2.1.5.4. Discussion

1. Habitats and species

Survey spots were classified into several habitat types according to their tidal situations and features of the sea bottom. The number of species in each habitat type is shown in Table 37.

Numbers of species in the supertidal, intertidal and subtidal zones were 50, 167 and 218 species respectively. The number of benthic species of abundance level 2 or higher were 32, 64 and 72 in the same respective zones. Species with low abundance levels were found more in the subtidal zone than in the intertidal zone.

Habitats in the intertidal zone are characterised by a sea bottom substrate of sand and bedrock, while habitats in the subtidal zone are more complicated with various elements such as sand, bedrock, seagrass bed and patch reefs. A comparison of habitats composed of sand and bedrock in the two zones suggests that the patch reefs in the subtidal zone are an especially important element for sustaining a benthic community with a high degree of diversity. The number of species in the intertidal zone is larger than in sand and bedrock habitats in the subtidal zone.

Table 37. Number of species observed in various habitat types.

Habitat type		Number of species		Number of spots
Tidal zone	Types of bottom	above abundance level 1	above abundance level2	
Supertidal zone	bedrock	34	(21)	2
	rock	5	(5)	1
	sand	13	(7)	6
	sand / bedrock	7	(7)	1
	Total	50	(32)	10
Intertidal zone	bedrock	64	(29)	9
	rock	7	(0)	2
	sand	49	(26)	3
	mud	14	(6)	2
	sand / bedrock	92	(35)	11
	sand / rock	9	(5)	1
	sand / seagrass	2	(0)	1
	sand / patch reef	11	(0)	1
	sand / seagrass / bedrock	21	(6)	1
	Total	167	(64)	31
Subtidal zone	bedrock	58	(21)	8
	sand	56	(27)	10
	patch reef	48	(18)	5
	sand / bedrock	96	(25)	11
	sand / rock	11	(0)	1
	sand / seagrass	17	(2)	4
	sand / patch reef	130	(43)	13
	sand / seagrass / patch reef	30	(10)	2
	sand / bedrock /patch reef	25	(3)	1
	Total	218	(72)	55

Species of abundance level 2 or higher seen in at least four spots are listed in Table 38. They are considered to be suitable species for observation of the Study Area.

The main species which were observed between the supertidal and the intertidal zones were *Scapimera* cf.*globosa*, *Cellana eucosmia* and *Acanthopleura haddoni*. Species that were distributed between the intertidal and the subtidal zones were SERPULIDAE, *Echinometra mathaei*,, *Diadema setosum*, *Tridacna maxima* and *Pedum spondyloideum*. Species observed extensively between the supertidal and the subtidal zones were DIOGENEIDAE, *Calcines latens*, *Clibanarius striolatus* and *Ophiocoma scolopendrina*.

Table 38. Distributions of the main species by tidal zone.

Scientific Name	English Name	Supertidal Zone	Intertidal Zone	Subtidal Zone	No.*
Scopimera cf.*globosa*	stalk-eyed crab	x	x		8
Cellana eucosmia	limpet	x	x		5
Acanthopleura haddoni	chiton	x	x		4
Nerita polita	slipper winkle	x	x		4
Strombus fasciatus	Lineated Conch		x		5
SERPULIDAE	calcareous tube-worm		x	x	23
Echinometra mathaei	echinometrid		x	x	22
Diadema setosum	diadematid		x	x	21
Tridacna maxima	clam		x	x	20
Pedum spondyloideum	scallop		x	x	15
Chama sp.	chama		x	x	12
Dendropoma maxima	worm shell		x	x	11
Strombus gibberulus albus	conch shell		x	x	9
Coralliophila violacea	Violet Coral Shell		x	x	10
Holothuria atra	holothuriid		x	x	8
Conus frigidus	cone shell		x	x	7
Conus arenatus	Sand Cone		x	x	6
Planaxis sulcatus	cluster winkle		x	x	5
Echinothrix diadema	diadematid			x	6
DIOGENIDAE	spotted hermit crab	x	x	x	11
Calcines latens	spotted hermit crab	x	x	x	9
Ophiocoma scolopendrina	ophiocomid	x	x	x	9
Clibanarius striolatus	spotted hermit crab	x	x	x	7
Nerita albicilla	slipper winkle	x	x	x	6
Morula granulata	comb shell	x	x	x	6
Nassarius arcularia plicatus	mud snail	x	x	x	6
Tetraclita sp.	barnacle	x	x	x	6
Thais savignyi	comb shell	x	x	x	5
Ophiocoma erinaceus	ophiocomid	x	x	x	5

Habitat types inhabited by the principal species are summarised in Table 39.

Many species were seen in habitats of sand, bedrock and patch reefs. The number of species observed in seagrass bed and rock habitats was low. Species observed only in habitats of sand or mud were *Scopimera* cf.*globosa*, *Macrophthalmus* cf. *convexus*, *Uca* cf.*lactea perplexa* and *Uca* cf.*tetragnon*.

Table 39. Habitat types where the main species were distributed.

SCIENTIFIC NAME	ENGLISH NAME	sand and bedrock			patch reef			seagrass bed			rock		mud	Num
		B	S	SB	P	SBP	SP	SS	SSB	SSP	R	SR	M	
SERPULIDAE	calcareous tube-worm	x		x	x	x	x			x				23
Echinometra mathaei	echinometrid	x	x	x	x		x			x		x		22
Diadema setosum	diadematid	x	x	x	x		x			x		x		21
Tridacna maxima	clam	x		x	x		x			x				20
Pedum spondyloideum	scallop	x		x	x		x			x				15
Chama sp.	chama	x	x	x	x		x			x				12
Dendropoma maxima	worm shell	x	x	x		x	x							11
DIOGENIDAE	spotted hermit crab		x	x	x		x		x				x	11
Coralliophila violacea	Violet Coral Shell	x	x	x	x		x			x				10
Strombus gibberulus albus	conch shell	x	x	x					x	x				9
Calcines latens	spotted hermit crab	x	x	x										9
Ophiocoma scolopendrina	ophiocomid	x	x	x			x							9
Scopimera cf.globosa	stalk-eyed crab		x	x									x	8
Holothuria atra	holothuriid	x	x	x	x									8
Conus frigidus	cone shell	x	x		x				x					7
Clibanarius striolatus	spotted hermit crab	x	x	x										7
Nerita albicilla	slipper winkle	x	x	x										6
Morula granulata	comb shell	x	x	x							x			6
Nassarius arcularia plicatus	mud snail	x	x	x					x					6
Conus arenatus	Sand Cone	x	x		x	x	x	x						6
Tetraclita sp.	barnacle	x	x	x							x			6
Echinothrix diadema	diadematid	x	x	x	x					x				6
Cellana eucosmia	limpet	x		x							x			5
Planaxis sulcatus	cluster winkle	x	x	x										5
Strombus fasciatus	Lineated Conch	x	x	x										5
Thais savignyi	comb shell	x	x	x										5
Barbatia setigera	ark shell	x		x			x							5
Ophiocoma erinaceus	ophiocomid	x					x			x				5
Uca cf.lactea perplexa	fiddler crab												x	1
Uca cf.tetragnon	fiddler crab												x	1

No. : The number of spots where the species were observed above abundance level 2

B: bedrock, S: sand, SB: sand/bedrock

P: patch reef, SBP: sand/bedrok/pacth reef, SP: sand/patch reef

SS: sand/seagrass, SSB: sand/seagrass/bedrock, SSP: sand/seagrass/patch reef

R: rock, SR: sand/rock

M: mud

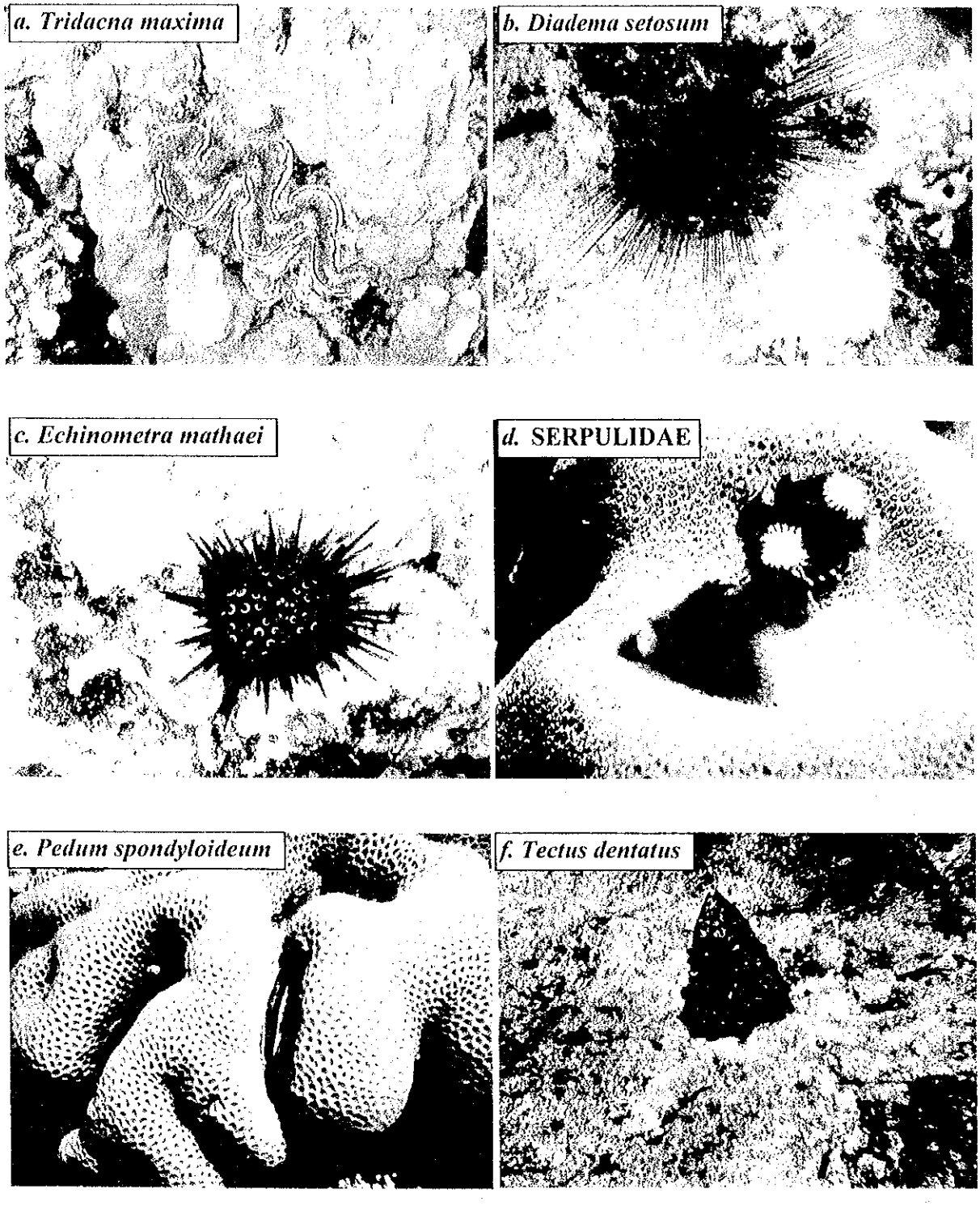
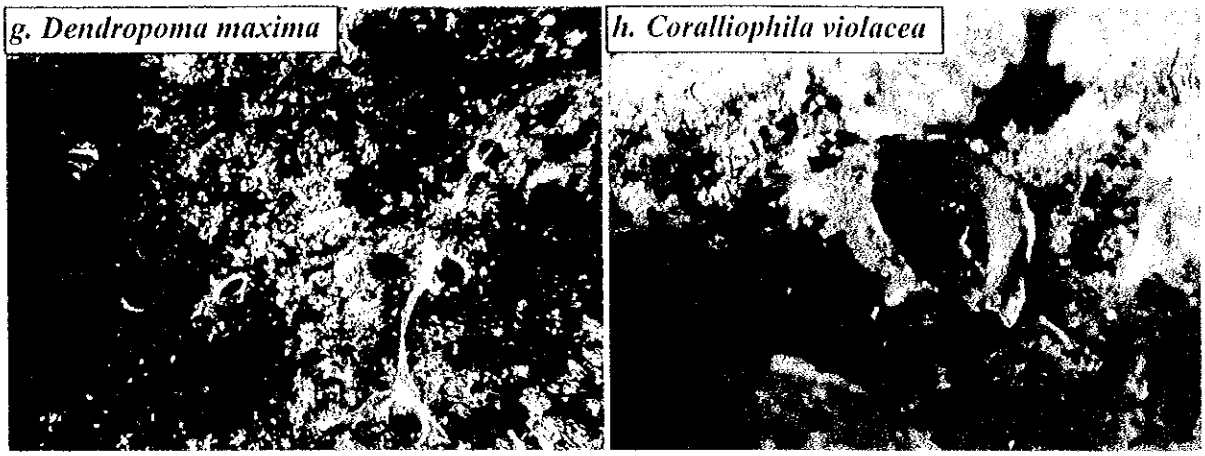


Photo. 4-1. Dominant species of benthos (1).



