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# Review of Grouper Fishery of the Maldives with additional notes on the Faafu Atoll Fishery

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# 1: Executive Summary

1. Targeted fishing for groupers in the Maldives started in 1994 as a response to a request from an Asian buyer. An organized fishery rapidly established starting from Faafu Atoll. Initially fishery operations were conducted on day trips selling their catch to the holding pens located in their atolls.
2. The fishery peaked in 1997 producing a record catch of over one million groupers earning MRF. 55 million as direct export revenue. This value however, represented only less than 5% of the total marine export earnings.
3. A data collection mechanism was established at MoFAMR based upon the recommendations of a status report prepared by MRC in 1995. These include maintaining a registry of grouper holding facilities and collection of catch and effort data by established means through island offices. The quality and completeness of grouper data was highly questionable. Estimates from export figures and catch reports show wide disparity. In some years, as much as 80% of grouper catch goes unreported.
4. Limited funding was sought to conduct a review of the grouper fishery. The work involved field visits to grouper holding facilities in Kaafu Atoll. The data collected includes information on total catch, species and location and of fishing effort. Additional information was obtained from an ADB funded report on Faafu Atolls' coastal and marine resources management and poverty reduction.
5. Estimates of total grouper catch show a sharp declining trend. From a high of over 1 million groupers in 1997 present catches are fewer than 250,000 per year. Presently two major companies maintain collecting and holding facilities close to Malé area. Collecting facilities are established in the central atolls as buyers no longer move where the fishing is good. Instead fishermen spend much longer time on fishing trip as well as travelling to grouper collecting and holding facilities.
6. The fishing method has gradually shifted from drop-line fishing from vessels to fishing in water by fishermen wearing snorkelling gear and with small floating cages. It is reported that more than 75% of fishermen use this method which is more efficient than fishing from vessels at a time groupers abundance is low.
7. The average sizes of groupers taken in the fishery have markedly reduced compared with the size estimates made in 1987-1991 when a targeted fishery was non-existent. Survey results showed 43% of groupers caught in the fishery were immature or have not reached the size at which they become mature.
8. The most commonly caught groupers in the fishery (not in their order of occurrence) are kas faana (*Epinephelus fuscoguttatus*), asdhaanu faana (*Epinephelus spilotoceps*), olhu faana (*Plectropomus areolatus*), olhu faana (*P. laevis*), kula olhu faana (*P. laevis*) mas faana (*Cephalopholis argus*), ginimas faana (*Aethaloperca rogaa*), boalhajehi faana (*Anyperododon leucogrammicus*), and kandu haa (*Variola louti*).
9. The fishery is found to be seasonal. Peak catches occur in April and lowest catches occur in September. It was also observed that this seasonality was related to the annual tidal cycle; times of highest catch rates coinciding with highest tides (spring equinox, usually on the 21<sup>st</sup>

March) and times of lowest catches coinciding lowest tides (autumn equinox usually 23<sup>rd</sup> September). Highest catches also coincide with the time of peak sea-surface temperature and also of Chinese New Year, both of which occur during the month of April.

10. In order to protect the grouper resource it was recommended to regulate the fishing effort. Possible options were setting up species quota, similar to the aquarium fishery and/or setting up minimum size on landings. Also of importance and which needs further research was identifying areas of spawning aggregations to consider time area closures.
11. It was recommended to strengthen collection of catch and effort data from the fishermen and export data from the Malé Customs Services. This was to facilitate the monitoring of management measures that will require enforcement.
12. The Grouper Management Plan formulated for Faafu Atoll under the assistance from ADB's Regional Technical Assistance Project should be implemented as soon as possible. This would create community awareness and facilitating the management of the grouper resource in Faafu Atoll and subsequently in other atolls.

## 2: Introduction

Prior to the development of export markets, reef fish were exploited at a low level, essentially for local consumption. This was because for centuries Maldivians relied on livebait tuna pole-and-line fishing for food and for employment. Reef fishery was carried out as an alternative, albeit at subsistence level during times of poor tuna fishing. The pattern of reef fishing started to change with the introduction of tourism in early 1970s. Tourism created local demand for reef fish and so the level of reef fishing increased, especially around the Malé Atoll. Subsequent economic developments together with improved transportation between the Maldives and the outside world facilitated the development of export-oriented reef fisheries.

The export business of groupers from the Maldives started in 1993 in response to an inquiry from Southeast Asian buyer to a local exporter. The fishery started in Vaavu Atoll and quickly spread to nearby atolls. By about 1995-1996, only two years later, the fishery had reached a peak. At the time the exports were contributing about 10% by value of total marine export earnings.

Groupers are a popular food fish of high market value in Southeast Asia particularly Malaysia, Japan, China, Hong Kong, Singapore and Taiwan. Over 100 species of groupers are known worldwide. Maldives has approximately 40 – 45 species, which belong to 7 genera; *Aethaloperca*, *Anyperodon*, *Cephalopholis*, *Epinephelus*, *Gracila*, *Plectropomus* and *Variola*. A complete list of all groupers found in the Maldives is listed in Shakeel (1994).

The habitats of groupers are coral reefs and stony environments. Groupers occur at depths of 100 to 200m and occasionally at 500m (Heemstra et al. 1993). In Maldives it is common to see groupers on shallow reef flats and reef slopes. In a study conducted in Laamu Atoll by Sluka (2001) groupers were shown to have specific microhabitats that were utilized preferentially to the surrounding general habitat. For example, *Variola louti*, the lyre tail grouper was most abundant on reef slopes outside the atoll rim, while *Plectropomus pessuliferus*, the rock cod was most abundant in faro reef slopes. Groupers were found more often in area of higher structural

complexity. They are usually the top predators of their food chain and are voracious feeders. Their diet normally includes other fishes and invertebrates such as large crustaceans and cephalopods.

Grouper species are typically long-lived often more than several decades. Research shows that groupers can live up to 40-50 years while some large grouper species can live for about 80-100 years. Most species, however, probably live no longer than 10-20 years, with larger species generally having a longer life span than smaller species (Morris et al., 2000).

Except at spawning periods groupers are solitary and generally remain on the same reef for long periods of time. Groupers aggregate to spawn for short periods at specific and often consistent sites every year. This spawning activity may last for few weeks and at times may be spread over several months. This aggregating behaviour makes them highly vulnerable to fishing gear and can be easily over-exploited. Sadovy (2002) highlights the case of *Epinephelus striatus*, Nassau grouper, in the Caribbean where the number of spawning fishes declined and aggregations ceased to form with the increasing fishing pressure. Currently *E. striatus* is listed as endangered on the IUCN (World Conservation Union) Red List of Threatened Species ([IUCN](#), accessed, May 2005). Recent survey by the Society for the Conservation of Reef Fish Aggregations (SCRFA) shows that 15% of the spawning aggregations no longer exist while 65% are under threat ([SCRFA](#) accessed May, 2005)

Many species of groupers begin their life as females and change into males at maturity or later (i.e., they are protogynous hermaphrodites). In this case, groupers spawn as females for about a year or more and then changes sex and functions as a male (Heemstra et al. 1993). Their sedentary life, sex change strategy, long life span, aggregation behaviour and the fact that they take bait readily, makes grouper populations highly susceptible to over-fishing. Only young females remain in over fished populations and consequently no spawning takes place. Population recovery then depends on migration of young or adults from other areas. In seriously over-exploited stocks cessation of fishing is required to allow young females to grow into large males.

The objective of this report is to review the grouper fishery and grouper export business in the Maldives. Fishery data collection methods and constraints faced in collecting and analyzing the data are highlighted. The report also highlights the existing grouper fishery in Faafu Atoll where Asian Development Bank assistance was sought to develop a poverty alleviation programme. The programme includes assessment of the grouper fishery and development of a 'Grouper Fishery Management Plan' for Faafu Atoll. This is expected to be implemented as the follow up of the ADB Technical Assistance Project (Regional Technical Assistance for Coastal and Marine Resources Management and Poverty Reduction in South Asia, 5974).

## 3: Grouper Fishery

In the Maldives, the utilization of marine resources is being shared by the fisheries and tourism sector. Snorkeling and diving are the main recreational activities of hundred of thousands of tourists visiting the Maldives every year. Groupers, which are been caught by the fishermen, contribute to be an important element of marine fauna being observed on these dives. Some species of grouper being very conspicuous and colorful provide much delight to the divers. In the recent years, the decline of their abundance has been causing much conflict between the two industries.

Export oriented grouper fishery in the Maldives started in 1993 (Shakeel, 1994) and was initially carried out in atolls near Male'. With the realization of the income potential the fishery expanded throughout Maldives in the mid 1990s. At present, grouper fishery is mainly carried out by fishermen of Raa, Alifu-Dhaalu, Faafu and Kaafu Atolls. Other atolls are also visited occasionally. Catches of groupers rose from 200t in 1994 to 1000t the following year (Shakeel et al., 1996) bringing in substantial amount of foreign exchange into the Maldivian economy. The main export markets include Thailand, Singapore, China, and Hong Kong.

Unlike the earlier years, buyers now do not always relocate collection facilities to where fishing is good. Instead fishermen conduct week long trips and return to main collection centres which offered the best and guaranteed cash. At times fishermen spend up to a month away from their islands whereas in the early days, when fishing was carried out in their own atolls, it would normally be a day trip when they would sell their catch to cages in their own atoll or those nearest to the atoll.

### **3.1. Previous Studies**

The Maldivian reef fishery resources have been assessed by the Marine Research Centre (MRC) on more than once occasion (for example, Van Der Knaap et al., 1991, Anderson et al., 1992). Grouper specific studies have also been undertaken by Shakeel (1994) which focused on Alifu and Vaavu Atolls where grouper fishery was prevalent at that time of the study. Information on fishing gear and depth, survival rate and catch effort were

collected from the fishermen. Information on grouper cages – stocking density, mortality, catch size, species composition were collected from the export companies. Main findings of the grouper studies were:

- Groupers were fished commonly by islands where the major fishing activity was not tuna.
- Both fishermen and export companies moved from atoll to atoll based on the condition (i.e., catch) of the fishery. When fishery in one atoll declined they moved to another atoll where the catch rates were higher.
- Expanding grouper fishery might affect livebait stocks as tuna bait was at times used for grouper fishing as well as feeding the groupers in holding cages.
- The fishery was considered to be opportunistic due to poor marketing, inadequate facilities (such as in instances when the grouper cages in base islands all become fully stocked and fishermen having to stop fishing) and limitation of the stock size.
- Ready cash for the sale of groupers provide an incentive to fishermen, which promoted and encouraged fishing without much care about the over-fishing and eventual stock collapse
- Both fishermen and exporters learnt techniques of fishing and keeping the fish alive in cages by trial and error.
- Conflicts existed between the grouper fishing industry and the tourism industry.
- Collection of grouper fishery statistics in particular and reef fish statistics in general needs to be revised to collect more biologically useful data.
- Urgent need to increase the public awareness on sustainable reef fishery.

