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DISTRIBUTION OF SEAGRASS SPECIES ALONG THE EGYPTIAN RED SEA COAST

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ABSTRACT

The distribution of the different seagrass species along the Egyptian coasts of the Red Sea was investigated. The seagrass species in the Red Sea form vast meadows from the tidal zone down to depths of 70 m. These coastal marine habitats are highly productive and support complex ecosystems; however, seagrasses of the Red Sea have not been adequately mapped leading to lack of systematic information on this valuable marine ecosystem. Approximately 1300 km of coastal and offshore (i.e. island) lines along the Egyptian Red Sea were surveyed, examined and an analysis of data on the distribution and abundance of seagrass species was done. The study area was from Ain Sukhna (40 km south of Suez city) to Abu Ramad in the south (20 km. North the Egyptian –Sudanese boarder), and from Ras Burkha (35 km south the Egyptian Israeli boarder) to Sharm El Sheikh City at the southern end of the Gulf of Aqaba. A total of six species belonging to five genera of seagrasses were identified during this study (*Halodule uninervis, Halophila stipulacea, Halophila ovalis, Thalassia hemprichii, Thalassodendron ciliatum and Syringodium isoetifolium*). The Gulf of Aqaba had the greatest number of seagrass species along the study area. Two sites (Ras Mohamed and Abu Galum) had the highest diversity (five species), from a single sampling site, while only three species were found along the Gulf of Suez. The Red Sea Proper had five seagrass species. The environmental factors controlling the presence and development of the seagrass species in the Red Sea have been related to temperature, sediment composition, water motion and salinity.

1. INTRODUCTION

Seagrasses—a unique group of flowering plants that have adapted to exist fully submersed in the sea— profoundly influence the physical, chemical, and biological environments in coastal waters, acting as ecological engineers (Wright and Jones, 2006) and providing numerous important ecological services to the marine environment (Costanza, 1997).

Seagrasses are distributed across the globe, but unlike other taxonomic groups with worldwide distribution, they exhibit low taxonomic diversity approximately 60 species worldwide (den Hartog, 1970).

The Egyptian Red Sea coastal zone is an area of great physical beauty with different ecosystems and a high biological diversity. However, since seagrass beds are much less spectacular visually than coral reefs; although, their ecological significance may well be comparable (Phillips and McRoy, 1980), several biological and ecological studies in the Red Sea have focused on coral reefs, beginning from the 18th century (Forsskal, 1775), and continuing to the present.

In the Red Sea the different seagrass species form vast meadows from the tidal zone down to depths of 70 m (Wahbeh, 1984). The commonest species in the Red Sea are *Halophila stipulacea, Halodule uninervis, Thalassodendron ciliatum, Thalassia hemprichii,* and *Halophila ovalis*, Table (1) exhibit the reported seagrass species in the Red Sea.

2. STUDY AREA

The Red Sea is a long, narrow body of water separating north-east Africa from the Arabian Peninsula. The Red Sea has been an important trade route throughout human recorded history. It is connected at the south with the Indian Ocean, and very nearly joins the Mediterranean Sea at the north of the Gulf of Suez. Seven countries have shorelines on the Red Sea. Egypt lies on the north western coast of the Red Sea ranking as the second country having shoreline on the Red Sea after the Kingdom of Saudi Arabia (Head and Edwards, 1987).

According to Morcos (1970), the Red Sea is 1932 km long, and averages 280 km in width. Even at its widest, in the south near Massawa, it is only 354 km wide, and narrows to 29 km at the shallow strait of Bab El Mandab. The northern Gulfs of Suez and Aqaba present great contrasts in bathymetry. The Gulf of Suez is a shallow flat-bottomed basin, with a depth of 55 to 73 m, deepening at the entrance to the Red Sea proper, while the Gulf of Aqaba is very steep-sided and deep, reaching maximum depths of over 1800 m near the East Coast, although the Gulf is only some 30 km wide in average.