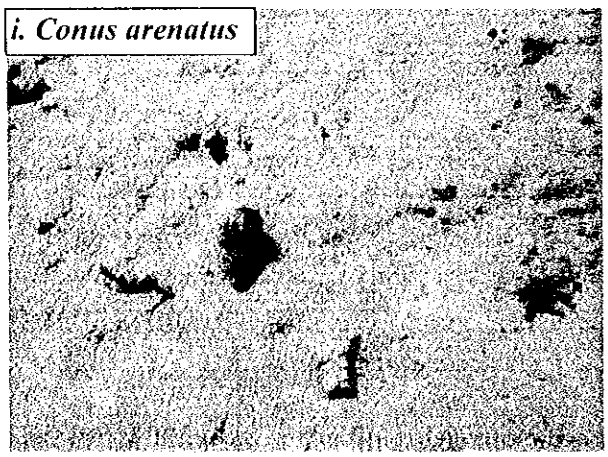


Photo. 4-2. Dominant species of benthos (2).

2. Assessment of the Study Area

A Model Study Area to be surveyed further in Phase III should have a high species diversity and biomass and a minimal degree of impact from human activities. The survey area in the northern part of the Red Sea is broadly divided into six areas according to its geographical features as follows:

i The Gulf of Aqaba

ii Tiran

iii Duba / Al-Wajh

iv Al-Wajh Bank

v Umluj / Ra's Baridi

vi Yanbu' / Jeddah

The areas were assessed in terms of the above-mentioned criteria in order to select the Model Area. The results of the assessment of the areas are summarised in Table 40.

The Gulf of Aqaba and Duba / Al-Wajh have high a score in point of species diversity.

In point of biomass, the Gulf of Aqaba and Duba / Al-Wajh have high scores and Al-Wajh Bank and Yanbu' / Jeddah have low scores.

In point of number of habitats, the Gulf of Aqaba and Tiran have low scores, while areas from Duba / Al-Waji southward have high scores. Al-Wajh Bank in particular has a higher score than any other area. This is because there are a greater number of kinds of habitat such as shallow lagoons, barrier reefs, islands and patch reefs in Al-Wajh Bank.

In point of lack of human impact, the Gulf of Aqaba and Tiran have high scores, while the Yanbu' / Jeddah area has the lowest score.

The area with the highest general score of assessment is Duba /Al-Wajh. Al-Wajh Bank should be seen in point of the number of habitats as being second to Duba / Al-Wajh.

Table 40. Assessment of the Study Area.

Point of view	Key Issue for Assessment	Gulf of Aqaba	Tiran	Duba/ Al-Wajh	Al-Wajh Bank	Umluj/ Ra's Baridi	Yanbu'/ Jeddah
Species diversity	Maximum number of species in each site of the area (Table.35)	3	2	3	2	2	2
Biomass	Maximum number of species that were observed above abundance level 3 in each site of the area (Table.36)	3	2	3	1	2	1
Number of habitats	Observations in field survey (Especially mangrove)	1	1	3	3+	3	3
Low Human impact	Observations in field survey	3	3	2	2	2	1

3: very good, 2: good, 1: not good

2.1.6. MARINE MAMMALS / MARINE TURTLES

2.1.6.1. Marine Mammals

1. Introduction

Very little information on Sirenia is available and very few reports have been published on Sirenia in the Red Sea. Only seven to eight species have been recorded frequently in the Red Sea. Ten species of Sirenia (Table 41) are described as occurring in the Study area (JEFFERSON et al. 1993). Only four species of Dolphins (Risso's, Indo-Pacific Humpback, Spotted, Bottle-nosed Dolphins) and Dugong are commonly observed in the northern part of the Red Sea. Humpback *Megaptera novaeangliae*, Fin *Balaenopterus physalus*, and Bryde's *B. edeni* whales are reported in the Arabian Gulf. Blue *B. musculus* and Sperm *Physeter macrocephalus* whales are also reported in the Gulf of Aden. Only Bryde's whale is observed at Farasan Island by NCWCD. The very narrow strait of Bab al-Mandab would be inhibiting their entrance and occurrence in the Red Sea.

Dugong belonging to the order Sirenia are found in tropic and subtropical areas from the Solomon Islands to East Africa. The Red Sea is the western extremity of the distribution range. MEPA conducted extensive surveys on Dugongs in the Red Sea and the Gulf Region (PREEN et al. 1989). The intensive and extensive aerial survey covering Al-Wajh, Al-Qunfidhah and Jizan areas indicated a significant population of 1,818+-382. The world Dugong population has been reported to be declining rapidly due to habitat loss and exploitation (MARSH 1993). The population in the Red Sea can therefore be recognised as being of global importance. It is well-known that Dugong feed exclusively on seagrasses and their mobility is limited in comparison with other species of marine mammal. Dugong is closely associated with local habitats, especially seagrass beds. Thus, from the conservation management point of view, Dugong is the most important species of marine mammal occurring in the Study Area .

Table 41. Species list of marine mammals in the Saudi Arabian Red Sea (derived from the published references and reports).

Family	Genus	Species	Common Name	By
Sirenia				
Balaenopteridae	*Balaenoptera*	*borealis*	Sei whale	JEFFERSON et al. 1993
Balaenopteridae	*Balaenoptera*	*edeni*	Bryde's whale	By NCWCD
Delphinidae	*Globcephala*	*macrorhynchus*	Short-Finned Pilot whale	FRAZIER et al. 1987 JEFFERSON et al. 1993
Delphinidae	*Sousa*	*chinensis*	Indo-Pacific Hump-Backed Dolphin	NISHIWAKI 1972 SAAYMAN & TAYLAER 1973
Delphinidae	*Steno*	*bredanensis*	Rough-Toothed Dolphin	LAYNE 1965 MITCHELL 1975 JEFFERSON et al. 1993
Delphinidae	*Grampus*	*griseus*	Risso's Dolphin	MITCHELL 1975 FRAZIER et al. 1987
Delphinidae	*Tursiops*	*truncatus*	Bottlenose dolphin	EVANS & BASTION 1969 TAYLER & SAAYMAN 1973 FRAZIER et al. 1987
Delphinidae	*Stenella*	*coeruleoalba*	Striped dolphin	FRAZIER. et al. 1987
Delphinidae	*Stenella*	*attenuata*	Spotted dolphin	PERRIN et al. 1973
Delphinidae	*Delphinus*	*delphis*	Common dolphin	FRAZIER et al. 1987 JEFFERSON et al. 1993
Delphinidae	*Pseudorca*	*crassidens*	False Killer Whale	PILLERI 1967 FRAZIER et al. 1987 JEFFERSON et al. 1993
Delphinidae	*Orcinus*	*orca*	Killer Whale	FRAZIER et al.1987
Dugongidae	*Dugong*	*dugong*	Dugong	PREEN et al. 1989

With the time and resources given, a questionnaire / interview and shoreline aerial survey and sighting were implemented simultaneously with the marine turtle survey.

2. Methods

In the questionnaire / interview, the interviewees were also requested to indicate encountered species from illustrated identification books on marine mammals together with sites of Dugong sightings and their frequency, mortality cases and /or known exploitation by people.

In the shoreline aerial survey, sightings of marine mammals were also recorded on the data sheet but it was quite difficult to identify species from the air. The sightings of marine

mammals by other Study members during the marine survey were recorded as far as possible and the possible species was intimated from the description by the members.

3. Results

3-1. Questionnaire / interview survey

Dolphins are the only marine mammals known by the respondents found throughout the Study Area. Common dolphin *Delphinus delphis* and Bottlenose dolphin *Tursiops truncatus* were commonly pointed out by the interviewees in illustrated books. Risso's dolphin *Grampus griseus* was also pointed out, less frequently. Sightings of whales over 10 m long in the deep sea were reported by many fishermen and coast guards in all parts of the Study Area. Sei Whale *Balaenoptera borealis* is the only species of whale over 10 m long mentioned in the literature. The respondents' descriptions of the whales sighted appear to be fall in two categories, one with an apparent dorsal fin and the other without; this would indicate the presence of two different species.

The sighting sites of Dugong known by the coast guards and fishermen are shown in Table 42. The majority of Dugongs sighted by them were solitary animals. At most two animals were sighted by the respondents in a spot which coincided with our aerial sightings. There is no information on sightings inside the Gulf of Aqaba, but they were sighted from the mouth of the Gulf of Aqaba down to the Yanbu' region. Large group formations of Dugong were not known by the respondents, but one fisherman only at Baraqan Island said that he had seen a large group of Dugong near the island. An evaluation of the sighting frequency of Dugong by areas is shown in Table 43.

The Dugong population in the Red Sea was thought to be on the increase from previous interviews with fishermen by MEPA (PREEN et. al. 1989). However, no respondent told of an increase in Dugong sightings in our survey. Dugongs have a certain level of

mobility, though they cannot travel long distances in short periods (PREEN et. al. 1995). The present results suggest that a more detailed survey is needed to ascertain their status.

Table 42. List of Dugong sighting sites known by coast guards and fishermen.

Coast Guard Station	Island	Water Along Main Coast
Haqel Region	-	-
Suwyhil- Ash Shaykh Humayd	-	-
Al-Qisbah	-	Front of Al-Qisbah CG Station
Gaid Al-Shiokh	-	South of Gaid Al-Shiokh CG Station
Hada	-	North of Hada CG Station
Qial	-	North of Qial CG Station, Al-Farsha Area
Al-Khuraybah	Baraqan, Yaboa islands	-
Al-Dalah	-	-
Al-Sorah	-	-
Al-Muwaylih	-	Al-Har Port
Duba	-	South of Duba
Al-Guff	-	Abu-Khaswa, Al-Thoraia
Zubaydah	Al-Norman island	-
Al-Dumaygh	Al-Dahra island	-
Antar	-	-
Haramil	-	-
Habban	-	Front of Habban CG Station
Ghawash	-	Front of Ghawash CG Station
Al-Muraysi	-	-
Al-Khurj	-	-
Safa'ih Island	All the islands between Safa'ih and Al Khawwarah CG Station	-
Qara'ir	Same as above	-
Al-Khawwarah	Same as above	-
Al-Harrah	-	-
Jabal Hassan	Zubaida island	
Al-Shabaan	-	Al-Shabaan Port
El Hassa	-	-
Al-Mukharraf	-	South of Al-Mukharraf CG Station
El Likoke		-
Al-Hinu	-	Front of Al-Hinu Coast
Al-Sharm	-	-
Al-Baraykah	-	-
Rayis	-	In the shallow area in front of Rayis coast
Masturah	-	-
Rabigh	-	-
Al-Zeaib	-	-
Tuwal	-	-

The Tiran, Al-Wajh Bank and south of Yanbu' areas are reported to have primary distributions of Dugong in the Study Area (PREEN et al. 1989). The interview results also indicate frequent sightings from the mouth of the Gulf of Aqaba to north of Duba, Al-Wajh Bank, Sharm Shabaan and from Ra's Baridi to south of Yanbu. In addition to the above areas, sightings were also reported at Sharms south of Duba where small seagrass habitats were observed.

