THE STATUS OF CORAL REEFS IN DJIBOUTI - 2000

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Executive Summary
Djibouti has a coastline of 372 km. The north coast generally shallow and sandy, with coral outcrops at Ras Siyyan and Kadda Gueini. The Sawabi (Sept Frères) archipelago east of Ras Siyyan is also fringed by coral reefs. The southern coast toward Somalia is shallow with several estuaries and poorly developed coral reefs, linked to the cold water upwelling from the Indian Ocean.

Three studies form the origin of the results presented herein. Two short but extensive reef assessments in 1998 and one comprehensive subtidal survey in 1999 have provided a wealth of information on Djibouti's reefs. At the south-western tip of Maskali, the reefs are very poor and turbidity is high. Moucha and Maskali had moderate to very good live coral cover (> 30 %). Live coral on the reefs to the north of Moucha and Maskali was moderate to good (25 to 40 % cover). The reefs of Khor Ambado had an average living hard coral cover of 52 %. Species diversity of benthic and sessile organisms was low. *Porites* and *Pocillopora* were the dominant reef forming corals on the reef edge and reef slope. Coral and other fauna were relatively rare on the back reef and reef flat. Eastward along the coast from Khor Ambado the reef was in moderate to good condition with coral cover within samples of up to 80 %. The status of the coral at Sept Frères was good (cover averaged 34 %), and most parts of the archipelago had balanced and healthy reefs. No significant signs of recent bleaching, other than COT feeding scars, were recorded on the reef face or reef flat. A total of 166 species of corals were recorded in the 1998.

The reefs of Djibouti are under pressure from many anthropogenic sources of impact Despite these threats, the living hard coral cover averaged 39 % with a maximum of 80 % (predominantly *Pocillopora)*. Water turbidity was high at all sites. Patches of coral substrate were widely spaced and interspersed with mud and soft sediment. However, living coral is able to persist in small patches around the Capital and very close to the port area.

Agriculture, cattle-breeding and fisheries contribute < 2.5 % of the national income, but the international port of Djibouti contributes significantly to the national economy. Coastal and marine tourism is still in its infancy. The major economic sectors in the coastal zone are maritime transport and port-related activities. At present, fisheries plays a limited role, although subsistence fisheries are locally important.

Most of the coasts and territorial waters are still in a largely pristine state, but there are signs of degradation and threats are increasing rapidly. Man-induced pressure is particularly high in the vicinity of the capital. The major threats to reefs in Djibouti are tourism and sewage discharges. A national biodiversity project supported by GEF is currently being implemented

in the country. The goal is to draft a strategy and an action plan for conservation of the biodiversity in Djibouti, inclusive of coral reefs. Djibouti has two declared marine protected areas, which have been established for more than ten years. There are two additional areas proposed for protected status, one of which is of regional importance.

Natural and anthropogenic stresses on corals in Djibouti are limited in extent and scope. Several key actions at the national level in the form of legislation and implementation could lessen the risks of ship-based pollution and oil spills. A dedicated research and monitoring programme that fed back into coastal area management plans would contribute greatly to efficient conservation actions.

1. Introduction

Djibouti has a coastline of 372 km which is fringed by extensive coral reefs in places. The north coast near Eritrea at Ras Bir faces the Straits of Bab al-Mandab and is generally shallow and sandy, with coral outcrops at Ras Siyyan and Kadda Gueini. The Sawabi (Sept Frères) archipelago east of Ras Siyyan is also fringed by coral reefs. The southern coast toward Somalia is shallow with several estuaries and poorly developed coral reefs, linked to the cold water upwelling from the Indian Ocean. Most of the coast of Djibouti lies along the deep (883 m) Sharm Tadjoura. Ghourbet al-Kharab, a shallow semi-enclosed basin separated from Tadjoura by a narrow opening, contains low diversity coral reefs. At the mouth of the Gulf of Tadjoura, north of Djibouti town, are Mush and Maskali islands, which are surrounded by extensive coral reefs (Fig. 1).

Djibouti lies in a hot and semi-arid zone where the weather is influenced by the Indian Ocean monsoon. Mean air temperatures vary between 25 ºC in the winter to 35 ºC in the summer. Annual rainfall ranges from 50 to 215 mm. During the south-west monsoon, from June to September, northerly winds move surface waters from the Gulf of Aden out into the Arabian sea. This is reversed during October to May, bringing cooler waters into nearshore areas. Salinity ranges from 36 to 39 ppt, increasing during south-west monsoon periods, and water temperature ranges between 25 ºC and 29 ºC.

Agriculture, cattle-breeding and fisheries contribute < 2.5 % of the national income, but the international port of Djibouti contributes significantly to the national economy. Coastal and marine tourism is still in its infancy.

At the confluence of three biogeographic zones, Djibouti is home to a unique assemblage of coral reef species. Ecologically, the confluence of warm-water tropical biota (from the Indian Ocean and Red Sea), with cold water upwelling habitats (from the Somali and Arabian regions) is notable at the Sept Frères Islands, and resembles marine conditions seen in only a few other parts of the world.

Current threats to coral reefs come from the tourism, shipping and coastal development sectors. A national biodiversity project supported by GEF is currently being implemented in the country. The goal is to draft a strategy and an action plan for conservation of the biodiversity in Djibouti, inclusive of coral reefs.

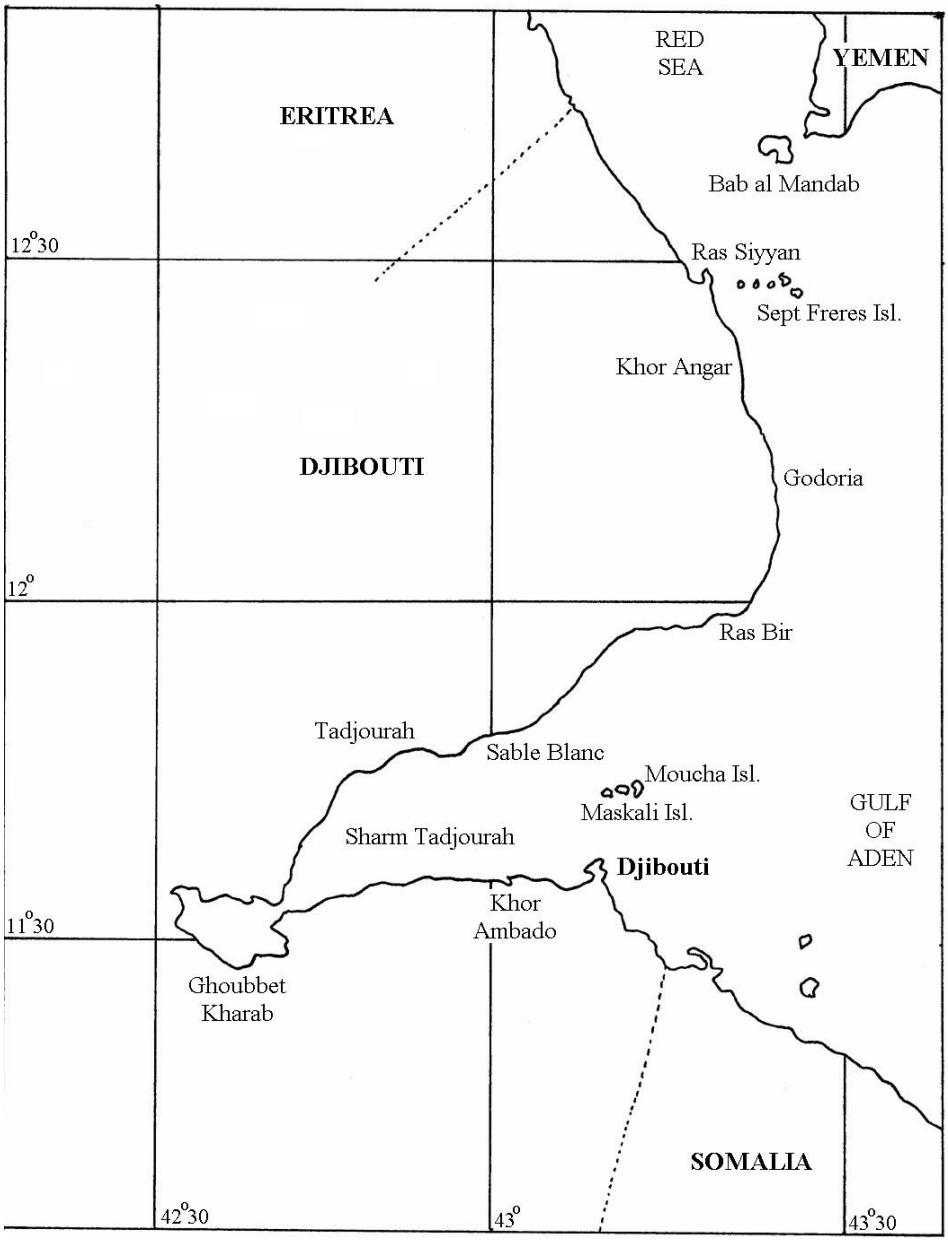

Fig. 1: Map of the Republic of Djibouti illustrating the location of major marine areas.