The Red Sea proper and the Gulf of Aqaba are part of the African Rift valley system. The Gulf of Aqaba is in these respects a model, on a very small scale, of the Red Sea it self (Head and Edwards 1987). The northern Red Sea is characterized by a narrow shelf. In the extreme north (Gulf of Aqaba), the continental shelf extends less than 1 km off shore. Consequently, there is a restricted intertidal and shallow subtidal zone, followed by an abrupt drop- off into deep water. This limits the occurrence of shallow water coastal biotopes. In this region, the more extensive seagrass beds are limited to the shallow soft bottomed creeks and embayments known as sharms or mersas, or to intertidal and submarine wadi out-wash plains.

The Red Sea lies between 30^{o} N and 12^{o} 30$^{\backslash}$ N, and in this considerable latitudinal range one might expect to find a range of climatic conditions. But, this is not the case. The hydrographic conditions of the Red Sea show unusual characters. This isolated tropical sea is located between two broad deserts with a very hot and extremely dry climate. Therefore, the evaporation is intensive which is uncompensated by land drainage or rainfall that exceeds about 18 cm per year, and the coastal vegetation is semi-desert.

Surface salinities in the Red Sea are generally high, increasing from 36-37‰ in the Gulf of Aden to 41‰ in the northern Red Sea. Mean annual surface water temperature increases from 22^{o}C in the north to a maximum of 28^{o} C in the south, but seasonal changes are more marked in the north. In deeper water (> 300-400 m.), both salinity (40.6 ‰) and temperature (21.6^{o}C) are more constant (Head and Edwards 1987).

SAMPLING SITES

The coastal survey covered almost all the coastal line of the Egyptian Red Sea between Ain Sukhna (40 km south Suez City, north Gulf of Suez) to Abu Ramad in the south (20 km north the Egyptian –Sudanese boarder), and Ras Borka (35 km south the northern Egyptian boarder, Gulf of Aqaba) to Ras Mohamed National Park at the south of Gulf of Aqaba. Samples were also collected from three islands of the northern Red Sea proper to end with 29 sites (Figure 1). Table (2) shows names of the sampling sites, with its coordinates.

Table (1): Red Sea seagrass families and their species (after Wahbeh, 1984).

RED SEA SEAGRASSES	
POTAMOGETONACEAE	**HYDROCHARITACEAE**
Cymodocea rotundata	*Enhalus acoroides*
Cymodocea serrulata	*Thalassia hemprichii*
Syringodium isoetifolium	*Halophila stipulacea*
Thalassodendron ciliatum	*Halophila ovata*
Halodule uninervis	*Halophila decipiens*
	Halophila ovalis