Table 43. Evaluation of changes in Dugong sightings by coast guards and fishermen.

Region	Area	N	Coast Guards			N	Fishermen		
			Decrease	Stable	Increase		Decrease	Stable	Increase
Tabuk	Haql	-				-			
	Maqna	1	1			1		1	
	Duba	4	3	1		7	2	5	
	Al Wajh	2		2		-	-	-	
	Umluj	-				2	1	1	
Madina	Yanbu'	-				4	2	2	
Makkah	Jeddah	-				-	-	-	

No intentional exploitation of Dugong was known of by the respondents. Only accidental catches were known to occur especially in fishing nets. Fishing by nets was not commonly done due to the numerous patchy reefs in Al-Wajh Bank where the significant population was reported by the previous report. One accidental catch by fishing net was known at Al-Khurj coast guard station in Al-Wajh Bank. Four accidental catches and one mortality case were noted by respondents from Yanbu to Thuwal, which indicated a few mortalities caused by human activities.

3-2. Shore line aerial survey

The sightings of marine mammals during the shore line aerial survey were very limited because the primary objective was to observe the beach habitats on marine turtle

nesting. The location and group size of Dugongs sighted are shown in Table 44.

Table 44. Location and group size of Dugongs sighted during the shore line aerial surveys.

Date	Time	Latitude (N)	Longitude (E)	Group Size	Location	Habitat
24-May	8:35 AM	274252	352739	1	North of Al Muwaylih CGS	Fringing Reef
	9:01 AM	271402	354548	1	Wadi Salma (north of Gulf CGS)	Shallow Inshore
	9:20 AM	265940	355424	1	Ra's ad Dubbah (north of Dumaygh CGS)	Fringing Reef
	9:45 AM	264007	361026	2	North of Dumaygh CGS	Fringing Reef
	9:50 AM	263828	361242	4	Front of Dumaygh CGS	Fringing Reef
26-May	8:03 AM	251000	371011	1	Front of El Hara CGS	Shallow Inshore
	8:15 AM	252114	370214	2	Front of Al-Hawra' CGS	Shallow Inshore

Six out of the seven sightings were of only one or two Dugongs, and no calves were observed. The largest group seen was four. These findings also match the results from the previous aerial survey, which indicated smaller group size than seen in the Arabian Gulf and a very low calf ratio.

3-3. Sighting during the field surveys

Sightings of marine mammals during the survey by the Study Team are shown in Table 45. The species were identified on the basis of their descriptions. Attempts were made to sight dolphins from the mainland coast, but the distance was too great for identification of species.

Table 45. Sighting of marine mammals recorded during the survey.

Sightings	N	By	Latitude (N)	Longitude (E)	Date / Time Sighted	Method
Dugong; *Dugong Dugong*	1	E. Turak	205300	363700	6/3/98 11:45 AM	From boat
Indo-Pacific Hump Back Dolphin; *Sous chinensis*	1	T.Tsubouchi, M. Marghany	254603	364603	6/4/98 10:30 AM	From boat
Indo-Pacific Hump Back Dolphin; *Sous chinensis*	4	S. Arai et.al	255102	363716	10/4/98 10:00 AM	During marine survey
Indo-Pacific Hump Back Dolphin; *Sous chinensis*	3	S. Arai et.al	255056	363716	6/7/98 1:00 PM	During the survey

4. Discussion and conclusions

4-1. Species occurrence and distribution

Several species of dolphin and possibly two species of whale are said to occur in the Study Area. However, only Indo-Pacific Hump Back Dolphin and Dugong were confirmed during the Study.

Sightings of Dugong in the Gulf of Aqaba were not known by any respondents in the Study. The primary distribution of the Dugong is 1) the mouth of the Gulf of Aqaba to Al-Khuraybah where there is an extensive silty area, 2) in the small sharms and shallow inshore waters from Al-Muwaylih to Al-Dumaygh, 3) Sharms in Habban, 4) Al Wajh Bank, 5) Al Shabaan, 6) inside small sharms and shallow inshore waters from Al-Mukharraf to Al-Sharm, 7) the shallow area in front of the Rayis coast.

4-2. Important habitats

Of all the marine mammals, Dugong is the species most dependent on the local habitats, because of its limited mobility. Dugong feeds only on seagrasses, mainly of the families Potamogetonaceae and Hydrocharitaceae. A dramatic decrease in population was

reported after the large scale loss of seagrass habitats in Australia (PREEN 1995). Seagrass habitats were found only in open sharms and /or sandy areas surrounded by patchy reefs in the Study Area. A certain level of wave energy is needed for the seagrass to grow in the Study Area. Very calm areas such as closed sharms experience little disturbance, so that fine silt accummulates and inhibits seagrass growth.

Sightings by coast guards and the fishermen are mainly inside sharms. Dugongs were sighted along the fringing reefs in the shore line aerial survey would be travelling individuals. Due to the limited number of seagrass habitats in the Study area, they would have to travel long distances from one open sharm to the next to obtain enough food. The home range of the Dugong in the Study Area would be significantly wider than that in the Arabian Gulf, where there are extensive seagrass habitats. The survival of Dugong in the Study Area is dependent on sustaining of the seagrass habitats.

The reproduction of Dugong is not understood well but is expected to take place in habitats adjacent to the feeding grounds, which is different from whale reproduction. The calf ratio in the southern part of Hervey Bay in Australia was reported at 22% in 1988 and 1992 surveys (PREEN 1995). The reason for the low calf ratio in the Study area needs to be further clarified; whether it is due to their movement or reproductive status. It can be, however, said that the low calf ratio may be a characteristic of Dugong population in the Study Area and may indicate high sensitivity to the impact of habitat loss or modification by natural and/ or human activity.

Reproduction by the other marine mammal species in the Study Area is not well known, and their habitat utilisation for reproduction is not understood. Thus it is difficult to evaluate habitats from the point of view of reproduction.

4-3. Endangered / Endemic species

It has been suggested that Dugong of the Red Sea is taxonomically different from that of the Indo-Pacific region. However, there has not been any distinct evidence yet. Bottle-nosed dolphins in the Red Sea are also described as taxonomically different from those in the Indo-Pacific region. However, this is still much in dispute.

Dugong, Sei whale and Indo-pacific Hump Back Dolphin are listed in CITES Appendix I. Dugong is also a protected species in the Kingdom. Little information is available on Sei Whale, Indo-pacific Hump Back Dolphin and other marine mammals that are less dependent on local habitat than Dugong. Therefore, important habitats from the point of view of endangered /endemic species conservation are the same as 1) and 2) at this point in time.

4-4. Human impact (exploitation)

The marine mammals which used to be food sources for local residents over 30 years ago, no longer have market value. Thus, the level of exploitation of marine mammals is found to be minimum in the Study Area. A potential threat to the marine mammals is accidental catches and habitat disturbance. Fishing grounds where the use of fishing nets is feasible pose a potential threat to marine mammals through entanglement in the nets. Accidental catches and habitat changes need to be monitored for conservation management.

4-5. Mortality

Only a few cases of Dugong mortality were known to the respondents in questionnaire / interview survey. Oil spills caused large scale mortalities in the Arabian Gulf. Increasing exports of oil from Yanbu' have been discussed as a potential threat to Dugong in a previous report by MEPA (PREEN 1989). Accidental catches in gill nets also caused the death of Dugong in Yemen during the winter periods. In the Study Area, net fishing was not

commonly practised due to the extensive development of coral reefs. However, because of the sensitiveness of the Dugong population suggested in the Study, mortality of the marine mammals, especially Dugong, need to be carefully monitored.

4-6. Priority areas

The priority areas are evaluated in terms of 1) species occurrence, 2) reproduction habitat, 3) endangered/ endemic species, 4) exploitation (human impact), 5) mortality. The Study Area was divided into six characteristic areas and the importance was evaluated at three levels. The results are indicated in Table 46.

Due to the lack of essential information on marine mammal species in the Study area, the evaluation is done basically in terms of Dugong conservation. Thus, the major areas of distribution for Dugong are the Tiran area and Al-Wajh Bank, evaluated as high priority areas. However, the seagrass habitats in open sharms from Duba to Al-Wajh Bank and from Al-Shabaan to Yanbu' need special attention.

Table 46. Summary of conclusions tabulated by area, categorized from the present results.

	Gulf of Aqaba	Tiran Area	Duba / Al-Wajh	Al-Wajh Bank		Umluj / Ra's Baridi	Yanbu' – Jeddah
				North	South		
Marine Mammals							
Species	1	2	2	2	2	2	1
Reproduction	1	3	2	3	3	2	1
Endangered/ Endemic Species	1	3	2	3	3	2	1
Exploitation	3	3	3	3	3	2	2
Mortality	3	3	3	3	3	2	2

3: very good, 2: good, 1: not good.

2.1.6.2. Marine Turtles

1. Introduction

Five out of seven marine turtle species (Green Turtle *Chelonia mydas*, Hawksbill Turtle *Eretmochelys imbricata*, Loggerhead Turtle *Caretta caretta*, Olive Ridley Turtle *Lepidohelys olivacea*, Leatherback Turtle *Dermochelys coriacea*) have been recorded in the Study Area (Table 47, FRAZIER 1987, TATWANY & AL-MERGHANI 1995). However, only two species (Green and Hawksbill Turtles) occur commonly and have been confirmed to nest in the area. High salinity and food availability would limit the distribution of Olive Ridley and Loggerhead Turtles. There are only several sighting records in the Gulf of Suez and Aqaba, of the Leatherback Turtle which has the largest body and the widest distribution, and feeds mainly on jelly fish. It has been suggested that this species is more common than records indicate because of a seasonal abundance of food sources in the Egyptian side of the Red Sea (FRAZIER 1993).

Only a few studies have been conducted on the Red Sea coast of Egypt and Sudan (HIRTH et al. 1980, FRAZIER 1984 and 1991). On the Saudi Arabian coast of the Red Sea, MEPA and NCWCD have conducted extensive marine surveys. From these surveys, four significant nesting and foraging areas (the vicinity of Tiran Island, the area between Al-Wajh and Yanbu' including Ra's al-Laquq and Ra's Baridi, south of Al-Lith to north of Gizan, and the Farasan Archipelago) have been identified in the Saudi Arabian Red Sea.

Table 47. Species list of marine turtles reported in the Saudi Arabian Red Sea.

Family	Genus	Species	English Name	Source
Chloniidae	*Caretta*	*caretta*	Loggerhead Turtle	FRAZIER et al. 1987, MILLER et al. 1989, TATWANY & AL-MERGHANI 1995
	Chelonia	*midas*	Green Turtle	Same as above
	Eretmochelys	*imbricata*	Hawksbill Turtle	Same as above
	Lepidochleys	*olivacea*	Olive Ridley	Same as above
Dermochlyidae	*Dermochelys*	*coriacea*	Leatherback Turtle	Same as above

NCWCD reported 25 primary nesting sites in the Study Area. Although Green and Hawksbill Turtles are recorded nesting in concurrent areas, it is known that the two species utilise different beach habitats for nesting. The mainland beaches south of Ra's Baridi have been identified as the most significant nesting site for Green Turtle, with around 100 turtles nesting annually. These beaches have been given special attention and monitored by NCWCD (PILCHER et al. 1990, 1992).