Of the various recommendations on managing grouper only few have been implemented. Lack of priority and initiative has slowed the implementation and monitoring of the grouper resource. Community based management interventions are inhibited due to lack of adequate fishery regulations and awareness (Hameedh, 2001).

Shakeel (1994) estimated the maximum sustainable yield of all groupers from the three habitats – shallow reefs, atoll basin and deep reef slopes – to be approximately 1800 tonnes/year. A breakdown of this value into the three habitats is shown below:

- Shallow reef areas – 811 t/yr
- Atoll basins – 959 t/yr
- Deep reef slopes – 62 t/yr

These first estimates were based on data obtained from surveys carried out in shallow reefs, atoll basins and deep reef slopes in the early 1990s when a targeted grouper fishery was non-existent in the Maldives. Assuming the catch rates per area observed in the survey at the time were from virgin stocks they were extrapolated to the whole of Maldives

Apart from these early studies, no further exploratory surveys and assessments have been carried out during the last decade. A number of reports provide the fishery trend from the export data, but no detailed analysis of the data has been carried out. Lack of trained staff and finance are major constraints.

In 1995, MRC (then Marine Research Section, MRS) introduced the "*Faana Masverikamuge Report*" Form (Grouper Catch Report form) to start collecting catch statistics of the grouper fishery. The data collected included:

- Daily catch and mortality rates due to captivity in vessels
- Daily catch and effort with respect to the gear used for fishing
- Area of catch on a monthly basis

The monthly summaries of the grouper catch and effort were collected from all the atolls of the Maldives. The Atoll offices distributed the forms to the fishermen and forward the completed forms to MRS. These forms were later revised to incorporate number of fishermen on board as a measure of effort to improve collecting fishing effort data.

With the expansion of the fishery, the major shortcoming of this data collection system was that while catch data is collected on a daily basis (per trip) the locations of catch were observed for a single atoll. Therefore, it was

very difficult from this data to separate the catch from any given atoll. Thus, the total catch for a given month would be from these atolls and catch per atoll cannot be assessed individually.

In addition, the Ministry of Fisheries, Agriculture and Marine Resources collects all cage registration data. However, the data set is not complete and not adequately monitored - another constraint for assessment and evaluations of trends in the development of the fishery.

### **3.2. Fishing Method**

Fishing is carried out mainly in small masdhonis using hand-lines. At the initial stages of the fishery development it was common to carry out grouper fishing in rowing boats (*bokkura*), sailing or mechanized trolling boats (*vadhu dhoni*) and mechanized pole and line fishing boats (*masdhoni*). *Vadhu dhonis* and *bokkuras* are rarely used now due to greater distances that are required to cover on any given trip.

Groupers are caught using handlines with normal hooks and sinkers. Hooks are baited with cut pieces of tuna. Fish finders are occasionally used by grouper fishermen to spot groupers aggregations as the declining stocks



have made it difficult to find groupers in the shallow reef areas. Groupers are caught from as deep as 80m. The rapid and forced ascend of groupers from such depths sometimes inflate their bladder. Such fish if not degassed properly die within a short period of time.

**Figure 1:** Fishing gear used for catching grouper include floating basket, fishing line and bait.

Fishing is also carried out by fishermen with the aid of snorkeling gear (Figure 1). All but one fisherman are dropped off at strategic points on the reef with snorkeling gear, baited lines and a basket to hold their catch. These fishermen catch targeted individuals. Upon spotting their target they

swim over to the fish and place the baited hook in front of the mouth of the grouper. Normally fishermen takes breaks once every hour or two, although it varies depending on the abundance of groupers in the area. On average a fisherman might spend about 8 to 10 hours total in the water in a day. The single crew on the boat (which should be at a distance no further than 50 m from all fishermen in the water) is responsible to keep a watchful eye to those in the water.

A daily catch of grouper by a small mechanized masdhoni in mid 1990s was around 100 - 170 fish (Shakeel, 1994), whereas now on average it is around 40 - 50 fish per day (n=17 boats). The groupers are kept alive in the boat holds where there is a constant flow of seawater through the plug holes. On average each fishing boat sell their catch to the exporters, at least once a week. There is a mortality rate of 5-20% of groupers during the period when they are kept in the boat hold. The main reasons for this mortality rate are poor water quality, damage to the fish and overcrowding in the boat hold (Shakeel, 1994).

## **4: The Export Industry**

### ***4.1. Export Companies and Grouper Cages***

At the time of survey three companies actively involved in the grouper export business. Together they had 11 grouper cage complexes located throughout the Maldives. Table 1 gives the companies involved in grouper fishery and the locations of their grouper cages (also shown in Figure 2).

A standard grouper cage complex consists of 12 cage units which are 12 by 12 feet wide by 15 feet deep (Figure 3). The cage structure is rigged onto a wooden frame kept afloat with plastic barrels. The cages have mesh sizes of 2.5 – 3.8 cm. The nets are tied to the wooden catwalk frame and sunk into the water with metal frames shaping the cages. Adjoint to the cage complexes is the floating living/ working quarters of the purchasing staff. A catwalk to the cages makes easy access (Figure 4).

**Table 1:** List of grouper cages operational in the Maldives – Sept – October 2004.

Company	Cage Location	No. of Cage complexes
Marine X Plus	K. Bangaafaru	1
Seaview Enterprises Pvt. Ltd.	HDh. Makunudhoo	1
	K. Bangaafaru	1
	V. Felidhoo	1
	F. Biledhdhoo	1
	GDg. Kafena	1
Seacom Maldives Pvt. Ltd.	HDh. Makunudhoo	1
	K. Bangaafaru	1
	M. Maduvvari	1
	Th. Hirilandhoo	1
	K. Kashiguraidhoo	1



**Figure 2:** Locations of grouper cages – 2004.



**Figure 3:** Cage complex with living and work space located in K. Bangaafaru.



**Figure 4:** Purchasing activities in a cage complex at K. Bangaafaru.

## **4.2. Buying and Stocking**

The buying price of a fish varies with size and species. The grouper categories used by export companies for buying purposes are given in Table 2. These size categories are almost the same for all companies but at times of poor catch may vary between buyers. Fishermen report that during times of poor fishing some exporters/buyers offers better prices, i.e., a fish which at times of good fishing might have been in the medium (*M*) size class would be considered a large (*L*) fish and paid the amount normally paid for the *L* size category. While this may prove less profitable for the buyers the scheme keeps the fishermen fishing and therefore maintains the supply of fish to the cages

**Table 2:** Various size categories used in the grouper export business.

Name used by export companies	Size category	Scientific Name
Bodu Molhu	Large (usually get the grey/brown variation of <i>P. laevis</i> in this size category of "Molhu" faana)	All species in the <i>Plectropomus</i> genus
Medhu Molhu	Medium ( 0.5 – 1.0 kg)	
Kudhi Molhu	Small ( < 0.5 kg)	
Baby Molhu	Up to 0.3 kg	
Bodu kas	Large (Usually get <i>Epinephelus fuscoguttaus</i> and <i>E. lanceolatus</i> in this size category of "Kas Faana")	All species of <i>Epinephelus</i> genus
Medu Kas	Medium (0.5 – 1.0 kg)	
Kudhi kas	Small ( < 0.5 kg)	
Baby kas	Up to 0.3 kg	
Kudhi raiy	Small (< 0.5 kg)	Refers to all species in the <i>Cephalopholis</i> genus other than <i>C. argus</i>
Kudhi kandu haa	Small (< 0.5 kg)	<i>Variola</i> spp.
Kanduhaa	Medium / Large ( over 0.5 kg)	
Boadhigu faana		<i>Anyperodon leucogrammicus</i>
Kalhu faana		<i>Cephalopholis argus</i>
Ginimas faana		<i>Aetheloperca rogaa</i>

The price of one grouper may vary from Rf 2.00 to more than Rf 100.00 depending on the buying category used by the buyer. This is in contrast to the early stages of the fishery when the most common practice was to divide the groupers into "red" and "black" categories. *Plectropomus pessuliferus* was considered "red" and all others considered "black". Rf. 13.00 was given for individuals of the "black" group measuring more than 20 cm in total length and Rf. 14.00 for the same size fish of the "red" group. In addition to this individuals of other species such as *Cephalopholis miniata*, *C. argus*, *Anyperodon leucogrammicus*, *Epinephelus polyphekadion*, and *Variola louti* were bought in two size groups: 18-25 cm fetched Rf 5 per fish and fish more than 25 cm in length fetched Rf 10 per fish. All other price details are very clearly shown in Shakeel (1994).

Stocking of groupers in the cages are based on the size and genus. Different genera are typically kept in separate cages. Stocking density is normally about 800 – 1400 fish per cage. This, however, varies with respect to size. All groupers are initially kept in the same cage unit at time of purchase from the fishermen and are separated after they have conditioned. Since fish are exported either live or fresh chilled, it is important that the individuals for live export are handled as little as possible. The candidates for fresh/chilled are either chilled instantly after being bought from the fishermen or are chilled after keeping them in the cage for a few days. Those, which are chilled instantly, are those fish, which are damaged or weak and have potentially a low probability of survival if kept alive in the cage for extended periods of time.

### **4.3. Feeding and Cage Maintenance**

Feeding is carried out once or twice a week and generally starts after a conditioning period of 2 – 3 weeks of purchase. Tuna and other small reef fish are used to feed the groupers. In the earlier days of the fishery feeding of fish was started on the second day of stocking in cages (Shakeel, 1994).

