Biodiversity Assesment for
Maldives Baa Atoll

Baseline Information for UNDP's Atoll Ecosystem-Based Conservation Programme

Prepared by:

Anna Valeria Bers
IFM-Geomar Leibniz Institute of Marine Sciences, Kiel, Germany
With support of the German Academic Exchange Service (DAAD) and the German National Academic Foundation in the framework of the Carlo-Schmid-Programme

For:
UNDP Maldives &
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Male', Republic of Maldives
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EXECUTIVE SUMMARY

- There is little documented information on biodiversity specifically for Baa Atoll. So far, there has been no comprehensive monitoring programme conducted, and therefore the information on the status of both terrestrial and marine environment in Baa Atoll are far from being exhaustive.
- The information compiled in this report are generally not quantitative (except for data on corals), since valid data on stock and population sizes, abundance and distribution of the various organisms are not available at all, not even for commercial fisheries. Nevertheless, many (especially marine) organisms face various anthropogenic threats and are endangered. Comprehensive monitoring of population sizes is urgently needed as well as an improved and enforced legislation for environmental protection.
- Baa Atoll has a distinctive biodiversity featuring some species that are only described for Baa Atoll so far, rare species and species that are endemic to the Maldives
- Corals reef ecosystems in Baa Atoll have, as in the entire Maldives, severely suffered from the 1998 ENSO-related coral bleaching event. The high coral mortality not only lead to dramatic decline of live coral cover, but also to a loss of topographic diversity due to subsequent erosion. This results in subsequent population declines of certain reef associated fishes.
- The mass mortality of corals caused a shift in coral community composition, with now massive coral species dominating instead of branching growth forms.
- Recruitment of juvenile corals occurs in mostly sufficient numbers, but reefs are recovering slowly according the coral's slow growth rates.
- Turtle populations are highly vulnerable and threatened in Baa Atoll due to the uncontrolled, and sometimes even commercial, harvesting of turtle eggs. This has long-term (20-60 years) consequences for population sizes, and populations of both hawksbill and green turtle are likely to crash within the next years. There is also a considerable loss of nesting beaches due construction of sea walls, development of tourist resorts, and beach erosion.
- Seabirds are threatened by increased disturbance by tourists in Baa Atoll. Their breeding grounds, mainly uninhabited sandbanks, are now frequently visited by tourist (resorts and safari boats). Furthermore, sand mining contributes to the loss of breeding and resting grounds.
- Shark populations in Baa Atoll are threatened: a constant decline in population sizes in mainly grey reef sharks and white tip reef sharks despite the official ban of shark fishery in Baa Atoll is of major concern. Sharks not only play a key role in coral reef ecosystems, they are also of high economic value for the tourism industry.
- Local fishermen report an overall decline in stocks of bait fishes. This is mainly due to the loss of habitat for many reef associated bait fishes caused by the mass coral mortality. The formerly abundant blue green damselfish, *Chromis viridis*, is now considered rare.
- The proliferation of sea grass beds indicates human induces nutrient enrichment of lagoonal sediment. Therefore, their occurrence should be monitored regularly.
- Mangroves in Baa Atoll are important ecosystems contributing to sediment stabilisation and therefore coastal protection. They are furthermore nursery grounds for juvenile fish. There is a lack of information on the ecology of mangroves in Baa Atoll, as is on species composition and ecosystem status. Protection of this unique ecosystem should be promoted.
- Dhigali Haa, the only Marine Protected Area (MPA) in Baa Atoll, is not at all adequately protected. Damage of corals caused by the tossing of anchors is often observed. Rules applying for MPAs should be enforced more rigidly.
- The conservation of the fragile atoll ecosystem is vital importance for the Maldives, and reducing anthropogenic impacts to a minimum should therefore be given top priority.

Recommendations

- Ban harvesting of turtle eggs as soon as possible with a simultaneous information/education campaign for locals and fishermen on the ecology of turtles and why they should be protected
- Enforce the ban of shark fishery, also linked with a information campaign about both ecological and economic benefits of a stable shark population for Baa Atoll
- Improve national legislation in order to protect vulnerable species such as sharks and marine turtles. The government should furthermore accede the CITES and Bonn Convention on Migratory Species in order to meet the objectives of turtle conservation regionally and internationally
- Incorporate locals and fishermen in conservation projects
- Enforce stock assessment in fisheries to prevent overexploitation
- Apply IUCN guidelines to the MPA at Dhigali Haa, assign the MPA to IUCN guidance; establishment of a non-fishing zone around of Dhigali Haa (closing the area even for traditional bait fishing practices) to give the declining populations of bait fishes a chance to recover; once the reef fish populations recover and population sizes increase, other reef areas will benefit, by spreading of fish larvae and emigration of bait/reef fish to adjacent fishing grounds; start a monitoring programme
- Introduce a fee system for divers who visit the MPA to support reef monitoring programmes and conservation projects, as practised in the Caribbean (Green & Donnelly 2003)
- Incorporate dive schools in annual reef checks; each dive school should be responsible for one or more reefs/dive sites and conduct an annual reef survey according to the reef check guidelines ("Adopt a reef"); the development of survey questionnaires for divers has been successful in stock assessments in the Mediterranean (Goffredo *et al.* 2004) and could be an valuable option in the Maldives to monitor the abundance of certain fish species (grouper, sharks etc.) and turtles
- Join the Ramsar Convention on Wetlands; establish a Ramsar Site at Goidhoo in order to protect the fragile mangrove ecosystem; promote clean-up activities in mangrove patches
- So far, schools and environmental clubs mainly conduct beach cleanups and tree planting activities. Both therefore need to be supported in the establishment of further conservation projects ("Adopt a reef", "Protect the Turtles" etc.). There is furthermore an enormous lack of knowledge with regards to the ecology of the marine environment. The development of an education program and/or manuals that are easy to understand would be of high benefit. Teachers should receive special training in order to develop and conduct conservation projects. Schools and environmental clubs should be encouraged to participate in conservation projects with a Green Award for their achievements
- Support sustainable and environmental friendly mariculture (e.g. sea cucumbers and mussels in polyculture) to provide alternative livelihoods for fishermen
- Improve and strengthen the cooperation between the various governmental sections that deal with environmental issues. The exchange of data and information is crucial for the success of interdisciplinary conservation projects and for the implementation of individual and team objectives.

INTRODUCTION

Baa Atoll is located in the northern third of the Maldives archipelago, and has a total surface area of 1,126.95 km^2 (Naseer & Hatcher 2004). It is located on the western side of the double chain of atolls making up the central Maldives. The atoll is approximately 40 km long and wide and unlike many Pacific atolls, has a discontinuous rim characterised by numerous deep passages which allow oceanic currents and waves to penetrate the lagoon. The lagoon contains numerous patch reefs and faros, which are patch reefs with centrally enclosed lagoons or depressions (Kench *et al.* 2003). The reefs making up the atoll margin are far smaller and more widely spaced than reef in the southern Maldives (tsunami report). Recent GIS satellite measurements recorded 105 reefs with a total reef area of 262.90 km^2 (Naseer & Hatcher 2004).

The atoll contains 53 islands found on peripheral and lagoon reefs with most islands concentrated on the east to south-eastern side of the atoll (Kench *et al.* 2003), making up a total land area of only 5.50 km^2 (Naseer & Hatcher 2004). They are generally flat with very few mounds and no rivers; the average elevation is just 1–3 m above high tide level. Some of the larger islands (i.e. Goidhoo) have small fresh-water lakes, some contain swampy depressions, and some have brackish water with mangroves along the edges. The soil on most islands has a poor water retaining capacity and is highly alkaline due to an excess of calcium from the basal coral rock. Rain water percolates through the highly porous sand and forms a freshwater lens above the sea water (Kanvinde 1999).

All islands are highly dynamic systems with regard to sediment transport. Their are changing their size and position on reef platforms in response to short-term and seasonal adjustments in wind, wave and current patterns (Kench *et al.* 2003), undergoing substantial morphological change between the two monsoon seasons. These changes are oscillatory in nature (Kench *et al.* 2003).

To date, 19 islands are populated, 6 of them as tourist resorts. Many examples exist where traditional shoreline engineering structures have been implemented without consideration of the natural seasonal reversals of sediment transport and shoreline position, with often disastrous results (Kench *et al.* 2003) for both terrestrial and marine habitats.

All economic activities are concentrated in the coastal zone. Historically, fishing (pole and line fishing for tuna) was the major source of employment in rural communities. However, with the expansion of tourism there has been a shift to other forms of employment associated with tourism and a diversification of fisheries (Clark 2001) including reef fish and invertebrates (e.g. sea cucumbers, lobsters) as well as the establishment of agriculture on 2 islands.

The continued physical and economic existence of the island communities depends on healthy underlying reefs. These provide not only the basis for world-class tourism, fisheries production and livelihood, they also give physical protection to urban communities and resort islands (Clark 2001).

STATUS OF THE TERRESTRIAL ENVIRONMENT

With regard to the terrestrial flora and fauna, Baa Atoll does not differ significantly from other atolls in the Maldives.

FLORA

The Maldive archipelago has a diverse vegetation cover, especially given the existence of poor and infertile soils. Some 583 plant species have been recorded for the Maldives, of which 55% being cultivated species (Adams 1984). Over 122 plant species are recognized for their medicinal value and are utilized for traditional medicine practices (Kanvinde 1999). In general, most of the plants currently found in the Maldives, both ornamental and agricultural, have been introduced from outside (Kanvinde 1999), and fewer than 100 species are considered truly indigenous (Adams 1988).

The islands in Baa Atoll support typical tropical coral island vegetation, with numerous coconut trees and halophyte shrubs. A comprehensive compilation of typical plants was prepared by ECOCARE for Sonevafushi Resort. 48 species of 36 families have been listed (see Appendix 1). This compilation is considered valid for all islands in Baa Atoll. A rare mangrove associated tree, *maru gas*, is reported only from Goidhoo.

Agriculture in Baa Atoll is of minor importance, with only two island involved in commercial agriculture (Kihadhooo and Goidhoo), mainly growing water melon, pumpkin and bilimbi (Table 1 and 2). The uninhabited island of Hibalhidhoo was formerly used for commercial agriculture as well, but to date, vegetables and fruits are cultivated for personal use only (*pers. comm*.). Cultivation of fruits and vegetables in home gardens for personal use is common in most islands throughout Baa Atoll.

Table 1. Fruit production in Baa Atoll, 1999-2003. (Source: Agricultural statistics 1999-2003; MoFAMR)

English name	Dhivehi name	unit	1999	2000	2001	2002	2003
Pomegranate	Annaaru	[no]	600	0	0	0	285
Papaya	Falhoa	[no]	50	70	50	105	1120
Guava	Feyru	[no]	50	138	150	200	880
Screw pine	Kashikeyo	[gandu]	60	85	0	0	903
Tender coconut	Kurunbaa	[no]	700	650	375	1700	6380
Stone apple	Kunnaaru	[no]	8450	10500	100	4300	1000
Water melon	Karaa	[no]	0	80	0	672	2758
Lime	Lunbo	[no]	600	0	0	0	0
Passionfruit	Jumhurymey	[no]	1700	2000	400	0	395
Banana	Dhonkeyo	[stem]	0	0	0	155	248
Custard apple	Atha	[no]	30	57	0	120	318

Table 2. Vegetable production in Baa Atoll, 1999-2003. (Source: Agricultural statistics 1999-2003; MoFAMR)

English name	Dhivehi name	unit	1999	2000	2001	2002	2003
Breadfruit	Babukeyo	[no]	5500	500	0	8150	5430
Pumpkin	Baraboa	[no]	1200	0	10	100	2829
Eggplant	Bashi	[kg]	0	0	0	0	502
Piper Betel	Bileh	[bun]	25	150	0	0	0
Bilimbi	Bilimagu	[no]	8500	10500	3500	17500	14860
Chili	Githeyomirus	[no]	800	1950	200	2000	7914
Curry leaf	Hikandhifaiy	[kohli]	0	0	1000	3302	5400
Drumstick	Murangatholhi	[no]	37500	0	0	0	1360
Luffa	Thoraa	[no]	0	0	0	0	750
Sweet potato	Kattala	[no]	159	0	0	0	0

FAUNA

Compared to the rest of the Indo-Malayan region, the Maldive Islands exhibit a relatively small proportion of representative species, and the archipelago is not associated with an abundant terrestrial wildlife (Webb 1988). Two gecko species (*Hemidactylus* spp.) are typically found, as well as two

agamid lizards, the common garden lizard (*Calotes versicolor*) and the snake shrink (*Riopa albopunctata*) (Webb 1988). The only native mammals to the country are two subspecies of fruit bat, with *Pteropus gigantus ariel* as the most common (Hameed 2002). Two snake species (*Lycodon aulicus* and *Typhlops braminus*) have been identified (Webb 1988) and more than 130 species of insects, including arachnids, flies and ants, have been recorded (Holmes *et al.* 1993). Spiders, in particular, appear to be rich in diversity.

On the shores of Baa Atoll islands, ghost crabs (*Ocypode* spp.*)* are very abundant, as well as hermit crabs (*Coenobita* spp.*)*. *Coenobita rugosus* has been recorded to occur on Ohlugiri (Hogarth *et al.* 1998). Grays land crabs (*Geograpsus grayi*) live in the underwood.

The extent of terrestrial birds is minimal compared to other tropical islands. Most of them have probably been introduced, but are now considered endemic subspecies, e.g. the Maldivian House Crow (*Corvus splendens maledivicus*) and the Asian Koel (*Eudynamys scolopacel*) (Hameed 2002). Both birds are abundant throughout Baa Atoll.

STATUS OF THE MARINE ENVIRONMENT

In contrast to the terrestrial biodiversity, marine biodiversity is of outstanding richness in the Maldives, especially in the coral reefs, which provide the basis for a highly diverse ecosystem.

CORAL REEFS

The coral reefs of the Maldives support a high diversity of reef animals, with about 250 species of corals (stony and soft corals) and 1,200 reef and reef associated fish species (Rajasuriya et al. 2004).The total number of hermatypic, i.e. reef building, corals recorded from Maldives to date is 209 species, representing over 62 genera (Zahir & Naeem 1996). The highest species diversity in the Maldives has been recorded within the family Acroporidae, with the genus *Acropora* being the most abundant on most Maldivian reefs (Zahir & Naeem 1996).

However, reef-building corals were severely impacted by the 1998 coral bleaching event caused by an El Niño Southern Oscillation (ENSO) event with major water temperature anomalities. Bleaching occurs when coral polyps release their symbiotic algae (zooxanthellae) due to thermal stress. In the Maldives, around 80% of corals wholly or partially bleached on the flat, with around 45% at 10 m depth on the reef slope, and 30-40% at 20-30 m depth (Rubens et al. 1998). The loss of the zooxanthellae results in a lack of vital nutrients. The subsequent bleaching-induced mortality reduced living coral cover from about 42% to only 2% on Maldivian reefs (Allison 1998, Zahir 2002). The bleaching was most severe in the northern and central parts of the archipelago, and recovery has been variable on reef flats and slopes (Rajasuriya et al. 2004). Mass mortality of corals also changed the topographic complexity of Maldivian reefs and has impacts on the degree of erosion (Wilhelmsson 2002) which should not be underestimated.