The most vulnerrable phases of the marine turtle life cycle with regard to predation are the egg and hatchling stages. Nesting has also been recorded on the small beaches of the islands and beaches of mainland coast in the Study Area. Low fecundity, with small clutches and large numbers of yolkless eggs, are reported as characteristic of Hawksbill Turtle in the Red Sea (ROSS 1981). Basic information on distribution, nesting beaches and breeding seasons is needed for conservation management.

In order therefore, to evaluate the extent of marine turtle distribution and nesting habitats, 1) questionnaire / interview, 2) shore line aerial, and 3) ground truth beach survey were conducted.

2. Methods

2-1. Questionnaire / Interview Survey

In order to gather local resident knowledge on marine mammals and marine turtles, coast guards and fishermen were interviewed by means of a questionnaire. All coast guard stations were targetted for this survey in a systematic manner. However, information was not obtained from some coast guard stations because the interviewees were reluctant to fill out the form or to give relevant information.

The number of respondents and the average length of stay in the respective areas are summarised in Table 48.

Table 48. Years spent by coast guards on duty and by fishermen in fishing in the Study Area.

Region	Area	Coast Guard				Fisherman			
		N	Average	Min	Max	N	Average	Min	Max
Tabuk	Haql					0			
	Maqna	12	4	1	8	2	19	15	23
	Duba	9	13	5	20	6	34	20	50
	Al Wajh	7	1	0.1	6	1	55	55	55
	Umluj	9	3	0.7	7	3	23	20	30
Madina	Yanbu'	5	3	0.5	8	4	31	10	48
Makkah	Jeddah	0				1	40	40	40
		42				17			

2-2. Shore line aerial survey

The shore line aerial surveys of the mainland coast and offshore islands were conducted primarily to evaluate the extent of the nesting area (N24°45-N28°00, Fig.31-1, 2, 3). Three flights were made by a NCWCD four-seater aircraft from 24 to 26 May 1998, which corresponts roughly with the Hawksbill Turtle nesting season. The aircraft, equipped with a radar altimeter, flew at an altitude of approximately 500 feet are speed of about 90 – 100 knots, along the coast and offshore islands. The right rear door of the aircraft was removed and the beaches were recorded using a digital video camera (SONY DCR-VX1000) from this position for later examination. Sightings of marine mammals/marine turtles by an observer were also recorded with the time. GPS position, UTC and other necessary information from GPS satellites were recorded into a computer at one second intervals during the flights. The digital video also recorded the UTC synchronised with GPS UTC. The exact positions where the video was taken and animals were sighted were located by matching the video UTC with GPS UTC. When many tracks and body pits were sighted on beaches, a closer view was taken in order to evaluate nesting intensity.

Fig. 31-1. Flight paths of the shore line aerial survey.

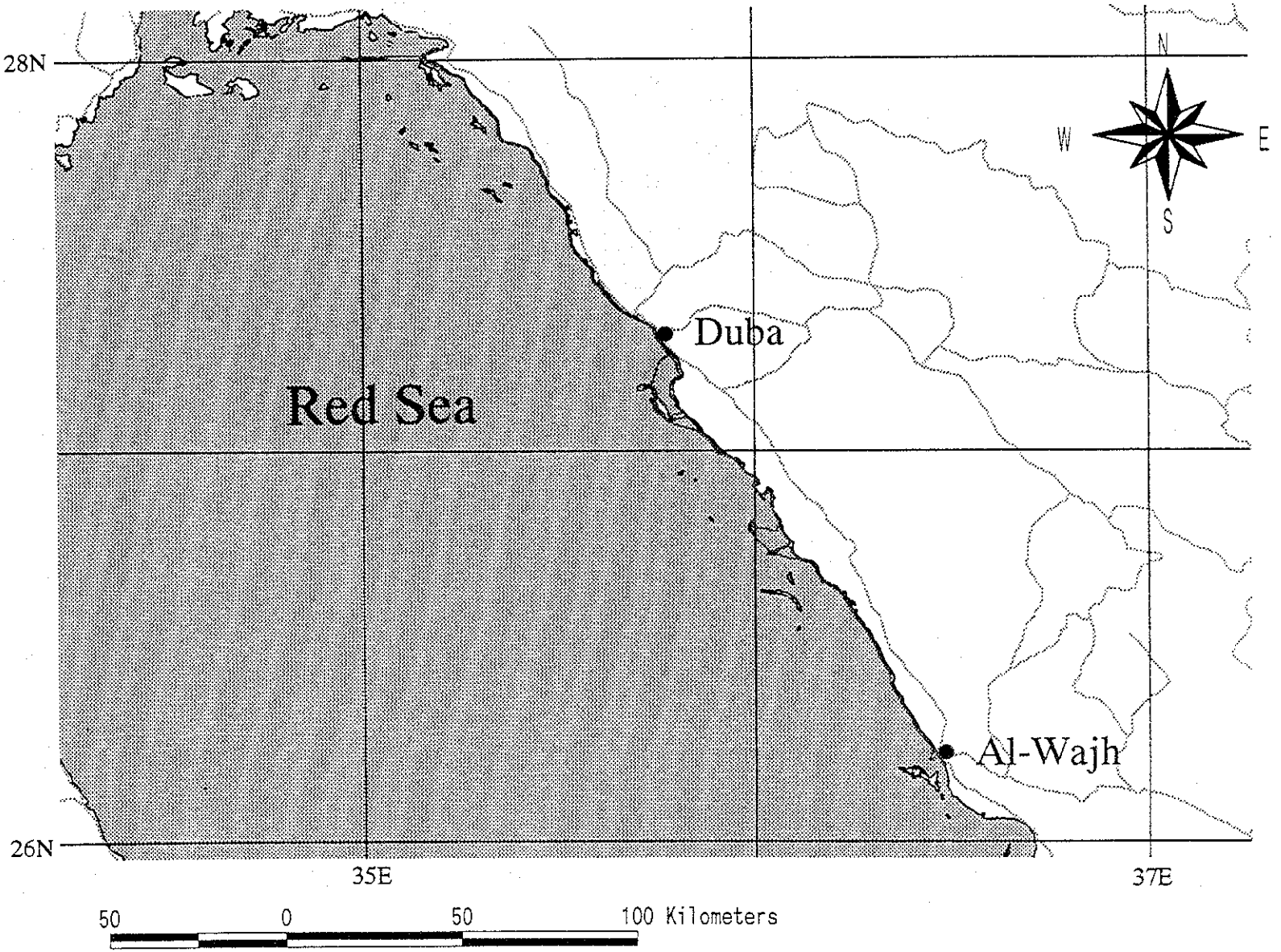


Fig. 31-2. Flight paths of the shore line aerial survey.

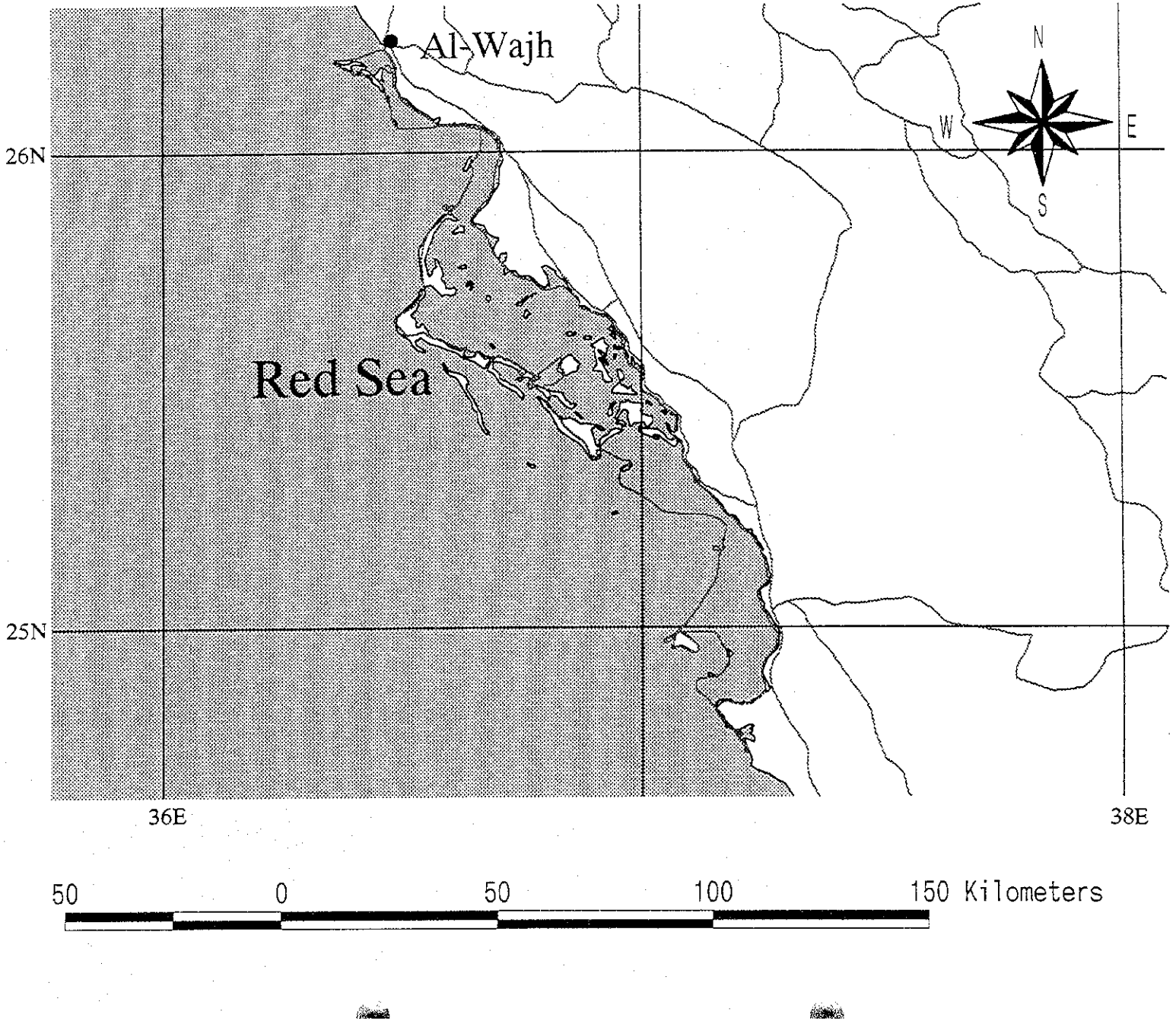
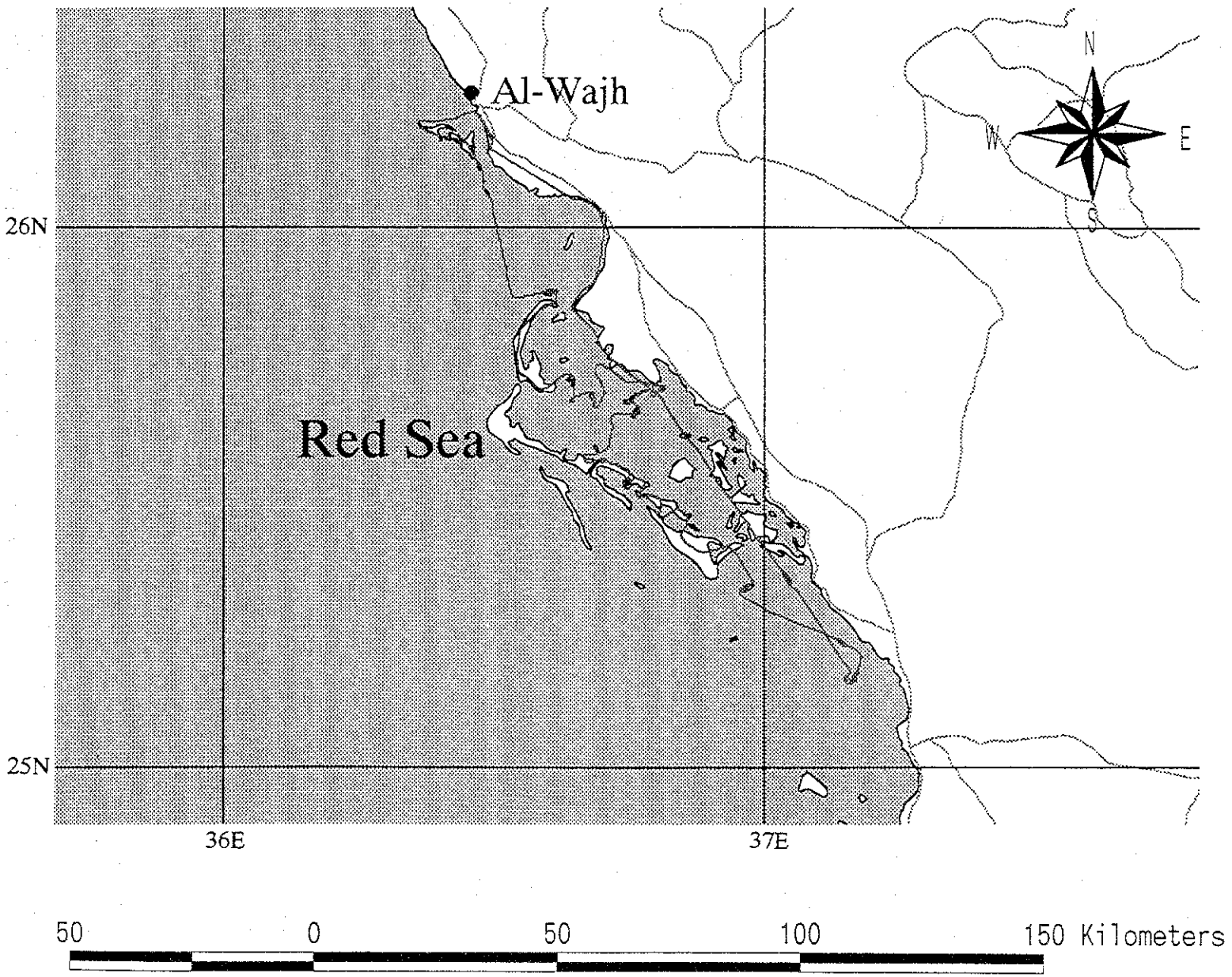