Daily cleaning of cages is carried out by removing the dead fish every morning. Dry cleaning, which involves replacing the fouled nets with dry nets and removing the used nets and drying them, is carried out monthly.

### **4.4. Control of Disease**

Whether infected or not the groupers are 'bathed' in clean sea water once a week. The chemical Oxylin (Ampicillin) is used to control disease in this environment. For certain species such as *Plectropomus areolatus* (Squaretail coral grouper, or locally known as Olhu faana) it is required that they are cleaned daily as these fish are highly susceptible to disease.

A survey carried out by MRC in September 2004 revealed that on average there is 5 – 10% mortality during the first 24 hours. From the second day onwards till the time of conditioning to the cage environment there is an additional average daily mortality of 5 – 10% of the remaining stock. On average, a monthly mortality rate of 10-30%, which amounts to an average of one tonne of fish per unit cage (at normal stocking density, i.e., 1000 per

cage) every month, is observed. As mentioned earlier, the *Plectropomus* genus is more susceptible to disease and eventual death. Causes of death include:

- Damage due to handling
- Internal and external injuries (especially in the *Variola* spp.)
- Disease of unknown nature (especially observed in the *Epinephelus* spp.)

Injury or death due to abrasion against the cage sides is rare but abrasion against the nylon material used in making the mesh damages the snout of the groupers.

Exporters as well as fishermen started noticing a high mortality rate in members of the *Epinephelus* genera, especially in *Epinephelus fuscoguttatus* (Brown Marbled Grouper, Kas faana). This started at the end of 2002 and continues to date, although the cases now are much less than before. One exporter sent tissue samples of the dead fish overseas, to determine the cause of the disease and the results suggest it was due to an infection of the respiratory system of the groupers. According to the exporter, the infected fish turns white around the gills before they die. Exporters report having lost approximately 50% of their grouper stocks at the time of peak outbreak of this disease.

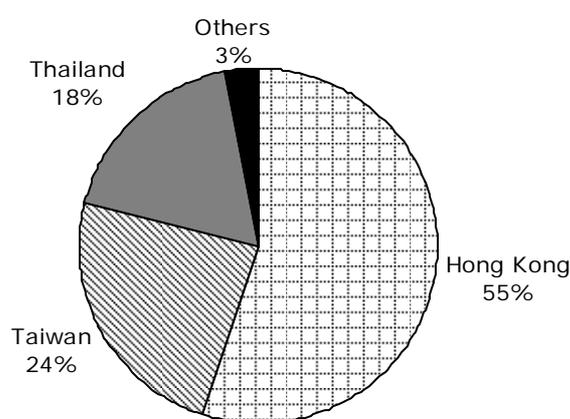
A fisherman from Faafu Atoll stated that during the period of high mortality rates, they noticed a thick layer of white foamy "substance" occupying the upper layers of the water (which they referred to as "Boh Kandhi"). They also observed that the fact that this disease normally afflicts to *E. fuscoguttatus* could be that this species is not very mobile and stay still for long periods of time with their mouths open thus increasing the chances of the substances being taken in and hence affecting this species.

The amount of time a single grouper spends in the cage depends on whether they are exported live or dead. If the fish is exported chilled, then it would spend either a day or two at the cage. If they are exported live the time spent at the cage varies from 1 – 3 months. This depends on the quantity of fish available and the orders received from overseas buyers. Fish

which belong to species with high disease susceptibility are chilled at the time of purchase. These are normally the candidates for fresh/chilled export.

#### **4.5. Packing and Export**

Thailand, Taiwan and Hong Kong are the three main grouper export destinations. Hong Kong accounts for the largest share of the exports (55%) while Taiwan accounts for 24% and Thailand accounts for 18% of the exports (Figure 5). The remaining 3% is exported to countries such as Singapore (MoFAMR unpublished data, MoFAMR).



**Figure 5:** Major grouper export destinations, 1998-2002. Source: SDMS, MoFAMR.

The fresh/chilled groupers are packed in styrofoam boxes with flake ice and are exported three to four times a week by air. Roughly a metric tonne is exported in an average shipment. The live fish are sent off once a month via special carrier vessels. Each export shipment of live groupers contains 8 to 10 tonnes. Groupers are at times also exported in the frozen form as well as in the form of grouper fillets.

Marine Research Centre started collecting species wise export data of groupers from the three export companies since 2002. These data shows species high in demand in the export market and the destinations to which they are exported as well as the price paid for the groupers. Table 3, shows the commonly exported species, the category they are exported in (live or fresh/chilled) and the average price per fish and average price per kg of these groupers in the international market.

*E. lanceolatus* which is listed as vulnerable in the IUCN Red List is one of the species exported from the Maldives. These groupers currently fetch approximately Rf 600.00 per grouper. It is very important to investigate the status of this species in the Maldives in order to establish the most relevant management strategy ([IUCN](#), website accessed May 2005).

**Table 3:** Commonly exported species of grouper and the category under which they are being exported.

Scientific name	English Name	Dhivehi Name	Exported: Live Fresh Chilled	Average purchase value (Rf/fish)	Average export value (Rf/Kg)
<i>Aetheloperca rogae</i>	Redmouth grouper	Ginimas Faana	L/FC	24	45
<i>Anyperodon leucogrammicus</i>	Slender grouper	Boalhajehi faana	L/FC	20	45
<i>Cephalopholis argus</i>	Peacock Hind	Mas faana	C	18	47
<i>C. miniata</i>	Coral Hind	Koveli faana	C	35	90
<i>Epinephalus flavocaeruleus</i>	Blue and Yellow grouper	Dhon Noo faana	L	45	
<i>E. fuscoguttatus</i>	Brown Marbled grouper	Kas faana	L/FC (very rare)	70	
<i>E. lanceolatus</i>	Giant grouper	Mudu faana	L	660	
<i>E. spilotoceps</i>	Four-saddle grouper	Asdhaanu faana	L/FC	12	35
<i>Plectropomus areolatus</i>	Squaretail grouper	Olhu faana	L/FC	200	125*
<i>P. laevis</i>	Black-saddled coral grouper	Kandu rasgefaanu	L/FC	180	125*
<i>P. pessuliferus</i>	Roving coral grouper	Dhon Olhu faana	L/FC	120	126*
<i>Varioloa louti</i>	Moontail sea bass	Kanduhaa	L/FC	64	86*

\* Price for chilled exports. The price/fish for live exports for *P. areolatus* is approx. Rf. 660.00; *P. pessuliferus* approx. Rf. 82.00; *P. laevis* is approx. Rf 110, and for *V. louti* is approx. Rf 70.

## 5: Data Collection and Analysis

### 5.1. Grouper Catch

The MoFAMR started collecting grouper catch statistics in 1995. Monthly data are collected from all grouper fishermen and shows the daily catch numbers and mortality on the boat and catch and effort. Catch area data is also available. Data collection, compilation and follow up in the early stages

were very inconsistent and as a result there are many gaps in the existing data. For example:

- the catch amount for 1995 and 1996 are only available for three months from Faafu Atoll,
- the data for 1998 and 2000 are only available for February,
- the data for 1999 are only available for 3 months (February, March and August),
- the data for 2001 are only available for 5 months (August to December) and finally
- although the data for 1997 are available for all months, it is not available from all fishing atolls.

Such data gaps make it nearly impossible to compare the catch from different years and to show the true trends in the fishery.

At times of poor fishing fishermen do not stay in their home atolls, instead they venture into other atolls covering two or three in any given month. The monthly data collection form, however did not allow showing the atoll of catch (or location) for any given fishing event and in this case aggregated monthly catch was recorded. In these cases the monthly atoll catch may be estimated by dividing the total catch by the number of atolls visited during that month.

The export data are collected by Maldives Customs Services. They maintain records of the grouper exports by various categories. The customs data represent a complete record of what is exported. Export data of groupers are either in numbers (live export) or by weight (fresh/chilled export). However, the fishermen report the catch in numbers. In order to compare the estimated total catch as represented in the export data collected by Maldives Customs Services and what is being reported by the fishermen the units have to be converted either to numbers or weights. To convert the weight of fish to numbers an average weight was estimated. In the most recent sampling trips 2,846 groupers were sampled covering 19 species (Table 4). The average weight of the groupers in the sample was 0.77 Kg.

Given that total catch is declining both because of decreasing catch and because of smaller individuals being taken in the fishery, one would assume the average weight of the grouper would be large in the earlier years. The

average weight of groupers fished in the early 1990s was computed using weight measurements taken in the Reef Resources Survey carried out in 1991 (Anderson et al., 1992). Using these two extreme values for average weight (1991 and 2004; i.e., 0.9 and 0.77 kg respectively) the annual change in average weight of groupers over the period of 12 years (1991 – 2003) was calculated. This was used to estimate the average weight of groupers in each year and in turn to estimate the total number of groupers been exploited in fishery (Figure 6). Also plotted is the number of groupers reported by the fishermen. The inconsistency in reporting is clearly is seen.

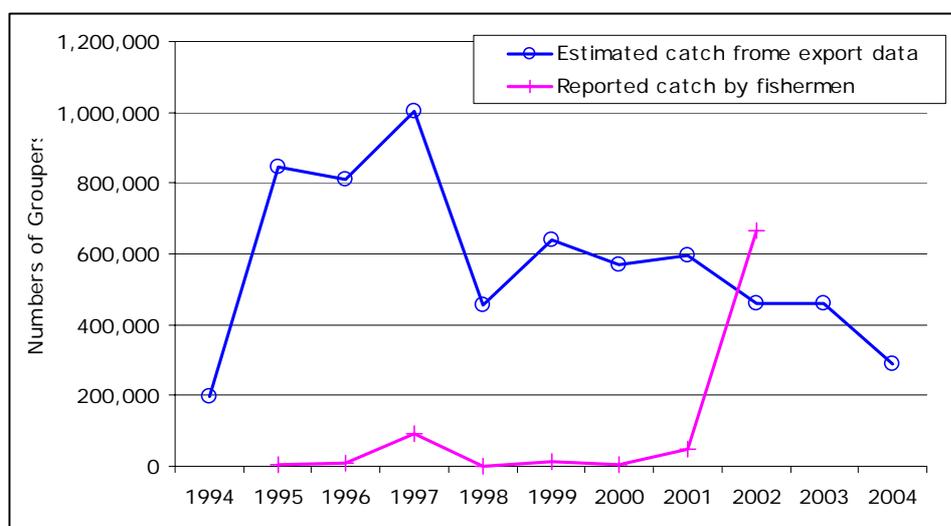
**Table 4:** Average weight and length (standard deviations in parenthesis; *n* is the sample size) of species (2003 – 2004).