The coral families that were most highly affected were branching Acroporidae and Pocilloporidae, whereas the majority of massive corals such as Poritidae, Faviidae and Agariciidae survived the bleaching (Allison 1999, Edwards et al. 2001): Agraciridae, especially *Pavona* sp., are now considered the dominant coral on Maldivian reefs (Loch et al. 2002), representing a shift in taxonomic patterns compared to the pre-bleaching community (Clark 2000).

Coral recovery is – however slowly – underway (Zahir et al. 2002). Recruitment of new colonies to the reefs and recruit growth was reported on all monitored sites (Haa Dhaal, Male', Addu, Ari, Vaavu Atolls), and reef recovery has been recorded highest in Addu Atoll followed by Ari Atoll, but remains highly variable within regions. Coral recruitment at all sites was dominated by colonies belonging to Agariciidae, followed by Poritidae and Siderastreidae. New recruits of branching corals Acroporidae and Pocilloporidae were found in low densities at all sites suggesting that recovery will be slow,

presumably due to the limited adult population and therefore limited source of larvae (Zahir et al. 2002).

Surveys conducted between February 2000 and July 2002 showed that the survivorship of recruits and small juvenile corals colonies was high (< 80 %) and overall loss (dead and missing) of recruits and juvenile corals were low. This, combined with a high influx of new recruits, indicates that the current potential for reef recovery in the Maldives is favourable (Zahir et al. 2002).

On average, living coral cover in the Maldives increased approximately only 3% from 1998 to 2002 (Zahir 2002). However, it is evident that the rate of recovery is variable among and between sites, demonstrating the complexity of the reef recovery processes.

Impacts of mass coral mortality on the wider ecology may continue for decades, even assuming no further extreme events (Spalding et al. 2001).

Coral reef status in Baa Atoll

Very little documented information is available on the coral reef status specifically in Baa Atoll. Of the few monitoring programmes that have been previously conducted in the Maldives, most studies have been carried out in Haa Dhaal, Ari, Addu, Vaavu, Laamu, Rasdhoo, Male' Atolls (Zahir et al. 1998, Edwards et al. 2001, Loch et al. 2002, Zahir 2002, Sprecher et al. 2003) and are far from being exhaustive.

The only data available for coral reef ecosystems in Baa Atoll are mainly derived from the Environmental Impact Assessment studies (EIA) undertaken in order to assess potential impacts of resort development on islands as required by the Environmental Protection and Preservation Act of the Maldives (4/93), and the post-Tsunami damage assessment prepared by AusAID and MRC.

In 1997, the islands of Dhunikolhu, Horubadhoo and Kihaadhuffaru were surveyed and coral communities were assessed quantitatively, using 50 m line intersect transect and qualitatively by visual estimation. Line intersects are a common practice in assessing benthic reef communities, providing percentage cover of the respective categories (English et al. 1997).

In all three islands, a reef community typical for the Maldives was found (Zahid 1997c, b, a):

- Shallow lagoon with dead branching corals, providing shelter for juvenile fish
- Reef flat (high energy zone) with small and scattered colonies of mainly digitate and branching *Acropora* spp.
- A highly diverse reef crest and upper reef slope with digitate, branching, submassive and tabulate *Acropora*, massive *Porites* spp., dome shaped *Favia* spp., branching *Pocillopora* spp. and *Millepora* sp. (Branching Fire Coral), as well as unidentified foliose and encrusting corals. Coral growth forms shifted from encrusting to massive, to branching and tabulate as wave energy and light decreased
- Occasionally, unidentified soft corals were found on the reef slope
- Coral recruitment was observed in most areas of the reef

The mean living coral cover (averaged over 3 to 4 transects) was 54 % for Kihaadhuffaru, 48 % for Dhunikolhu, though there was a very high variance between the transect sites, and 56 % for Horubadhoo.

There are monitoring data available for Fonimagoodhoo from studies in 1997 and 2000/01 (Naseer et al. 1997, Anonymus 2002), giving a good example on the impacts of the 1998 ENSO-related reef bleaching event on coral reef health.

In 1997, two 20 m line transects on the western reef were assessed as well as three coral patches on the east side of the islands. The pattern of coral composition and distribution were similar to those found on the three other islands, with massive growth forms in the high energy zones and digitate, branching and tabulate species towards the slope. Overall living coral cover was about 45 %. Despite the dominating hard coral families Acroporidae, Poritidae and Faviidae, 5 other hard coral families and a total of 15 species were identified (Appendix 2), amongst them some species (*Gardineroseris planulata, Diploastrea heliopora, Montastrea* sp., *Merulina ampliata*) are regarded as uncommon (Zahir & Naeem 1996). Black corals (*Anthipatharia* sp.) were abundant on the west side of Fonimagoodhoo, on the deep reef slope (Naseer et al. 1997).

Furthermore, some algae and invertebrate life forms and species have been identified, such as

- Coralline algae
- Polychaetes (*Spirobranchus* sp.)
- Soft corals (*Lobophytum* sp., *Sarcophytum* sp., *Sinularia* sp.)
- Molluscs (*Pedum spondyloideum, Tridacna crocea*)
- Ascidians
- Anemones
- Crustaceans (small lobsters)
- Echinoderms (*Echinostephanus aciculata*)

The same reef was assessed in 2000/01 within the scope of the annual environmental impact assessment. Four 20 m line intercept transects assessed benthic cover. Living coral cover slightly increased from 3.75 % (November 2000) to 4.1% (April 2001). At that time, 11 genera were observed, but only 8 coral species of 5 families have been identified (see Appendix 2). Furthermore, the gastropod *Drupella* sp. and the cushion sea star *Culcita* sp. were observed on the reef.

The reef of Landaa Giraavaru were assessed in 2000 (Aslam & Zahir 2000). Three transects on the southern side of the islands were surveyed using 50 m line intercept transects, and one reef patched was qualitatively assessed by snorkeling. The average live coral cover was very low with an average of 1.3%. Living corals were generally massive *Pavona* and encrusting *Porites* colonies. Furthermore, massive Faviidae (*Leptoria phrygia, Platygyra* sp. and *Leptastrea* sp.), some Fungiidae, few Acroporidae and Siderastreidae such as *Psammocora* sp. were found on the reefs, though not at transect location. The number of recruits indicate reef recovery (Aslam & Zahir 2000).

The reefs of Kunfanadhoo have been surveyed quantitatively (50 m line intercept transects) various times in the last couple of years (Allison, pers. comm.). In early 1999, the overall living coral cover was 3%, increasing to 6% at the end of July 2000. Coral community consisted mainly of encrusting and massive coral species (Allison, *pers. comm.*). Although recruits were common, they did not contribute significantly to coral cover at this time. Settlement and growth continued, with live coral cover reaching 8% in June 2001, and 9% by July 2002. Bleaching, but no mortality of juvenile *Pocillopora* colonies was observed in early 2002. Live coral cover in January 2003 was 10%, increasing to 12% by late 2004 and holding there in April 2005 (Allison, *pers. comm.*).

On Dhigali Haa, some juvenile colonies of *Acropora* sp. were measured in September 1999 and June 2001. During this 22 month period, these colonies displayed an 18-fold increase in surface area its surface area. (Allison 2005)

Dive schools report that reefs inside Baa Atoll are to date in a generally better condition than reefs on the outside margin of the atoll.

In summary, studies within the Maldives after the bleaching event clearly show a shift in coral community composition, with now more massive coral species (Poritidae, Faviidae) dominating the community due to their higher survival rates (Edwards et al. 2001, McClanahan 2001, Loch et al. 2004). Most coral types are recovering however slowly, including the branching growth form such as *Acropora* spp. and *Pocillopora* spp. (Edwards et al. 2001, Sprecher et al. 2003). Certain species of pocilloporid corals (*Stylophora* spp., *Seriatopora* spp.) are, however, not observed in Baa Atoll (Allison, *pers. comm.*).

Various non-reef building corals also contribute to the ecosystem's diversity: before the El Niño in 1998, the rare pink coral *Distichopora nitida* was found on many dive sides in Baa Atoll and around Goidhoo. To date, they can be found mainly on Maaddoo Giri and near Landaa Giraavaru, generally below 25 m (Soleni Dive Centre, Kuhadhoofaru, *pers. comm.*).

Soft corals of the genus (*Scleronephthya* sp. and *Dendronephtya* sp.) are found often at the eastern reefs of Baa Atoll. They are abundant on overhangs near Fares and Maavaru Kandu.

Black corals (*Antipatharia* sp.), listed as endangered in Appendix II of the Convention on International Trade in Endangered Species (CITES), can be found on Baa Atoll's coral reefs below depth of 20 m (Soleni Dive Centre, Kuhadhoofaru; Delphis Diving, Horubadhoo, *pers. comm.*).

Tsunami Impact on reefs in Baa Atoll

Impacts of the Indian Ocean Tsunami of December 2004 on Maldivian coral reefs were examined by Australian scientists in collaboration with the MRC (Gunn et al. 2005). Broad scale and dive operator surveys were conducted – amongst others – on 33 sites in Baa Atoll (Figure 1)

Reefs on the western atoll rims consisted mainly of small *Pocillopora* spp., digitate *Acropora* spp. and massive Faviidae colonies, though coral community was very sparse (< 5% living coral cover). Below 5 m, larger tabulate *Acropora* sp. colonies occur (Gunn et al. 2005).

The level of direct Tsunami impact on the upper reef slope coral communities was typically minor, bearing in mind that coral recovery after the El Niño has been very slow, so there was little coral to be damaged (Allison, *pers. comm.*). However, the large number of corals that have settled over the past years and that survived the Tsunami could be emphasized. On only 12% of the examined reef in Baa Atoll damage to the coral community was recorded, with 9% showing damage to more than 10% of the living corals (Gunn et al. 2005). Corals on fore-reefs and channel margins along the Eastern atoll rim off Baa Atoll showed limited evidence of tsunami damage to corals. The damage was generally restricted to the upper reef slope and crest and was mainly due to of cascading of coral rubble (Allison, *pers. comm.*), breaking the tips of small digitate and submassive coral species, and then accumulating just before the algal ridge (Gunn et al. 2005). The damaged coral have been reported to heal rapidly with partial mortality observed on few colonies.

The most severe Tsunami impact was observed on the reefs of Maahuruvalhi, Maa Faru and Boatu Urunu Faru, (all on the western side of Baa Atoll). On Maahuruvalhi, the reef was excavated on a length of more than 1 km, due to the wash out of rubble and sediment, leading to a collapse of larger blocks in the reef framework. The erosion left pits of up to 3 m depth, and the coral colonies were broken, tumbled down the reef slope and partially buried in sand (Gunn et al. 2005).

Smothering of corals with fine sediment was the most common impact (43% of transects noted at least minor incidence). Toppling and breakage of colonies was also evident on a number of transects (22% and 17% respectively), but was limited to a small portion of the community. Alteration to the substrate was more common than obvious damage to the coral community with 52% of transects having some form of observed alteration. The most extensive effect observed was a light "dusting" of the substrate with very fine sediment or in situ turning of rubble and small coral blocks (Gunn et al. 2005).

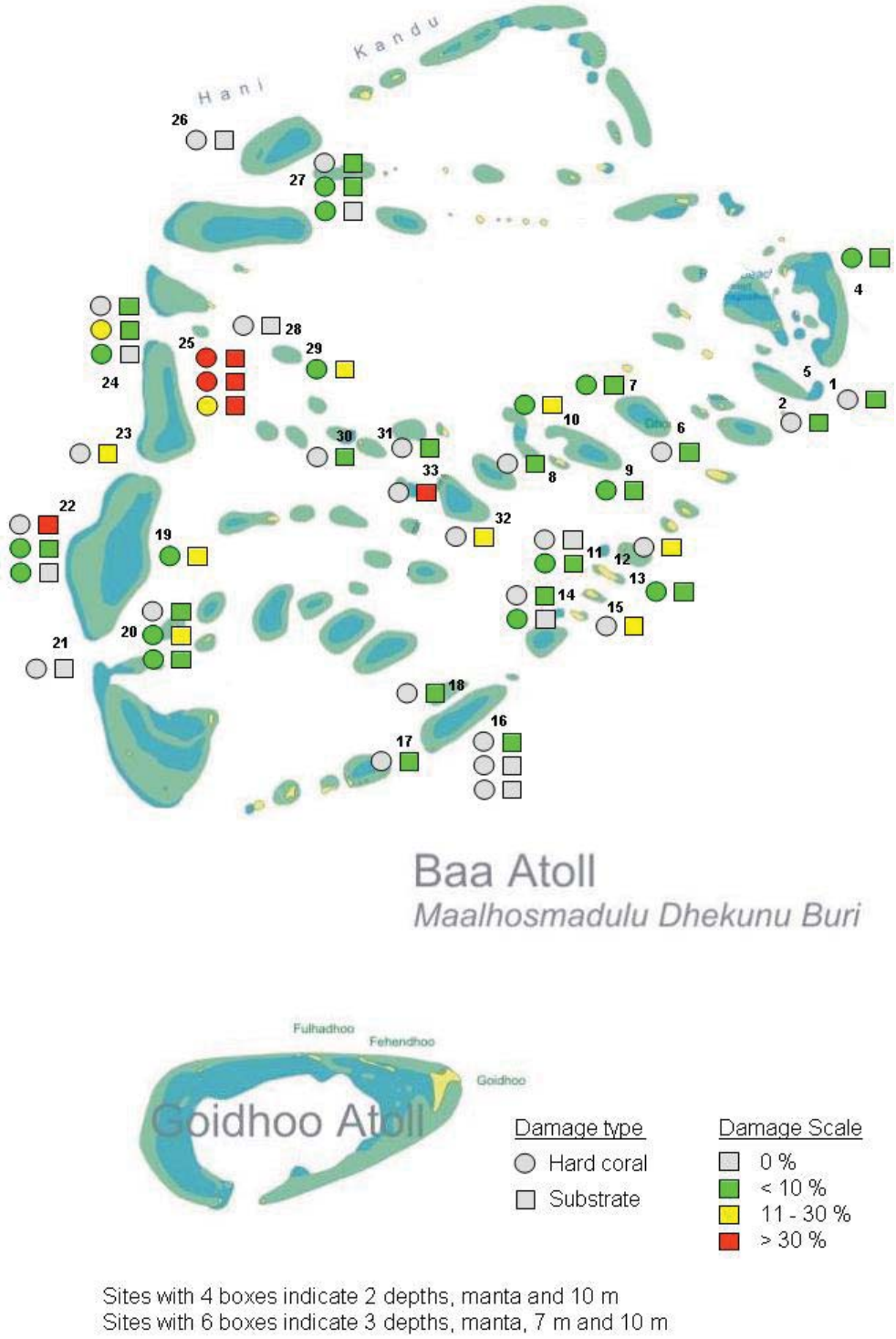

Figure 1. Tsunami impact on 33 reefs in Baa Atoll. (after Gunn et al. 2005)

Dusting was most prevalent on sections of reef either in or facing the atoll lagoon. The eastern slope of Borangali was the most severely dusted site visited with fine white sediment from the crest to a depth of at least 25 m. The depth of sediment ranged from layers a few millimeters thick to several centimeters). The corals on dusted sections of reef were generally free from sediment with the exception of some deeper depressions in the surface of individual colonies. While neither of these

disturbances had an observable impact on the coral colonies observable during the surveys it is very likely that small newly recruited colonies were killed (Gunn et al. 2005).