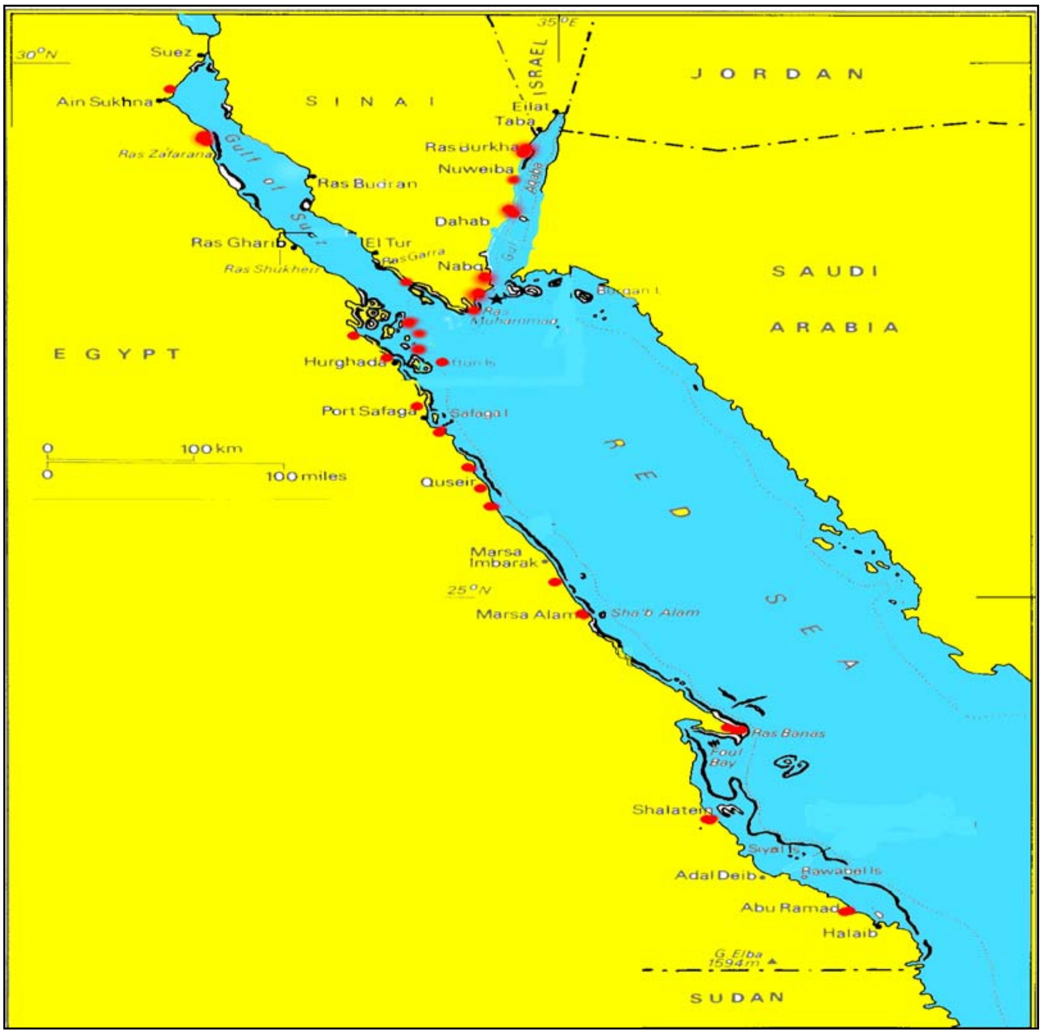

Fig. (1): Map of the Egyptian Red Sea Coast showing the sampling sites (red dots).

Table (2): Names, coordinates of the sampling sites.

Site Number	Site Name	Latitude	Longitude
1	Ras Mohamed National Park	27° 47.178′ N	34° 13. 032′ E
2	Marine Station(SCU)	27° 51.000′ N	34° 16. 706′ E
3	Sharm El Moya	27° 51.809′ N	34° 18. 100′ E
4	Nakhlet El Tal (Napq)	28° 32.350′ N	34° 20. 407′ E
5	Dahab	28° 27.253′ N	34° 30. 034′ E
6	Abu Galum	28° 44.004′ N	34° 37. 176′ E
7	Hebeik	28° 52.689′ N	34° 38. 906′ E
8	Ras Burkha	29° 10.512′ N	34° 43.403′ E
9	Ras Abu El Darg	29° 22.776′ N	32° 33.907′ E
10	El Kafrawy Project	29° 40.675′ N	32° 21.670′ E
11	Ras Millan	27° 46.37′ N	34° 06 17′ E
12	Twal Island	27 ° 32. 51′ N	33 ° 44. 50′ E
13	Umm El hamat Island	27 ° 36.37′ N	33 ° 40. 29′ E
14	Umm El Bessian Island	27 ° 37.24′ N	33 ° 46.57′ E
15	Abu Monkar Island	27 ° 13.03′ N	33 ° 54.00′ E
16	Ish El Milaha	27° 31.284′ N	33° 34.000′ E
17	Marine Station (NIOF)	27° 17.083′ N	33° 46.211′ E
18	Ras Abu Somah	26° 51.008′ N	33° 54.034′ E
19	Gasous	26° 36.074′ N	34° 0.05′ E
20	El Hamrawen	26° 15.148′ N	34° 12.064′ E
21	El Qusier City	26° 0.8113′ N	34° 17.07′ E
22	Sharm El Bahari	25° 87.113′ N	34° 41.67′ E
23	Marsa Asalay	25° 09.247′ N	34° 51.040′ E
24	Marsa Allam	25° 04.165′ N	34° 53.586′ E
25	Abu Ghuson port	24° 27.074′ N	35° 12.077′ E
26	Hamata	24° 17.561′ N	35° 12.010′ E
27	Ras Banas	23° 55.285′ N	35° 45.545′ E
28	Shalatin	23° 09.599′ N	35° 36.542′ E
29	Abu Ramad	22° 24.153′ N	36° 25.155′ E

- (1-8) Gulf of Aqaba. - (9-11) Gulf of Suez.
- (12-15) Northern Islands. - (16-29) Red Sea Proper.