Fig. 31-3. Flight paths of the shore line aerial survey.



2-3. Ground truth beach survey

1). Nesting beach/nest examination

Representative marine turtle nesting beaches on the mainland coast and the islands known to the interviewees were surveyed for evidence. Jazirat Jabal Hassan and surrounding islands were surveyed June 1999 during the Model Area Study and others were surveyed during the Inventory. The beaches of islands not accessible by boat were observed through binoculars from the boat, and a video record was taken for later examination. A few nests were examined to acquire basic data on reproduction status.

Nest temperature is the key parameter for nesting activity and hatching success, and the sex of the hatchling is determined by the nest temperature. Four data loggers to record temperature every hour for three years were set on three nesting beaches; Jazirat Baraqan and al-Waqqadi for Hawksbill Turtle at 30 cm depth and Ra's Baridi for Green Turtle at 30 and 50 cm depth.

2). Nesting female (tagging)

A survey of nesting females was conducted in Baraqan and al-Waqqadi Islands on 31 May and 7 June respectively for Hawksbill Turtle, and at Ra's Baridi beach from 17 to 20 October 1998 for Green Turtle. No Hawksbill nesting female was captured within the given time in 1998. The survey was conducted again in June 1999 on al-Waqqadi, which is identified as the most significant nesting island for Hawksbill Turtle in the Model Area Study.

3. Results

3-1. Questionnaire/interview

Nesting is reported on many islands, islets and a few mainland locations by coast guards and fishermen. Most of the coast guard stations from Ash-Shaykh Humayd to Thuwal

except those in the Gulf of Aqaba, reported nesting beaches. The coast guards in some stations other than those in the Gulf of Aqaba reported no nesting beaches. However, those respondents were mainly newly-assigned guards or very reluctant to give any information. These results indicate that marine turtle nesting occurs from north of Jeddah to the mouth of the Gulf of Aqaba, and the nesting intensity seems to be very low. Only two locations were given for nesting inside the Gulf of Aqaba but no evidence of nesting was found.

Most of the islands and locations are also reported in the previous survey by MEPA except for some north of Jeddah and north of Duba (MILLER et al. 1989). General characteristics of the nesting beaches on the mainland coast are 1) facing deep water over 50 m in depth, 2) narrow shallow water area in front of the beaches, 3) no characteristics in beach size. The general characteristics of the nesting islands are; 1) mainly outer most offshore islands; 2) narrow shallow water area in front of the beach or the sandy bottom.

The islands, frequently mentioned by the respondents for nesting, which would be indicative of the nesting intensity, are shown in Table 49. Ten respondents mentioned Jazirat Baraqan where a coast guard station is located. Nine people mentioned Walih which has very limited accessibility for people but is well known by them. The islands mentioned can be evaluated as important nesting habitats.

Table 49. No. of coast guards and fishermen telling of turtle nesting on islands in the present survey.

Name of Island	No of Coast Guards	No of Fishermen	Total
Baraqan	5	5	10
Walih	4	5	9
Umm Qusur	4	3	7
Yuba	3	2	5
Shusha	3	2	5
Riman	0	5	5
Jabal Hassan	2	3	5
Jazirat al-Waqqadi	2	1	3
Al-Norman	1	2	3
Birrim	1	2	3
Alfwaida	2	0	2
Umm Almesk	2	0	2
Al-Ausailah	2	0	2
Jazirat Umm Shujayrat	1	1	2
Jazirat Umm Kud	0	2	2
Libnah	0	2	2
Safaih	1	0	1
Safaihat	1	0	1
Mizab	1	0	1
Al-Awindia	0	1	1
Al-Nabakia	0	1	1
Al-Ourme	1	0	1
Zubaydah	0	1	1
Jazirat ash Shaykh Marbat	0	1	1
Jazirat Umm Rumah	0	1	1
Al-Bridi	0	1	1
Ashkah	0	1	1
Husilah	0	1	1
Umm Alhassani	0	1	1

Evaluation of changes with regard to marine turtle nesting and sighting in the respective areas by coast guards and fishermen is summarised in Table 50. No respondents evaluated marine turtle nesting to be increasing. In the Jeddah and Yanbu' areas where a lot of coastal development has taken place, four respondents out of twelve evaluated a decrease. The

comparatively frequent accidental catches and mortality at the nesting beaches are also known to the respondents in the area. This is an indication of the impact of human activities on the marine turtle population in the areas.

Fishermen stayed in the respective areas longer and spent a longer time on the sea than the coast guards did. The assignments of the coast guards are rotated regularly. No fishermen told of a decrease in Al-Wajh and Umluj. However, four coast guards with an average stay of 3 years evaluated a decrease here. This difference would indicate significant yearly fluctuation of nesting activities and sightings, and further confirmation is needed. Three respondents evaluated a decrease in the Duba area where many nesting sites on the mainland coast are noted and the coast guards spent longer at each place than in other regions. The recent development of a cement factory, ports and residential areas on the north coast of Duba are on or adjacent to the nesting areas. The responses might indicate the development had some impact on the marine turtle nesting. Two coast guards and one fisherman responded that their was a decrecase in nesting in the Maqna area where little coastal development has taken place. Nesting is known on the offshore islands and a few mainland coastal areas in the Maqna area. A more detailed survey on the nesting activities in this area is needed to evaluate the results.

Table 50. Evaluation of changes in marine turtle nesting seen by coast guards and fishermen.

Region	Command	Coast Guards				Fishermen			
		N	Decrease	Stable	Increase	N	Decrease	Stable	Increase
Tabuk	Haql					0			
	Maqna	9	2	7		2	1	1	
	Duba	11	2	9		6	1	5	
	Al-Wajh	6		6		1		1	
	Umluj	8	4	4		3		3	
Madina	Yanbu'	5	2	3		4	2	2	
Makkah	Jeddah	2		2		1		1	

No significant exploitation of eggs and/or turtles was known to the respondents in the present survey. The exploitation of marine turtles, which were once hunted for food, is minimum all along the coast at present. However, some intentional harvesting of marine turtles for medicinal purposes is known to some respondents. They indicated that the male organ of the marine turtle is believed by some people to be an aphrodisiac. This belief creates a small market for the product which stimulates illegal harvesting by fishermen.

3-2. Shore line aerial survey

Various factors make it inappropriate to estimate the nesting female population through the counting of new tracks on the beach or through sightings. A significant fluctuation in the number of nesting females is known in Australia. Information essential for management and monitoring is the location site of nesting. The present shore line aerial surveys were conducted along beaches and around islands to find evidence of beaching turtles in order to determine the location sites of nesting. The sites recorded on video were located exactly by GPS for future monitoring and reference.

The aerial survey revealed nesting evidence such as tracks and body pits on many beaches on offshore islands, islets and the mainland coast. The majority of nesting sites found by the survey matched with previous reports and the results from the questionnaire/interview survey. Among the offshore islands where many body pits and a few tracks were found are; Sanafir, Shusha, Al-Norman in the preliminary survey, Al-Shikh Marbat, Birrim, al-Waqqadi, four islets west of Al-Khurj coast guard station (inside Al-Wajh Bank), six islets west of Qara'ir coast guard station (N25°34'E36°40'—N25°34'E36°46'), seven islets west of Al-Hara coast guard station (N25°13'E37°08'—N25°09'E37°09'), Jazirat Jabal Hassan, Libnah and Malihah. A few islands such as Baraqan and Yuba, known by sites fishermen and coast guards to have nesting could not be covered by this survey because of unavoidable

circumstances.

On the mainland coast, areas with a little evidence of turtle nesting are; Ra's Wadi Tiryam, south of Al-Muwaylih coast guard station, south of Sharm al-Harr, north of Duba, north of Sharm Jubbah, south of Zubaydah coast guard station, north and south of Ra's al-Ubayd, Ra's Marjah (south of sharm Antar), Ra's Muraybit (north of Haramil coast guard station) and south of Ra's Abu Mullah (south of Al-Wajh).

The findings of the aerial survey are shown in Fig.32 together with the results from the questionnaire / interview and the ground truth beach survey.