Other Marine Invertebrates

Records of marine invertebrates in the Maldives are far from being exhaustive, and little is known with specific regards to Baa Atoll.

For the Maldives, 36 species of sponges are recorded, over 400 species of molluscs, some 350 species of marine crustaceans and over 80 species of echinoderms (Ahmed & Saleem 1999, Hameed 2002).

The knowledge on other marine invertebrate groups in the Maldives, such as Chaetognatha (arrow worms), Plathelminthes (flat worms), Nematoda (round worms), Annelida (segmented worms), Bryozoa (moss animals), Sipuncula (peanut worms) and Brachiopoda (lamp shells) is mainly based on early expeditions 50 – 100 years ago, with samples being taken patchily. Therefore, the knowledge on and understanding of their biodiversity and ecology remains fragmentary (Anderson 2003, and references therein).

Crustaceans in Baa Atoll

Two subtidal hermit crabs have been recorded in Baa Atoll (Hogarth *et al.* 1998): *Calcinus* sp. and *Trichopagurus trichophthalmus* occur on the reefs of Ohgali; the latter was recorded for the first time in the Maldives.

Soleni Dive Centre reports the occurrence of various cleaner shrimps (*Stenopus hispidus*, *Leandrites cyrtorhynchus*), pistol shrimps (*Alpheus djeddensis*) and spiny lobsters (*Panulirus versicolor*).

Fiddler crabs (*Uca* sp.) live associated with mangroves and are quite abundant in the underwood (*pers. observ.*).

Molluscs in Baa Atoll

In 2000, the MRC conducted a survey of marine gastropods in collaboration with Carl Ehrlich, covering sites in Baa Atoll and recording 51 species there (see Appendix 3). Collections on the beaches of islands in Baa Atoll contributed another 17 species of gastropods, 3 bivalve species and 2 cephalopod species (*pers. observ.*; Appendix 3). At Dhigali Ha, boring bivalves (*Lithophaga* sp.) are abundant (Allison, *pers comm*.). Furthermore, two nudibranchs, the Maldivian sponge snail *Coriocella hibyae* and the wart sea slug *Phyllidia varicosa* are frequently spotted during SCUBA dives (Hoffmeister, *pers. comm.*). *C. hibyae* is considered endemic to the Maldives (Wellens 1991).

During a survey on Opistobranchs (gastropods) in the Maldives, 3 new species were recorded from Baa Atoll (Yonow, 1994, see also species list Appendix 3): *Notodoris gardineri* var. *nigerrima*, *Tambja olivaria* and *Chelidonura castanea*.

Giant clams (*Tridacna maxima* and *T. squamosa*), can be found in Baa Atoll, but due to a lack of monitoring, their abundance remains unknown.

Vertebrates

Fishes (Pisces)

The fishes are one of the better-studied groups of Maldivian marine animals. A total of 1090 fish species including sharks and skates have been recorded (Randall & Anderson 1993, Randall & Goren 1993, Anderson *et al.* 1998a). The most diverse group of fishes are gobies (90 species), followed by the wrasses and groupers (70 and 60 species respectively). Nearly 40 species of sharks and 16 species

of skates have been recorded (Hameed 2002). The Maldives Blenny (*Ecsenius minutes*) has so far been identified only in the Maldives, while the distribution of certain species, like the Maldivian anemone fish (*Amphiprion nigripes*) is restricted to the Maldives, Laccadives and Sri Lanka (Hameed 2002). Both species occur in Baa Atoll.

Despite the numerous studies on fishes in the Maldives, there is a lack of monitoring of fish stocks and their distribution. Therefore, records from Baa Atoll can only be based on observations from local fishermen and divers and are therefore far from being exhaustive.

The community of reef fish is highly diverse and appears not significantly different after the coral bleaching event of 1998 (Naseer *et al.* 1997, Anonymus 2002; see also Appendix 4). The abundance of herbivorous fishes (surgeonfish, wrasses, rabbitfishes) is thought to have increased over the past years due to the high algal cover on coral reefs, but no comprehensive study has been conducted so far.

Dive schools in Baa Atoll (Delphis Diving, Horubadhoo; Soleni Dive Centre, Kunfanadhoo; Ocean Pro Dive, Dhunikolhu) report that overall reef fishes (surgeonfishes, triggerfishes, butterflyfishes, groupers, soldierfishes, snappers, puffer- and porcupine fish, fusiliers, moray eels etc.) are diverse and abundant. While Giant moray eels (*Gymnothorax javanicus*), White-mouth morays (*G. meleagris*) and Blackcheek morays (*G. breedeni*) are abundant, both Honeycomb moray (*G. favaginens*) and Ribbon eel (*Rhinomuraena quaesita*) are rare. White tipped reef shark (*Triaenodon obesus)*, grey reef sharks (*Carcharhinus amblyrhynchos)* and tawny nurse sharks (*Nebrius ferrugineus)* are considered very rare, even in those places where they have been previously abundant (Dhigaali Haa, Angu Faru, see also below). Tawny nurse sharks were listed as *ENDANGERED* on the Red List of Threatened Animals by International Union for the Conservation of Nature and Natural Resources (IUCN) in 2001.

Stingrays (*Taeniura melanispilos*) and Spotted Eagle rays (*Aetobatus narinari*) appear to be common.

The Maldives are home to globally significant populations of whale sharks (*Rhincodon typus*), and manta rays (*Manta birostris*). The whale shark is listed as *VULNERABLE* on the Red List of Threatened Animals by IUCN (1994), there are occasionally spotted near Hanifaruhuraa. Manta rays are spotted frequently in Baa Atoll near Dhonfanu, Hibalhidhoo and Hanifaruhuraa during Iruvai monsoon (December – April) (Soleni dive Centre, Kunfanadhoo, *pers. comm.*).

Lionfish (*Pterois antennata, P. radiata*), Stonefish (*Synanceia verrucosa)* and Scorpionfish (*Scorpaenopsis barbatus)* are very common on most reefs throughout Baa Atoll. The Ghost pipe fish (*Solenostomus paradoxus*) and the Frog fish (*Antennarius maculates*) can be found in certain places. Garden eels *(Heteroconger hassi)* are abundant, and found on most sandy bottoms, e.g. near Nelivaru and Dharavandhoo in 15 – 25 m depth (Delphis Diving, Horubadhoo; Soleni Dive Centre, Kunfanadhoo; Ocean Pro Dive, Dhunikolhu, *pers. comm*)

Napoleon wrasses (*Cheilinus undulates)*, ranked as *ENDANGERED* and Giant Groupers (*Epinephelus lanceolatus)*, ranked as *VULNERABLE* by IUCN (2004, and 1994, respectively), are rare in Baa Atoll.

Fishermen report an overall decline in the stock of bait fishes, but especially for the blue damselfish (*Chromis viridis*). More detailed information on bait fish, tuna, grouper and shark species are provided below in the Local Fisheries section.

Marine turtles (Reptilia)

Five species of marine turtle occur in the Maldives: the Green Turtle *Chelonia mydas*, the Hawksbill Turtle *Eretmochelys imbricata*, the Olive Ridley *Lepidochelys olivacea*, the Leatherback Turtle *Dermochelys coriacea* and the Loggerhead Turtle *Caretta caretta* (Frazier *et al.* 2000).

The Green Turtle (*vela*) and the Hawksbill Turtle (*kahambu*) occur in globally significant numbers in the Maldives, and both species nest in Baa Atoll (Frazier *et al.* 2000, Zahir 2000). The number of nests and eggs of the Green Turtle exceed the ones of the Hawksbill Turtle (Fisheries statistics 1998 – 2001; Table 3), but adults of the latter are more often observed near coral reefs of uninhabited islands (Frazier *et al.* 2000).

Table 3. Number of turtle nests Baa Atoll (Source: Fisheries Statistics 1998 – 2001: MoFAMR).

year	Vela nested	Vela eggs dug	Kahambu nested	Kahambu eggs dug
1995	211	24533	43	4909
1996	198	21986	24	2932
1997	192	20115	17	1831
1998	215	21527	24	2820
1999	233	22422	10	1551
2000	111	11167	4	441
2001	242	26789	1	0

Sea turtles typically show a slow growth-rate, a long life-span and a high age at maturity (Miller 1996), making them generally vulnerable to anthropogenic impacts (i.e. over exploitation of adult females as well as unregulated long-term collection of eggs, and the loss of nesting beaches due to sand mining, lights and the construction of sea walls (Zahir 2000)). Figure 2 shows a generalized life cycle of sea turtles together with estimates for the duration of the different phases and intervals. After leaving the beach as hatchlings sea turtles acquire an aquatic lifestyle, with the males never returning onto land and only the females regularly coming ashore briefly to lay eggs.

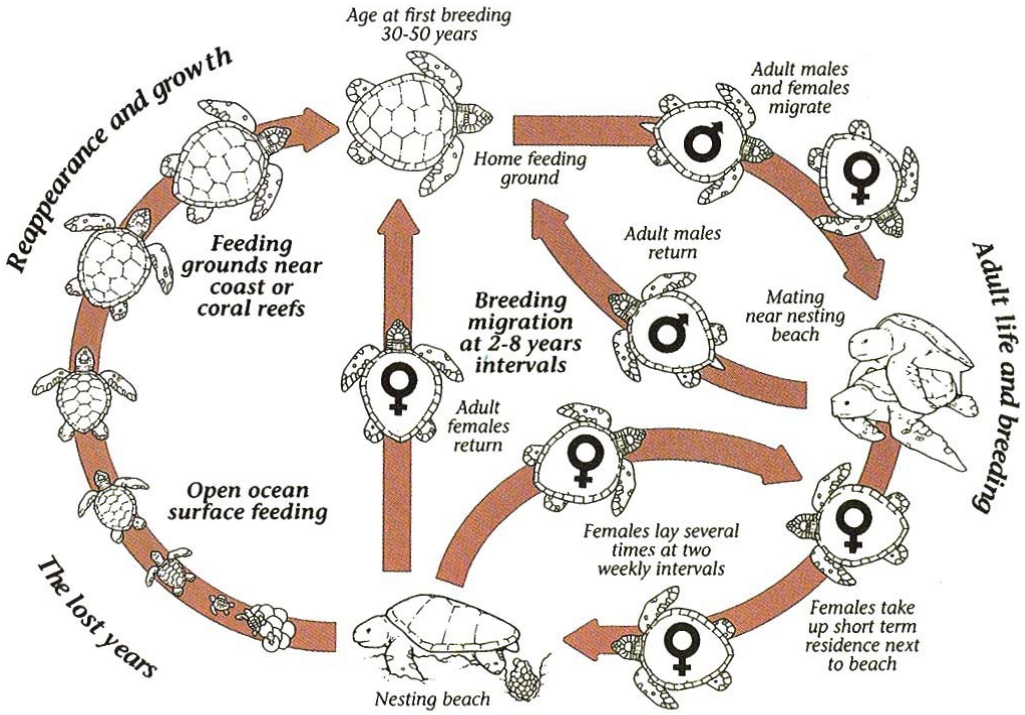

Figure 2. Life cycle of marine turtles (after Miller 1996)

Baa Atoll has numerous nesting islands for mainly Green Turtles (*vela*). Islands of particular importance for turtle nesting in Baa Atoll were reported to include Vakkaru, Kunfunadhoo, Maadhoo, Miriyandhoo, Olhugiri, and Medufinolhu (Clark 2001). But also on Maalhoss, for example, turtle nest are reported regularly (generally every 2 month); there, turtle eggs were formerly heavily exploited/harvested. To date, smaller numbers of eggs are still taken from the nests, but this is

controlled by the island office, and awareness for turtle protection has been created amongst the Maalhos inhabitant's.

Kunfunadhoo (Sonevafushi Resort) is an important nesting island for Green Turtles (Frazier *et al.* 2000, Zahir 2000): since the beginning of a consistent monitoring in April 2005, at least 22 observations of turtle tracks and individuals have been made, indicating an average of one animal crawling up to the beach per week (Hofmeister, *pers. comm*). The resort management does actively protect turtle nests by minimizing human impact through light and noise reduction (Hofmeister, *pers. comm.*). In contrast, Dhunikolhu (Coco Palm Resort) and Horubadhoo (Royal Island) were previously major turtle nesting islands, but now very few turtle come there for nesting. Even though both islands protect turtle nests as they do occur, resort development has again limited the availability of suitable nesting beaches for turtles, due to increased disturbance by light, the building of break waters as well as movement of the guests.

Despite the numerous nesting islands in Baa Atoll, dive schools report that both Green Turtles and Hawksbill Turtles are rarely spotted during dives (Soleni Dive Centre, Kunfanadhoo; Ocean Pro Dive, Dhunikolhu, Delphis Diving, Horubadhoo; *pers. comm.*).

Table 4. Baa Atoll turtle nesting islands as reported by local fishermen from thirteen inhabited islands, May 2001 (Source: Fisheries component Report 2001, Appendix 2)

	Ku	Ke	Ka	Ki	Do	Da	Ey	Ma	Th	Hi	Fu	Fe	Go	Tot
Bathala	1													1
Anhenfushi	1													1
Dhakandhoo												1		1
Ahivafushi											1			1
Fares	1	1										1		3
Landaa Giravaru	1													1
Thiladhoo			1											1
Mudhdhoo											1			1
Mendhoo		1				1	1				1			4
Vakkaru	1				1				1	1	1	1		6
Horubadhoo	1													1
Hanifarurah						1								1
Dharavandhoo						1								1
Hibalhidhoo								1						1
Maalhos								1						1
Kunfunadhoo	1	1		1	1		1							5
Maadhoo		1		1		1	2				1	2		8
Hulhudhoo	1											1		2
Miriyandhoo	1	1		1		1	2				1	1		8
Muthaafushi									1	1	1			3
Embudhoo										1				1
Olhugiri	1	1		1		1			1	1	1	1		8
Maamaduveri										1				1
Kanifushi					1		1		1	1				4
Medufinolhu		1		1		1	1		1	1	1	2		9
Innafushi											1			1
Dhoru Kandu bodu huraa											1			1

Note: 1 = present; 2 = most important island

In October 2003, a turtle conservation project was launched at Kendhoo in collaboration with Four Seasons Resort Maldives and SEACOLOGY. Kendhoo was supported in building a pre-school in exchange for the island's role in protecting turtles and their eggs on Kendhoo and nearby islands

(http://www.responsibletravel.com/Copy/Copy101730.htm). However, locals now report the establishment of a daily turtle feeding with fish. Nine to twelve, both Green and Hawksbill Turtles are coming to the lagoons regularly to be fed by the locals. Feeding of turtles (as any other animals) is highly ecologically questionable, as there is no reason for feeding. There are plenty of feeding grounds available for turtles, and feeding by human beings interferes with the natural equilibrium and changes there behaviour with long lasting effects, creating an unjustifiable dependence on human beings. Furthermore, fish might be the appropriate food for the generally carnivorous Hawksbill Turtle, but certainly not for the generally vegetarian Green Turtle.