3. MATERIALS AND METHODS

Seagrass plants were harvested randomly by hand from the seafloor by SCUBA diving or by free diving according to the depth of the meadow. A wide edged knife was used to collect the plant materials to ensure that all the plant parts (above and under ground) were represented in the sample. Care was taken to ensure that no parts of the plants were lost. Replicates were taken from different parts of the meadow to provide a good representation of the seagrass plants.

The collected plant materials were washed with habitat seawater at the sampling site to remove sediments and then transferred to clean labeled plastic bags (1 kg capacity), stored in cool dark area and transported to the laboratory of the National Institute of Oceanography and Fisheries (NIOF), Suez

In the laboratory, all the plant material of each station was pooled, separated to individual plant identified and sorted into different species according to:

- The Seagrasses of The World (den Hartog, 1970).

Data were analyzed using one-way ANOVA (SPSS 10.0) to detect the differences in diversity among the three studied regions of the Egyptian Red Sea (Gulf of Aqaba, Gulf of Suez and Red Sea Proper).

4. RESULTS

A distance of approximately 1300 km. was surveyed along the coasts of the Egyptian Red Sea. A total of six species of seagrasses belonging to five genera were identified during this survey. Table (3) summarizes the results of studying the distribution of the different seagrass species along the surveyed area.

Table (3): Records of seagrass species along the different sampling sites.

Species / Sites	*Halophila ovalis* (R.Br.) Hook.f	*Halophila stipulacea* (Forssk.) Aschers	*Halodule uninervis* (Forssk.) Aschers	*Thalassia hemprichii* (Ehrenb.) Aschers	*Thalassodendron ciliatum* (Forssk.) den Hartog	*Syringodium isotifolium* (Aschers.) Dandy	Total species number
Ras Mohamed National Park	+	+	++	++	++	-	5
Marine Station(SCU)	-	+++	-	-	-	-	1
Sharm El Moya	-	++	-	-	-	-	1
Nakhlet El Tal (Napq)	-	++	-	-	-	-	1
Dahab	-	-	+	-	-	-	1
Abu Galum	+	+	+	++	+	-	5
Hebeik	-	+++	++	-	-	-	2
Ras Burkha	-	++	++	-	+	+++	4
Ras Abu El Darg	-	-	++	-	-	-	1
El Kafrawy Project	+	++	-	-	-	-	2
Ras Millan	-	+++	++	-	-	-	2
Twal Island	-	++	++	-	-	-	2
Umm El hamat Island	-	-	+++	-	-	-	1
Umm El Bessian Island	++	-	+++	-	-	-	2
Abu Monkar Island	-	++	-	-	-	-	1
Ish El Milaha	-	++	++	-	-	-	2
Marine Station (NIOF)	+	++	++	-	++	-	4
Ras Abu Somah	-	-	+	-	-	-	1
Gasous	-	++	-	-	-	-	1
El Hamrawen	-	-	++	++	-	-	2
El Qusier City	++	-	++	-	-	-	2
Sharm El Bahari	-	++	-	-	-	-	1
Marsa Asalay	++	-	+	++	-	-	3
Marsa Allam	-	-	++	-	-	-	1
Abu Ghuson port	-	-	++	-	++	-	2
Hamata	-	+	-	-	-	-	1
Ras Banas	-	-	-	++	-	-	1
Shalatin	-	-	+	+++	-	-	2
Abu Ramad	+++	+	-	-	++	-	3
Frequency	27.6	58.6	65.5	20.7	20.7	3.4	**6**

(Not found = - ; present = +; common = ++; abundant = +++).