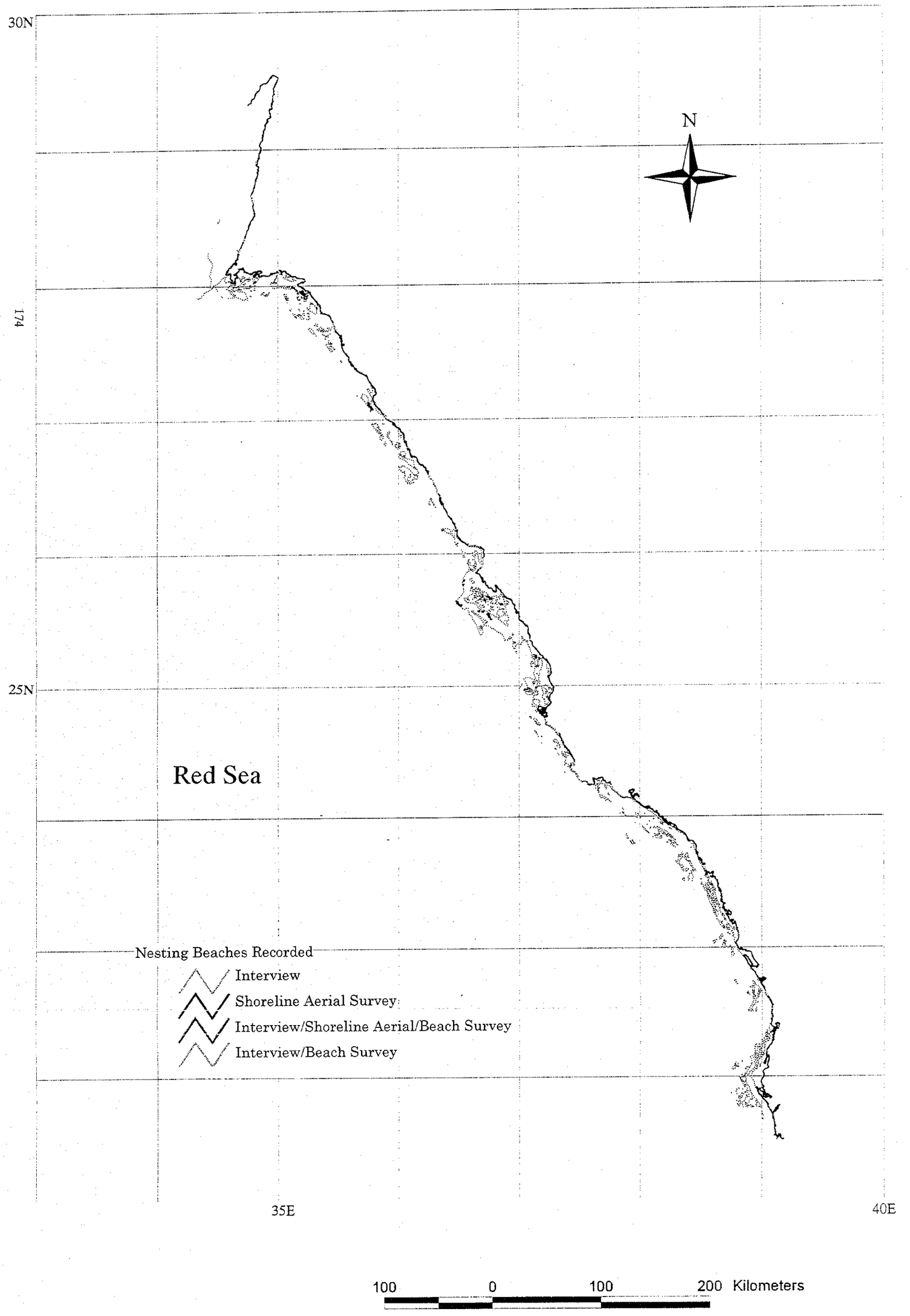


Fig. 32. Nesting sites of marine turtles in the Study Area.

Most of the islands and islets and the mainland coast have little evidence of nesting, which indicates low density and the scattered nesting. This is also noted in the previous surveys by MEPA. The aerial survey showed that the beach habitats experience little human impact and the marine habitats are also found to provide extensive foraging areas for Hawksbill Turtles. The availability and abundance of sponges, which is Hawksbill's main food source, need to be studied in the coral habitats to understand the discrepancy between the scattered, low density nesting and the feeding habitats.

Species and number of marine turtles sighted in the shore line aerial survey together with time and location are shown in Table 51. Most of the sightings were of turtles travelling on the surface near the fringing reef north of Al-Wajh Bank. No turtle was sighted on the second and third flights inside Al-Wajh Bank. The sighting of turtles inside Al-Wajh Bank might be limited by the clarity of the sea water or the feeding behaviour of the turtles.

Table 51. Location, species and numbers of marine turtles sighted during the shore line aerial survey.

Date	Time	Latitude (N)	Longitude (E)	Species	No.	Name of area
24 May	8:23 AM	275721	351514	Cm	3	North of Sharmah
	8:26 AM	275258	351837	Cm	1	North of Sorah CGS
	8:27 AM	275225	351915	Cm	1	North of Sorah CGS
	8:27 AM	275148	351945	Ui	1	Ra's Wadi Tiryam
	8:30 AM	274748	352123	Ui	1	North of Al-Muwaylih
	8:35 AM	274334	352714	Ui	2	Front of tank farm in Duba
	8:57 AM	271912	354417	Ui	2	South of Ra's adh-Dhanab
	9:20 AM	265943	355442	Ei	1	South of Ra's adh-Dhanab
	9:20 AM	265959	355406	Ei	3	South of Ra's adh-Dhanab
	9:20 AM	270014	355414	Ei	2	South of Ra's adh-Dhanab

Cm: *Chelonia mydas*, Ei: *Erectmochelys inbricata*, Ui: unidentified

3-3. Ground truth beach survey.

I). Nesting beaches

The results from the ground truth beach survey together with the findings of observations from the boat and the preliminary survey are shown in Table 52. High nesting intensity was observed only on Baraqan, al-Waqqadi and Jabal Hassan islands, south of Al-Shabaan, and Ra's Baridi where NCWCD conducts a monitoring survey on nesting on the mainland coast. The number of nests seems to be relatively low compared with the number of body pits found on the beaches.

Table 52. Results of marine turtle ground truth beach survey.

Site	Spot	Name	Latitude (N)	Longitude (E)	Date Surveyed	Truck	Body	Nest	Nest Examined	Specie
T-1	T1	Jazirat Baraqan	275402	350424	05/31/98	0	0	0	0	
	T2	Jazirat Baraqan			05/31/98	7	13	0	0	ei
	T3	Jazirat Baraqan			05/31/98	0	1	0	0	ei
	T4	Jazirat Baraqan			05/31/98	2	6	1	1	ei/cm
	T5	Jazirat Baraqan			05/31/98	1	1	0	1	ei
	T6	Jazirat Baraqan			05/31/98	4	5	2	0	ei
	T7	Jazirat Baraqan			05/31/98	6	5	1	0	ei
	T8	Jazirat Baraqan			05/31/98	2	4	1	0	ei
T-2	T9	Jazirat Umm Rumah	254603	363218	06/04/98	n/c	n/c	n/c	0	
	T10	Jazirat Umm Rumah			06/04/98	n/c	n/c	n/c	0	
T-3	T11	Jazirat Umm Kud	254750	363235	06/04/98	n/c	n/c	1	0	ei
T-4	T12	Jazirt Safaih Hat	254039	364059	06/07/98	0	n/c	n/c	0	
T-5	T13	Jazirt Safaih	254207	364053	06/07/98	0	n/c	n/c	0	
T-6	T14	Jazirat al-Waqqadi	252013	365802	06/07/98	44	58	39	1	ei
T-7	T15	Jazirat ad Dilaydilah	230812	384700	06/15/98	n/c	n/c	n/c	0	-
T-8	T16	Jazirat Quwa'ah	230701	384745	06/15/98	0	0	0	0	-
T-9	T17	Jazirat Umm Safaro	280336	344420	10/14/98	0	0	0	0	
T-10	T18	Jazirat Umm 'Usayli	280340	350519	10/14/98	n/c	n/c	n/c	0	
T-11	T19	Jazirat Umm Shujayrat	280225	350439	10/14/98	0	n/c	n/c	0	
T-12	T-20	Ra's al-Baridi South			10/17/98- 10/20/98	>10	>100	>100	2	cm
		Ra's al-Baridi South			6/15/99	38			0	cm
T-13	T-21	Jazirat Jabal Hassan	245743	370405	06/14/99	19	>10	3	1	cm/ei
	T-22	Jazirat Jabal Hassan	245931	370301	06/14/99	13	>10	2	0	cm/ei
	T-23	Jazirat Jabal Hassan	245834	370402	06/14/99	4	>10	-	-	cm/ei
T-14	T-24	Jazirat Umm Libnah	245817	370301	06/14/99	3	>10	-	-	ei
T-15	T-25	Jazirat Malihah	245912	370856	06/15/99	2	-	1	1	cm/ei
ob		Jazirat Shusha	275606	345442	05/31/98	some	n/c	n/c	0	ei
ob		Jazirat Yuba	274613	353845	05/31/98	some	n/c	n/c	0	ei
ob		Jazirat Walih	274706	351017	05/31/98	many	many	n/c	0	ei
ob		Jazirat ad Dilaydilah	274612	351109	05/31/98	some	some	n/c	0	

ob: observation form the boat, rs: reconnaissance survey, n/c not confirmed, cm: *Chelonia mydas*, ei: *Erectmochelys imbricata*

2). Nest examination

Nine nests were examined in the Study and the results are shown in Table 53. The average number of healthy eggs per nest for Hawksbill Turtle was 66.3±19.0. The number and percentage of yolkless eggs per nest was 30.0±19.2 and 30.2%±14.5. Only two nests of Green Turtle eggs were examined in Ra's Baridi, and the number of healthy eggs was 124 and 128. Five yolkless eggs only were found in one of the Green Turtle nests.

The two nests on Baraqan Island were found to be in a quite inferior condition. This would indicate the characteristics of reproductive condition of Hawksbill Turtle in the Study Area.

Table 53. Results of marine turtle nest examination.

No.	Location	Beach No.	Date Examined	Species	Healthy Eggs	Yolkless Eggs	Hatched Egg	Status
1	Jazirat Barqan	4	31-May-98	Cm?	85	23	1	Old Nest
2	Jazirat Barqan	5	31-May-98	Ei	94	29	-	New Nest
3	Jazirat al-Waqqadi	14	7-Jun-98	Ei	78	24	-	New Nest
4	Ra's Baridi	20 (S1)	20-Oct-98	Cm	128	0	-	New Nest
5	Ra's Baridi	20 (S1)	19-Oct-98	Cm	124	5	-	New Nest
6	Jazirat Jabal Malihah	25	15-Jun-99	Ei	61 (59)	25		C 2 week old
7	Jazirat al-Waqqadi	14 (NW)	20-Jun-99	Ei	73	18		C 1 week old
8	Jazirat al-Waqqadi	14 (NW)	20-Jun-99	Ei	45	16		C 1 week old
9	Jazirat al-Waqqadi	14 (NW)	21-Jun-99	Ei	47	68		C4 days old

Cm: *Chelonya midas*, Ei: *Erectmochelys imbricata*, NW: North West. ():Fertile egg

3). Nest temperature

Due to defects in the data loggers set in the three nesting beaches, only one reliable set of temperature data was obtained at 50 cm depth on the Ra's Baridi nesting beach.

Therefore comparison of the temperature between the three nesting beaches was not possible in the Study. The data obtained at Ra's Baridi is shown in Fig.33. A monitoring survey at Ra's Baridi was conducted from late August for about 2 months by NCWCD. The nest temperature in this period ranged from 32°C down to 28.5°C. The same range of temperatures was available from the end of April to July, upward from 28°C to 32°C. Significant nesting activities by Green Turtles on Ra's Baridi and Jazirat Jabal Hassan were observed inn June 1999. Therefore, Green Turtle nesting activities might have two phases or might start from April, and a confirmation survey is needed.