All turtles were heavily hunted prior to 1995, and their numbers were significantly reduced, despite first, though deficient restrictions on capture and export in February 1978 (Fisheries Law 24/78). In June 1995 a 10-year moratorium on the catching or killing of turtles was introduced (Fisheries Law 5/87, section 10), but killings still occur on certain islands in Baa Atoll, e.g. Thuladhoo. Beyond that, turtle eggs are still exploited. Despite the decreasing number of turtle nests found in Baa Atoll (as reported by locals), eggs are currently being harvested in an unsustainable manner: most locals report that eggs are taken from turtle nests when they are spotted; occasionally, the number of eggs taken is controlled by the island office. When eggs are removed for personal use, usually some 50 eggs are taken, when eggs are taken to be sold on the islands (mainly Eydhafushi and Thuladhoo) or in Male' 90-99 % of the eggs (i.e. usually 150-170, occasionally 200 eggs per nest; *pers. comm.*) are removed. Lack of information about the ecology of marine turtles and the insufficient legislation regarding the protection of turtles have already lead to a decrease in population size and will inevitably lead to a crash of the entire population within the next decade if no further efforts for protection are made, but especially if such unregulated egg harvesting continues.

Furthermore, juvenile turtles (few days to month old) are still kept as pets, generally in inadequate conditions (e.g. small tanks, filled with fresh water; *pers. observ.*). As a result, survival rate is generally negligible. The serious lack of knowledge on turtle ecology amongst islanders again contributes to the increasing threat of marine turtles.

Hawksbill Turtles are ranked in the Red List of Threatened Animals by IUCN as *CRITICALLY ENDANGERED*, while Green Turtles are ranked as *ENDANGERED* (Baillie & Groombridge 1996). Furthermore, all five marine turtles occurring in the Maldives are listed in Appendix I of the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) as *MOST ENDANGERED SPECIES* since 1977, recognizing the threat of extinction that is, or may be, affected by trade. Green Turtles are also listed as *ENDANGERED* in Appendices I and II of the Convention on Migratory Species (CMS).

Despite the conservation efforts currently undertaken, legislation is still insufficient, since the collection of turtle eggs is still legal, but should be banned as soon as possible. Furthermore, the Maldives have not yet acceded to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Therefore, the government should accede the CITES and Bonn Convention on Migratory Species in order to meet the objectives of turtle conservation regionally and internationally.

Sea- and Shorebirds (Aves)

167 bird species have been recorded for the Maldives (Ash & Shafeeg 1994, Anderson & Baldock 2001), some in regionally significant numbers. They include breeding residents, southern winter visitors (shearwaters and storm-petrels), and northern winter visitors (most waders, raptors and passerines plus some terns). For some of the latter, the Maldives lies at the southern end of the major Indus Valley – West Indian flyway (Fisheries Component Report 2001).

The major threats to seabirds include: (1) destruction of habitat, e.g. cutting down trees or removing sand from sandbanks, (2) taking of eggs, juvenile and adult birds for food or for pets, and (3) disturbance by people of roosting and nesting birds on islands and sandbanks (Anderson 1996).

Pressure on birds has always been high in the Maldives (Ash & Shafeeg 1994). In the past, the harvesting of eggs and chicks as food presumably took place to supplement the diet (Ash & Shafeeg 1994). Keeping a wide range of species of captured birds as pets and toys has long been very popular in the Maldives (Ash & Shafeeg 1994), and it still is: in Baa Atoll, white herons, noddies, and falcons are kept captured (*pers. observ.*, Figure 3).

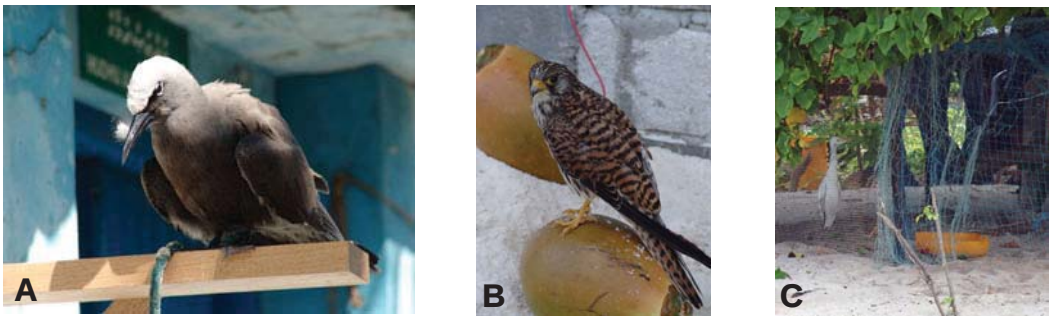

Figure 3. Birds captured as pets. Baa Atoll. (A) Brown Noddy (*Anous stolidus*), protected bird. (B) Peregrine Falcon (*Falco peregrinus*). (C) Cattle Egret (*Bubulcus ibis*), protected bird.

To date, seabirds also suffer considerably from increased disturbance by tourists in Baa Atoll. Particularly noteworthy is the loss of all breeding *Bodu Gaadhooni* (Great Crested Terns - *Sterna bergii*) from Nelivarufinolhu (a sandbank adjacent to Kunfunadhoo (Sonevafushi Resort) and much used by resort guests) (Fisheries Component Report 2001, Appendix 2).

Table 5. Baa Atoll bird nesting and roosting islands as reported by local fishermen from thirteen inhabited islands, May 2001 (Fisheries Component Report 2001, Appendix 2).

	Ku	Ke	Ka	Ki	Do	Da	Ey	Ma	Th	Hi	Fu	Fe	Go	Tot
Gaagandufaruhuraa				1										1
Boifushi	1	1		1		1			1					5
Kashidiparu finolhu									1					1
Ahivahfushi		1												1
Atolugali finolhu									1					1
Maafushi finolhu			1		1			1						3
Veyofushi faru finolhu			1											1
Mudhdhoo					1									1
Hurai faru finolhu					1									1
Anga Faru finolhu					1		1	1			1			4
Mendhoo												1		1
Nibiligaa		2	1	1		1		1	1	1	1	1	1	11
Dhigu Faru finolhu											1			1
Nelivarufinolhu	x	x				x	x	x					x	0
Maaneigaa finolhu										1	1		1	3
Ohgali finolhu										1				1
Muthaafushi		1		1				1	1	1				5
Olhugiri	1	1				1	1		1	1	1	1	1	9
Fulhadhoo finolhu											1			1
Dhoru Kandu bodu huraa											1	1	1	3
Dhoru Kandu kuda huraa											1	1	1	3

Note: 1 = present; 2 = most important island; x = formerly but no longer important

Islands reported to still be of major importance for seabirds in Baa Atoll include Boifushi, Nibiligaa, Muthaafushi and Olhugiri (see also Table 5). *Dhivehi raabondhi* (Maldivian Little Heron - *Butroides striatus albidulu*), *iruvaihudhu* (the Cattle Egret - *Bubulcus ibis*) and *findhana ilolhi* (Wood Sandpiper - *Tringa glareola*) are nesting regularly on Maalhoss. The Maldivian Little Heron and the Cattle Egret are protected by the Environment Protection and Preservation Act (4/93).

Nibiligaa is a small island, much visited by safari boats; the effects of such disturbance on the local seabirds remain unclear. Olhugiri is one of only two islands in the entire Maldives with regular roosting frigate birds (mostly Lesser Frigate birds, *Fregata ariel*), which are protected in the Maldives (Fisheries Component Report 2001).

Colonies of some nesting terns and noddies, are likely to have suffered complete loss of chicks and eggs due to the Tsunami, some nesting islands maybe completely disappeared, but these species are generally able to adapt to such losses and can be expected to re-nest or seek out new nesting sites.

Most seabirds have been protected since 1996 (see Appendix 5), since they help pinpoint tuna schools and are therefore of great importance to local tuna fishermen. A decrease in bird population therefore affects tuna fisheries considerably (Anderson 1996). The need for bird conservation in the Maldives is, however, still increasing, mainly because the far reaching consequences of human impacts (such as sand mining, tourism), that lead to the loss of nesting grounds, are by far underestimated.

Whales & Dolphins (Cetaceans)

Some 20 species of whales and dolphins are known from the Maldives (Anderson *et al.* 1999, Ballance *et al.* 2001). These include the Blue Whale (*Balaenoptera musculus*), listed by IUCN as *ENDANGERED*. Marine mammals in the Maldives have recently received much attention, but information on population sizes and distribution are still fragmentary due to the lack of monitoring. However, whales and dolphins have been given protected status in the Maldives since 1993 (Hameed 2002).

The most common inshore species in Maldivian waters is the Spinner Dolphin (*Stanella longirostris*) (Hameed 2002), which appears to be frequently spotted in Baa Atoll (Soleni Dive Centre, Kunfanadhoo, *pers. comm.*).

BENTHIC MARINE ALGAE

Marine benthic algae are usually divided into four phyla: Cyanobacteria (blue-green algae), Phaeophyta (brown algae), Rhodophyta (red algae) and Chlorophyta (green algae). The most comprehensive account of marine algae in the Maldives is provided by Hackett (1977) and Wynne (1993), stating together 21 species of Cyanobacteria, 20 species of Phaeophyta, 158 species of Rhodophyta and 87 species of Chlorophyta. (Hackett 1977, Wynne 1993)

No specific study on marine algae in Baa Atoll has been undertaken so far. From Dhigali Ha, however, red encrusting coraline algae are reported to be abundant and showing high growth rates. At Landaa Girvaaru, calcareous algae covered between 2.5 and 12.5% of the reef transects that were examined (Aslam & Zahir 2000). Most coral reef throughout Baa Atoll are characterised by low coral cover and high cover by macro algae and turf algae (Clark 2001).

SEA GRASS

Sea grasses in the Maldives are poorly known and extensive sea grass beds in natural environments are rare in the archipelago. However, large stands of mostly *Thalassia hemprichii* and *Syringodium isoetifolium* were found in 4 sites in Baa atoll (Dhonfaru, Hitaadhoo, Thulahadhoo, Goidhoo) (Clark

2001). Sea grass beds are of high ecological value as there are the important feeding grounds for marine turtles, and they protect shorelines and prevent coastal erosion by stabilising the sediment. Sea grass absorbs nutrients from the sediment and is therefore capable of recycling nutrients into the ecosystem that would otherwise be trapped in the bottom and unavailable (Nybakken 2001). Associated with sea grass beds, the sea grass ghost pipefish (*Solenostomus cyanopterus*) is found in Baa Atoll, especially around Dhunikolhu (Ocean-Pro Dive, Dhunikohlu, *pers. comm*.)

In recent years, proliferation of sea grass beds has been observed throughout the Maldives, especially near traditional fishing islands. This phenomenon has been reported from Laamu Atoll (Miller & Sluka 1999), North Male' (Hofmeister, *pers. comm.*) and North Ari Atoll (Sørensen *pers. comm*.). Although sea grass beds are generally considered of high ecological importance as sediment trap, fish nursery and turtle feeding ground (Nybakken 2001), the rapid proliferations in the Maldives is due to anthropogenic impacts (Miller & Sluka 1999). Studies in Laamu Atoll showed that anthropogenic enrichment of lagoonal sediments, caused by the disposal of fishing waste over generational time scales, leads to substantial proliferation of sea grass beds. Unlike marine algae, which obtain their nutrients from the water column, sea grass obtains nutrients from the sediment via roots.

It remains unclear whether the rapid spread is ecological beneficial. A comprehensive monitoring on the occurrence and /or proliferation of sea grass beds in Baa Atoll is therefore of great importance in order to detect human induced ecosystem changes as early as possible. The rapid growth of sea grass may have negative impacts on the weak, though recovering coral communities.

MANGROVES

Mangroves communities are unique and occur in sheltered estuaries where regular tidal influence of sea water prevails, providing an invaluable purpose to whole islands and coastline communities. They have a high biological productivity, stabilise the sediment and play a key role as a nursery area for many fish and crustaceans, e.g. for shrimp and fishes that live as adults offshore (Nybakken 2001). They are important feeding, mating and nesting grounds for migratory sea birds. Protection of mangroves throughout the Maldives is therefore of great importance.

Mangrove ecosystems are scattered throughout the Maldives, found primarily in the northern and southern atolls. There are several places in Baa Atoll where mangroves can be found (Goidhoo (Figure 4 A), Olhugiri, Maamaduvvari and Keyodhoo; *pers. comm*. with island offices), representing the most central occurrence of mangroves in the Maldives. The uninhabited island of Madirivaadhoo used to have mangrove patches as well, but that area totally eroded during the past years (*pers. comm*. Kamadhoo island office). Except for Goidhoo, mangrove patches are rather small, and no extensive mangrove forests have developed. While mangrove abundance is low, mangrove species richness is notably high (Spalding *et al.* 2001), with twelve species reported for the Maldives (Jagtap & Untawale 1999). Three of the species in the region are reported only for Maldives (*Bruguiera cylindrica, Exoecaria agallocha, Sonneratia caseolaris),* but are not actually endemic to the archipelago (Tomlison 1986). Other species, in particular *Avicennia marina* and *Rhizophora mucronata*, are more widespread (Clark 2001). Locals report Ran'doo (*Rhizopora mucronata*) and Kan'doo (*Bruguiera cylindrica*) being the most abundant mangrove species in Baa Atoll. To date, however, no comprehensive survey was conducted with regard to the community composition of mangrove patches in Baa Atoll.

The mangrove fern *Acrostichum aureum* and the *maru gas* tree (*Xylocarpus moluccensis*) are associated with the mangrove ecosystem on Goidhoo (*pers. observ*.). *Maru gas* appears to be a very rare species throughout the Maldives. It grows in the transition zone, where sediment is more stabilised, and which is subject to only a few tidal washes each month. The area occupied by mangroves on Goidhoo was significantly reduced during the past decades due to the use of Kandoo woods for boat building, and to recent land reclamation activities that also diminished mangrove habitat. Recent attempts to re-grow Kandoo in mangrove areas failed (*pers. comm.* with island office).

The mangrove area on Goidhoo is littered with rubbish, but clean-up activities recently started (*pers. observ*.).

Also on Goidhoo, the Upside-Down Jellyfish (*Cassiopeia xamachana*) occurs in great numbers in the shallow mangrove bays (*pers. observ*., Figure 4 B). These sea jellies rely on their symbiotic algae (zooxanthellae) which are a steady source of oxygen and nutrients. Furthermore, *C. xamachana* are an important food source for certain fish and turtles. Along with coral reefs, the Upside-Down Jellyfish faces great danger from the effects of global warming, and slight temperature changes can cause bleaching, i.e. the loss of the symbiotic algae. Environmental change and degradation, caused by human activities, is threatening the populations of *C. xamachana*. Their hypersensitivity to water temperature, substrate composition, turbidity, and salinity make it difficult for the jellies to adjust to human-induced changes.