2. Methods

i. Geographical Scope

A study was undertaken by a national team led by David Obura in 1998 which surveyed Moucha and Maskali islands, Khor Ambado, Les Trois Plages, Sable Blanc, Ras Duan, Sept Frères, Recif d'Ambouli and a site off Tadjorah (Obura & Djama 2000). A separate survey by Hunting Aquatic Resources ocn behalf of PERSGA surveyes coastal and marine resources at Moucha and Maskali Islands, Khor Ambado, Djibouti city, Sable Blanc, Godoria, Khor Angar, Sept Frères islands and Ras Siyyan in April 1998, at which a total of 185 locations were sampled (PERSGA 1998). Obura also carried out a more detailed study at 21 sites between November and December 1998, covering the Gulf of Tadjourah, the Moucha and Maskali islands, and the Sept Frères Islands in the north.

ii. Survey Techniques
In the Obura & Djama study, the number and percent cover of soft and hard corals was counted, along with counts of major invertebrates using circular plots at random locations. The status of corals was assessed and any evidence of algal blooms were recorded.

In the PERSGA study, visual assessment by snorkel of 10 m × 10 m quadrats centered on a demarcating line between the reef edge and the reef face was used to assess principal sessile and anthropogenic indicators / features on the reef. In addition, timed 20-minute swims by snorkel along the line of the reef edge starting and ending at quadrat sample sites, were used to assess percentage cover within a 10 m band transect of different life forms, along with counts for indicator species such as butterfly and angel fishes, the Humphead Wrasse *Cheilinius undulatus*, and several commercial fishes.

Benthic features were assessed for percent cover following English et al. (1997) with the exception of 'algal film', which was a generic term used to cover all forms of non-calcareous algae that were too small to distinguish by the unaided eye. Certain features were counted rather than listed as a percentage cover, in particular macro invertebrates such as lobsters and Crown of Thorns starfish *Acanthaster planci*. A number of indicator fish species were counted following methods in English et al. (1997).

In the Obura study in late 1998, data was collected by snorkelling in water < 5 m depth, and by SCUBA in depths > 5 m. Circles covering 100 m^2, marked by a radial line of 5.6 m, were used as the basis for estimation, in which estimates were made of the percent cover of 3 types of bottom substrate and six types of living cover. Broad 10 percentile ranges (i.e. 10 %, 30 %, 90 %, etc.) were used, with additional categories for low-cover presence indicated by categories of 1 % and 5 %. The principal objective of the method was to sample large areas of the bottom rapidly rather than obtain detailed measurements of small areas as provided by line transect and quadrat techniques.

4. Status of Coral Reefs – Benthos and Fish

i. Summary
The reefs off the main beach of Maskali (currently demarcated with mooring buoys) are in very poor condition. Towards the south-western tip of Maskali, near the navigation beacon, the reefs are also very poor and turbidity is very high. In contrast, most of the other reefs Moucha and Maskali had moderate to very good live coral cover (estimated at > 30 %). Sample sites on patch reefs and coral gardens to the south of Maskali had good live coral coverage with associated fish populations. Live coral cover on the fringing reefs to the north of Moucha and Maskali was moderate to good (25 to 40 %), and framework corals at these sites appeared substantive and robust. Additionally, the patch reefs in the channel between Maskali and Moucha are reasonably well developed. The fringing reefs to the north of Moucha and Maskali had a relatively high cover of broken *Acropora* now colonised by coralline algae. This was possibly a result of a bleaching event, with most breakage subsequently occurring due to wave action. However, living substrate cover at these sites is substantive and may be indicative of a regenerating system.

The fringing reefs of Khor Ambado had an average living hard coral cover of 52 %. This was high compared to many other sites in Djibouti and elsewhere in the Red Sea, despite very

turbid conditions at the time of the present survey. Species diversity of benthic and sessile organisms was low relative to other study sites visited, and *Porites* and *Pocillopora* were the dominant reef forming corals on the reef edge and reef slope. Coral and other fauna were relatively rare on the back reef and reef flat. The fringing reef directly offshore from the tourist beach at Sable Blanc had large *Porites* coral cascades on a steep reef slope which dropped off to sand at approximately 20 m. Most colonies exhibited signs of minor impact possibly due to disease or sedimentation damage.

Eastward along the coast, the reef was in moderate to good condition with coral cover within samples of up to 80 %. The influence of localised factors such as wadi outwashing and run-off, rather than visitor pressures, appeared to dictate the overall reef condition.

The reef flat at Sable Blanc exhibits a greater array of small coral colonies and living substrate cover than the reef at Khor Ambado. Observations indicated that the predominant coral species on the reef flat was *Pocillopora.* Small colonies of *Acropora* were also present on the reef flat particularly to the west of the main tourist beach. No significant signs of recent bleaching, other than COT feeding scars, were recorded on the reef face or reef flat.

The reefs of Djibouti are under pressure from many anthropogenic sources of impact Despite these threats, the living hard coral cover averaged 39 % with a maximum of 80 % (predominantly *Pocillopora)*. Water turbidity was high at all sites. Patches of coral substrate were widely spaced and interspersed with mud and soft sediment. However, living coral is able to persist in small patches around the Capital and very close to the port area.

The status of the coral habitats at Sept Frères is good. Live coral cover for the islands averaged 34 %, and although not very high, observations of general substrate diversity indicated that most parts of the archipelago had balanced and healthy reefs. Impact was difficult to attribute to any specific cause and possibly reflects long-term environmental disturbances. No indications of a COT epidemic, either current or recent, were recorded during the 1998 study. Most of the reefs located in the Gulf of Tadjourah showed no signs of bleaching. In some areas like the offshore Maskali island, degraded reefs have been encountered, but the causes of degradation could not be determined. The only site with notable bleaching are the islands of Seven Brothers located in the Red Sea portion of Djibouti waters. These islands are quite unique because there are rising cold waters which contribute to a better productivity of the ecosystem (important fishing ground). The Trois Plages is in a pristine state showing extensive reefs and containing one of the highest number of butterfly fish species recorded in the survey Obura & Djama 2000).

ii. Coral Diversity

A total of 166 species of corals were recorded in the 1998 survey, dominated by *Acropora hemprichi, Echinophora fruticulosa* and *Porites nodifera*. Only 10 % of the species were found at all sites, 40 % were present at several sites. Nearly 50 % of the coral species were restricted to a handful of sites. *Acropora* sp. suffered high mortality in Khor Ambado and off Maskali.

In 1998, Oboura identified a total of 167 coral species (including 3 species of black coral). at a The highest diversity was recoded at Arta Plage (93). Grande Isl. in the Sept Frères had the second highest diversity of corals (84 species), followed by Trois Plages in the Gulf of

Tadjourah (75 species) (Tables I & II). Only one coral species was recorded at every site, *Porites lutea*, and only 10 % of the species identified were recorded in 14 or more sites.

Table I: Coral species diversity and length of survey at each individual site (Source: Obura 1998).