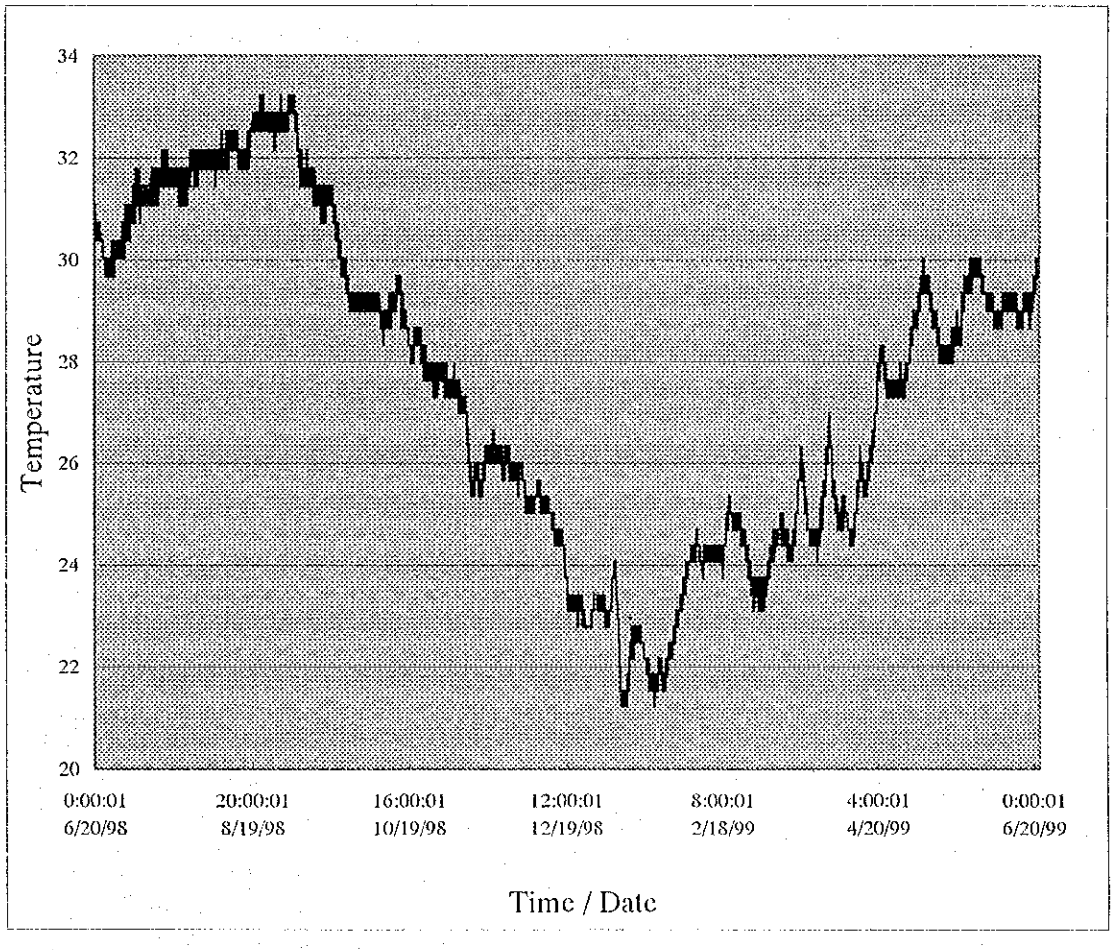


Fig. 33. Nest temperature at 50 cm depth of the nesting beach in Ra's Baridi.

4). Nesting females

No Hawksbill Turtle nesting females were captured on Baraqan or al Waqqadi Islands in 1998. Only one female Hawksbill Turtle was captured at al-Waqqadi Island in June 1999. Five new nesting females and one tagged female Green Turtle were captured at Ra's Baridi on October, 1998. One was captured ont Jazirat Jabal Hassan in June 1999. The females were measured SCL, CCL, SCW and CCW and the new females were tagged with English/Arabic numbers. The measurements including those of the dead female are shown in Table 54.

The previous monitoring data of nesting females on beaches south of Ra's Baridi suggested quite a low rate of nesting female recruitment. Five new nesting females were found within the very limited present survey which was conducted late in the nesting season. The long time gap since the last tagging survey may be a factor in the finding of the new females. Five new nesting females, however, indicate that a certain level of recruitment is taking place.

Table 54. Marine turtles nesting female examined in the Study.

Species	Tag.	Date	SCL (mm)	SSC (mm)	SCW (mm)	SCW (mm)	BW (kg)	Location	Status
C. mydas	13160(e) 17160(a)	10/18/98	1036	1080	786	100		Ra's Baridi S1	Nesting
C. mydas	13161(e) 17161(a)	10/19/98	990	1030	778	970		Ra's Baridi S1	Nesting
C. mydas	13162(e) 17162(a)	10/19/98	968	1000	749	890		Ra's Baridi S1	Nesting
C. mydas	13163(e) 17163(a)	10/19/98	1027	1080	780	990		Ra's Baridi S1	Nesting (healthy 124, yokeless 5)
C. mydas	13159(e) 17159(a)	10/19/98	984	1010	735	895		Ra's Baridi S4	Nesting (aborted)
C. mydas	9847(e) 11847(a)	10/20/98	969	1005	725	900		Ra's Baridi S1	Nesting (with tag)
C. mydas	13164(e) 17164(a)	14/6/99	991	1085	747	945		Jazirat Jabal Hassan	Nesting, laid eggs
E.imbricata	13185(e) 17165(a)	20/6/99	660	690	505	605	30	S/W beach of Jazirat al-Waqqadi	Nesting (aborted)

5). Mortality

Seven mortality cases were found during the beach survey and they are listed in Table 55. One adult male Hawksbill Turtle was found dead on Umm Libnah Island. It had apparently been killed and its male organ taken; some people believe that the male organ has aphrodisiac effects. The sex of marine turtles is usually biased toward the female. Cuba reported their Hawksbill Turtle population to be 80% - 90% female. (ELVIRA per. comm.) A higher sex bias was reported in Japan (KAMEZAKI per. comm.). There were no data on the Red Sea marine turtle population. However, considering the sex bias reported from other areas, the selective hunting pressure on the male would have some impact.

One mortality case of a tagged nesting female was found on south beach number 5 at Ra's Baridi on October 1998. The tag had been removed but not yet reported to NCWCD. One or two mortality cases of Green Turtle nesting females at Ra's Baridi in one breeding season were noted during the monitoring survey. The mortality rate seems to be quite high in comparison with the number of nesting females reported. The mortality of the reproductive population has a significant impacts on the population. The cause and the rate of mortality need to be assessed for effective management of the local population.

Table 55. Mortality cases found during the Study.

Location	Date Found	Species	Size	Sex	Remarks
El Gragib	2/16/98	Ei	Juvenile		Found dead on the beach.
South of Ghawash coast guard station	2/16/98	Ei	Adult	F	Found a few weeks after death. No evidence of being killed.
Umm Libnah Island	2/19/98	Ei	Adult	M	Killed quite recently. The male organ had been removed.
Umm Kud Island	6/4/98	Ei	Adult	F	Apparently killed a long time ago.
Umm Kud Island	6/4/98	Ei	Adult		
Umm Kud Island	6/4/98	Ei	Adult		
Ra's Baridi	10/19/98	Cm	Adult	F	Found dead on the beach in August. Probably dehydrated during nesting activities.

Cm; *Chelonia mydas*, Ei; *Eretmochelys imbricata*

4. Discussion

4-1. Inventory and distribution of species occurrence

Two species, Hawksbill and Green Turtle, of the five species recorded in the literature were found in the Study Area. The other three species (Leatherback, Loggerhead and Olive Ridley Turtles) were not recorded in the Study Area and there have been only a few records of these three species in the past.

Hawksbill Turtle feeds mainly on sponges and Green Turtle eats extensively from the seagrasses. Both species were found in the entire Study Area, but Hawksbill Turtle was found to be more common and to have a wider distribution than Green Turtle. Both species are less frequently sighted and very rarely known to nest inside the Gulf of Aqaba, where foraging and nesting areas are limited especially for Green Turtle.

The sightings of Green Turtle in the Study were mainly of adult size individuals, and it was very rare for juveniles to be sighted. A significant population is reported in the Mediterranean (GELDIAY et al., 1982), and in Israel (SELLA, 1982). There is also a large nesting population in South Yemen, along the shores of the Gulf of Aden (FAO, 1973). Green Turtle nesting habitats were found to be spread through the Study area. Therefore, the Green Turtles sighted might be individuals migrating between foraging and nesting habitats. This would make the population of the species in the Study Area less than would be expected.

Sightings of Hawksbill Turtle included juveniles and adults. Hawksbill Turtle is thought to be more closely associated with the local habitat especially with the coral habitat which provides the main food source. Very extensive coral habitats exist in the Study Area but the the species was sighted less frequently than might be expected. The population in the Study Area might not be large in comparison with the extensiveness of the coral habitats. Moreover, because of the sedentary nature of Hawksbill Turtle, the population in the Study Area might have very limited interchanges with those in the Gulf of Aden and the Indian

Ocean. No Hawksbill Turtle population has been reported in the Mediterranean. No distinct difference between the Red Sea Hawksbill Turtle and the Indian Ocean population is evident or has been reported, but the level of isolation would be one of the most important keys for conservation management.

4-2. Extensiveness of the nesting habitats.

The most critical phase of the marine turtle life cycle depends on the nesting habitats. A number of islands and islets and locations of the mainland coast were found to provide nesting habitats but nesting sites were rather limited and scattered.

Coast development from south of Yanbu' to Jeddah seems to be limiting nesting activities. The only two nesting cases known to the coast guards were inside the Gulf of Aqaba. Many small islands and islets in the Tiran area up to Al-Khuraybah provide significant nesting beaches. Several islands and some beaches on the mainland coast from Al-Khuraybah to Al-Wajh provide nesting habitats and nesting sites are quite limited. Numerous islands and islets in Al-Wajh Bank including Jazirat Jabal Hassan provide primary nesting habitats for both species. Many small beaches from Sharm Shabaan to Sharm Al-Hisay, Ra's Laquq, Ra's Baridi to Sharm Yanbu' provide nesting habitats mainly for Green Turtle. Among those areas Ra's Baridi is the primary site for Green Turtle.

The other critical phase of the marine turtle life cycle is the first few years that the hatchlings are believed to spend under the offshore Sargasso. The growth and development of Sargasso in the Study Area is not well studied. The scattered and low intensity nesting in the Study area might be caused by the high mortality. Well-developed Sargasso would be a second important habitat, though the location is not well known.

4-3. Reproductive condition

The nesting season of Hawksbill Turtle in the Study area lasts from April to the beginning of July when the temperature is above 28°C. The nesting season of Green Turtle seems to be April to June and August to September, when the temperature is rising above and dropping to 28°C.

Low numbers of eggs and a high rate of yolkless eggs per nest were reported to be characteristic of Hawksbill Turtle in the Red Sea (ROSS 1982). These characteristics were discussed in terms of environmental constrains and thermal stress in the Red Sea (ROSS 1982, FRAZIER 1984). The average number of eggs per nest in the Study Area was much less than that previously reported. The percentage of yolkless eggs in the Study Area was similar to that in the previous report. Compared with the present results, over 150 eggs per clutch with no yolkless eggs for Hawksbill Turtle was reported in the Seychelles (FRAZIER 1984); the characteristics of reproduction in the Study Area indicate the very high sensitiveness of the species.

Clutch size for Green Turtle in Ra's Baridi was around 120, with much fewer yolkless eggs compared to Hawksbill Turtle. However, clutch size is smaller than those reported in the Arabian Gulf and the Indian Ocean (MILLER et. al. 1989). This smaller clutch size is a common characteristic for both species in the Red Sea, though Green Turtle seems to be doing better than Hawksbill Turtle.