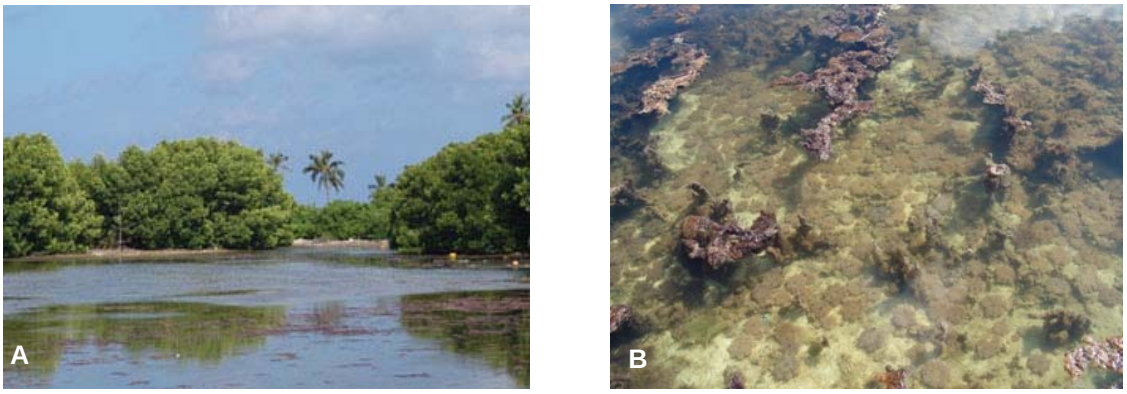

Figure 4. (A) Mangroves on Goidhoo. (B) Upside-down jellyfish in the mangrove lagoon on Goidhoo.

In association with a study on mangroves in Haa Dhaalu, Shaviyani and Seenu atolls (Untawale & Jagtap 1991), marine fungi have also been investigated. 39 species of marine fungi were identified by (Chinnaraj 1993).

However, knowledge of mangrove ecology in the Maldives remains incomplete and there is urgent need for further ecological studies, especially since mangrove ecosystems face increasing anthropogenic threats.

ANTHROPOGENIC IMPACTS ON THE ATOLL ECOSYSTEM

LOCAL FISHERIES

Tuna

Maldivian tuna fishery is the world's largest remaining pole and line fishery. Skipjack tuna (*Katsuwonus pelamis)* is the most important species caught in the Maldivian tuna fishery, comprising more than 80% of the total tuna landings in the Maldives (Adam & Sibert 2002). The fishery has been in existence for nearly a millennium (Adam *et al.* 1997) and despite the economic diversification in recent years, tuna fishing remains the main economic activity in the outer islands (Adam & Sibert 2002) and is one of the pillars of the Maldivian economy (Anderson *et al.* 1998b).

The main tuna species targeted in the Maldives are:

- *kalhubiamas* (Skipjack tuna – *Katsuwonus pelamis*)
- *kanelli* (Yellowfin tuna – *Thunnus albacares*)
- *raagondi* (Frigate tuna – *Auxis thazard*)
- *latti* (Little tuna – *Euthynnus affinis*)
- *woshimas* (Dogtooth tuna – *Gymnosarda unicolor*)

Both Skipjack and Yellowfin tuna are highly migratory and freely move between different Exclusive Economic Zones (EEZs) and High Sea Waters (Anderson *et al.* 1998b). Because of that, there is a legitimate concern that Maldivian tuna catches will be adversely affected by the great increase in tuna fishing effort elsewhere in the Indian Ocean, especially since also in the Maldives tuna is now being exploited at a higher level than ever before (Anderson *et al.* 1998b). Already the Skipjack catches have stagnated, and the average sizes have declined. Furthermore, the stocks of live bait fishes are declining due to the enormous demand of bait fishes for pole and line fishery.

Different species of tuna often school together, especially with other tunas of the same size (e.g. Skipjack and juvenile Yellowfin tuna, or Frigate and Little tuna). But not only tuna species interact with each other, they also interact with other fish species

In Baa Atoll, tuna fishing is now of major importance on only two islands (Thulaahoo and Hithadhoo), although some is still carried out from other islands, including Kendhoo and Eydhafushi. Mainly skipjack tuna (*Katsuwonus pelamis)* and Yellowfin tuna (*Thunnus albacares*) are targeted, for both export and personal use.

The continued health of the tuna fishery is therefore of immense importance to the Maldives (Fisheries Component Report). Despite this, many fishermen are leaving the tuna fishery. Reasons for this include the lure of lucrative reef fisheries, and also the decrease in live bait stocks, which reduces profitability of tuna fishing (Fisheries Component Report 2001).

The recent precipitous decline in Baa Atoll catches (Figure 5) probably also reflects a withdrawal from tuna fishing by fishermen of several islands in favour of reef fishing.

Maintaining a viable, but sustainable tuna fishery is therefore not only important for the economy of the country as a whole, but also for the health of the reef resources, which could otherwise be very rapidly depleted if too many fishermen leave tuna fishery (Fisheries Component Report 2001).

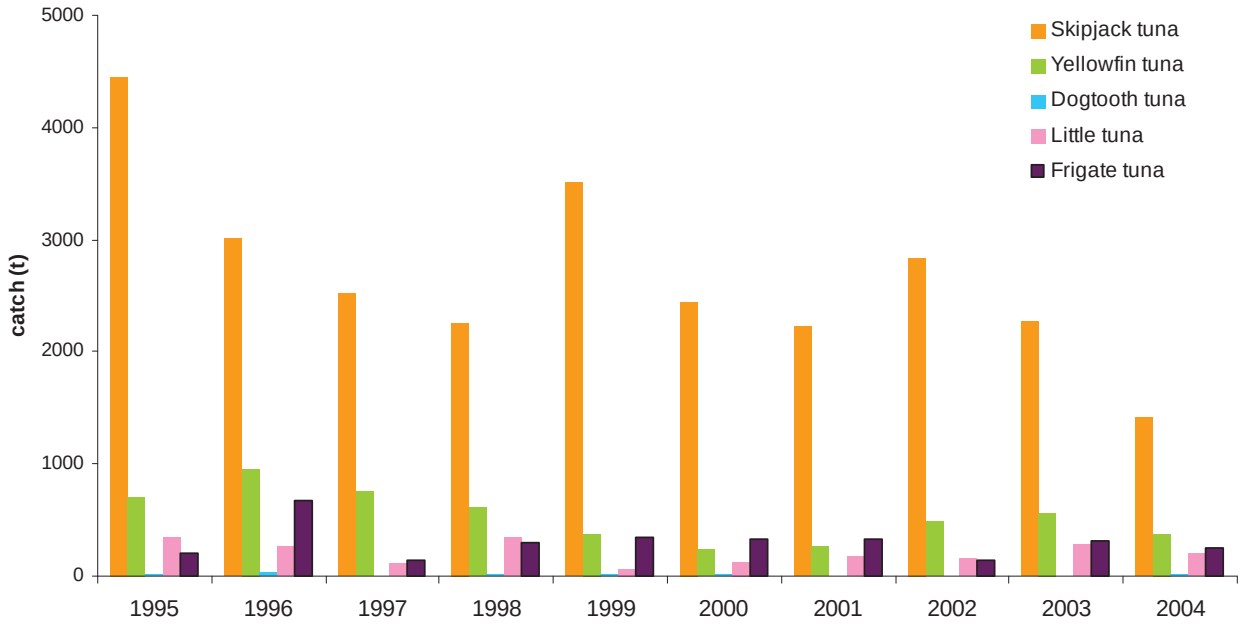

Figure 5. Tuna fisheries in Baa Atolls (Source: Fisheries Statistics 1995 – 2004, MoFA)

Live Baitfish

Live bait fishery is a traditional fishery that has been carried out in the Madlives for at least 1000 years. Small fishes of 100 species are used as bait in the pole and line tuna fishery. Although live bait fishery is widely considered to be sustainable, the quantities of bait caught now are very much larger than the quantities taken traditionally, and fishermen in Baa Atoll report an overall decline in live bait fish stocks, but escpecially for stocks at Anga Faru, Dhonfaru Thila, Kihaadhubimatheefaru, Maavaru, Maahuruvahli. Especially one type of bait fish, *nilamehi* (Blue Damselfish - *Chromis viridis*,) is now very rarely found in entire Baa Atoll. This is considered to be due to mass mortality of branching corals during the El Niño in 1998, leading to the loss of habitat for this species, which is living among the coral branches.

Live bait fishing is carried out on Maalhoos, Dharavandhoo, Thuladhoo and Kendhoo, and main live bait species caught are *rehi* (Silver sprat - *Spratelloides gracilis*), *muguraan* (various species of Fusiliers), *hondheli* (Blue sprat - *Spratelloides delicatulus*), *boadhi* and *fatha* (various species of Cardinalfish - Apogonidae) and *nilamehi* (Blue Damselfish - *Chromis viridis*).

On Thuladhoo, bait fishing is carried out all year round; on the other islands, bait fishing varies with the seasons.

Some fishermen of Thuladhoo have started using lights to fish for bait at night (*pers. comm*. with local fishermen), which can bring them into conflict with more traditional daytime bait fishers. Some fishermen use destructive methods (breaking the corals) to catch bait (Fisheries Component Report 2001)

Reef Fish

At least 100 species of reef fish (e.g. snappers, emperors and jacks) are in demand at Male' market and at tourist resorts. At present these resources appear to be being fished in a sustainable manner, but this may change if valuable export markets develop, as demand from the tourism sector continues to grow, or if more fishermen switch to these resources as other ones are overfished (Fisheries Component Report 2001). Fishermen in Baa Atoll target reef fishes to supply the resorts. The main islands involved are Dhonfanu, Dharavandhoo, Kihaadhoo, Maalhos, Fehendhoo and Kendhoo (*pers. comm.* with local fishermen).

The main reef fish species caught in Baa Atoll are *maaniyamas* (Rainbow runner - *Elagatis bipinnulata*), *giulhu* (Green jobfish - *Aprion virescens*), *fani handhi* (Bluefin jack - *Caranx melampygus*), *raiymas* (Two-spotted red snapper - *Lutjanus bohar*) and other jacks (*handhi*). Fishing grounds mainly on Maabeyrufaru and the entire east side of Baa Atoll (*pers. comm*. with local fishermen)

Aquarium fish collection started in 1980 (Adam *et al.* 1997). It also is an important fisheries activity in the Maldives, although this is centred around the international airport. There have been changes in collection areas over time. In 2000, collection was carried out in Haa Dhaalu, Male', Laamu and Thaa Atolls, while at present, collection sites are mainly in Baa, Male' and Vaavu Atolls (Saleem & Adam 2004). In Baa Atoll, mainly fishermen of Goidhoo are involved in aquarium fisheries (*pers. comm*). The shift in collection sites may aid in the replenishments of fish stocks (Saleem & Adam 2004).

Sharks

As top predators, reef sharks are ecologically of great importance, and their removal is believed to have implications for other reef biodiversity. As one example, fishermen consistently report that the removal of reef sharks reduces catches of live bait, since baitfish usually form schools as a protective measure against predatory sharks, which makes them more accessible for fishermen (Fisheries Component Report 2001), and that the taking of silky sharks from tuna schools reduces subsequent the tuna catches (Anderson *et al.* 1998b)

Under the fisheries law 5/87, MoFA banned the fishing of sharks within Baa Atoll (and 6 other atolls) in September 1998 and within a 12 mile distance from these atolls for a period of 10 years as it was noticed that there was a significant decrease in shark population in the country. Unfortunately, shark population in Baa and other atolls are not monitored, so that there are no data available about population sizes. There is also a lack of enforcement with regard to this legislation.

Figure 6. Shark fishery, Thuladhoo, Baa Atoll

The Fisheries Component Report (2001) furthermore states that illegal shark fishing is still continuing, particularly in Baa Atoll. This is supported by observations of the diving schools (Soleni Dive Centre, Kuhadhoofaru; Delphis Diving, Horubadhoo), since they spot sharks with wounds from fishing hooks, sometimes carrying a fishing line. Despite the official ban of shark fisheries, dive schools have observed a constant decline of the shark population in Baa Atoll over the past years: white tipped reef sharks (*Triaenodon obesus*) are now considered as rare, and the numbers of grey reef sharks (*Carcharhinus amblyrhynchos*) spotted during the dives are constantly decreasing. At "Shark Nursery", a dive site near Angu Faru, the number of sharks has dramatically declined over the past years: of the formerly 40 juvenile and adult sharks, that were regularly spotted, only a couple (max. 5) have been left and can be spotted mainly during December and February (Soleni Dive Center, Kunfanadhoo; Delphis Diving, Horubadhoo; Ocean Pro Dive, Dhunikolhu, *pers. comm*.). The drop in reef shark abundance is believed to have resulted in a considerable loss of diving revenue to the tourism industry.

However, shark watching is probably now more important for the tourist economy in the Maldives than ever before, following the widespread coral mortality following the 1998 El Niño.

Sharks are also associated with oceanic tuna schools, controlling the schools as predators. In the Maldives, these are *oivaali miyaru* (Silky shark – *Carcharhinus falciformis*) and *fee kanfaiy miyaru* (Oceanic white tip shark – *Carcharhinus longimanus*). Local fishermen in Baa report by-catch of juvenile silky sharks during tuna fisheries; regular shark fishing is still carried out by fishermen from Thuladhoo, although they report to fish outside the Atoll, targeting mainly silky sharks (*pers. comm*. with Thuladhoo fishermen).

Grouper

Some 40 species of grouper have been recorded from the Maldives, with only few being currently exploited (Shakeel & Ahmed 1994). Their habitats are coral reefs and stony environments, and they are top predators in the coral reef ecosystem, feeding mainly on fishes, large crustaceans and cephalopods (Sattar & Adam 2005). Their voracious feeding habits and shallow habitats, these fish are easy targets for small-scale fishermen (Shakeel & Ahmed 1997). Handlines are the main gear used in this fishery, and normally baited with live bait (fusiliers) or with pieces of tuna or scad (Adam *et al.* 1997). The fishermen keep their grouper catches alive and sell them to middlemen with holding cages. In 1993, a market has developed exporting groupers to other south-east Asian countries and to supply the tourist resorts in the Maldives (Sluka & Reichenbach 1996, Sattar & Adam 2005).

Because of the high price paid, grouper resources have being exploited unsustainably during the last years, with clear signs that they are being overexploited (Fisheries Component Report 2001). Their sedentary life style, their sex change strategy, their long life span, their aggregation behaviour during spawning season and the fact that they take bait easily, makes groupers especially vulnerable to over-exploitation (Sattar & Adam 2005).

In Baa Atoll, commercial grouper fisheries is now restricted to Fulhadhoo. From 1997 – 2000, fishermen had one grouper holding cage, and the main fishing grounds were around Goidhoo Atoll and inside Baa Atoll (*pers. comm.* with island office). In 2003, 1.26 metric tons of groupers were caught in Baa Atoll (Fisheries statistics 2003). To date, Fulhadoo fishermen target grouper mainly in Kaafu Atoll, and the catch is brought to holding cages there (Sattar & Adam 2005). The main species targeted are *Kas faana* (Brown marbled grouper – *Epinephalus fuscoguttatus*), *Mohlu faana* (Black-saddled coralgrouper – *Plectropomus laevi*), *Kalhu faana* (Eight bar grouper – *Epinephalus fuscoguttatus*), *Thoshi faana* and *Gaburu*.

On Dhonfanu, fishermen were using grouper holding cages, but they stopped using them since the Tsunami in December 2004 (*pers. comm*. with local fishermen).

In all other islands of Baa Atoll, grouper has not been commercially fished for at least three years, mainly due to employment opportunities in the resorts. However, some groupers are caught for personal use, especially in the northern part of Baa Atoll around Kudarikulu.

Baa Atoll is a potential High Priority Area (HPA) with regard to its grouper resource (Sattar & Adam 2005), so there may be a grouper fishery or aquaculture developing in the very near future. This should be kept in mind for ecosystem management issues.