Region	*Site*	*# species*	*Sample time (min)*
Sept Frères	I. Grande	84	45
Tadjourah, south	Trois Plages	75	55
Sept Frères	I. Sud	71	100
Tadjourah, south	Arta Est	70	45
Sept Frères	I. Est	69	35
Moucha and Maskali	Moucha Est	67	35
Tadjourah, south	Arta Ouest	66	20
Moucha and Maskali	Maskali Buoy	64	40
Tadjourah, south	Khor Ambado	64	45
Tadjourah, north	Ras Duan-flat	63	30
Moucha and Maskali	Maskali Lighthouse	62	40
Tadjourah, north	Sable Blanc	58	40
Tadjourah, north	Ras Duan-Fringing Reef	57	35
Sept Frères	I. Double	52	60
Tadjourah, north	Tadjourah	49	25
Moucha and Maskali	Moucha N	43	30
Moucha and Maskali	Moucha S	21	30
Moucha and Maskali	Maskali S	19	20

Table II: Coral species diversity and length of survey for each major area (areas had 2 or more sites) (Source: Obura 1998).

Site	*Region*	*# species*	*Sample time (min)*
Arta	Tadjourah, south	93	65
Ras Duan	Tadjourah, north	90	65
Grande	Sept Frères	84	45
Maskali	Moucha and Maskali	84	100
Moucha	Moucha and Maskali	82	95
Trois Plages	Tadjourah, south	75	55
Sud	Sept Frères	73	100
Est	Sept Frères	69	35
Khor Ambado	Tadjourah, south	64	45
Sable Blanc	Tadjourah, north	62	40
Double	Sept Frères	52	60
Tadjourah	Tadjourah, north	49	25

iii. Coral Cover

Seventy-two quadrats (10 m by 10 m) were visually assessed for percentage cover of various life forms and abiota (see Appendix III & IV). Living hard coral was absent from only 2 of the 72 quadrats. Percentage cover ranged from 5 % (offshore of the main tourism beach on Maskali) to 90 % (at Hamra Island, Sept Frères). At this latter site the dominant coral was Acropora, forming a coral garden. In 26 samples, percentage cover of live hard coral was equal to, or greater than, 50 %. In reef edge swims, percentage cover of living hard coral ranged from 5 % to 70 %, and exceeded 20 % in all but 3 samples (PERSGA, 1998).

Macroalgae were recorded in 38 of 72 reef assessment quadrats. The percentage cover in a quadrat ranged from 1 % at Sable Blanc to 60 % at the Fish Market, Djibouti City. A cover of 50 % was recorded in the vicinity of Moucha at 2 sites. No macroalgae were recorded during quadrat assessments performed around Sept Frères. Algal film was observed in 13 of 72 quadrats. Percentage cover ranged from 5 % (at Khor Angar) to 25 % (at Radio Mast at Djibouti City). Coralline algae was observed in 62 of 72 quadrats. Values ranged from 5 % at 17 sites to a maximum percentage cover of 60 %. In reef edge swims, macroalgae were recorded in 24 of the 34 reef edge assessments. Percentage cover ranged from 1 % at Sable Blanc to 60 % at a site near the Navigation Buoy off Maskali. Macroalgae were not recorded during reef edge swims at Sept Frères. Agal film was observed in 6 of the 34 reef edge assessment swims, with percentage cover ranging from 5 % (at Khor Angar) to 20 % (Fish Market, Djibouti City). Coralline algae was observed in 27 of 34 reef edge swims. The highest percentage cover recorded was 48 % (at Sable Blanc). A further 13 reef edge swims had a percentage cover of 20 % or more (PERSGA, 1998).

Dead coral was observed in only one sample quadrat. In this quadrat percentage cover was low (1 %). However, dead coral with a covering of algae was observed in 25 quadrats. Values ranged from 4 % to 20 %. Dead coral was observed in only one reef edge swim (at Sable Blanc). However, dead coral with algae was noted in 21 reef edge swims, with percentage cover ranging from 5 % to 25 % (at Khor Ambado) (PERSGA, 1998).

Soft coral was observed in 19 reef quadrat samples. The maximum cover was 40 % (at Kadda Dabali and Rhounda Dabali). In the reef edge swims, soft coral was observed in 10 samples. Percentage cover ranged from 1 % (at Moucha) to 35 % (at Rhounda Komayto, Sept Frères) (PERSGA, 1998).

iv. Fish Communities

Turtles were observed in 3 samples (at Khor Angar, Godoria and Radio Mast, Djibouti City). On each occasion only a single animal was sighted. Sharks were observed in six samples. Four sharks were sighted at Hamra Island, Sept Frères, and single individuals were observed in the remaining samples.

Angelfish were observed at all sites. Counts ranged from 6 to 31 (around Moucha). Twenty-eight samples contained 10 or more angelfish. *Holocanthus xanthotis* and *Pomocanthus imperator* were observed at three and five sites respectively. H. *xanthotis* was observed in a group of 11 individuals at Rhounda Komayto, Sept Frères. P. *imperatorwas* was only observed as single individuals. *Genicanthus caudoviffatus* was not observed at any site. *P. asfur* was observed at all but one site (at Kadda Dabali, Sept Frères). Counts ranged from 1 to 20 (at Maskali). *P. maculosus* was observed in 31 of 34 samples. Counts ranged from 1 to 15 (at Godoria), but 21 samples contained < 10 individuals. *Pygoplites diacanthus* was observed in 21 samples. Counts ranged from 1 to 15, with 14 samples containing < 10 individuals.

Total butterflyfish counts (i.e. the sum of counts for all species) ranged from 8 (at Sable Blanc and Fish Markt, Djibouti City) to 110 (at Moucha). Fifty or more butterflyfish were observed in 15 of 34 samples. The most frequently observed butterflyfish were *Gonochaetodon larvatus* (a total of 510 individuals) and *Heniochus intermedius* (a total of 45 individuals). *H. intermedius* was also observed in all samples. Counts ranged from 1 (at Fish Market, Djibouti City) to 48 (at Hamra Island, Sept Frères). Eighteen samples contained 10 or more individuals, while 6 samples contained more than 20 individuals. *Chaetodon*

semilarvatuswas was observed in all samples, with counts ranging from 1 to 65 (at Moucha). Twenty two samples contained 10 or more fish, and 9 samples contained over 20 individuals. *C. auriga* and C. *austriacus,* were not observed in any samples (PERSGA 1998).

The total number of groupers observed (i.e. sum of all counts for grouper species) ranged from 0 (at Fish Market, Djibouti City) to 56 (at Godoria). Twenty-eight samples contained 10 or more groupers, while 17 samples contained 20 or more. Two species of grouper, *Variola louti* and *Plectropomus truncatus* were not observed in any sample. *Cephalopholus miniata* was only observed in one sample at Khor Ambado, while a fourth species, *Epinephelus tauvina,* was only observed in 2 samples (at Rhounda Komayto, Sept Frères and Sable Blanc). No species was ubiquitous to all samples. The most frequently observed species, both in number of samples it occurred in and total number of individuals was *C. hemistiktos*. This species was absent from only 2 samples (at Moucha and Fish Market, Djibouti City) Counts *of C hemistiktos* ranged from 2 to27.

Six species of snapper were numerically assessed during the PERSGA survey. One species, *Lutyanus argentimaculatus,* was not recorded in any sample, while *Macolor niger* was only observed in one sample (at Maskali). *L. kasmira* was observed in 20 assessments, and counts ranged from 1 to 260 individuals (at Maskali). *L. monostigma* was observed in 29 samples. Counts ranged from 1 individual (at Moucha) to a maximum count of nearly 2000 (at Kadda Dabali, Sept Frères). A further sample, (at Hamra Island, Sept Frères), also contained greater than 1000 individuals of *L. monostigma.* Ten swims recorded counts for *L. monostigma* of greater than 100 individuals.

Only one species of wrasse, *Cheilinus undulatus,* the humpheaded wrasse, was numerically assessed. This fish was recorded in 14 samples. The highest count was 5, observed at Maskali. A total of 28 individuals were observed during all of the 34 reef edge assessment surveys. Pre-spawning of this species was observed in the vicinity of the Maskali reserve.

