	0	0
Reef access points (number)		0	0	0	0
Environmental awareness field signs (number)		0	0	0	0
Visibility (m)		20	4	7	20



Fig. (2). Clownfish living in sea anemone at Dahab, a fishing thread is an evidence of angle fishing impact.

branching corals was also higher than other growth forms of the same site. This was due to the shallowness and high illumination at Taba (3m depth). Branched colonies usually decrease with increasing depth and are replaced by encrusting and flattened colonies which have a great ability to entrap light [14]. However, an exception was the massive coral *Asteriopora myriophthalma* that was also dominant in that

shallow site because its corallite morphology expand, extend and deepen like those of branching corals, thus favouring the life in shallow areas. A relationship between corallite morphology and light, where the corallites expand, extend and deepen in light conditions [15]. The highest percent cover of soft corals at Nuweiba (the site impacted by highest amount of garbage and high amount of algae can be explained by the



**Fig. (3).** Heavy boating in Ras Umm Seid, Sharm El-Sheikh.

conclusion of Ammar [16] that soft corals have a higher recovery rate and a faster recovery time than stony corals because soft corals could adapt and compete for space more faster after being subject to impacts especially physical impacts. Benayahu [17] showed that soft corals replace stony corals and cause their death, this is an important factor affecting coral recolonization [18]. Increased massive and encrusting corals than branching corals in Dahab especially in deeper areas can be explained by the wider surface areas that can entrap a larger amount of light in case of weak illumination at deeper areas and caves or at higher turbidity. The studied site in Dahab is an open site with a very steep and deep slope having a lot of caves and shadow areas which initiate a condition of weak illumination. Sheppard [19] referred to the occurrence of *Porites* sp. (a massive coral) in abundant cover in turbid water with weak light compared to *Acropora* sp. (a branching coral). On the contrary, Ras Umm Seid is a site protected from winds and waves, with a gentle slope initiating good illumination until up to 20m depth, promoting the abundance of branching corals. The high percentage cover of hydrocorals especially in shallow areas at Ras Umm Seid, compared to other sites, agrees with the finding of Ammar [20] that, *Millepora* sp. (a hydrocoral) prefers high illumination and has a strong skeletal density to tolerate strong waves. On the contrary, the lowest amount of hydrocorals (*Millepora dichotoma*) in Taba is due to the soft sandy bottom with increased algae and seagrasses. However, the highest percent cover of the soft coral *Xenia* sp. than other species in Ras Umm Seid agrees with the result of Atrigenio and Alino [21] that, the soft coral *Xenia* sp. is a potent competitor and plays an important role in determining succession and community structure.

The absence of the bivalve *Tridacna* sp. in Nuweiba and its abundance in other sites is attributed to the highest amount of garbage (plastic bags, cans, chains, tyres and on-shore faeces as well as the lowest visibility in Nuweiba compared to other sites. Hean and Cacho [22] indicated that low visibility or increased turbidity have negative effects on the clams *Tridacna* sp. causing them to grow poorly. Hart *et al.*

[23] showed that water clarity is one of the main factors affecting growth of the clam *Tridacna* sp. However, the presence of Nudibranch only in Nuweiba agrees with the conclusion of Barbeau *et al.* [24] that sea slugs preferred darkness over light, they also preferred rough substratum over smooth substratum when they are in dark. Presence of sea cucumbers only in Taba and Dahab is due to the better patrolling efficiency in both sites preventing illegal collection of cucumbers. The variations in the amount of sea urchins with the amount or kinds of algae or seagrasses in different sites is explained by the result of Carpenter [25, 26] that some control of algal abundance is affected by the grazing activity and food preference of sea urchins.