The most commonly found seagrass species was *Halodule uninervis* (Forssk.) Aschers, it occurred in 19 sites with a frequency of 65.5. *Halophila stipulacea* (Forssk.) Aschers.– second species in abundance- was found in 17 sites with a frequency of 58.6. *Halophila ovalis* (R.Br.) Hook.f., was found in 8 sites, with a frequency of 27.6, while, *Thalassia hemprichii* (Ehrenb.) Aschers and *Thalassodendron ciliatum* (Forssk.) den Hartog occurred each in 6 sites with a frequency of 20.7 for each one. Finally, *Syringodium isoetifolium* (Aschers.) Dandy was found in only one site -in the northern Gulf of Aqaba- resulting a frequency of 3.4.

Although results of one-way ANOVA showed no significant difference ($P<0.05$) in the number of species between the different regions of the Egyptian Red Sea; some distribution patterns were detected;

The Gulf of Aqaba had the greatest number of seagrass species along the study area. Two sites (Ras Mohamed and Abu Galum) had the highest diversity (five species), from a single sampling site. Four species were recorded in Ras Burkha (Gulf of Aqaba) and the marine station of NIOF, Hurghada (Red Sea proper). On the other hand, the Gulf of Suez showed lower seagrass diversity. Two species were recorded in El Kafrawy Project site (western side) as well as the site of Ras Millan on the eastern side. Two of the surveyed northern islands got two seagrass species while the other two and the rest of the visited sites were only dominated by one species. Figure (2) shows the number of seagrass species along the study area.

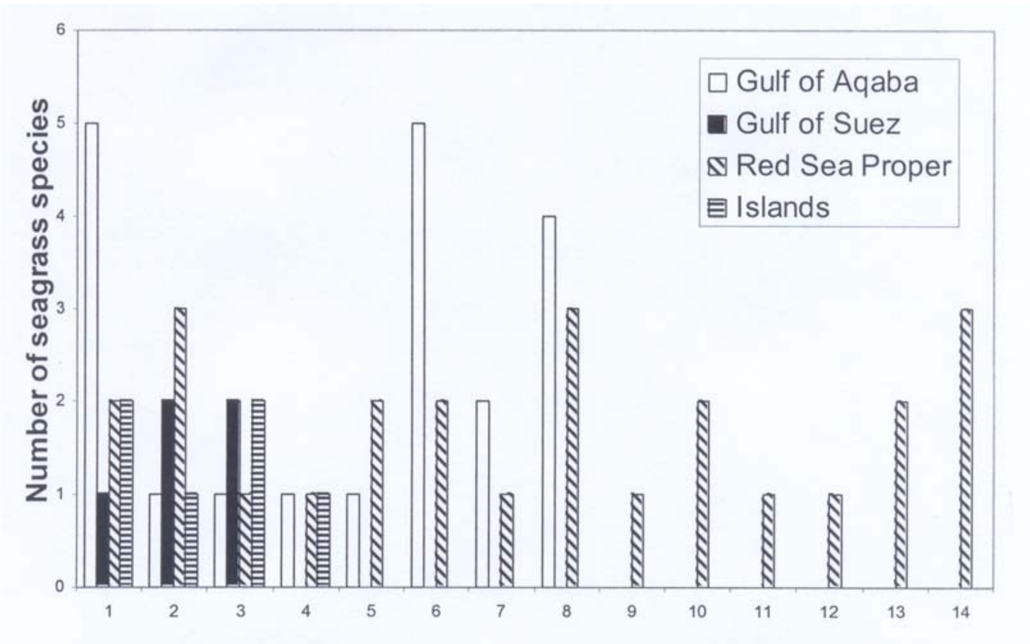

Fig. (2): Number of seagrass species at the different localities of the study area.

5. DISCUSSION

From the eleven seagrass species known from the Red Sea (Jacobs and Dicks, 1985), six species were identified during the present study (Table 4).