One species of Sparid, *Acanthopagrus bifasciatus,* was numerically assessed. This species was observed in 9 samples. Counts never exceeded 10 individuals in a single assessment swim. The maximum of 10 was recorded at Moucha. The total number of sparids for all assessments was only 31 (PERSGA 1998).

v. Invertebrate Communities

Anemones were observed in 13 samples but the number of anemones was low (maximum = 7 at Rhounda Dabali at Sept Frères). The number of Crown of Thorns starfish (COT) was also. Aggregations of COT were not observed. The maximum number of COT found was 14 (Moucha) with 12 individuals in Rhounda Dabali, Sept Frères. 11 starfish wereobserved in a further 3 samples. In total, 96 Crown of Thorns starfish were observed in 34 reef assessment swims. Giant clams were observed in all but 3 samples. Samples which did not contain giant clams were Godoria, Djibouti City South, Fish Market, Djibouti City. The number of clams ranged from 1 to 52 (Sable Blanc). Thirteen samples contained more than 10 clams, and a total of 348 clams were observed in the swims. A total of 15 lobsters were observed in 6 swims. The maximum number observed in any sample was 6 (Hamra Island, Sept Frères). Sea cucumbers were observed in all but three swims of which 10 swims recorded 10 or more sea cucumbers. Counts ranged from 1 to 30 (Moucha). In total, 284 sea cucumber were observed during the swims. The highest recorded count for long spined sea urchin *(Diadema)* was 81 individuals, (Radio Mast, Djibouti City). A further 80 individuals were also recorded

during a reef swim at Sable Blanc. A total of 374 urchins were observed during reef edge assessment swims. No large aggregations of *Diadema* were observed. Slate pencil urchins were recorded in only 5 of 34 samples. A maximum of 17 slate pencil urchins was counted at the Navigation Beacon on Maskali. A further 11 were counted at Sable Blanc. Nine urchins were distributed between the remaining three samples. Top shells were absent from all but one sample, at Maskali, which contained 2 shells (PERSGA 1998).

Presence / absence of six species of damselfish were noted in reef assessment swims. *Plectroglyphidodon* spp. were not observed in any sample. *Chromis dimidiata* was only observed in one sample at Hamra Island, Sept Frères. The most frequently observed damselfish were *Abudefduf* spp, which were observed in all assessments.

Five parrotfish were assessed for presence / absence. *Scarus ferrugineus* was present in all samples, and S. *sordidus* was absent from only one sample (Rhounda Komayto, Sept Frères). S. *frenatus* was absent from all samples. S. *niger* was observed in 26 samples, and *Cetoscarus bicolorwas* present in 20 samples.

Of the four species of surgeonfish recorded for presence/absence, one species, *Zebrasoma xanthurum,* was ubiquitous. Z. *veliferum* was found in all but 3 samples. *Ctenochaetus striatus* and *Acanathurus sohalwere* recorded as present in 31 and 18 Reef Edge Assessment Swims respectively.

Thirteen species of wrasse were recorded as present or absent. Of those, 3 species, *Gomphosus caeruleus, Thalassoma lunare* and *Larabicus quadrilineatus* were present in all samples, and *Halichoeres hortulanus* was absent from only two samples. In contrast, *T. klunzingeri* and *Macropharyogodon bipartitus* were absent from all samples. Although *H. marginatus* was only present in 15 samples, the remainder of the species were recorded in more than 20 swims (PERSGA 1998).

5. Status of Coral Reef Fisheries

i. Summary

The major economic sectors in the coastal zone are maritime transport and port-related activities. At present, fisheries plays a limited role, although subsistence fisheries are locally important. There are about 90 artisanal fishing boats, of which 75 are small, open boats (6 - 8 m) powered by outboard engines. Each boat operates with an average of three fishermen over one day trips. Some 15 of the boats are longer (10-14 m) and equipped with inboard engines. These carry an average of five fishermen each and go out for four days. Most of the fisheries are at the subsistence level and fishing effort is generally low.

ii. Fishery Distribution

The majority of the catch is landed by hook and line. To a lesser extent gill nets and throwing nets are used. Catches consist almost entirely of large food fish which is marketed fresh. There is no processing of any relevance. About 75 % of the catch is landed at Boulaos. Other small landing places are Escale (5 %), Tadjourah (5 %) and Obock (10 %). Club Nautique is entirely used by sport fishermen, and accounts for 3 % of landings. The remaining 2 % are consumed on board.

iii. Fishery Composition and Trends

Catches are composed of grouper (23 %), Spanish mackerel (14 %), red snappers (13 %), antak (12 %), blackspot snapper (10 %), bonito (5 %) and jacks (4 %). All other species are of minor importance. Fisheries production increased from 200 tonnes in 1980 to 400 tonnes in 1984 and 700 tonnes in 1988. Between 1988 and 1991 the increase in production slowed down due to poor marketing efforts. From 1991 to 1994 the production decreased dramatically, due to political unrest in the north of the country.

Fishery production is highest in May, June and September. During the five year period 1986-1990, when the production was fairly stable, the highest yields were recorded in May (44,522 tonnes) and the lowest in February (25,110 tonnes).

Barratt & Medley (1988) indicated that there is a substantial market for aquarium fish from the Red Sea and Western Indian Ocean waters of Djibouti, with the USA, Hong Kong, Germany, Japan and other European countries as the main export markets. No major trade exists at present.

6. Threats to Coral Reef Biodiversity

i. Summary

Although parts of the coasts and territorial waters are still in a largely pristine state, the few studies that have been conducted show that in several areas there are alarming signs of degradation and threats are increasing rapidly. Man-induced pressure is particularly high in the vicinity of the capital. The major threats to reefs in Djibouti are tourism and sewage discharges. Coral bleaching needs to be monitored more closely to determine its impact on reefs.

ii. Habitat Destruction

Extensive coastal development, which includes dredging and filling, destroys large tracts of coral reefs. Urban, industrial and port development coupled with inadequate environmental planning, and little or no environmental assessment near developed areas is severe. The lack of management and awareness, and lack of enforcement of regulations results in physical damage to coral reefs, a loss of coral habitat and a decline in reef-associated fauna. This is brought about by anchor damage, ship groundings, and tourism related activities. Poor navigational control systems, and a lack of moorings throughout the area compound these problems.

Damage to corals that was unequivocally caused by anchoring was noted in 9 reef edge assessments in 1998. Two of these sites were around Maskali; 3 were off the beach at Sable Blanc; 3 were situated around Moucha, and signs of minor anchor damage were noted at Rhounda Dabali, Sept Frères. Suspected damage from small anchors was also observed outside the samples at locations to the south of Maskali and Moucha, and the reef flat at Sable Blanc exhibited damage most likely to have been caused by small anchors or trampling.

iii. Exploitation of Living Marine Resources

There is potential overfishing of game fish resulting in a decrease in average catch size, as the level of fishing efforts exceeds the Maximum Sustainable Yield. The lack of surveillance

and enforcement of existing regulations, such as that regulating the use of spearguns in capital areas and MPAs is widespread. The illegal shark fisheries supplying the Oriental shark fin market has resulted in a decline in shark stocks. There is also a large by-catch of turtles, dolphins and finfish, and damage to reefs from nets.

iv. Navigation and Maritime Risks

Maritime transport is a major commercial sector in Djibouti. Since the re-opening of the Suez canal activities at Djibouti Port developed rapidly. The port offers container handling facilities at two berths of a total length of 400 m with depths alongside of up to 12 m. A 780 km railway links Djibouti with Addis Ababa and goods coming from and going to Ethiopia are shipped via Djibouti. The income of the International Autonomous Port of Djibouti is a very important contribution to the national economy.

There are risks of ship collisions and groundings due to limited navigational control devices and poorly separated traffic. The extensive coral reef systems at the entrance to the port pose problems to navigation. Coupled with complex navigational hazards, the heavy maritime traffic throughout the area, poses significant threats to reef health. Marine vessel sewage and discharge of solid waste is localized, washing up on the shores and along the mangroves. There is inadequate on-board treatment, and a lack of port reception and disposal facilities, and inadequate surveillance and enforcement throughout the area.

v. Petroleum Development and Transport

Small oil spills (< 20 tons) cause beach contamination and damage to the coastal and marine biota. These occur through the discharge of ballast and bilge water, discharge of waste oil, bunker oil spill. The lack of reception facilities at the port; inadequate control, and lack of enforcement compound the problem.

Medium oil spills (20-100 tons) also cause beach contamination and damage coastal and marine biota. These occur through discharges from terminals and small accidents at sea. There are inadequate control and monitoring of procedures, equipment and personnel and training.