Sea Cucumber

Approximately 20 species of sea cucumber have been recorded from the Maldives. They are generally dried and exported to the Chinese markets of the Far East, notably Singapore, Hong Kong and Taiwan.

Harvesting of holothurians only started in 1985 in the Maldives, and reached its peak in the early 1990s (Joseph 1992, Ahmed *et al.* 1997). The uncontrolled expansion of sea cucumber fisheries, however, resulted in rapid overexploitation of resources, especially the high-valued but less abundant species like *alanaasi* (*Thelenota ananas*) and *batu* (*Microthele nobilis*). Too little regulatory measures were taken too late (Ahmed *et al.* 1997). In 1993, the taking of sea cucumbers using SCUBA equipment was prohibited in order to protect some breeding stocks (Fisheries Law). However, this prohibition was not being adequately enforced, and illegal diving is still carried out mainly in the northern part of Baa Atoll (*pers. comm.* with local fishermen). This illegal diving is normally carried out by untrained fishermen, who have suffered several fatalities and many injuries through uninformed diving practices (Fisheries Component Report 2001).

The stock depletion leads to a shift in the species which are commercially exploited. Today, *batu* (White Teatfish – *Microthele nobilis*), which is the most valuable species in the market, can only be harvested in low numbers (Fisheries stats 2004). Both *elephant* (Elephant's trunkfish – *Microthele axiologa*) and *kachchala* (Giant Beche-de-mer – *Thelenota anax*), which were rarely exploited in the

1990s (Ahmed *et al.* 1997), are now the second biggest catch in Maldivian sea cucumber fisheries (Fisheries statistics 2004).

Holhi (Lollyfish - *Halodeima afro*), formerly the most abundant holothurian species in the Maldives (Ahmed *et al.* 1997), is still harvested, but numbers show high seasonal variation (Fisheries stats 2004). Recently, a dramatic decline of more than 40 % in the numbers harvested occurred: while in 2003 111,436 *hohli* were caught, the total catch dropped to 66,442 in 2004.

Alanaasi (Surf Redfish - *Thelenota ananas*) is now considered very rare, with small amounts only available in deeper waters (Ahmed *et al.* 1997). However, they are still commercially exploited (Fisheries stats 2004). *Feeru* (Green fish – *Stichopus chloronotus*) was thought to be of little commercial value before 1994 (Ahmed *et al.* 1997); to date, it is exploited in large numbers throughout the Maldives (Fisheries statistics 2004).

In the early 1990s, this fishery was located in Baa Atoll on Goidhoo, Hithaadhoo, Thulhaadhoo and Kendhoo (Joseph 1992), while to date sea cucumber fishing is being carried out mainly on Thuladhoo during Iruvai monsoon (*pers. comm*. with local fishermen), and occasionally on Kamadhoo, Eydhafushi and Fehendhoo (Fisheries Component Report 2001). No sea cucumber fishing has been done on Dharavandhoo for two years. Stocks are also said to be depleted in most of Baa Atoll.

The processing of sea cucumbers can cause considerable harm to fish stocks. Many species, especially *Alanaasi*, *Feeru* and *Hohli*, contain the toxin Holothurin, which is poisonous to fish. By boiling sea cucumbers, the toxin leaks out and contaminates the boiling water, which is generally discharged in the island's lagoon, and leads to fish mortality (Joseph 1992).

Lobster

Ihi (lobsters) are commercially exploited generally for the tourist market, and hardly harvested for personal use. Five species of spiny lobster are reported from the Maldives:

- *Panulirus longipes*
- *Panulirus penicillatus*
- *Panulirus ornatus*
- *Panulirus versicolor*
- *Panulirus polyphagus*

Fishermen collect lobsters at night by swimming with lights, diving along the reef face and also walking on the reef flat (Ahmed *et al.* 1997).

Lobster Fishery in Baa Atoll shows a very high variation within the years (Figure 7). While in the late 1990s lobster was caught in relatively high numbers, they are now hardly targeted. The main islands for lobster fishery are Kihaadhoo and Thuladhoo, although no lobster was collected in 2004. On Thuladhoo, lobsters are generally collected during Iruvai monsoon. On Dhonfanu and Kudarikilu, lobster is sometimes caught, though not commercially. On Maalhoss and Dharavandhoo, no lobster fishery has been carried out for at least two years (*pers. comm.* with local fishermen).

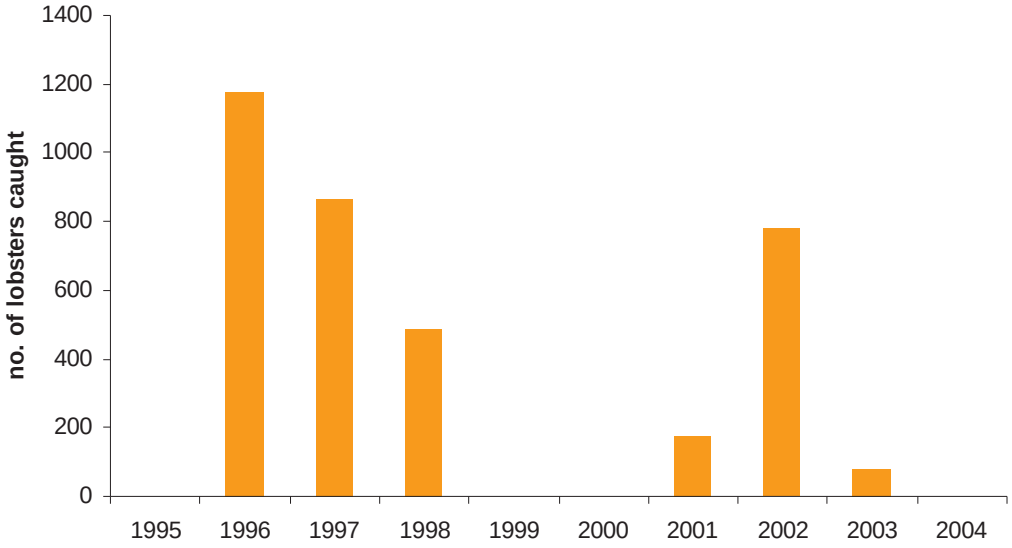

Figure 7. Lobster catch in Baa Atoll 1995 – 2004 (Source: Basic Fisheries Statistics 1995 - 2004; MoFAMR)

Tourist Impacts

Diving & Snorkelling

Although most dive schools in the Maldives have relatively high standards in diving safety and are creating awareness for protecting the reef ecosystem, both diving and snorkeling has an enormous impact on coral reef ecosystems (*pers. observ*.; *pers comm*. with Soleni Dive Centre, Kufanadhoo). Branching and tabulate hard corals and well as gorgonians (horn corals) are particularly vulnerable to being kicked with fins (Figure 8), resulting in breakage and damage of the living tissue (Allison 1996).


PHOTOS: LAURETTA BIRKE

Since coral polyps are slow growing organisms, it does take a very long time for the colony to reach its original size. Touching corals causes tissue damage, making the coral polyps perceptive to infections.

Especially after the mass bleaching event in 1998, wide areas of the reef flat appear to be dead, so tourist show a rather careless behaviour, and standing on the reef is observed more often. However, standing on the reef crushes juvenile, and therefore overseen, coral colonies. This is of particular importance for long term reef recovery.

Figure 8. Snorkeler standing on table corals.

Fishing

Night fishing as well as Big Game Fishing is a regular practice in most resorts in Baa Atoll. Frequently visited reefs for night fishing are Dhigu Faru, Mendhoo reef, Binmathee Faru, Hibalhidhoo Kandu, Nelivaru and Dharavandhoo Bodu Kandu. While night fishing trips are carried out on a daily basis with 2-3 boats, Big Game Fishing is offered several times a week (Royal Island Resort, Horubadhoo, *pers. comm.*). During night fishing trips, red snappers and groupers are caught, whereas during the Big Game fishing trips, mainly tuna, barracuda, marlin and giant trevallies are caught.

Tourist fishing activities have a considerable negative impact on the fragile reef environments and should be banned, since they are not carried out for a livelihood but just for leisure.

Night Fishing is carried out in rather shallow water, above the coral reef. The most common practice is hand-lining from a boat. The major concerns associated with this kind of fishing are:

- Fishing lines getting entangled in coral colonies, causing considerable damage to the living tissue or even breakage (Figure 9 A).
- The boat's anchors are often tossed onto the reef, thereby damaging corals (Figure 9B). Since resorts are generally visiting the same sites for night fishing, this leads to a cumulative damage of the corals in these sites.
- Reef associated fish are caught in an unselective way, *i.e.* all by-catch such as moray eels, stingrays and triggerfish is generally also killed, either right away or after having been thrown back into the water with the cut fishing line and hook.

By removing these coral reef associated species, which often play a key role in the ecosystem functioning (e.g. triggerfish, but also top predators like Marlins and Giant Trevallies), humans interfere with the natural ecological balance, and therefore contributing to coral reef degradation in the Maldives.

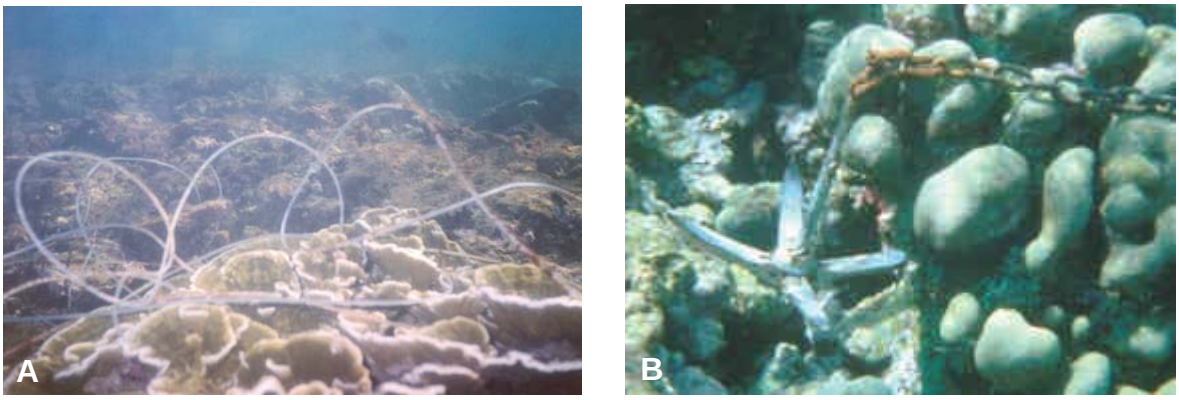

Figure 9. Fishing impacts on coral reefs. (A) Fishing line entangled in corals (http://www.deborahbrosnan.com/) (B) anchoring damage on massive corals (http://www.dep.state.fl.us/coastal/habitats/coral.htm).

Souvenir trade

Many marine organisms, mainly shells of gastropods (such as cowrie, queen and spider conches and triton shells), bivalves and cephalopods (*Nautilus* sp.), but also shark jaws and porcupine fish are traded as souvenirs in the tourism industry. Fortunately, since 1995, the trade of products made of turtle shell is prohibited in the Maldives.

In Baa Atoll, there are 25 souvenir shops on Dharavandhoo, and one shop on Dhonfanu. Most souvenir shops actually import most marine souvenirs from Indonesia (*pers. comm.* with shop owners). This reduces the pressure on local marine ecosystems, but this benefit is highly equivocal since other tropical ecosystems are overexploited in an unsustainable way, bearing in mind the huge amounts of shells and shark jaws found in Maldivian souvenir shops.

CORAL, SAND AND AKIRI MINING

In the past, coral mining has severely impaired the capacity of some reefs to act as natural sea defences, and undermined their biological role as fishery areas and repositories of biodiversity. Since mainly extremely slow growing massive coral species like Poritids and Faviids have been taken (Naseer 1996), the consequences of mining activities will be prevalent for many years after the activity

has stopped, since rubble mobility and increased abrasion limits larval settlement (Naseer 1996). The removal of large portions of corals furthermore increases erosion of the remaining reef, leading to a persistent loss of biomass and habitat for reef associated species, especially economically important bait fish species.

Sand mining activities do affect the atoll ecosystem by reducing the size of beaches, particularly with regard to sand banks and uninhabited islands, which are frequently visited by turtles and seabirds. Limitation of nesting grounds has far reaching consequences for reproductional success and therefore population sizes.

The major trend is a decline in the amount of coral being mined within Baa Atoll since the introduction of the 1992 legislation and the introduction of the block building industry (Clark 2001). At the same time quantities of sand being extracted from the beaches for the building block industry are increasing (Figure 9), and peaked in 2000, probably due to large land reclamation activities on Hithadhoo and Thuladhoo. There appears to be a slight increase in the amounts of Akiri being collected.

Privious coral mining sites are Dhigu Faru, Dhimuathi faru, Vandhu maafaru, Bodughaa falhu, Magii, Hanifarurah and Ogalhi (Clark 2001). The removal of corals has long term consequences for reef biodiversity: reef recovery at mine sites will take a long time, not only due to the extremely low growth rates of massive coral species, e.g. Poritidae, but also to the unstable substrate that prevents settlement and abrasion of newly settled coral larvae by loose rubble.

Sand mining is undertaken regularly on the islands of Maalhoss, Dharavandhoo, Thuladhoo, Eydhafushi, Goidhoo, Fehendhoo, Dhonfanu, Kihaadhoo, Kamadhoo and Kudarikilu, with sand normally taken from the island's house beach (Clark 2001). Until 2000, Bodufinolhu near Thuladhoo was a major sand mining site, but due to erosion mining activities were terminated (Clark 2001). In recent years, sand is also taken from the uninhabited islands Maaddoo, Mudhdhoo, Finolhas and Kinavanhuruvalhi (MEEW). Especially on Maaddoo and Mudhdhoo, sand mining activities interfere with nesting activities of turtles and sea birds.

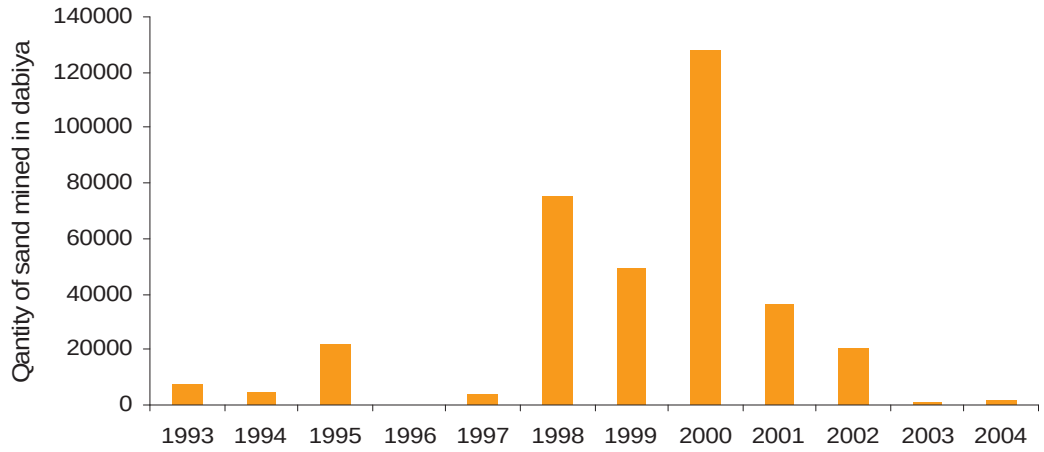

Figure 9. Amounts of sand mined in Baa Atoll 1993-2004 (Source: MEEW)

On Maalhoss, Akiri that is washed on the beaches is collected for construction purposes (*pers. comm*.). Other Akiri mining sites are Maamaduvvari and Ohlugiri (Clark 2001).