4-4. Endangered / endemic species

All marine turtle species are listed in CITES Appendix I, and all marine turtle species are also protected species in the Kingdom.

Marine turtle habitats in the Red Sea were dramatically influenced by the Ice Ages because of fluctuations in the sea level, high salinity, and temperature fluctuations. The most

recent Ice Age ended about 15,000 to 20,000 years ago. The marine turtle population in the Red Sea has been recovering since then. It is believed the sea level reached its present level about 5,000 years ago. From around that time, the two species started utilising the nesting beaches in the Red Sea. Thus, the present nesting population seems to be rather young.

Whether the founder population of the present nesting population is large enough or regular/ periodical recruitment to the nesting population takes place from the Indian Ocean has important implications for conservation management, especially in view of the reproduction characteristics found in the Study Area. Therefore, a study of the DNA of the Red Sea and the Indian Ocean populations using modern techniques is important for the development of a suitable management program.

4-5. Exploitation

Though very limited, some exploitation of turtles was noted during the survey. No information or data are available on the level of exploitation. The magnitude of exploitation needs to be studied further.

4-6. Mortality

1 – 2 mortality cases per year of nesting female Green Turtles is reported in Ra's Baridi . Six mortality cases of nesting females which were most probably Green Turtles were known to the coast guards at Rayis in 1997. Compared to the number of nesting females in the area, the mortality rate seems to be quite high. Mortality of the reproductive population has a significant impact on the population. Though their nesting beach habitats suffer little impact from human activities, the nesting intensity was found not to be so high. This discrepancy especially in the case of Green Turtle needs to be further clarified from the point of view of management of the local population.

Human communities produce solid waste. Dumping organic substances into the environment increases the survival rate of scavenging animals such as rats, foxes, lizards and crabs, many of which are natural predators of the turtle hatchlings. An increase in the predator population causes a further increase in hatchling mortality. An increase in the number of crabs on the nesting beaches at Ra's Baridi was noted during the monitoring survey in the area. The turtles have been redistributing in the Red Sea since the end of the Ice Age and surviving in a harsh environment. Because of the reproduction characteristics of the marine turtle noted in the Study Area, a small impact would have rather a large effect on their survival. Therefore, natural predator species and changes in their beach habitats need to be monitored with regard to the primary nesting sites.

4-7. Priority areas for marine turtle conservation

The priority areas are evaluated in terms of 1) species occurrence, 2) extent of nesting habitat, 3) endangered/ endemic species, 4) exploitation (human impact), 5) mortality. The Study area was divided into six characteristic areas and the importance of each area evaluated on three levels. The results are shown in Table 56.

Al-Wajh Bank and the Tiran area are evaluated as high priority areas for conservation with the same levels apparent from Duba to Al-Wajh Bank where scattered nesting habitats were found. The present evaluation is limited by many limitations of unknown factors which need to be further studied. The results of these further studies might suggest additional priority areas and conservation management programmes.

Table 56. Summary of the conclusions tabulated by area categorised from the present results.

	Gulf of Aqaba	Tiran Area	Duba / Al-Wajh	Al-Wajh Bank		Umluj / Ra's Baridi	Yanbu' / Jeddah
				North	South		
Marine Turtle							
Species occurrence	1	2	2	2	2	2	2
Nesting habitat	1	3	2	3	3	3	2
Endangered/ Endemic Species	1	2	2	2	2	2	2
Exploitation	3	3	3	3	3	2	?
Mortality	?	?	?	?	?High	?High	?

2.1.7. MANGROVES / COASTAL VEGETATION

2.1.7.1. Introduction

The Middle East is often divided into the following four major floristic regions according to each regional climate, topography, and geological history: Mediterranean, Irano - Turanian, Saharo – Arabian (or Saharo –Sindian), and Sudano – Deccanian. The region north from the Red Sea including the Study Area belongs to the Saharo-Arabian Floristic Region, having a hyper - arid and subtropical climate with low precipitation and high temperatures. This floristic region contains many elements of the neighbouring regions and a relatively low proportion of endemic species (MANDAVILLE 1990). Under these harsh climatic conditions, the Red Sea coastal area is widely covered by barren land. Some of the offshore islands and shorelines are, however, covered by mangroves which have adapted to the highly saline waters.

There are some reports on the vegetation of the Red Sea coastal zone. Most of these reports, however, pertain to the coastal areas on the African side. KASSAS (1957) surveyed the vegetation of the Red Sea coastal belt in Sudan, and classified eight types of salt marshes and six types of desert plain communities. ZAHRAN (1977, 1992) gives accounts of the vegetation types of the African Red Sea coast. VESEY-FITZGERALD (1956) describes the vegetation of the coastal plain and highlands north of Jeddah in Saudi Arabia. However, discriptions of coastal plains and beach vegetation are applicable to the Study Area. According to VESEY-FITZGERALD (1956), the coastal vegetation in the section north of Jeddah is characterised by an increase in the number of species of halophytes, especially in areas close to the sea. Halophytes in this area are more varied and more abundant than in the section south of Jeddah. CHAUDHARY et al. (1999) delineate five major plant communities of the Red Sea coast in Saudi Arabia. These are, the Panicum – Aeluropus community, the Limonium – Sporobolus – Aeluropus community, the Mangrove community, the Suaeda – Limonium –

Aeluropus community, and the Suaeda – Tamarix community.

Research on mangroves has been undertaken in the Arabian region, particularly along the Sinai coast and in the western Red Sea coast (SHEPPARD et al. 1992). Four mangrove species exist in the Red Sea area, and two species (*Avicennia marina* and *Rhizophora mucronata*) were recorded on the eastern coast of the Red Sea (SHEPPARD et al. 1992). *Avicennia marina* is by far the most common species, but *Rhizophora mucronata* is found as far north as latitude 25° N (ORMOND et al. 1986, GAZANFAR et al. 1998). The extent of mangroves has almost been certainly reduced over time by felling, for timber and fuel (ORMOND et al. 1986). Degradation of the mangrove forests caused by grazing by camels has also been reported (MOHAMED 1984, MIYAMOTO & AL-WETAID 1993).

2.1.7.2. Methods

1. Preliminary survey

In order to obtaint an outline of the vegetation and flora in the Study Area, a preliminary field survey was carried out in February 1998. The width of the survey area extends from the shoreline to 1 km inland. The Study Area was surveyed using a 4WD - vehicle and one island was visited.

2. Vegetation survey

On the basis of the preliminary survey, 25 sites (V1 - 25) including three offshore island sites were selected in order to examine the typical pattern of coastal vegetation in the Study Area. The locations of the sites are shown in Fig. 3.

Each site was in the coastal zone within 1 km from the shoreline, and had an area of approximately 1,000 m x 500 m (maximum). Every plant community in the Study Area was surveyed using the quadrat method of BLAUN-BLANQUET (1964), mainly in May - June 1998. That is, the cover-abundance and sociability of every plant appearing in a quadrat (spot) were

recorded. The quadrat size was decided according to its plant cover and the height of the dominant species. The area of each quadrat was in the range of 5m x 5m to 30m x 30m.

The distribution of plant communities at each site was sketched on a vegetation map and a profile of the site was drawn. After the field work, each vegetation map was amended using aerial photographs.

3. Flora survey

During the preliminary survey (Phase I), vascular plants with flowers and / or seeds were collected for specimens at optional points in the Study Area. In the inventory survey (Phase II), a flora survey was conducted at each site in the same way as the vegetation survey. In addition to these sites, the flora in V2 (Taip esim), the bottom of a gorge, was also surveyed. All species observed at each site were recorded on a flora list. Plants were collected for specimens whenever possible. Plant species were identified using COLLENETTE (1985), MIGAHID (1988, 1989), MANDAVILLE (1990), CHAUDHARY (1983, 1989, 1999) and all specimens collected were rechecked and labelled with their appropriate scientific names by Dr. S.A. Chaudhary.

4. Surveyed sites

The sites were classified into 12 types according to the geomorphological features around the sites and the main landforms in them, so that a description and comparision of the vegetation and flora at each site could be made (Table 57). Each type represents at least one site and has its own typical features such as soil humidity, salinity and continuous landforms behind the sites. The names of the sites arranged by location from north to south are shown in Table 58.

Table 57. Geomorphological types of the sites.

Geomorphological type	Main landform at the site	Soil humidity (salinity)	Continuous landform behind the Site	Site No.
1. Off shore island	A. Flat	High (intensive)	Flat	V19
	B. Terrace of fossil coral	Low	Terrace	V10
	C. Steep slope	Low	Mountain	V21
2. Alluvial fan	A. Flat(near sea level)	High (intensive)	Alluvial fan	V18,V22,V24
	B. Flat (slight high in elevation from sea level)	Middle	Alluvial fan, hill	V5,V20,V25,V26
	C. Gentle slope	Low	Hill, mountain	V6,V9,V11,V17
3. Inlet enclosed by terrace of fossil coral or hill	A. Flat (mouth of wadi)	High	Wadi and terrace	V7,V8,V13,V14,V15
	B. Gentle slope (sand deposits)	Middle	Terrace or hill	V4,V23
	C. Steep slope	Low	Hill	V12
4. Mountain or hill	Steep slope	Low	Hill, mountain	V3
5. Wadi	A. Flat	High	Wadi	V16
	B. Gentle slope	Low	Hill, mountain	V1
	C. Gorge	Middle	Hill, mountain	V2*

* The flora survey only was conducted in V2.

Table 58. The distribution of the sites.

Region	Site.	Place name	Type	Geomorphological type
Gulf of Aqaba				
	V1	Al-Durah	5-B	Wadi with gentle slope
	V2*2	Taip esim	5-C	Gorge
	V3	Maqna	4	Mountain
	V4	Ash Shaykh Humayd	3-C	Inlet with gentle slope
Tiran				
	V5*3	Sharma	2-B	Alluvial fan with flat (slight elevation)
	V6	Ash Sharma	2-C	Alluvial fan with gentle slope
Duba / Al-Wajh				
	V7	Sharm al-Badu	3-A	Inlet with flat wadi
	V8	Rawd az-Ziyan	3-A	Inlet with flat wadi
	V9*3	Al-Quff	2-C	Alluvial fan with gentle slope
	V10	Jazirat an Numan	1-A	Off shore island with terrace of fossil coral
	V11*3	Zubaydah	2-C	Alluvial fan with gentle slope
	V12	Marsa Hawwaz	3-C	Inlet with steep slope
	V13*3	Sharm 'Antar	3-A	Inlet with flat wadi
	V14	Sharm Haramil	3-A	Inlet with flat wadi
	V15	Habban	3-A	Inlet with flat wadi
Al-Wajh / Umluj				
	V16	Wadi al-Hamd	5-A	Wadi with flat
	V17	Al-Muresy	2-C	Alluvial fan with gentle slope
	V18	Duqm Sabq	2-A	Alluvial fan with flat (sea level)
	V19	Jazirat Shaybarah	1-B	Off shore flat island
	V20	Duqum	2-B	Alluvial fan with flat (slight elevation)
Umluj / Yanbu'				
	V21	Jazirat Jabal Hassan	1-C	Off shore mountainous island
	V22	Ash Shabaan	2-A	Alluvial fan with flat (sea level)
	V23	Marsa al-Khawr	3-C	Inlet with gentle slope
Yanbu' / Jeddah				
	V24	Yanbu'	2-A	Alluvial fan with flat (sea level)
	V25*3	Masturah	2-B	Alluvial fan with flat (slight elevation)
	V26*3	Rabigh	2-B	Alluvial fan with flat (slight elevation)

*1 : Type No refers to Table 1. *2 : The flora survey only was conducted in V2.
*3 : The sites were surveyed in two seasons.