Potential large oil spills and disasters could cause large-scale destruction of coastal and marine habitats and biota and devastation of beach habitats. These would occur through rupture of oil tanks through collision or wreckage. Poor navigation aids would be a main contributing factor.

vi. Industrial Activities

Excessive exploitation of surface and groundwater for industrial use. Excessive pumping coupled with inadequate concern for water conservation and poor regulation of water exploitation could affect natural water discharge patterns. Industrial pollution has lead to a decline in water quality through the chronic release of pollutants, a lack of enforcement, and inadequate technology.

vii. Urban Development

The discharge of untreated or insufficiently treated sewage in coastal areas alters the marine environment, and is a threat to public health. The lack of sewage treatment plants, lack of maintenance of existing plants and inadequate pollution control regulations, monitoring and

enforcement result in severe damage to coastal and marine life. Sewage discharges also cause algal booms throughout the coral reefs ecosystems.

viii. Natural Predators

In early May 2000 a large number of Crown of Thorns (COTs) *Acanthaster planci* were found at Khor Ambado. A survey of an area ca. 5000 m^2 at Iles Moucha also found large numbers of COTs. However, at present it is not believed that these are in plague densities, and that their impact on the reefs is minimal. Continued monitoring of the densities of COTs ios recommended to detect early signs of infestations.

7. Marine Protected Areas (MPAs) and Level of Management

i. Summary

Djibouti has two declared marine protected areas, which have been established for more than ten years. There are two additional areas proposed for protected status, one of which is of regional importance.

ii. MPAs Declared

Moucha was first established by regulation 72-1363/SG/CG (1972), which prohibits the collection of corals and molluscs. Decree 80/062/PR/MCTT (1980) extended the protection to the Maskali reserve. This latter Decree was modified by Decree 85/103/PR/AG (1985) to strengthen conservation of these areas. Only artisanal fisheries of edible species is allowed in these zones. Protection is supposed to prevent all extractive utilization except for artisanal fishing, which is defined as fishing using traditional techniques on trips not longer than a day or two. The islands and reefs within and outside of the reserves are used extensively for weekend recreation, including picnicking, swimming, snorkelling, diving, water-skiing, and camping.

Moucha Territorial Park: Established in 1972, the Park covers an area of ca. 3 km^2 at 11°43'N 43°12'E and encompasses extensive coral reefs and rich reef-associated fish and invertebrate fauna and mangroves. There are severe pressures from reef trampling, collection of souvenirs and spearfishing.

South Mascali Islands Integral Reserve: Established in 1980, the reserve covers an area of ca. 10 km^2 at 11°40'N 43°10'E and contains coral reefs and rich reef associated fish and invertebrate fauna. There are severe pressures from reef trampling, collection of souvenirs and spearfishing.

iii. *de facto* and Planned MPAs

Godoriya: This is an extensive mangrove area, rich in mangrove-associated fauna. There are no coral reefs within the proposed area.

Iles des Sept Frères and Ras Siyan: Lying at the junction of the Red Sea and the Gulf of Aden, this is a group of high-aspect islands and an adjacent coastal stretch with a mangrove-fringed bay. There are diverse coral reefs and rich reef-associated fish and invertebrate fauna.

There is a significant level of recreation- and fishing-related pressure, and sedimentation through nearby shipping activities.

8. Current and Potential Climate Change Impacts

Most of the reefs in the Gulf of Tadjourah showed no signs of bleaching. At Maskali island degraded reefs were encountered in 1998 (Oboura & Djama 1998), but the causes of degradation could not be determined. The only site with significant bleaching was at Sept Frères, in Djibouti's Red Sea waters. In a survey in early 1998, Obura & Djama did not find any evidence of bleaching at any of the survey sites, either inshore or offshore. In late 1998 at the same sites, coral mortality was estimated at 30 % at Sept Frères, but there was no mortality at other sites. Observations by recreational SCUBA divers since that time (early 1999) suggest that bleaching mortality has increased to 40 % at Sept Frères, principally tablular corals in the shallow water zones that are not affected by longshore currents. Only low incidence of bleached corals was found by Obura in late 1998 (Table III; Obura, 1998).

Table III: Coral condition recorded from 100 m^2 benthic circlesindicating extent of Crown of Thorns (COTs) predation and the percent cover of bleached and recently dead coral.

Region / Site	*No of*	*COT predation*		*Bleached coral*		*Dead coral*	
	Samples	*(Num. Colonies)*		*(% cover)*		*(% cover)*	
		Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
Sept Frères							
I. Double	5	0	0	2	2.7	4	8.9
I. Est	4	0	0	0	0	0	0
I. Grande	6	0	0	0	0	0	0
I. Sud	7	0	0	0.7	1.9	1.4	3.8
Overall	22	0		0.7		1.4	
Moucha/Maskali Islands							
Maskali Buoy - edge	6	1.2	2.9	0	0	0	0
Maskali Buoy - top	2	0	0	0	0	0	0
Maskali Lighthouse	9	0.9	2.7	0	0	0	0
Maskali South	9	0.3	0.7	0	0	23.3	35
Moucha A	5	1.6	2.3	0	0	0	0
Moucha B	4	1.3	2.5	0	0	1.3	2.5
Moucha C	6	2	3.2	0	0	3.3	5.2
Moucha N	3	0.3	0.6	0	0	36.7	20.8
Overall	44	0.9		0		8.1	
Gulf of Tadjourah, north shore							
Ras Duan flat	2	0	0	0	0	2.5	3.5
Sable Blanc Beach	1	0		0		0	
Sable Blanc East	1	0		0		0	
Tadjourah	6	0	0	0	0	1.8	4
Overall	10	0		0		1.1	
Gulf of Tadjourah, south shore							
Ambado Banc	1	0		0		0	
Arta Plage A	6	0.3	0.8	0	0	5.8	8
Arta Plage B	5	5.4	4.2	0	0	10	7.1
Banc d'Ambouli	2	0	0	0	0	0.5	0.7
Khor Ambado	9	2.8	4.7	0	0	6.7	10
Trois Plage	3	1.3	2.3	0	0	0	0
Overall	26	1.6		0		3.8	

9. Current Monitoring and Management Capacity to Conserve Coral Reef Resources

At present the number of environmental initiatives in Djibouti is limited. The most important ones are a sub-regional contingency plan for the Gulf of Aden developed in 1990, through which an oil spill response centre was established for Djibouti, Yemen and Somalia and the rules for the management of marine protected areas and the exploitation of reef associated species issued in 1992 by the Maritime Administration.

A number of institutions in Djibouti are involved with coastal and marine area and resource management. These are the Ministry of Agriculture and Hydraulic through the Directorate of Stock-farming and Fisheries; the Ministry of Transport and Telecommunications through its Directorate of Maritime Affairs; the National Office for Tourism, Arts and Crafts; the Presidency of the Republic, through the Institute of Higher Studies, Scientific and Technical Research; the Service for Management and Environment, the Inter-ministerial Co-ordination Commission on the Protection of the Marine Fauna and the Seabed and the National Council of the Sea.

10. Government Legislation, Strategies and Policy Pertinent to Reef Conservation

i. Summary

Given of the importance to protect the marine environment and to fight all kinds of pollution, the Republic of Djibouti is a signatory to a number of international conventions and has enacted several national instruments through which conservation and management of coral reefs are directly or indirectly addresses.

ii. International Agreements

The Republic of Djibouti is a signatory to the London Convention (modified 1954) which is applicable through National Law No. 64/83; the London Convention (1971) on international compensation funds; the London Convention (1973, modified 1978) and its four annexes; the Brussels Convention (1969) on the intervention at high sea; and the United Nations convention on the Law of the Sea (UNCLOS 1982). The first three were approved by Law No. 94/AN/89 2º L in 1989, while the last one was approved by Law in 1985.

The Republic of Djibouti is also a signatory to the CITES Convention. Decree 80-62/PR/MCTT of 25 May 1980 provides for the protection of the seabed and the marine fauna, whereby the capture of marine mammals and turtles is illegal, as well as the trade with or export of these animals. Spearfishing is also illegal in Djibouti.