The Gulf of Aqaba (western coast) had all the six recorded seagrass species, while only three species were found along the western coast of the Gulf of Suez. The Red Sea Proper had five seagrass species.

Seagrasses of the Red Sea have not been adequately mapped, but some general points have emerged from the few studies of their distribution.

Conditions in the Gulfs of Suez and Aqaba (particularly the former) appear to be at the limits of temperature tolerance for the majority of the seagrass species. *Halophila stipulacea* appears to be most abundant towards the northern and southern ends of its range in the western Indian Ocean and is perhaps best regarded as a subtropical rather than a truly tropical seagrass (Price *et al.*, 1988). This would account for its predominance in the relatively cooler waters of the northern Red Sea and for why it has been the only Red Sea seagrass able to colonize the Mediterranean Sea.

Table (4): Distribution of the different seagrass species along the Red Sea coasts.

Seagrass species	Gulf of Suez	Gulf of Aqaba	Red Sea Proper	
			African coast	Asian coast
Halodule uninervis (Forssk.) Aschers.	XO	XO	XO	X
Cymodocea serrulata (R. Br.) Aschers.	-	-	X	-
Cymodocea rotundata Ehrenb.& Hempr.	-	X	X	X
Syringodium isoetifolium (Aschers.) Dandy	-	XO	X	X
Enhalus acoroides (L.F.) Royle	-	-	X	X
Thalassodendron ciliatum (Forssk.) den Hartog	-	XO	XO	X
Thalassia hemprichii (Ehrenb.) Aschers.	-	XO	XO	X
Halophila ovalis (R. Br.) Hook.	XO	XO	XO	X
Halophila ovata Gaud.	-	-	-	X
Halophila stipulacea (Forssk.) Aschers.	XO	XO	XO	X
Halophila decipiens Ostenfeld	-	-		X

X = previous records (Wahbeh, 1984; Jacobs and Dicks, 1985; Price *et al*., 1988; Geneid, 1995)
O = present survey

However, conditions favour the development of soft bottom biotopes and colonization of seagrasses, which flourish in the shallow subtidal regions are not fully explained. According to Lipkin (1975) the number of seagrass species reported along the eastern side of the Gulf of Aqaba was 4 species, while the western side (Sinai) had 6 species. The difference in the occurrence of the number of seagrass species may be that subtle environmental differences between the eastern and western sides, or differences in community development (Hulings and Kirkman, 1982). In contrast, species more common in the northern Red Sea (e.g. *Thalassodendron ciliatum*) may be less frequent, or even be excluded from the central and southern Red Sea because of excessive summer temperatures in shallow water.

In brief, individual species of seagrasses showed latitudinal trends in abundance; *Halophila ovalis, Halodule uninervis, Thalassia hemprichii, Cymodocea sp.* and *Enhalus acoroides* all showed a significant increase in abundance towards the southern Red Sea. Conversely, the abundance of *Halophila stipulacea, Syringodium isoetifolium* and *Thalassodendron ciliatum* increased significantly towards the northern Red Sea (Price *et al*., 1988).

Environmental factors controlling the presence and development of seagrass species have been related to temperature, sediment composition, water motion and salinity, but in the absence of controlled field experiment, these factors are rather dubious. Within the area investigated, the seawater temperature ranges from 16 to 27^0C; salinity is more or less constant; 39.7-41.2 $‰_0$ (Geneid, 1995).

Through this study and other studies (Geneid, 1995, Price *et al*., 1988) the sediment composition inside the seagrass bed was noticed being fine grained to clay, however, some changes were observed: *Thalassodendron ciliatum* and *Thalassia hemprichii* mostly inhabit coral rubbles and coarse sand while, *Halophila ovalis* prefer fine sand, the remaining seagrass species were associated with sediment of intermediate grain size (0.125-0.063 mm). This may simply explains the presence of *Halodule uninervis* and *Halophila stipulacea* as the most frequent species along the study area. On the other hand, Bouchon, 1980 stated that the biological activity in term of grazing especially by sea urchins can be a significant factor in seagrass bed dynamics in shallow areas.