Scientific Name	Length	Weight	n
<i>Epinephelus spilotoceps</i>	27.7 (4.0)	0.5 (0.3)	130
<i>Anyperodon leucogrammicus</i>	35.1 (4.7)	0.6 (0.3)	359
<i>Plectropomus pessuliferus</i>	39.9 (9.3)	0.9 (1.0)	181
<i>Epinephelus macrospilos</i>	39.0 (22.5)	0.9 (0.9)	3
<i>Aetheloperca rogga</i>	30.9 (5.8)	0.6 (0.3)	240
<i>Epinephelus caeruleopunctatus</i>	38.5 (13.4)	1.7 (1.5)	4
<i>Epinephelus octofasciatus</i>	36.0 (4.8)	0.9 (0.1)	4
<i>Plectropomus laevis</i>	41.8 (10.3)	1.2 (1.3)	122
<i>Variola louti</i>	36.3 (7.9)	0.9 (0.8)	441
<i>Epinephelus fuscoguttatus</i>	43.7 (17.3)	2.0 (3.4)	165
<i>Epinephelus ongus</i>	27.0 (2.5)	0.3 (0.1)	9
<i>Epinephelus longispinis</i>	39.0	0.8	1
<i>Cephalopholis miniata</i>	33.4 (7.0)	0.6 (0.4)	199
<i>Epinephelus merra</i>	27.0	0.7	1
<i>Cephalopholis argus</i>	28.4 (4.5)	0.5 (0.3)	812
<i>Plectropomus areolatus</i>	40.2 (11.1)	1.2 (1.6)	134
<i>Variola albimarginata</i>	29.5 (1.9)	0.7 (0.2)	6
<i>Epinephelus areolatus</i>	31.8 (4.8)	0.6 (0.5)	23
<i>Cephalopholis sonnerati</i>	35.5 (5.5.)	0.4 (0.4)	4

In a normal situation, and assuming entire catch is sold to the buyers, one would expect the catch reported by fishermen would be slightly higher than the estimate from the export data. These could be due to either or combination of the following:

- mortality while in captivity in the boat hold;
- mortality while in the grouper holding cage; and
- rejects which are discarded due to small size or injury

However, except for 2002 none of the years show this expected result confirming the heavy under reporting of catch by fishermen.



**Figure 6:** Grouper catch from Maldives as reported by fishermen and the estimated grouper catch (1994 – 2004).

This underreporting could be due to many reasons such as the difficulty in handing over the forms to the island office at the end of the month or simply fishermen failing to report their catches. The apparent 'complete reporting' in 2002 could be due to the revised form which was introduced in 2001 which is much simpler to fill. The catch data for 2003 and 2004 was not available at time of compiling this report. Table 4 shows the estimated catch from the export data and the reported catch by the fishermen along with degree of under /over reporting. There was virtually no reporting of catch in the earlier years. Estimates of catch computed from the export data may be an under estimate as relatively a large proportion would have been 'lost' due to mortality on board the vessel, mortality in the cages and the undersized ones that may be discarded when they die. This proportion may be higher in the earlier years as both the fishermen themselves and the buyers had only little experience of the keeping groupers in captivity.

**Table 5:** *Estimated total catch from export data, reported catch by fishermen and percentage of under reporting / over reporting of grouper data.*

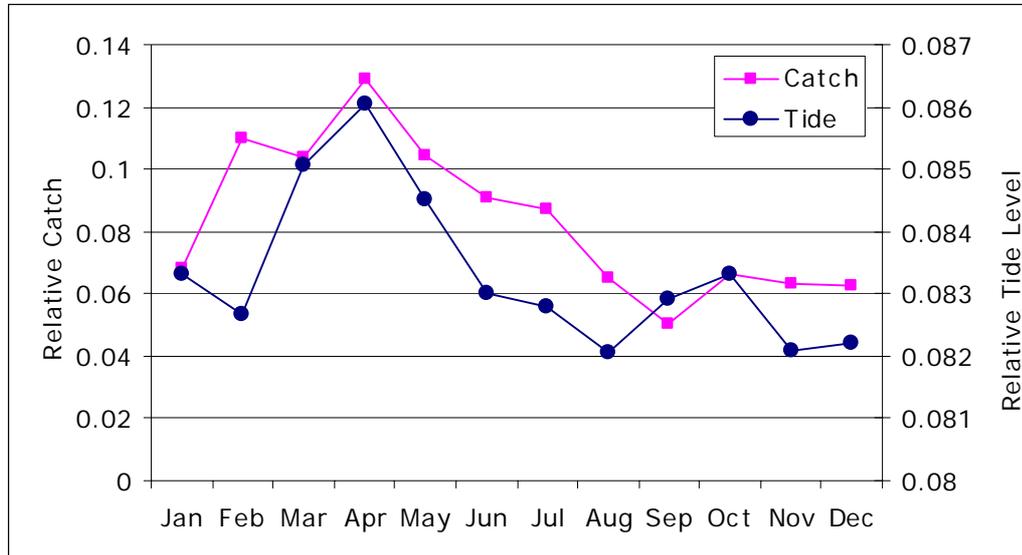
Year	Estimated Total catch from export data (Nos).	Total reported catch by fishermen (Nos)	Percent under /over reported
1994	198,131	---	--
1995	846,722	4,072	- 99
1996	808,825	7,783	- 99
1997	1,004,404	90,298	- 91
1998	457,609	401	-99
1999	637,695	12,577	-98
2000	568,138	3,160	-99
2001	595,901	45,998	-92
2002	460,193	665,371	44
2003	460,218	--	--
2004	287,579	--	--

## **5.2. Seasonality of the Catch**

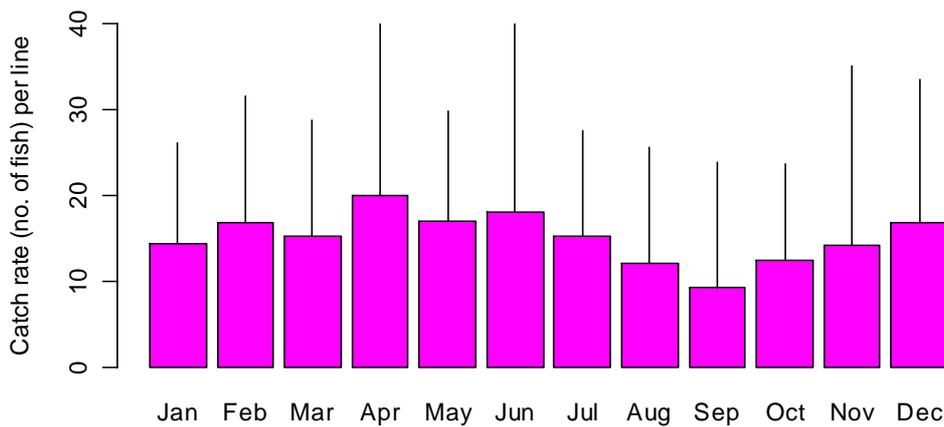
The only year in which the catch data were complete with reasonable amount of information was 2002 (see data section above). This allowed showing the seasonality of fishery as indicated by the monthly variations in the amount of the catch (Figure 7). Highest catches were taken in March, April and May during which nearly 40% of the 2002's catch was taken. Catches were lowest during September. Part of this observed trend in seasonality may be related to weather conditions; March to May are dry months and seas are calmer allowing fishermen to efficiently conduct the fishing operations (improved visibility for instance), whereas during September the seas conditions are generally rougher with poor under water visibility.

Alternatively it is also plausible that behavior of groupers during March – May make them highly vulnerable to fishing gear. Indeed, catch rates as measured by number of groupers caught per fishing line per trip was highest in April and lowest in September (Figure 7 and Figure 8). The high and low catch periods coincide with highest and lowest tides, respectively, for any given year (Figure 7). Highest and lowest tides in any given year occur one or two days after the full or new moon nearest to the equinoxes. The spring equinox is usually the 21<sup>st</sup> March and the autumn equinox is the 23<sup>rd</sup> September. Thus, it is likely these high catches in April coincide with the peak spawning periods. Furthermore the periods of high and low catch are

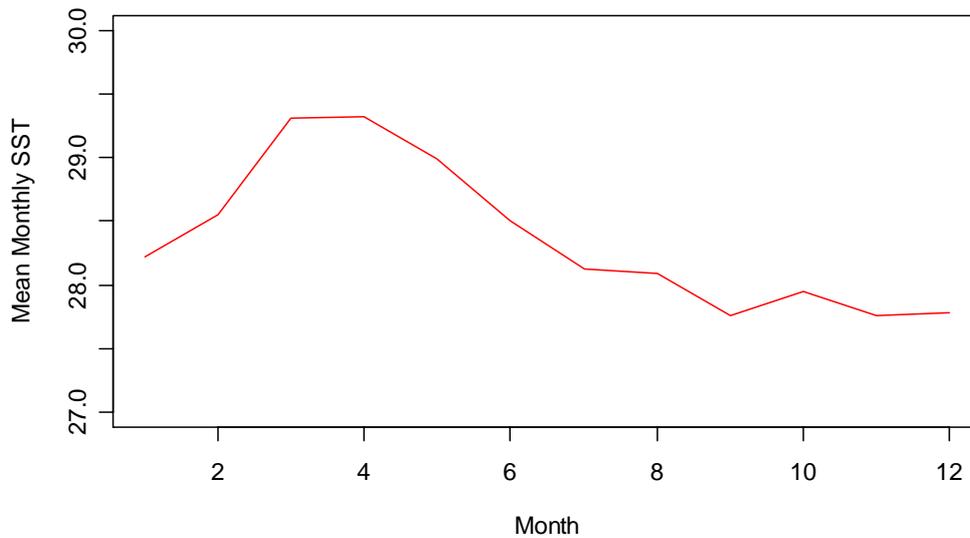
also linked to the sea surface temperature (Figure 9). The Chinese New Year marked in April will also increase the demand of live groupers complicating these relationships. More information would be required to ascertain these inter-relationships.