At the regional level, an agreement was signed by Yemen, Djibouti and Somalia on the establishment of a sub-regional centre to combat oil pollution in the Gulf of Aden. Oil spill response facilities are stored at Djibouti. Yemen and Djibouti are currently negotiating a bilateral agreement regarding the use of this equipment. On 20 January 1986 Djibouti and Somalia signed a bilateral fishing agreement.

iii. National Legislation

National regulations on the protection of the marine environment include provisions on marine pollution, protection of endangered species and the creation of protected areas (Summarised in Table IV). Regulations on the prevention and combat of marine pollution include:

Law 76-599 (1976) - Enacted by regulation 675/SELAG concerning ship and aircraft based pollution, as well as the combat of accidental marine pollution.

Law 76-600 (1976) - Enacted by regulation 676/SELAG regarding pollution by incineration operations.

Laws 9/AN/82 (1982) and 137/AN/85 1º L (1985) on oil pollution

Ordinance 86-042/PR/PM (1986) containing regulations on action to be taken in case of abandonment of ships, which poses a threat to the environment in the territorial waters.

Decree 89-085/PR/AE (1990) providing for the implementation of a contingency plan in the case of pollution by oil spills.

Decree 89-085/PR/PM (1989) and Regulation 90-0534/MPAM (1990) concerning the passage of foreign ships through territorial waters in order to prevent pollution and the dumping of hazardous wastes.

Code of Maritime Administration - The present fisheries law was drafted before the independence, with the exception of some articles, and is part of the Code. Articles 148, 149 and 220 to 225 (enacted by law 212/AN/82), and Articles 16 to 19 of Law No. 52/AN/78 (1979) regulate the fishery. Certain fishing techniques, such as the use of explosives and poisons, are illegal. They determine the conditions for the exploitation of fishery resources including fishing zones and closed seasons. They also include sanctions in case of violation of these regulations by fishermen.

Table IV: National laws and regulations related to coastal and marine environments and resources (Source: PERSGA 1996).

Law, Ordinance, Regulation	*Year (in force)*	*Government Agency Concerned*
Regulation 72-1363/SG/CG, establishment of Mousha Territorial Park	1972	Maritime Administration
Law 76-599 on ship based pollution	1976	Maritime Administration
Law 76-600 on pollution caused by combustion	1976	Maritime Administration
Ordinance 77-038/PR on registration of pleasure boats	1977	Maritime Administration
Law 52/AN/78 article 16-19, fisheries regulations	1979	Maritime Administration
Decree 80-062/PR/MCTT on protection of the seabed and the marine fauna, establishment of South Maskali Islands Integral Reserve	1980	MCTT
Law 9/AN/82, on hydrocarbon pollution	1982	Maritime Administration
Law 212/AN/82, fisheries regulations	1982	Maritime Administration
Law 137/AN/85, on hydrocarbon pollution	1985	Maritime Administration
Regulation 84-0969/PR/PM, on security of pleasure boating	1984	Maritime Administration
Decree 85/103/PR/AG on marine protected areas	1985	Maritime Administration
Ordinance 86-042PR/PM, regulating abandoned ships	1986	Maritime Administration
Regulation 86/0717/PR/MCTT on camping huts on beaches and islands	1986	National Office for Tourism, Arts and Crafts
Decree 89-085/PR/PM on passage of foreign vessels	1989	Maritime Administration
Decree 89-085/PR/AE on oil spill response	1990	Maritime Administration
Regulation 90-0534/MPAM on passage of foreign vessels	1990	Maritime Administration

National Law No. 64/83 (1983) includes the approval of four international conventions on maritime navigation.

Coastal Zone Regulations: Regulation 86-0717/PR/MCTT (1986) concerning the waste from camping on the islands and beaches; Ordinance 77-038/PR (1977) regulates registrations of pleasure boats; and Regulation 84-0969/PR/PM (1984) on security of pleasure boating and beach activities.

11. Gaps in Capacity and Requirements for Improved Conservation

i. Summary

The two major requirements in Djibouti are staff with expertise in coral reef biology and ecology, with an understanding of research and monitoring practices, and funding to undertake conservation work. The lack of trained staff stems largely from the lack of a higher education system and the funding avenues for post-graduate study of Djibouti nationals.

ii. Institutional Capacity.

Personnel for managing marine resources is lacking, although recently the PERSGA-funded field project and the National Biodiversity Project have initiated training of national counterparts in coral reef survey techniques. At present there is no monitoring or conservation programs for coral reefs. The Environment Department was created recently (1996) and finalised the National Environmental Action Plan (NEAP) in April 2000 and a National Strategy for Biodiversity Conservation with financial support from the GEF. These include a National Law which will require mandatory Environmental Impact Assessments for all projects concerning the marine environment. It is assumed that with the adoption of the NEAP and Biodiversity Strategy, the Environment Department will be involved in all development projects. There is a need for the managerial staff of the key national institutions to be trained in coral reef survey techniques, and the biology and ecology of coral reef ecosystems.

iii. Financial

Financial constraints are a major obstacle towards the conservation of coral reefs. There has been no funds for short surveys to assess the status and health of coral reefs in Djibouti, except for foreign-based research. The Environment Department has had to rely on GEF and PERSGA financial support to conduct the first assessments of coral reefs since 1988. It is possible that financial resources could be raised through levying of fines and fees for infringements of national laws. The NEAP calls for the creation of an Environmental Fund which should be established in the near future. It is expected that this fund will be used for conservation of key ecosystems such as coral reefs.

iv. Expertise

There is a general lack of experts at tertiary education levels with a knowledge of coral reefs because Djibouti does not have a University. There is a proposal for the development of a National University in September 2000, but it will take 5 years or longer before it offers a degree in Marine Biology and Ecology of a post-graduate level. Additionally, there is a proposal to create a Marine Research Institute which will be in charge of conservation of marine ecosystems.

v. Equipment
Only two Government institutions possess diving / snorkelling equipment. These are the Port and Maritime Affairs Department. The equipment of Maritime Affairs Department has been used during the recent surveys undertaken by foreign consultants. Many SCUBA diving clubs and private companies also own diving equipment.

12. Recommendations to Improve the Conservation of Coral Reef Resources

i. Summary
Natural and anthropogenic stresses on corals in Djibouti are limited in extent and scope. Several key actions at the national level in the form of legislation and implementation could lessen the risks of ship-based pollution and oil spills. A dedicated research and monitoring programme that fed back into coastal area management plans would contribute greatly to efficient conservation actions. Specifically:

ii. Legislation
It is recommended that a National Maritime Law be drafted and implemented. Related laws and regulations should also be revised. It is important to strengthen enforcement of existing regulations relating to the management of coastal and marine areas and resources. The enforcement of legislation related to the management of coastal and marine areas should be strengthened, and a national Integrated Coastal Zone Management Plan is urgently needed. MARPOL should be ratified to bring Djibouti in line with international efforts at combating oil pollution.

iii. Coastal Area Management
Institutions involved in the management of coastal and marine resources and in law enforcement need strengthening. A framework and programme for visitors to coral reef areas has to be developed. This will include guidelines and moorings for boats.

iv. Reef Conservation
A coral reef monitoring, protection and management programme should be developed. Management programmes should to be developed for the existing marine protected areas and a feasibility study for the conservation and management of additional marine protected areas should be conducted. These might include the Sawabi Islands and Ras Bir. Stocks of reef fish populations should be assessed properly before a programme of collection of ornamental fish for the aquarium trade is developed and implemented.

v. Research and Monitoring
Marine habitats and biota should be studied and monitored on a regular basis. The establishment of a marine biology department and the training of Djibutians in marine biology is recommended. An environmental data base containing information on biological resources should be developed. A monitoring programme should be set up to support management and enforcement activities. Institutions involved in applied research need strengthening.

vi. Shipping and Navigation

Monitoring of vessels passing through territorial waters of Djibouti, communication with vessels and the installation of navigational markers, above all along major shipping channels, should be improved. The national oil spill response contingency plan should be updated and implemented. The response capacity has to be upgraded, and waste reception facilities installed at ports. A feasibility study on waste management and the development of port reception facilities and a waste management systems are needed.

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Appendix III: Substrate cover at thirty four Djibouti coral reef sites.