The highest amount of dead corals in Ras Umm Seid, Sharm El-Sheikh is due to the increased boating (Fig. 3) and diving pressure compared to other sites. Jameson *et al.* [9], in his damage assessment of some Red Sea diving sites, found that diving sites suffer, in varying degrees, from physical damage and need management attention. Coral reefs worldwide are subjected to extensive human impacts caused by snorkelers and SCUBA divers [8, 11]. Wielgus *et al.* [12] found that SCUBA divers are significant causes of coral partial mortality. However, the lowest amount of dead corals in Dahab is due to the rough conditions (strong wind and waves) causing difficulties in accessing that site. That result is supported by the finding of Ammar [27], in his estimation of the alarming threats to the red organ pipe coral *Tubipora musica*, that flourishing live *Tubipora* colonies were found in considerable amounts in Wadi El Mahara, because of the very strong wave breaking on the reef crest, the zone containing the *Tubipora* colonies, making it difficult to access for collection. The highest amount of bare rocks and rubbles in Ras Umm Seid is an evidence of the highest amount of past coral breakage compared to other sites [28]. The high percent cover of sands in both Nuweiba and Taba play a key role in the considerable amount of dead corals in both sites. This agrees with the results of Hudgson & Carpenter [29] and Ammar & Mahmoud [5] that sediments plays an important role in decreasing coral distribution in the Red sea.

Lowest recruitment rate (as indicated by the lowest percent cover of new recruits) in Taba is due to the soft sandy bottom which is weak enough to prevent stability and settlement of coral larvae while the highest recruitment rate in Ras Umm Seid is due to the rocky bottom, water clearance and being well sheltered to allow larval stability, also the damage due to divers in Ras Umm Seid may initiate recruitment (recolonization). Damage can initiate recolonization through the accumulation of small broken branches (nubbins) and the availability of substratum used for settlement and survival of those nubbins. Pearson [18] and Nezali *et al.* [30] showed that factors which can influence coral recolonization include the extent of damage and its location, the availability of coral larvae, the requirement for a "conditioning" period of the substratum before corals can settle, the availability and diversity of microhabitats for settlements and survival, the role of grazers, and competition with other organisms such as algae and soft corals. Highest amount of coral diseases in Nuweiba is associated with the highest amount of garbage in that site initiating bacterial diseases.

### FUTURE NEEDS

Highest recorded average number of divers per day in Ras Umm Seid (140 diver/day) means that the number of divers per year is more than 51000 which is far exceeding the diver carrying capacity (DCC). From guidelines developed in 1992 by the World Tourism Organization and the UN Environment Programme, a basic equation for calculating visitor carrying capacity is:

*Carrying capacity = Area used by tourists / Average individual standards*

Here, the average individual standard (often measured in square meters per person) is the space a tourist requires for an acceptable experience in the protected area, which will vary depending on the area, activity, and management. Hawkins and Roberts [31] concluded that the diver carrying capacity, which is the number of dives per site per year, the site can tolerate, to be a total of 6000 dives/site/year. Therefore, one of the future needs of Ras Umm Seid site is to decrease the number of divers to the diver carrying capacity. However, no future needs for other sites in that regard is required as they are far beyond the DCC. Since Ras Umm Seid has only 3 mooring buoys which are deteriorated, repair of existing buoys and incorporation of more buoys (5 more buoys) is urgent especially the site can tolerate up to 8 buoys. Other sites have no future needs in these regards as they are far beyond the DCC. Since Nuweiba has the highest amount of garbage, it needs first of all to be cleaned then being protected for giving the chance of recovery. Except for Taba which has efficient patrolling, the other 3 sites need efficient terrestrial and marine patrolling as well as enforcement of EEAA regulations to stop illegal fishing or collection of marine species and to ensure compliance with EEAA regulations. However reef access points, which were absent in all sites, have to be established to minimize reef damage on accessing deeper water. Several authors [32-34] documented the degradation of coral reefs by reef walkers in the absence of reef access points. Also, the environmental awareness field signs which were absent in all sites need to be established and well managed. As the site of Taba has the bottom largely covered with seagrasses, a substrate that is

useful for feeding of the threatened species like marine turtles or manta rays, beside being useful as a nesting site, it is recommended as a protected area. As the site of Ras Umm Seid has the highest boating and diving pressure, it is recommended establishing an artificial reef in that site to draw the attention of divers and snorklers from the natural reefs and prepare artificial shelters for fishes promoting the fish resources. From the review of some articles [35-41], it was concluded that artificial reefs could be potentially used for tourism SCUBA diving, recreational angling, surfing, beach enhancement, fisheries, nature conservation and science.

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