**Figure 7:** Seasonality of grouper catch, 2002 data only, and its relationship with the tide levels in 2002. Tide data obtained from public archives of University of Hawaii Sea Level Centre.



**Figure 8:** Monthly catch rate (number of grouper) per line per trip. Monthly data used here are from all available data. Bars represent one standard deviation from the mean



**Figure 9:** Mean (1997 – 2004) sea surface temperature around Male area.

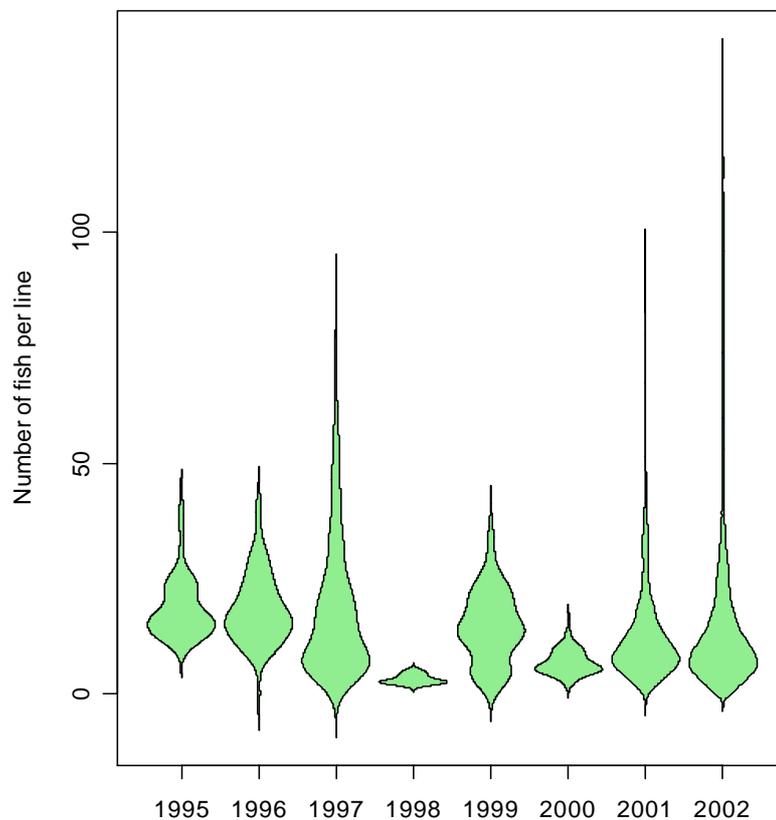
### **5.3. Catch and Effort**

MoFAMR started collecting grouper catch and effort data from 1995. Daily log of the catch has to be reported with breakdowns of species under 7 categories and including the numbers of handlines used. Each form is to have one-month data. This form of reporting was in place till about the middle of 2001. A slightly different form has been in use since then. The difference between these forms is the unit of effort measurement; the ‘number of handlines’ was replaced by ‘average number of fishermen’ who participated during the month.

As noted earlier, catch and effort was reported as the number of fishing lines or more recently as the number of fishermen engaged in fishing activity (normally 1 minus the number of fishermen on boat). Figure 10 shows the average annual catch (no. of fish) per line per trip. The data is drawn as violin-plots to show the density distribution of the catch rates.

The most recent data set is of 2002. This is also the most complete data. The data is highly variable with few instances where extremely high catches have been observed (Figure 10). Overall the annual trend shows that there is declining catch rate (or abundance) of groupers over time. In the actual fact this decline in catch rates will be more apparent if the efficiency in effort were to be taken into account. Initially fishing effort was concentrated on a

single spot at any given time as fishing operation was conducted from the vessels. In the more recent years, and as a direct response to poor catch per unit effort, fishing is carried out by fishermen in water wearing snorkelling gear, which makes the effort spread out to a larger area and therefore more efficient. Moreover, they would be able to locate and drop the line close to the grouper dramatically making the fishing effort more efficient.



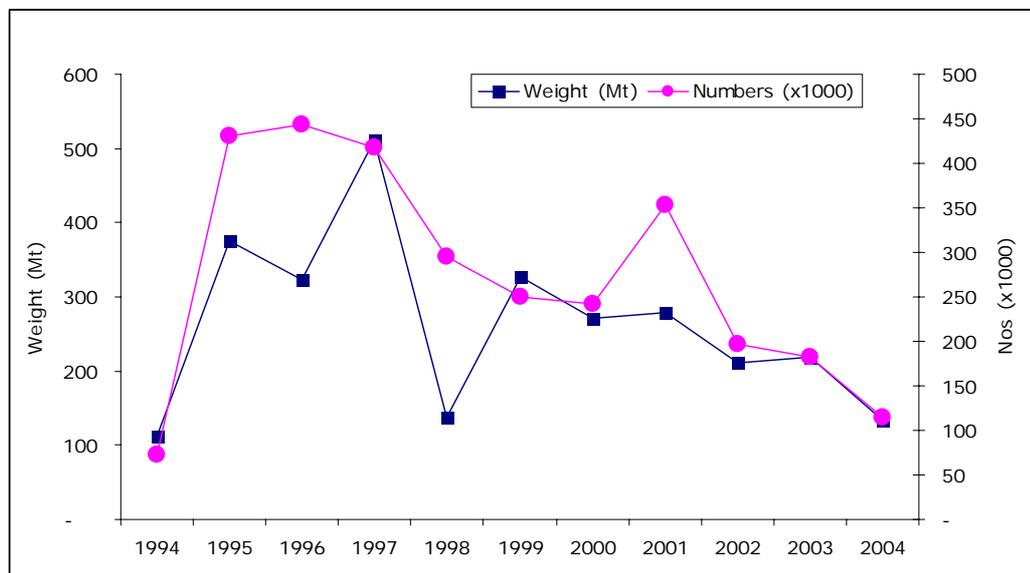
**Figure 10:** Catch per unit effort (CPUE, indicated by numbers of groupers caught per line per fishing trip) for groupers (all species combined). The violin plot show the density distribution of cpue values extending to the inter-quartile ranges. The decline in the trend of mean cpue is apparent.

During the survey conducted for Faafu Atoll in 2003, fishermen were interviewed on the method of fishing and the time spent on each fishing trip. This survey revealed that on average each fishing trip currently lasts a week with at least 5 days of active fishing. During the trip groupers are kept alive in the flooded hull of the vessel. With good circulation the groupers appear healthy even after 5 or 6 days in captivity. Fishermen now travel long

distances of about 60 – 80 miles to sell their catch to the collectors (exporters).

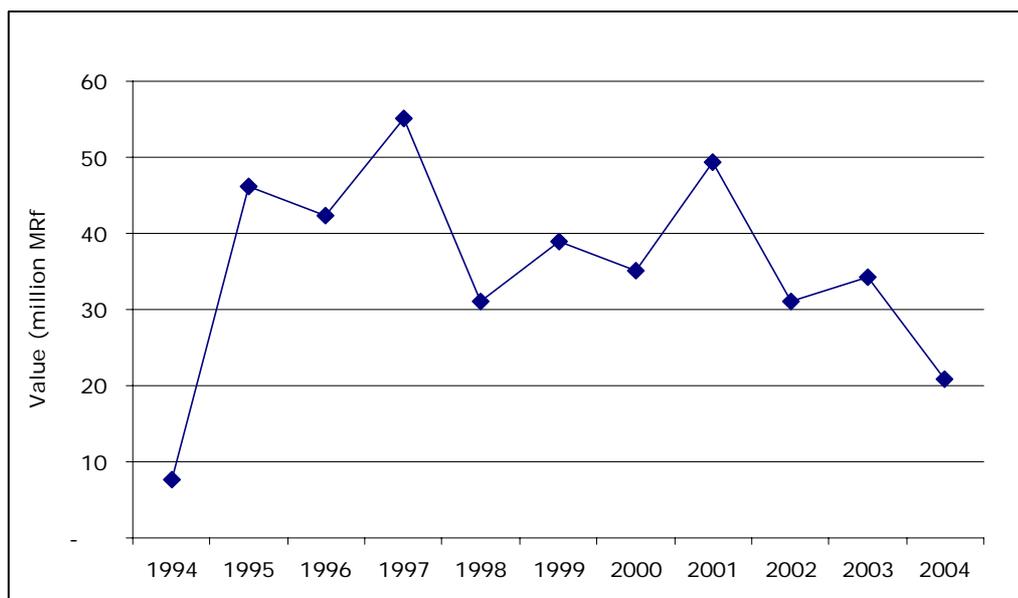
### 5.4. Grouper Exports and Income

Economic Research and Statistics Services of MoFAMR collects export data from Maldives Customs Services on a monthly basis. The data collected do not show the species being exported but shows quantities and value for various grouper categories (i.e., live, fresh-chilled, frozen, grouper fillets). This data is available in the Basic Fisheries Statistics book, which is published annually. Similar to the catch (estimated from export data) the export numbers are declining (Figure 11).



**Figure 11:** Export quantities of fresh/chilled (Mt) and live groupers (numbers), 1994-2002).

The value of the exports follows a similar trend but the decline in the last few years appears not so sharp (Figure 12). This could be due to the increased value of the grouper and grouper products in Taiwan in recent years (McGilvary and Chan, 2002) or more generally increase in unit value in major export markets.



**Figure 12:** Total value obtained from fresh / chilled and live grouper exports, 1994-2002. \*Even though groupers are also exported in frozen, fillet and salt-dried form are not included in the graphs above as they are very small fraction of the total quantity exported, hence generating very little earnings.

## 5.5. Cage Registration

MoFAMR started collecting grouper holding cage registration data in 1995. This data shows the atoll and island where cage is being registered, year, cage registration number, dimensions of cage, when fish stocking was started and when all fish were removed. This form was later revised and excludes the cage dimension data. The collection and monitoring of this data was very inconsistent and not up to date. Hence it is very difficult to deduce the exact numbers of operational cages in a year as the cancellation of registrations were not being monitored.

Table 5 shows the distribution of cages in the three regions of Maldives. Northern region included Haa Alifu to Baa, the central regions included Lh to Thaa and the southern region included Laamu to Seenu atolls. Also given is the number of atolls in each region where cages were present in any given year.