Site ID	*Location Name*	*Lat N*		*Long E*		*AF*	*CA*	*DC*	*DA*	*HC*	*SC*	*S*	*GR*	*OT*
		(deg)	*(min)*	*(deg)*	*(min)*									
945		11	35.729	43	1.282	0	10	0	25	40	10	5	0	10
948	Khor Ambado	11	35.607	43	0.975	0	5	0	15	45	0	0	25	5
952	Khor Ambado	11	35.744	43	1.822	0	20	0	15	35	0	10	10	10
958	Khor Ambado Seghir	11	42.936	43	10.729	0	0	0	20	35	0	25	20	0
961	Maskali Isl.	11	43.280	43	9.967	0	20	0	10	40	0	10	15	5
964	Maskali Isl.	11	43.100	43	9.436	0	30	0	0	5	0	5	10	20
970	Maskali Isl. (Beacon)	11	42.831	43	9.961	0	15	0	0	5	0	10	15	0
973	Maskali Isl. (AF Bcn)	11	42.380	43	9.181	0	0	0	5	60	0	10	25	0
976	Maskali Isl.	11	41.770	43	8.621	0	10	0	15	45	5	20	0	0
979	Maskali Isl. Sand Atoll	11	44.689	43	10.183	0	10	0	5	40	5	20	15	0
982	Moucha Isl.	11	44.468	43	10.844	0	0	0	10	50	0	10	20	0
985	Moucha Isl.	11	44.860	43	12.892	0	5	0	5	55	0	20	15	0
992	Moucha Isl.	11	42.220	43	12.943	0	5	0	10	40	0	20	25	0
995	Moucha Isl.	11	42.870	43	13.477	0	20	0	0	25	0	10	30	0
998	Moucha Isl.	11	44.815	43	13.127	0	40	0	5	25	0	5	10	0
1001	Moucha Isl.	11	44.772	43	14.180	0	30	0	0	35	0	5	10	0
1004	Moucha Isl.	11	43.830	43	14.875	0	10	0	0	20	0	5	2	5
1029	Khor Angar	12	21.421	43	22.086	5	20	0	0	30	10	20	10	0
1032	Godoria	12	9.573	43	25.459	10	10	0	0	30	20	5	10	10
1047	Rhounda Komaytou	12	26.937	43	27.070	0	20	0	0	30	35	0	5	10
1050	Kadda Dabali	12	27.909	43	26.115	0	20	0	0	50	20	5	5	0
1053	Rhounda Dabali	12	28.076	43	23.162	0	0	0	5	20	30	20	10	15
1056	Hamra Isl.	12	27.764	43	21.874	0	30	0	10	20	0	25	0	15
1065	Sable Blanc	12	46.742	42	55.422	0	30	0	20	20	0	5	10	10
1068	Sable Blanc	12	46.739	42	55.447	0	48	1	10	15	0	15	10	0
1071	Sable Blanc	12	46.765	42	54.233	0	25	0	0	50	1	9	10	0
1074	Sable Blanc	12	46.394	42	57.305	10	15	5	10	30	0	10	10	5
1082	Moucha Isl.	12	42.164	43	9,956	0	5	0	5	40	0	20	15	0
1085	Moucha Isl.	12	42.093	43	11.011	0	0	0	5	50	0	15	15	0
1088	Moucha Isl.	12	41.865	43	11.857	0	0	0	0	64	1	15	15	0
1109	Buoy Carrett Ambouli	12	36.750	43	7.226	10	0	0	5	70	0	5	5	0
1112	Radio Mast	12	35.970	43	5.203	15	15	0	0	40	0	0	10	20
1115	Djibouti City South	12	37.387	43	9.535	0	5	0	5	30	0	5	40	15
1118	Djibouti Fish Market	12	35.502	43	9.668	20	20	0	0	50	0	10	5	0

Note: AF = Algal Film, CA = Coralline Algae, DC = Dead Coral, DA = Dead coral with Algae, HC = Living Hard Coral, SC = Soft Coral, S = Sand, GR = Gravel, OT = Other

Source: Adapted from tables in PERSGA (1998).

Appendix IV: Counts for selected benthic organisms during 20-minute swims.

Site ID	*Location Name*	*Lat N*		*Long E*		*AN*	*COT*	*GC*	*LOB*	*SCU*	*DIA*	*SPU*	*TS*
		(deg)	*(min)*	*(deg)*	*(min)*								
945	Khor Ambado	11	35.729	43	1.282	2	7	12	0	22	27	0	0
948	Khor Ambado	11	35.607	43	0.975	0	4	5	1	3	13	0	0
952	Khor Ambado Seghir	11	35.744	43	1.822	0	2	3	0	27	8	0	0
958	Maskali	11	42.936	43	10.729	3	0	17	0	7	17	0	2
961	Maskali	11	43.280	43	9.967	N	0	35	0	2	10	0	0
964	Maskali	11	43.100	43	9.436	N	5	18	0	0	7	0	0
970	Maskali (Beacon)	11	42.831	43	9.961	N	0	7	0	3	0	17	0
973	Maskali	11	42.380	43	9.181	N	2	2	0	3	0	1	0
976	Maskali (Buoy)	11	41.770	43	8.621	N	11	17	1	7	0	0	0
979	Maskali (AF Bcn)	11	44.689	43	10.183	H	0	8	0	7	1	0	0
982	Moucha	11	44.468	43	10.844	N	0	2	0	0	0	0	0
985	Mousha Sand Atoll	11	44.860	43	12.892	H	0	12	0	6	0	0	0
992	Mousha	11	42.220	43	12.943	H	1	15	0	22	0	0	0
995	Mousha	11	42.870	43	13.477	N	1	4	1	0	1	0	0
998	Mousha	11	44.815	43	13.127	N	0	11	0	6	1	0	0
1001	Mousha	11	44.772	43	14.180	N	0	27	0	2	0	0	0
1004	Mousha	11	43.830	43	14.875	N	1	3	0	12	0	0	0
1029	Khor Angar	12	21.421	43	22.086	N	0	1	5	3	0	0	0
1032	Godoria	12	9.573	43	25.459	H	0	0	0	1	0	0	0
1047	Rhounda Komaytou	12	26.937	43	27.070	N	0	7	0	4	0	0	0
1050	Kadda Dabali	12	27.909	43	26.115	3	0	11	0	7	1	0	0
1053	Rhounda Dabali	12	28.076	43	23.162	7	12	2	0	8	0	0	0
1056	Hamra Isl.	12	27.764	43	21.874	2	1	1	6	16	0	0	0
1065	Sable Blanc	12	46.742	42	55.422	3	11	27	0	3	80	1	0
1068	Sable Blanc	12	46.739	42	55.447	0	11	52	0	13	32	0	0
1071	Sable Blanc	12	46.765	42	54.233	0	5	27	0	17	22	11	0
1074	Sable Blanc	12	46.394	42	57.305	0	0	4	0	6	0	0	0
1082	Moucha Isl.	12	42.164	43	9,956	2	3	8	0	30	1	0	0
1085	Moucha Isl.	12	42.093	43	11.011	0	14	3	0	18	0	0	0
1088	Moucha isl.	12	41.865	43	11.857	0	2	3	0	23	4	0	0
1109	Buoy Carrett Ambouli	12	36.750	43	7.226	1	0	1	0	4	53	0	0
1112	Radio mast	12	35.970	43	5.203	1	3	3	1	1	81	7	0
1115	Djibouti South	12	37.387	43	9.535	0	0	0	0	0	8	0	0
1118	Fish Market	12	35.502	43	9.668	0	0	0	0	1	4	0	0

Note: AN = Anenome; COT = Crown of Thorns starfish; GC = Giant Clams; LOB = Lobster; SCU = Sea Cucumber; DIA = Diadema sea urchins; SPU = Slate Pencil Urchins; TS = Top Shells.

Source: Adapted from PERSGA (1998).

Appendix V: Numbers by Family of selected pelagic species in reef assessments.