Navigational channels

Eight islands in Baa Atoll have navigational channels, which have been cleared on the shallow reef flat. For maintenance, these channels need to be frequently dredged in most cases (Clark 2001).

The construction of channel, although necessary and socio-economically beneficial, results in direct habitat loss for corals and reef associated species, and increased sedimentation.

Sedimentation and smothering of the surrounding reef with silt is a direct consequence of maintenance dredging and a major source of persistent reef degradation. Sedimentation and smothering physically disturbs coral polyps and also reduces light penetration in the water column. This leads to reduced photosynthesis of the coral's symbiothic algae (zooxanthellae) and therefore results in a reduced net productivity of the corals with reduced growth and calcification rates as well as a reduced reproduction.

Harbour operations

Harbours also incur an element of environmental risk. The major environmental concerns associated with harbour operations include:

- Potential for shipping/boating accidents which could release massive amounts of oil, petrol or other hazardous substances into the marine environment
- Release of waste oil, bilge water and other substances, which are likely to become an environmental problem
- Release of toxic compounds (e.g. organic petroleum residues, heavy metals and antifouling compounds)
- disturbance and re-suspension of marine sediments

Threats to biodiversity result from a degradation of water quality (i.e. changes in turbidity, salinity and temperature) and increased eutrophication in the nearshore area. Changes in coastal current patterns, as a result of dredging, may also have effects on the biodiversity by influencing the reef community structure (Clark 2001).

Jetties and breakwaters

The placement of breakwaters in nearshore areas is often inappropriate with regard to natural coastal processes (Kench *et al.* 2003), often interrupting the longshore transport in the updrift area of the breakwater and increased water velocity around it. This can result in adverse environmental effects, such as:

- Increased sediment transport away from the breakwater, scour holes may develop
- Breakwaters or seawalls can cause total blockage resulting in increases in velocity along their sides
- Erosion of adjacent beaches as a result of changes in currents.

Six islands in Baa Atoll have jetties, but some are old and not in use. Generally jetties are favoured by tourist resorts. Breakwaters have been built on eight islands. Erosion of beaches is a major environmental concern on many islands in Baa Atoll, e.g. Maalhoss, Dhonfanu, Eydhafushi, Thuladhoo and Hithadhoo (*pers. observ.*).

Although not a serious threat to marine biodiversity, it is a serious environmental issue because it results in loss of beach and vegetation, which provide critical habitat for turtle and bird nesting. In addition it can cause severe erosion and bring about loss of coastal infrastructure.

ENVIRONMENTAL PROJECTS IN BAA ATOLL

MARINE PROTECTED AREA

In October 1999, the first – and to date only - Marine Protected Area (MPA) in Baa Atoll was established at Dhigali Haa/Horubadhoo Thila (05°08.842' N, 73°02.43' E) by the Ministry of Home Affairs, Housing and Environment (MoHAHE). This site was recommended by resorts and dive schools since grey reef sharks, white tipped reef sharks, barracudas, jacks and turtles were frequently sighted.

According to the Environment Protection and Preservation Act (4/93), the following activities are protected within the marine protected area:

- anchoring (except in emergency)
- coral and sand mining
- rubbish dumping
- removal of any natural object or living creatures
- fishing of any kind (e.g. for sharks or reef fish) with exception of traditional live bait fishing
- any other activity which may cause damage to the area or its associated marine life

Populations of grey reef sharks and white tipped reef sharks, however, have substantially declined during the past years. Although all fishing activities are banned within the MPA, except traditional bait fishing, divers regularly remove fishing lines and hooks, entangled in the hard corals (Delphis Diving, Horubadhoo, *pers. comm.*), which clearly indicates that there are fishing activities illegally carried out. Local fishermen report that Dhigaali Haa is a regularly visited bait fishing ground. Furthermore, damage of corals caused by anchoring is observed frequently (Allison, *pers comm.*).

Dhigali Haa /Horubadhoo Thila is, as all MPAs throughout the Maldives, still not assigned by IUCN (Spalding *et al.* 2001), and lacks consistent monitoring.

CONSERVATION PROJECTS ON LOCAL ISLANDS.

The school of Dharavandhoo is offering an environmental club for their students, supervised by a teacher. The main activities of this club only focus on terrestrial habitats and include beach cleanup and tree planting activities, as well as watering and culturing the previously planted trees, on a regular basis. The school in Maalhos is not able to offer such a club for its students due to a lack in capacities, but the youth association on this island conducts regular beach and reef clean-ups and tree plantings. Further environmental clubs can be found on Thuladhoo, Kendhoo, Hithadhoo, Kudarikilu, Goidhoo, Eydhafushi (*pers. comm.*).

ONGOING AND PLANNED PROJECTS

The only ongoing conservation project in Baa Atoll is the turtle hatchery project on Kendhoo. Awareness has been successfully created amongst islanders not to exploit turtle eggs, and knowledge on turtle ecology has been increased.

Besides the conservation projects planned within the scope of this UNDP programme, no further projects are planned for Baa Atoll in the near future (Jameel and Zuhair, *pers. comm.*)

OUTLOOK AND RECOMMENDATIONS

Especially in the marine environment, various conservation needs have been identified for Baa Atoll, since several species face human-induced threats. There is an urgent need for protection especially for the populations of both Hawksbill and Green Turtles, sharks and sea birds. All three groups are already protected by Maldivian law. However, legislation is insufficient (in the case of turtles and sea birds), or there is lack of enforcement of legislation as in the case of shark fisheries. The lack of knowledge amongst fishermen and locals regarding the ecology of turtles, seabirds and sharks is serious, and there is the urgent need of increasing the awareness for environmental issues. This is of vital importance for the people of Maldives whose livelihood entirely depends on healthy atoll ecosystems, and reducing anthropogenic impacts to a minimum should therefore be given top priority.

Since the threats are human induced, they should – and actually can – be reduced as soon as possible.

Various factors contribute to the non-sustainable utilization of the atoll ecosystem in Baa atoll:

- Inadequate reef resources management due to the lack of a clear management structure
- The lack of information on the biological status of reef resources and socio-economic aspects of the fisheries exacerbates the establishment of adequate conservation programmes. Even for those resources that have been investigated, up to date information is lacking.
- Underlying both of the factors above is a lack of trained personnel
- Inadequate institutional capacity to enforce existing conservation and fisheries regulations has resulted in a *laissez-faire* attitude towards management of reef resources

Recommendations

- Apply IUCN guidelines to the MPA at Dhigali Haa, assign the MPA to IUCN guidance; establishment of a non-fishing zone around of Dhigali Haa (closing the area even for traditional bait fishing practices) to give the declining populations of bait fishes a chance to recover; once the reef fish populations recover and population sizes increase, other reef areas will benefit, by spreading of fish larvae and emigration of bait/reef fish to adjacent fishing grounds; start a monitoring programme
- Introduce a fee system for divers who visit the MPA to support reef monitoring programmes and conservation projects, as practised in the Caribbean (Green & Donnelly 2003)
- Incorporate dive schools in annual reef checks; each dive school should be responsible for one or more reefs/dive sites and conduct an annual reef survey according to the reef check guidelines (“Adopt a reef”); the development of survey questionnaires for divers has been successful in stock assessments in the Mediterranean (Goffredo *et al.* 2004) and could be an

valuable option in the Maldives to monitor the abundance of certain fish species (grouper, sharks etc.) and turtles

- Ban harvesting of turtle eggs as soon as possible with a simultaneous information/education campaign for locals and fishermen on the ecology of turtles and why they should be protected
- Enforce the ban of shark fishery, also linked with a information campaign about both ecological and economic benefits of a stable shark population for Baa Atoll
- Improve national legislation in order to protect vulnerable species such as sharks and marine turtles. The government should furthermore accede the CITES and Bonn Convention on Migratory Species in order to meet the objectives of turtle conservation regionally and internationally
- Join the Ramsar Convention on Wetlands; establish a Ramsar Site at Goidhoo in order to protect the fragile mangrove ecosystem; promote clean-up activities in mangrove patches
- Enforce stock assessment in fisheries to prevent overexploitation
- Incorporate locals and fishermen in conservation projects
- Support sustainable and environmental friendly mariculture (e.g. sea cucumbers and mussels in polyculture) to provide alternative livelihoods for fishermen
- So far, schools and environmental clubs mainly conduct beach cleanups and tree planting activities. Both therefore need to be supported in the establishment of further conservation projects (“Adopt a reef”, “Protect the Turtles” etc.). There is furthermore an enormous lack of knowledge with regards to the ecology of the marine environment. The development of an education program and/or manuals that are easy to understand would be of high benefit. Teachers should receive special training in order to develop and conduct conservation projects. Schools and environmental clubs should be encouraged to participate in conservation projects with a Green Award for their achievements
- Improve and strengthen the cooperation between the various governmental sections that deal with environmental issues. The exchange of data and information is crucial for the success of interdisciplinary conservation projects and for the implementation of individual and team objectives.

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APPENDIX 1

Vegetation found on Kunfanadhoo, Baa Atoll (after ECOCARE: "A hand guide of the plants of Sonevafushi")

Scientific name	Family	English name	Dhivehi name
Crinum asiaticum	Amaryllidaceae	Nagadamani	Maakan'dholhu
Plumeria obtusa	Apocynaceae	Pagoda tree	Gulchampaa
Ochsrosia borbonica	Apocynaceae	Cork wood	Dhun'buri
Cerbera odollam	Apocynaceae	Odallum Tree / Dog-Bane	Bodu dhun'buri
Cantharanthus roseus	Apocynaceae	Madagaskar periwinkle	Malikuruvaa
Colocasia esulenta	Araceae	Elephant ear	Ala (kahanala)
Cocos nucifer	Arecaceae	Coconut tree	Dhivehi ruh
Calotropis gigantea	Asclepiadaceae	Gigantic swallowwort	Ruvaa
Wedelia calendulacea	Asteraceae	Bicolored lespedeza	Mirihi
Tournefortia argentea	Borangiaceae	Tree heliotrope	Boashi
Cassia fistula	Caesalpiniaceae	Golden shower	Na'malthaashi
Caesalpinia bonduc	Caesalpiniaceae	Fever nut / Bonduc nut	Kashi Kun'buru
Casuarina equisetifolia	Casuarinaceae	Horsetail	Fithroanu
Terminalia catappa	Combretaceae	Indian almond	Midhili
Ipomoea bonanox	Convolvulaceae	Moon flower	Fehan'da
Polystichum munitum	Dryopteridaceae	Western sword fern	Keesfilaa
Cordia subcordata	Ehretiaceae	Sea trumpet	Kaani
Ricinus communis	Euphorbiaceae	Castor	Aamanka
Canavalia maritima	Fabaceae	Beach bean	Maanifaa
Sophora tomentosa	Fabaceae	Silver bush	Fusthulhaa
Seaevola taccada	Goodeniaceae	Sea lettuce tree	Magoo
Calaphyllum inophyllum	Guttiferae	Alexandrian laurelwood tree	Funa
Hermandia peltata	Hermandiaceae	Jack in the Box	Mas Kan'dhu
Cassytha filiformis	Lauraceae	Love vine	Velan'buli
Barringtonia asiatica	Lecythidaceae	Fish poison tree	Kim'bi

Gloriosa superba	Liliaceae	Malabar glory lily	Vihalagon'di
Pemphis acidula	Lythraceae	Iron wood	Lhis Kuredhi
Hibiscus tiliaceus	Malvaceae	Yellow mallow tree	Dhiggaa
Thespesia populnea	Malvaceae	Portia tree	Hirun'dhu
Azadirachta indica	Meliaceae	Neem tree	Hithigas
Adenanthera pavonina	Mimosaceae	Coral wood / Red bead tree	Madhoshi
Leucaena leucocephala	Mimosaceae	Ipil ipil	Ipil Ipil
Ficus bengalensis	Moraceae	Banyan tree	Nika
Pandanus tectorus	Pandanaceae	Screw pine	Boa Kashikeyo
Pandanus odoratissimus	Pandanaceae	Common seashore screw pine	Kashima
Passiflora suberosa	Passiofloraceae	Cork-barked Passion flower	Rangu
Zizyphus mauritina	Rhamnaceae	Stone apple	Kunnaaru
Guettarda speciosa	Rubiaceae	Nit pitcha	Uni
Morinda citrifolia	Rubiaceae	Cheese fruit	Ahigas
Dodonea ciscosa	Sapindaceae	Giant hop bush	Kudhiruvaali
Allophylus timorensis	Sapindaceae		Dhon Moosa
Suriana maritima	Simaroubaceae	Tassel plant	Halaveli
Physalis minimalis	Solanaceae	Country goosberry	Muraaki
Tacca pinnatifida	Taccaceae	Indian arrowroot	Hiththala
Muntingia calabura	Tiliaceae	Chinese cherry	Jeymu
Turnera ulmifolia	Tumeraceae	Saga Rose	Bakarinukaa
Premna obtusifolia	Verbenaceae	Premna	Dhakan'dhaa
Lantana camara	Verbenaceae	Wild sage / Lantana weed	Kashikothan

APPENDIX 2

Reef-building corals found on Foniimagoodhoo in 1997 and 2001 (after Naseer *et al.* 1997, Anonymus 2001)

Family	1997	2001
Acroporidae	*Acropora formosa* *Acropora grandis*	*Acropora* sp. *Montipora* sp.
Oculinidae	*Galaxea* sp.	
Merulinidae	*Merulina ampliata*	
Agrariciidae	*Gardineroseris planulata*	*Gardineroseris planulata* *Pavona* sp.
Siderastreidae	*Psammocora* sp.	
Poritidae	*Porites* sp. *Goniopora* sp.	*Porites* sp.
Faviidae	*Platygyra* sp. *Goniastrea* sp. *Diploastrea heliopora* *Montastra* sp. *Echinopora* sp. *Leptastrea* sp. *Leptoria phrygia*	*Favia* sp. *Cyphastrea* sp.
Fungiidae	*Fungia* sp.	
Musiidae		*Symphillia* sp.
Pocilloporidae		*Pocillopora* sp.