**Table 5:** Distribution of cages in three regions of Maldives

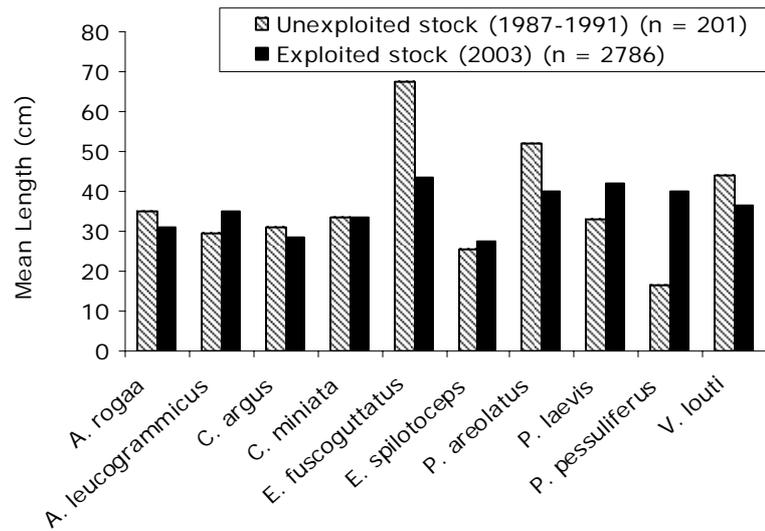
Year	North			Central			South			Total		
	No. of cages	No. of atolls	Cages /Atoll	No. of cages	No. of atolls	Cages /Atoll	No. of cages	No. of atolls	Cages /Atoll	No. of cages	No. of atolls	Cages/ Atoll
1995	15	4	3.8	32	5	6.4	0	0	0	47	9	5.2
1996	3	1	3.0	4	2	2.0	0	0	0	7	3	2.3
1997	2	2	1.0	8	3	2.7	0	0	0	10	5	2.0
1998	3	1	3.0	3	3	1.0	0	0	0	6	4	1.5
1999	2	2	1.0	1	1	1.0	0	0	0	3	3	1.0
2003	7	5	1.4	6	4	1.5	2	2	1	15	11	1.4
2004	2	1	2.0	7	5	1.4	2	2	1	11	8	1.4

As seen from this table the number of grouper holding cages was highest in 1995, which was when the grouper fishery was most developed. Unfortunately the cage registration data for 1994 is unavailable and we are unable to show if there was a substantial increase in the number of cages from 1994 to 1995, which would correspond with the increase in the export industry.

It is clearly seen from the table that the central region has always had grouper holding cages in a greater number of atolls than in the North and South regions. This shows that the fishery has always been more intense in the Central region, as it has been reported by fishermen and exporters both that the exporters move around with the fishery. This is due to the easy access to the international airport which is located in Kaafu Atoll, near Malé. Other reasons could be the easy access to packaging materials such as boxes and ice. The Northern and Southern atolls are well-established tuna fishing regions and this could also be a reason why the fishery has always been more intense in the central region.

## ***5.6. Size Measurements***

MRS conducted two Reef Resources surveys; in 1987/1988 and 1990/1991 (Van Der Knaap et al., 1991, Anderson et al., 1992) where length-weight measurements of all reef fish caught were measured. Length-weight measurements of groupers caught in these surveys are compared with length-weight measurements of groupers, which were caught in 2003. The mean length of the most commonly caught grouper species before and after the initiation of commercial exploitation of the resource is compared in Figure 13. Further details on this comparison are given in Table 7.



**Figure 13:** Comparison of mean length of groupers in the unexploited stock and exploited stock (sample numbers in parentheses are for total numbers of individuals represented by 11 species shown in the graph).

Length-weight measurements of groupers were taken from those groupers, which were brought to the cages in Kaafu Atoll. This was carried out over 3 visits. This cage was visited by fishermen from Raa, Baa Alifu, Vaavu, Meemu, Faafu, and on occasion Haa Alifu, Laamu, and Seenu Atolls and so the areas of fishing varies and distributed throughout Maldives.

Nearly 20 species of groupers were measured for size during the survey. We were only able to measure a proportion of the stock for the *Epinephelus* genus as most of these are exported in the live form and excessive handling of these fish were not allowed by the exporters.

For most species, it is obvious that the mean length of fish at present is much lower than it used to be. These data should be treated with caution when such a comparison is made. The grouper samples taken during the reef fisheries surveys were not from targeted grouper fisheries, but of general reef fishery prevalent at the time. Besides the sample size is comparatively low (201 vs. 2786) compared to the size samples taken from the field surveys at present.

However it should be noted that even with the little data available together with reports by fishermen and buyers it is safe to say that the sizes of

groupers now being caught are considerably smaller than what they used to be in the initial stages of the fishery.

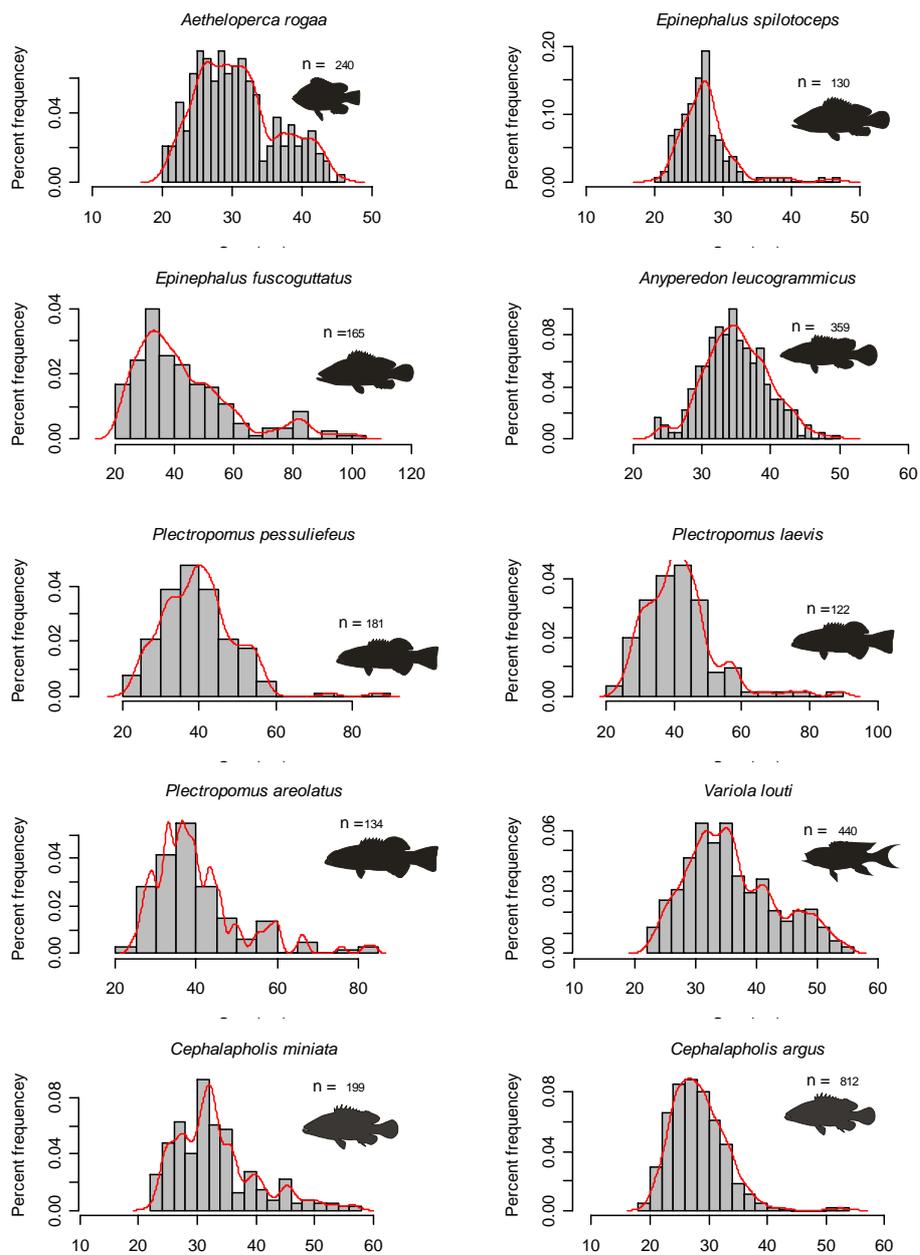
The most frequently caught groupers are shown in Table 6 which also details the maximum length obtained during the survey trips compared with that reported in literature. Size composition data shows that 43% of the total grouper catch are now generally fished before they reach their maturity lengths. Some of the species are commonly taken at the length when they have just reached their maturity ages. These species include *A. rogaea*, *C. argus*, *E. fuscoguttatus*, *P. laevis* and *V. louti*. The maximum total lengths are as reported by Heemstra et al. (1993) and the theoretical length at maturity is as reported by Shakeel et al. (1996), where this length was estimated by assuming that a fish generally spawns for the first time at half the maximum length it attains (Table 6).

**Table 6:** Average sizes of groupers in the fishery along with the reported maximum length and theoretical maturity length.

Species	Sample Size, n	Average length (cm)	Most common length (cm)	Max. length (cm)	Max. length reported in literature (cm)	Theoretical maturity length (cm)
<i>A. rogaea</i> *	229	30.9	29	46	60	30
<i>A. leucogrammicus</i>	346	35.1	35	50	52	26
<i>C. argus</i> *	789	28.0	27	54	55	28
<i>C. miniata</i>	191	33.3	32	57	40	20
<i>E. fuscoguttatus</i> *	160	43.8	31	101	95	48
<i>E. spilotoceps</i>	123	27.8	28	47	31	16
<i>P. areolatus</i>	132	40.4	33	84	68	34
<i>P. laevis</i> *	119	41.9	42	89	125	63
<i>P. pessuliferus</i>	157	40.2	40	86	63	32
<i>Variola louti</i> *	441	36.3	35	97	81	41

\*Species that were fished prior to them reaching theoretical maturity lengths. Source: Heemstra et al. 1993; Shakeel 1996.