Site ID	*Location Name*	*SH*	*TUR*	*AF*	*BF*	*TF*	*PF*	*GR*	*GT*	*SR*	*SD*	*WS*
945	Khor Ambado	0	0	20	26	0	0	12	14	17	0	0
948	Khor Ambado	0	0	7	28	0	0	6	4	10	0	0
952	Khor Ambado Seghir	0	0	14	68	0	0	22	12	251	0	0
958	Maskali	0	0	25	31	0	0	14	81	302	0	1
961	Maskali	0	0	26	32	0	0	22	0	8	0	1
964	Maskali	0	0	10	20	0	0	12	5	63	0	0
970	Maskali (Beacon)	0	0	11	18	2	0	14	13	111	0	5
973	Maskali	0	0	15	85	0	0	14	0	3	0	0
976	Maskali (Buoy)	0	0	18	93	1	0	11	11	13	1	1
979	Maskali (AF Bcn)	0	0	13	59	6	0	16	5	33	0	1
982	Moucha	1	0	31	29	0	0	20	5	10	1	0
985	Mousha Sand Atoll	0	0	15	72	1	0	22	5	23	0	0
992	Mousha	0	0	8	36	0	0	8	1	1	0	0
995	Mousha	0	0	10	17	0	0	3	19	46	0	0
998	Mousha	1	0	28	56	0	0	27	15	9	0	0
1001	Mousha	0	0	9	47	2	0	24	24	3	0	0
1004	Mousha	0	0	6	27	0	0	5	9	6	0	0
1029	Khor Angar	1	1	11	31	0	0	30	31	9	6	0
1032	Godoria	0	1	17	24	1	0	56	8	21	0	0
1047	Rhounda Komaytou	1	0	23	46	3	0	45	1	6	0	3
1050	Kadda Dabali	0	0	10	71	2	0	33	4	1988	4	0
1053	Rhounda Dabali	1	0	17	60	3	0	24	445	301	0	1
1056	Hamra Isl.	4	0	18	127	7	0	24	347	1047	4	4
1065	Sable Blanc	0	0	16	29	2	00	37	24	252	3	3
1068	Sable Blanc	0	0	14	8	0	0	26	1	138	1	0
1071	Sable Blanc	0	0	27	50	1	0	33	17	31	1	2
1074	Sable Blanc	0	0	19	44	0	0	25	0	1	0	1
1082	Moucha Isl.	0	0	22	80	0	0	19	24	112	0	1
1085	Moucha Isl.	0	0	16	110	0	0	10	5	159	0	1
1088	Moucha isl.	0	0	25	75	0	0	24	4	79	10	2
1109	Buoy Carrett Ambouli	0	0	6	68	0	0	12	2	10	0	0
1112	Radio mast	0	1	16	47	0	0	17	30	123	0	0
1115	Djibouti South	0	0	13	34	1	0	12	31	136	0	0
1118	Fish Market	0	0	8	8	0	0	0	13	60	0	0

Note: SH= Sharks; TUR = Turtles; AF = Angelfish; BF = Butterflyfish; TF = Triggerfish; PF = Parrotfish; GR = Groupers; GT = Grunts; SR = Snappers; SD = Sparids; WS = Wrasse.

Source: Adapted from PERSGA (1998).

Appendix VI - Benthic cover statistics for survey sites grouped by region from benthic circle surveys.

Region / Site	*Substrate*						
	No. of Samples	*Hard Mean*	*SD*	*Rubble Mean*	*SD*	*Sand Mean*	*SD*
Sept Frères							
Double	5	80	10	10	7	10	7
Est	4	60	18	28	22	13	10
Grande	6	80	15	11	14	9	5
Sud	7	64	20	29	16	7	11
Regional Average		71		19		10	
Moucha/Maskali Islands							
Maskali Buoy - edge	3	67	6	13	6	20	10
Maskali Buoy - top	1	70		20		10	
Maskali Lighthouse	3	60	10	23	15	17	6
Maskali South	3	12	8	85	5	3	3
Moucha A	3	47	25	33	25	20	0
Moucha B	2	65	7	10	0	25	7
Moucha C	3	43	40	8	8	15	22
Moucha N	3	20	10	60	26	20	20
Regional Average		48		32		16	
Gulf of Tadjourah, north shore							
Ras Duan flat	1	82	8	15	5	3	3
Ras Duan fore	2	60	0	20	14	20	14
Sable Blanc Bch	1	73	17	14	6	14	12
Sable Blanc E	1	68	5	23	5	10	0
Tadjourah	3	77	12	7	3	17	10
Regional Average		72		16		13	
Gulf of Tadjourah, south shore							
Ambado Banc	1	30		60		10	
Arta A	3	87	6	13	6	2	3
Arta B	4	48	24	29	20	24	8
Djibouti Port	2	50	0	20	0	30	0
Khor Ambado	3	50	10	50	10	0	0
Trois Plage	3	77	12	13	6	10	10
Regional Average		57		31		13	

Source: Adapted from Oboura (1998).

Appendix VI - Continued..

Region / Site	*Invertebrates*						
	No. of	*Coral*		*Soft coral*		*Sponges*	
	Samples	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
Sept Frères							
Double	5	19	11	9	5	7	7
Est	4	28	5	33	17	0	0
Grande	6	27	10	38	12	3	8
Sud	7	21	13	24	16	4	8
Regional Average		23		26		4	
Moucha/Maskali Islands							
Maskali Buoy - edge	3	30	10	4	2	4	2
Maskali Buoy - top	1	40		1		5	
Maskali Lighthouse	3	23	15	0	0	3	6
Maskali South	3	5	0	2	3	0	0
Moucha A	3	50	10	0	0	0	0
Moucha B	2	55	7	1	1	1	1
Moucha C	3	33	25	0	1	2	3
Moucha N	3	9	10	2	3	0	0
Regional Average		31		1		2	
Gulf of Tadjourah, north shore							
Ras Duan flat	1	80	5	0	0	0	0
Ras Duan fore	2	25	7	1	1	0	0
Sable Blanc Bch	1	13	12	0	0	0	0
Sable Blanc E	1	28	10	1	1	0	1
Tadjourah	3	57	12	0	0	2	3
Regional Average		40		0		0	
Gulf of Tadjourah, south shore							
Ambado Banc	1	40		0		0	
Arta A	3	67	6	0	0	0	0
Arta B	4	35	13	3	3	1	0
Djibouti Port	2	40	0	0	0	0	0
Khor Ambado	3	25	5	0	1	0	1
Trois Plage	3	40	0	0	0	0	0
Regional Average		41		1		0	

Source: Adapted from Oboura (1998).

Appendix VI - Continued…

Region / Site	*Algae*						
	No. of	*Fleshy*		*Turf*		*Coralline*	
	Samples	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
Sept Frères							
Double	5	0	0	46	11	16	9
Est	4	0	0	19	9	14	5
Grande	6	0	0	14	9	8	3
Sud	7	1	2	8	7	21	13
Regional Average		0		22		14	
Moucha/Maskali Islands							
Maskali Buoy - edge	3	8	3	23	6	13	6
Maskali Buoy - top	1	10		20		10	
Maskali Lighthouse	3	27	15	22	8	10	9
Maskali South	3	73	6	8	3	8	3
Moucha A	3	10	9	23	12	8	3
Moucha B	2	15	7	5	7	8	4
Moucha C	3	10	10	30	20	3	3
Moucha N	3	20	13	50	20	7	3
Regional Average		22		23		8	
Gulf of Tadjourah, north shore							
Ras Duan flat	1	5	0	8	3	3	3
Ras Duan fore	2	23	25	20	14	13	11
Sable Blanc Bch	1	9	3	59	20	6	3
Sable Blanc E	1	2	2	43	10	10	0
Tadjourah	3	0	0	17	6	8	3
Regional Average		8		29		8	
Gulf of Tadjourah, south shore							
Ambado Banc	1	0		40		10	
Arta A	3	2	3	22	8	10	5
Arta B	4	0	0	28	10	13	5
Djibouti Port	2	0	0	25	7	8	4
Khor Ambado	3	43	12	10	0	20	0
Trois Plage	3	12	8	22	3	18	8
Regional Average		10		24		13	

Source: Adapted from Oboura (1998).

Appendix VII: Fish families and the number of species identified in each family in Djibouti.

Family	*# spp.*
Acanthuridae	10
Balistidae	8
Caesionidae	3
Carangidae	5
Chaetodontidae	10
Haemulidae	3
Kyphosidae	1
Labridae	1
Lethrinidae	3
Lutjanidae	8
Monacanthidae	1
Mullidae	1
Ostracidae	1
Platacidae	1
Pomacanthidae	5
Scaridae	9
Serranidae	6
Sparidae	1
Tetraodontidae	2
Zanclidae	1
Elasmobranchs	6
Total families (include. Elasmobranchs)	25
Total species	86

Source: Obura (1998)

Appendix VIII - Acknowledgements

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