APPENDIX 3

Marine mollusks recorded from Baa Atoll. List compiled from a gastropod survey (Carl Ehrlich & MRC, 2000), personal observations, and a publication by Yonow (1994)

Gastropoda

Austroclavus exasperatus (Reeve 1843)
Bufonaria margaritula (Deshayes 1832)
*Cantharus (Prodotia) iostomus (*Gray 1834)
Cerrithium sp.
Chelidonura castanea sp. nov.
Chromodoris geometrica
Colubraria muricata (Lightfood 1786)
Colubraria nitidula (Sowerby 1833)
Colubraria souverbii (Reeve 1844)
Conus alicus (Linne 1758)
Conus aureus ((Hwass 1972)
Conus bandanus (Hwass 1792)
Conus barthelemyi (Bernardi 1861)
Conus distans (Hwass 1792)
Conus eximius (Reeve 1849)
Conus leehmani (DaMotta & Rockel 1979)
Conus leopardus (Roding 1789)
Conus lividus (Hwass 1792)
Conus mustelinus (Hwass 1792)
Conus obscurus (Sowerby 1837)
Conus pertusus (Hwass 1792)
Conus quercinus (Lightfoot 1786)
Conus rattus (Hwass 1792)
Conus scabrinsculus (Dillwyn 1817)
Conus tessulatus (Born 1778)
Conus vergo (Linne 1758)
Conus violacus (Gimelin 1791)
Conus zonatus (Hwass 1792)
Coriocella hibyae (Hypsogastropoda)
Cymatium hepticum (Roeding 1798)
Cymatium pilerra (Reeve 1844)
Cypraea argus (Perry 1811)
Cypraea carneola (L. 1758)
Cypraea cribraria (Linne 1758)
Cypraea erosa (L. 1758)
Cypraea gangramosa (Dellwyn 1817)

Cypraea histrio (Gemlin 1791)
Cypraea lynx (L. 1758)
Cypraea microdone (Gray 1828)
Cypraea moneta (L. 1758)
Cypraea poraria (Linne 1758)
Cypraea punctata (Linne 1771)
Cypraea vitellus (Linne 1758)
Cypraea ziezac (Lamarck 1810)
Imbricaria punctata (Swanson 1821)
Lambis truncata (?)
Mitra fraga (Quoy & Galimard 1833)
Mitra mitra (Linne 1758)
Murex chcoreus palmarosae (Lamarck 1822)
Murex chcoreus sauliae (Sowerby 1841)
Murex favartia brevicula (Sowerby 1834)
Murex naquetia trigonolus (Lamarck 1816)
Murex naquetia vokosae (Houart 1986)
Nassarius glans (Linne 1758)
Nassarius graniferus (Kiener 1834)
Neocancilla clathrus (Gmelin 1791)
Nerita chamaeleon (L. 1758)
Notodoris gardineri var. nigerrima var nov.
Oliva annutate (Gmelin 1791)
Otopleura nodicinota (Adams 1857)
Phyllidia varicosa (Opistobranchia)
Pollicina sp.
Spondylus gaederopus (L. 1758)
Strombus dentatus (Linne 1758)
Strombus gibberulus albus (Mörch 1850)
Tambja olivaria sp. nov
Tectus pyramis noduliferus (Lamarck 1822)
Terebridae columellaris (Hinds 1844)
Terebridae hastula striligate (Linne 1758)
Terebridae hestala (Linne 1767)
Terebridae subulata (Linne 1767)
Trochus maculatus (L. 1758)
Tuna taytoniana (Reeve 1846)
Vexillum (Costellaria) sanguisugum (Linne 1758)

Bivalvia

Tridacna sqamosa (L. 1758)
Tellina virgata (L. 1758)
Arca sp.
Lithophaga sp.

Cephalopoda

Spirula spirula (L. 1758)
Sepiotheutis lessoniana

A6

APPENDIX 4

Reef associated fish found on Fonimagoodhoo during 1997 and 2001 (after Naseer *et al.* 1997, Anonymus 2001).

Family	Species	Common name	Dhivehi name	1997	2000
Muraeidae	*Gymnothorax* sp.	Moray eels	Ven	x	
Serranidae	*Aethaloperca rogaa*	Redmouth grouper	Ginimas faana	x	
	Anyperodon leucogrammicus	Slender grouper	Boalhajehi faana	x	x
	Cephalopholis argus	Peacock hind	Mas faana	x	x
	Cephalopholis miniata	Coral hind	Koveli faana	x	
	Ephinephelus merra	Honeycomb grouper	Lah faana		x
	Pseudoanthias evansi	Yellowback anthias	Mathi dhon bureki	x	
	Pseudoanthias squamipinnis	Scalefin anthias	Kashikeyo mas	x	
	Variola louti	Moontail sea bass	Kandu haa	x	
Carrangidae	*Caranx melampygus*	Blue fin trevally	Fani handhi	x	
Lutjanidae	*Aprion virescens*	Green jobfish	Giulhu	x	
	Caesio sp.	Fusilier	Mugaraan	x	
	Lutjanus bohar	Two-spot red snapper	Raiymas	x	
	Lutjanus monostigma	One-spot snapper	Filolhu	x	
	Macolor macularis	Midnight snapper	Kalhu foniyamas	x	
	Pterocaesio tile	Dark-banded fusilier	Garahitha muguraan	x	
Mullidae	*Parupeneus bifasciatus*	Doublebar goatfish	Asdhaanu kaluoh'		x
	Parupeneus cyclostomus	Goldsaddle goatfish	Ran kaluoh'	x	
Pomacentridae	*Amphiprion clarkii*	Clark's anemonefish	Maagandu mas	x	
	Amphiprion nigripes	Maldive anemonefish	Dhivehi maagandumas	x	
	Chromis viridis	Blue-green damselfish	Nilamehi	x	
	Chryseptera brownrigii	Surge demoiselle	Faiga koshaa dhanbaa		x
	Dascyllus aruanus	Three-bar dascyllus	Muraka mas	x	
	Plectroglyphidodon lacrymatus	Jewel damsel	Thijjehi dhanbaa	x	
	Pomacentrus chrysurus	Whitetail damsel	Hudhu nigoo dhanbaa		x
	Pomacentrus indicus	Indian damsel	Kula dhanbaa		x
Labridae	*Anampses meleagrides*	Marble wrasse	Koveli hikaa	x	
	Cheilinus trilobatus	Tripletail wrasse	Hikaa		x
	Epibulus insidiator	Slingjaw wrasse	Thun dhamaa hikaa	x	
	Gomphosus caeruleus	Bird wrasse	Theyofulhi hikaa	x	x
	Halichoeres hortulanus	Checkerboard wrasse	Gulsanpaa hikaa	x	x
	Labroides dimiatus	Cleaner wrasse	Theyofulhi mas	x	x
	Novaculichthys taeniourus	Rockmover wrasse	Gaa furolhaa hikaa		x
	Stethojulis albovittata	Bluelined wrasse			x
	Thalassoma amblycephalum	Bluntheaded wrasse	Baiypen hikaa		x
	Thalassoma hardwicke	Sixbar wrasse	Kaashi hikaa		x

hlorurus sordidus	Daisy parrotfish	Landaa	x	x
hlorurus strongylocephalus	Steephead parrotfish	Landaa	x	x
carus niger	Dusky parrotfish	Landaa	x	x
carus rubroviolaceus	Ember parrotfish	Landaa	x	x
carus scaber	Fivesaddle parrotfish	Landaa	x	x
haetodon auriga	Threadfin butterflyfish	Naruvaa bibee		x
haetodon falcula	Saddleback butterflyfish	Asdhaanu bibee	x	x
haetodon kleinii	Klein's butterflyfish	Alanaasi bibee	x	
haetodon adagaskariensis	Madagascar butterflyfish	Madagaskara bibee	x	
haetodon meyeri	Meyer's butterflyfish	Oirongu bibee	x	x
haetodon trifascialis	Chevron butterflyfish	Haluvi bibee	x	
haetodon trifasciatus	Oval butterflyfish	Bisburu bibee	x	x
haetodon xanthocephalus	Yellow head butterflyfish	Boareendhoo bibee		x
orcipiger longirostris	Long-nosed butterflyfish	Thundhigu bibee	x	x
emitaurichthys zoster	Black pyramid butterflyfish	Oimathi bibee	x	
eniochus monoceros	Masked bannerfish	Maasku bibee	x	
oolemichthys trimaculatus	Threespot angelfish	Dhon kokaamas	x	
entropyge sp.	Angelfish	Kokaamas	x	
omacanthus imperator	Imperator angelfish	Ras kokaamas	x	
ygoplites diacanthus	Regal angelfish	Kula kokaamas	x	
canthurus leucosternon	Blue surgeonfish	Noo kaalhu	x	x
tenochaetus striatus	Straited surgeonfish	Rongu dhemi kaalhu	x	x
aso brevirostris	Spotted unicornfish	Thunbi	x	
aso hexacanthus	Sleek unicornfish	Dhalhu neiy thunbi	x	
aso lituratus	Orange spine unicornfish	Ran geri	x	x
aso unicornis	Bluespine unicornfish			x
aso vlamingi	Vlaming's unicornfish	Vaalan mas		x
ebrasoma scopas	Brushtail tang	Kalhu dhunfaiy mas	x	x
ebrosoma desjardinii	Desjardin's sailfin tang	Dhunfaiy mas	x	
ereleotris evides	Blackfin dartfish	Funna	x	
anclus cornutus	Moorish idol	Dhidha mas	x	x
xymonocanthus ngirostris	Longnose filefish	Thundhigu fathirondu	x	
alistatpus undulates	Orangestriped triggerfish	Dhaifuku rondu	x	x
alistatpus viridescens	Titan triggerfish	Maarondu	x	
alistoides conspiculum	Clown triggerfish	Bis rondu	x	
elychthys indicus	Indian triggerfish	Hindhu kalhu rondu	x	x
donus niger	Redtoothed triggerfish	Vaalan rondu	x	
aracirrhites sp.	Hawksfish	Gobaa	x	

Haemulidae	*Plectorhinchus vittatus*	Oriental Sweetlip	Kandu guruva	x	
Holocentridae	*Myripristis murdjan*	Pinecone soldierfish	Berebedhi dhanbodu	x	x
Clupeidae	*Spratelloides gracilis*	Silver sprat	Rehi	x	
Apogonidae	var spec.	Cardinalfishes	Boadhi	x	
Tetradontidae	*Canthigaster valentini*	Sharpnose puffer	Thaakihaa koli		x
Kyphosidae	*Kyphosus cinerascens*	Snubnose rudderfish	Kirulhiya mas		x
Synodontidae	1 species				x

APPENDIX 5

Birds protected under the Environment Protection and Preservation Act (4/93)

Local Name	Common Name	*Scientific Name*
Ainmathee Gaadhooni	Lesser Crested Tern	*Sterna bengalensis*
Alaka	Grey Plover	*Pluvialis squatarola*
Angoti Bondana	Common Ringed Plover	*Charadrius hiaticula*
Beyndu	Sooty Tern	*Sterna fuscata*
Bileymaa Dhushin	Pacific Golden Plover	*Pluvialis fulva*
Boakalhu Gohorukey	Black-Headed Gull	*Larus ridibundus*
Bodu Hoagulhaa	Wedge-Tailed Shearwater	*Puffinus pacificus*
Bodu Raabondhi	Western Reef Egret	*Egretta gularis*
Bondana Ilolhi	Curlew Sandpiper	*Calidris ferruginea*
Bondhu Dhooni	Saunders's Tern	*Sterna saundersi*
Bulhithunbi	Whimbrel	*Numenius phaeopus*
Chon Chon Ilolhi	Common Greenshank	*Tringa nebularia*
Dhanbu Maakanaa	Purple Heron	*Ardea pupurea*
Dhandifulhu Dhooni	White-Tailed Tropicbird	*Phaethon lepturus*
Dheyfaiy Dhooni	Eurasian Spoonbill	*Platalea leucorodia*
Dhivehi Hoagulhaa	Audubon's Shearwater	*Puffinus lherminieri*
Dhivehi Kanbili	Maldivian Water Hen	*Amaurornis phoenicurus maldivus*
Dhivehi Koveli	Asian Koel	*Eudynamys scolopacea scolopacea*
Dhivehi Raabondhi	Maldivian Little Heron	*Butorides striatus albidulusi*
Dhon Fenfoah dhooni	Tree Pipit	*Anthus trivialis*
Dhon Raabondhi	Yellow Bittern	*Ixobrychus sinensis*
Dondheeni	White Tern	*Gygis alba*
Eshunga Ilolhi	Black-Tailed Godwit	*Limosa limosa*
Fenfoah Dhooni	Yellow Wagtail	*Motacilla flava*
Funamaa Dhushin	Lesser Golden Plover	*Pluvialis dominica*
Furedhdhe Ilolhi	Marsh Sandpiper	*Tringa stagnatilis*
Girubaa Dhooni	Spot-billed Pelican	*Pelecanus philippensis*
Gohorukey	Pallas's Gull	*Larus ichthyaetus*
Bodu Gaadhooni	Great Crested Tern	*Sterna bergii*
Gudugudaa Dhooni	Greater Flamingo	*Phoenicopterus ruber*
Hoara	Lesser Frigatebird	*Fregata ariel*
Hudhumaa Dhooni	Masked Booby	*Sula dactylatra*
Huvadhoo Raabondhi	Maldivian Pond Heron	*Ardeola grayii phillipsi*
Iruvaihudhu	Catlle Egret	*Bubulcus ibis*
Kalhu Bulhithunbi	Glossy Ibis	*Plegadis falcinellis*
Kalhu Maadhooni	Brown Booby	*Sula leucogaster*
Kalhu Raabondhi	Black Bittern	*Dupetor flavicollis*
Kandu Kanbaa	Wilson 's Storm-petrel	*Oceanites oceanicus*
Kanifulhu Dhooni	Gull-Billed Tern	*Gelochelidon nilotica*
Kiru Bondana	Kentish Plover	*Charadrius alexandrinus*
Kirudhooni	Black-Naped Tern	*Sterna sumatrana*
Kuda Bondana	Lesser Sand Plover	*Charadrius mongolus*
Kulhee Kukulhu	Watercock	*Gallicrex cinerea*
Kunburu Reyru	Garganey	*Anas querquedula*
Kurangi	Lesser Noddy	*Anous tenuirostris*

Kurulla Dhooni	House Sparrow	*Passer domesticus*
Lagnaa	Great Egret	*Casmerodius albus*
Maa Dhooni	Red-footed Booby	*Sula sula*
Maa Hoagulhaa	Flesh-Footed Shearwater	*Puffinus carneipes*
Maahoara	Great Frigatebird	*Fregata minor*
Maaranga	Brown Noddy	*Anous stolidus*
Medhuraajjethere Raabondhi	Central Maldivian Heron	*Butorides striatus didii phillipsi*
Miyaremu Dhooni	Caspian Tern	*Sterna caspia*
Mushi Fenfoah Dhooni	Red-Throated Pipit	*Anthus cervinus*
Noo Maakanaa	Black Headed Heron	*Ardea melanocephala*
Olhuvalu Kanbili/Kulhee Kanbili	Common Moorhen	*Gallinula chloropus*
Onna Ilolhi	Jack Snipe	*Lymnocryptes minimus*
Raabondhi	Black-crowned Night Heron	*Nycticorax nycticorax*
Rahmathee forike	Northern House Martin	*Delichon urbica*
Rathafai	Ruddy Turnstone	*Arenaria interpres*
Rathu Reyru	Ferruginous Pochard	*Aytha nyroca*
Reyru	Northern Shoveler	*Anas clypeata*
Salvaa Dhooni	Common Coot	*Fulica atra*
Theyravaa Ilolhi	Black-Winged Stilt	*Himantopus himantopus*
Theyravaa/Moalha Lunbo	Crab Plover	*Dromas ardeola*
Vaali	Bridled Tern	*Sterna anaethetus*
Valhoa Dhooni	Whiskered Tern	*Chlidonias hybridus*
Valla	Roseate Tern	*Sterna dougallii*
Valla	Common Tern	*Sterna hirundo*
Valu Bondana	Greater Sand Plover	*Charadrius leschenaultii*

Biodiversity Assesment for
Maldives Baa Atoll

Legislative Framework for
Biodiversity Conservation