Size composition graphs for the 10 most common species of groupers are shown in Figure 14.



**Figure 14:** Size composition of 10 most common groupers in the fishery (2003-2004).

Table 7 compares the average size and weight of the commonly fished species before (1990-1991) and after the targeted exploitation of the grouper resource (2003-2004). The samples size for the 1990-1991 period from which these estimates were drawn was much smaller than the 2003-2004 period. The smaller size and weight of the groupers at present suggest that fishery is having an impact on the demographic structure of the population. For the three most heavily exploited species, *A. rogae*, *E.*

*fuscoguttatus*, and *V. louti* the average weight has declined nearly 50% than what it used to be during 1990-1991.

**Table 7:** Comparison of average sizes of groupers between pre-exploited (1990-1991) and exploited stock (2003-2004).

Species	Average length		Average weight		Sample Size	
	Stock before fishery intensified	Exploited stock	Stock before fishery intensified	Exploited stock	Stock before fishery intensified	Exploited stock
<i>A. rogae</i>	35.0	30.9	1.1	0.6	23	229
<i>A. leucogrammicus</i>	29.7	35.1	0.4	0.6	12	346
<i>C. argus</i>	30.8	28.0	0.5	0.5	13	789
<i>C. miniata</i>	33.3	33.3	1	0.6	29	200
<i>E. fuscoguttatus</i>	67.7	43.8	6.3	1.9	5	160
<i>E. spilotoceps</i>	25.7	27.8	0.3	0.5	48	123
<i>P. areolatus</i>	52.1	40.4	1.9	1.2	23	132
<i>P. laevis</i>	32.8	41.9	0.7	1.2	4	119
<i>P. pessuliferus</i>	16.5	40.2	0.1	0.9	11	157
<i>V. louti</i>	44.1	36.3	1.6	0.9	33	431

## 6. Grouper Fishery in Faafu Atoll

The assessment of the grouper fishery in Faafu Atoll was carried out as part of the Asian Development Bank Regional Technical Assistance Project (ADB-RETA Project 5974, 2003) on Coastal and Marine Resources Management and Poverty reduction in South Asia. This project focused on identifying marine resource exploitation issues in Faafu Atoll and providing a basis for protecting, restoring and preserving the diverse coastal resources of this atoll. One of the main objectives of the project was to restore and preserve the grouper fishery in the atoll through a 'best practice' involving community at every in the decision making process.

Faafu Atoll was selected as the focus area of the study after assessing all potential High Priority Areas (HPAs) in Maldives. The selection of HPAs was based on social, economic and ecological factors, which were developed by the IUCN Regional Marine Programme in Sri Lanka. In Maldives, HPAs were chosen based on thematic issue areas, i.e., groupers, sharks and mangroves. Four sites based on these thematic areas were chosen:

- Baa Atoll for its grouper resource
- Faafu Atoll for its grouper resource
- HDh. Kulhudhuffushi for its shark resource and
- Eidhigali Kulhi in S. Hithadhoo for its mangroves

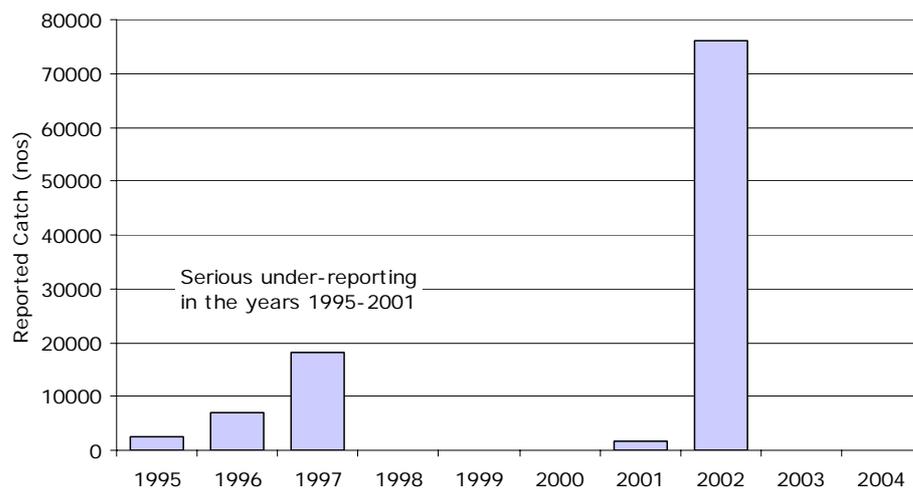
After assessing all potential HPAs, the expert group involved in the project recommended to conduct the pilot study in Faafu Atoll to study the impact of grouper fishery (MoFAMR, 2003a) and provide a sound basis for management of resource.

Faafu Atoll was also selected due to its nearness to Malé, its small size and the presence of only few inhabited islands (which was advantageous in conducting the study over a short period of time) and also due to the extensive exploitation of groupers in the atoll (MoFAMR, 2003b).

Being one of the first atoll to have started grouper fishing, and over the past 10 years or so, grouper fishing has been a major source of income for Faafu Atoll fishermen. Prior to that, it was a source of alternative income for fishermen at times of low tuna fishery. In the later 1990s heavy exploitation

has resulted in declining catch rates and fishermen moving over to other atolls. Catch records show that fishermen from Faafu Atoll frequent Vaavu, Meemu, Dhaalu, Lhaviyani and Kaafu Atolls. In general these fishermen visit almost all areas of Maldives for grouper fishing.

Like other atolls information on grouper catch from Faafu atolls is scant in the earlier years. The data for recent years were confounded with the other atolls' as the fishermen moved to other areas. Export data is reported in aggregated form making it impossible to obtain atoll level data. Information on catch as reported by Faafu Atoll fishermen are given in Figure 15. There are gaps in the missing years; 1998-2000 where no data were available from Faafu Atoll. Extremely high catches are reported in 2002 presumably as a result of the introduction of the new form.

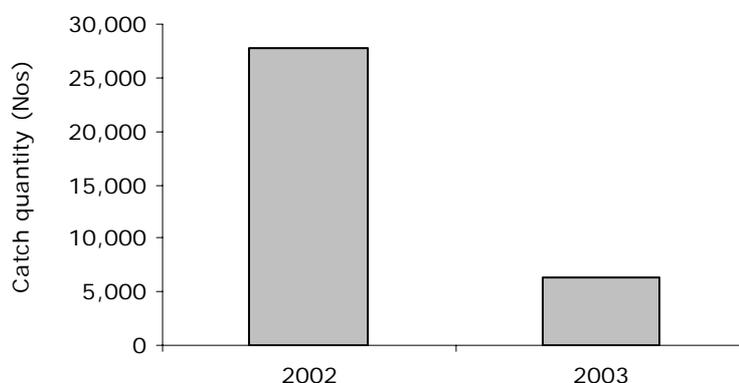


**Figure 15:** Grouper catch from Faafu Atoll as estimated from catch data. Note data were and incomplete for years prior to 2002.

The information in the graph is somewhat misleading as it shows continued increase of catch. However, there are serious gaps in the data. For the years 1995, 1996, 1997 and 2001 only 2 data sets<sup>1</sup>, 1 set, 3 sets and 4 sets respectively were available from Faafu Atoll. In comparison to this a complete set of data for all months were available in 2002. Figure 16 shows that complete 12 months data sets from single dhoni for the 2002 and 2003. Where as the catch in 2003 were relatively high the catch in 2003 is dropped to 77% of the 2002 levels. These can be largely attributed due to a decline in abundance of groupers in Faafu Atoll areas. Alternatively it may

<sup>1</sup> A data set consist one more completed forms (monthly) from a single dhoni

be possible that fishermen simply stopped fishing due to a drop in prices because of the Severe Acute Respiratory Syndrome (SARS) epidemic.



**Figure 16:** Total catch of groupers as reported by fishermen from a single dhoni from Faafu Atoll.



**Figure 17:** The only existing collection facility in Faafu Atoll in the uninhabited island of Adhangau, July 2004.

At present there is one grouper holding cage in Faafu Atoll which is located in Adhangau; an uninhabited island north of Bilehdhoo (Figure 17). This cage is owned by Seaview Enterprises and is visited by the few fishermen in Faafu Atoll who still fish within or nearby the atolls. The greater proportion of grouper fishermen from Faafu Atoll sell their catch to other cages especially the one in Kaafu Atoll as most of their fishing is carried out in the atolls around the area. Another reason why fishermen continue selling their catch to the cages in Kaafu Atoll is the higher price being paid there. In total 4 vessels visit the cage in Faafu Atoll on a regular basis. All 4 of these dhonis were from Faafu Atoll but fishing in other nearby atolls such as Dhaalu and Thaa atolls.

Surveys conducted by MoFAMR in Faafu Atoll in the year 2002 showed that almost all males above the age of 18 years (over 60%) were involved in the fisheries activity. The majority of this 60% were involved in grouper fishing and about 10% were engaged in other types of reef fishing. Only six to seven small fishing crafts were engaged in tuna fishery.

The outbreak of the SARS epidemic in 2003 led to a decline in the grouper export as the demand for groupers in the international markets during that period fell rapidly. Not surprisingly there was a corresponding decline in the economy of Faafu Atoll showing the strong link between the grouper fishery and livelihoods of this community. The effect was felt not only in the Maldives but also in countries such as Indonesia (Pet-Soede et al. 2004).

### ***6.1. Survey Analysis***

On three visits to a nearby grouper holding cage (Between September – December 2003), a survey was conducted amongst fishermen from Faafu Atoll. Eighteen fishermen were interviewed and although this was a small proportion of the fishing community in Faafu Atoll, the results provide reasonable assessment about the grouper fishery of Faafu Atoll. The purpose of the interview was to obtain an overview of fishermen's perceptions about the state of the grouper fishery in the atoll. The findings of the survey are summarized below.

When inquired as to what the fishermen felt was the current status of the grouper fishery, 24% thought that there was not much change in the fishery, and 41% thought that the fishery was faring pretty well. However, 29% of the fishermen reported that the fishery was low compared to what it was when they first started, which was in contrast to what was reported by a minority (6%) who believed that the fishery was doing better than before.