For such case, carefully designed experiments are needed to determine details of the factors controlling the occurrence and abundance of seagrasses in the Red Sea to give who is interested in conservation and planning of the marine environment the facts to make good and effective plans.

Finally, the preservation of seagrasses and their associated ecosystem services—in particular, biodiversity, primary and secondary production, nursery habitat, and nutrient and sediment sequestration—should be a global priority. The following diagram illustrate the number of scientific documents on seagrass is below those on salt marshes, mangroves, and coral reefs (figure 3).

As for the Red Sea area, prior to or in the framework of this basic survey, particular attention should be given to establishing an updated bathymetric map and obtaining some remote sensing imagery of the area that would help in the delineation of acoustically distinct areas and in the formulation of ground-truth strategies. A more comprehensive and thorough investigation should be undertaken for the further understanding of the habitats' ecosystem and their biodiversity, as well as of the nature and distribution of the area's living resources, their potentials for rational utilization and conservation.

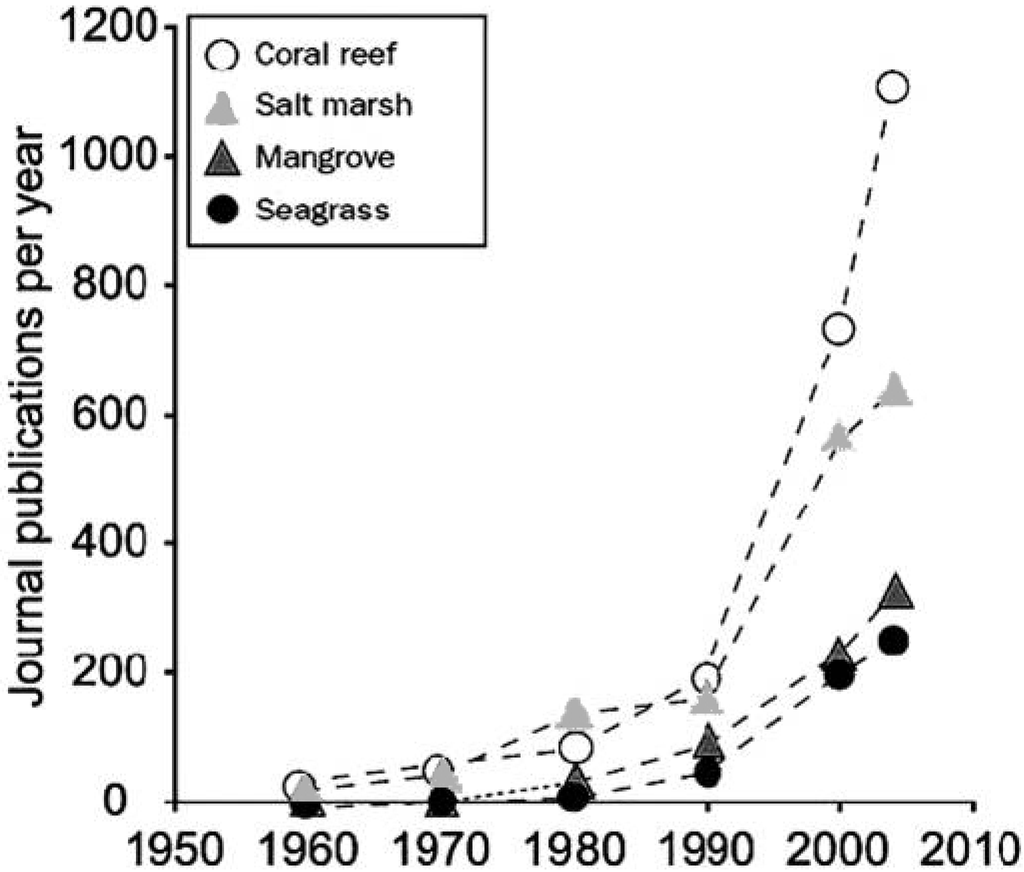

Fig. (3): Comparison of seagrass, salt marsh, mangrove, and coral reef habitats in terms of journal publications {(Web of Science 1950–2006) (*BioScience*, *2006*)}.

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