Fifty three percent of the interviewed fishermen had chosen grouper fishery due to the better income they earned, while 18% reported that it was an easier method of earning money than tuna fishery. 12% of the interviewees had turned to grouper fishery after their previous line of work (e.g. turtle fishery and sand mining) was banned. Other interviewees also stated reasons such as Faafu Atoll being a central atoll and the easy access for

grouper holding facilities, which makes it easy to sell their catch thus getting instant cash.

Although in previous surveys fishermen in Faafu Atoll believe that the fishery had declined in the atoll, when interviewed 41% of all interviewees reported that there was no variation in catch quantity and size. However, 29% responded a change in quantity but not size. They state that they now have to put in more effort to catch reasonable amount of fish, which would fetch them sufficient amount of money. Another 24% reported smaller size but no variation in the quantity of catch over time. However 6% of the interviewees still attest that the fishery in general is decreasing (in both size and quantity).

Handlining used to be the most common method of grouper fishing in the early period of this fishery. The recent survey carried out shows in contrast that handline fishing while snorkeling is now the preferred method over handlining fishing from the boat. Seventy five percent of the interviewed fishermen reported snorkeling to find groupers where as 12.5% reported handlining from boat. The remaining 12.5% reported using both methods. When snorkeling, the fishermen spend an average of 8 hours in the water.

Survey results show that on average each individual fisherman earns approximately Rf 6,500<sup>2</sup> per month. This was obtained from a survey where some people reported getting as much as Rf 15,000 per month and others reported getting Rf 1,500 per month. Fishermen reported that the income they generate from this fishery is declining day by day while the expenses are increasing. This is due to the greater amount of travel required, increasing fuel prices and smaller size and amount of fish caught.

On average each fishing trip lasts for a week, the range between 3 and 10 days. On average these trips produce a catch of 200 groupers per trip with an average catch rate of 40 to 50 groupers per day. Groupers of the *Epinephelae* genera make up the largest share of all groupers caught. These fish are mostly exported live and fetch higher prices than other species (export data shows that live exports contribute 40 – 50% to the total value obtained from grouper exports). Prices paid to fishermen for species in the

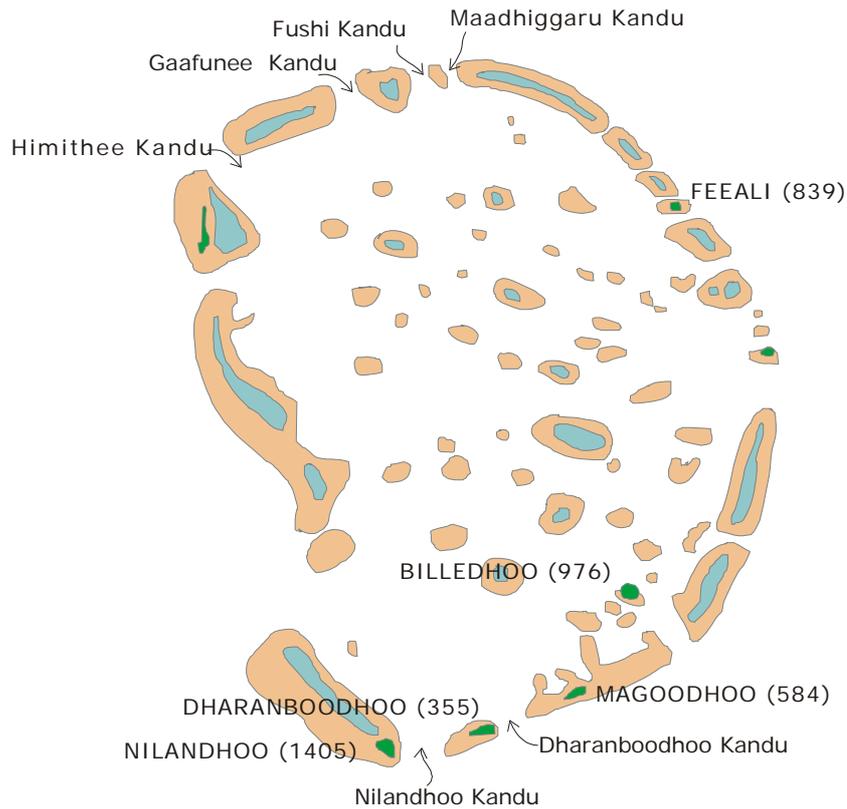
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<sup>2</sup> 1 US\$ = MRf 12.75

Epinephelinae genus can fetch as high as MRf 600.00 per fish depending on the size and species of the fish.

Some species of groupers in their normal behaviour form spawning aggregations. Previously in Faafu Atoll, fishermen observed large aggregations swimming up to the shallow areas to spawn during the spawning season. According to sources from the atoll these aggregations are no longer observed. Nilandhoo Kandu Olhi and the Dharaboodhoo Kandu Olhi on the Southern end of the atoll and Maadhiggaru Kandu, Fushi Kandu, Himitheo Kandu and Gaafunee Kandu on the Northern periphery inclusive of their channels, ring reefs and locations both at the outer and inner of the atoll have been reported as major fishing grounds (Figure 18). Out of these sites some areas, especially the channels have been identified as grouper aggregating sites (MoFAMR, 2003c).

The two most intensely used areas in Faafu Atoll due to their resource richness were Magoodhoo falhu and Feeali area. These sites are no longer used due to resource decline. As reported by MacAllister Elliot and Partners (2002), the health of a grouper spawning aggregations is a good indicator of the health of the population as a whole because the depletion of spawning aggregation has very serious consequences for the reproductive output of the population. Hence the absence of these spawning aggregations in Faafu Atoll is additional indication of the declined grouper stocks within the atoll.



**Figure 18:** Faafu Atoll in the south central Maldives showing the inhabited islands (capitals letters) and its population in parentheses and major areas for grouper fishing.

In a biodiversity study conducted in Faafu Atoll in May 2003, a snorkeling survey was conducted to obtain an estimate of size, abundance and species. Only 4 species of groupers were observed and 3 of these belonged to the economically low-valued *Cephalopholis* genus. The other was *Epinephelus merra* (MoFAMR, 2003c). This is further proof that economically important species have now been overfished from the shallow areas and can only be fished from the deeper areas not visible in a simple snorkeling survey.

The measurable management quantities which can be used to assess the performance of the grouper management plan are catch rates, abundance, average sizes of species and the species diversity in the area. There is a dearth of atoll specific catch data which does not enable us to assess the amount of resource being utilized from Faafu Atoll. Field visits of short duration might not have yielded the additional required information due to the absence of fishing carried out in Faafu Atoll. These trips to Faafu Atoll to carry out abundance surveys were not possible due to a multitude of reasons. It is believed that the national catch rates and average sizes in the

catch are reasonable measures that can be used for Faafu Atoll fishery as well.

Since surveys carried out in K. Bangaafaru in 2003 revealed *E. fuscoguttatus*, *P. areolatus*, *P. pessuliferus*, *P. laevis*, *C. argus*, *C. miniata*, *A. roгаа*, *A. leucogrammicus* and *V. louti* to be the most commonly caught species, it is suggested that these species be used as the indicator species in the proposed "Grouper Management Plan for Faafu Atoll", which is detailed in Section 9 of this report.

The fishermen and the local community in Faafu Atoll appear to be aware of the decreasing grouper fishery in the atoll. They are also aware of the important role groupers play in the economy of the atoll. For these reasons together with the fact that the men in the family now have to be away for long periods of time, the atoll community is supportive of the introduction of management measures for this fishery, even if it means the closing of certain areas in the atoll for fishing for a certain period of time.

## 7. Major Findings

1. In the beginning the grouper fishery was concentrated in the central atolls. With decrease in catch rates the fishery and the buyers quickly spread out to northern and southern atolls. Although the current catches are taken from various atolls the buyers are centrally located in Malé Atoll.
2. Groupers are no longer simply caught from any shallow reef areas. Over the years fishermen have learnt a great deal about their biology and behavior, particularly about areas where groupers periodically aggregate to spawn. Most fishermen now regularly target spawning aggregations located in various atolls.
3. The method of catch has shifted from simple drop-handlining operated from vessels to targeted deployment of handline by fishermen in water wearing snorkeling gear. This allows fishermen to spread out their fishing effort and to selectively target the sought after species.

4. In the recent years catch rates, crude measure abundance, have consistently declined. From about 100—170 groupers per day in 1990s (observed from an experimental survey) the current catch rates have dropped to 40-50 groupers per day. Fishermen are constantly moving from one area to another in search of new aggregation. Declining catch rates have made the fishermen start using fish finders loaned by buyers.
5. The sizes of the individuals taken in the fishery have declined indicating the fishery is heavily over-exploited. Survey results indicate on average 43% of the catches consists of immature individuals.
6. Species of *Epinephelus* are most exploited as these are mainly exported live and therefore fetch high prices.
7. Most fishermen are aware of the declining catch rates and sizes. The relatively few who are in the fishery are most experienced and the economic returns are still high enough to keep them going fishing.
8. To keep the fishermen in business buyers manipulate the prices. For example at times of low fishing, exporters change the prices they pay of the size category so a fish which would normally be in the small size category is considered as medium size.
9. Conflicts exist between the grouper fishery and other reef fisheries, such as sea-cucumber and bait. Grouper and bait fishermen claim that the water in which sea-cucumber has been cooked is later released to the lagoon and contains toxins which have a negative impact on the abundance or availability of groupers and bait fish. While it may be possible, such claims however, have yet to be proved scientifically.
10. Conflicts between the grouper fishery and the tourism industry have reached a point where the grouper fishermen in water are being chased away by the tourist dive boats. Grouper fishermen report that some resorts have self-declared protected areas in an attempt to stop the grouper fishermen visiting there.

11. Collection and reporting of grouper catch and effort data are poor. There is no follow-up of the reported catches and as a result there are major inconsistencies in reporting of catch and effort data from the fishermen. The structure and type of information being collected on the data forms are not valid as fishermen constantly move from atoll to atoll. The data collection form needs to be revised urgently.
12. Atoll specific information in the data is lacking. This does not allow estimating quantifiable management measures specific to Faafu atoll. The estimates of catch rates and size composition data from the survey were considered to reflect the situation of Faafu atoll.

## 8. Management Recommendations

- **Protecting Spawning Aggregations:** It is believed that fishermen routinely target spawning aggregations to optimize their effort and to catch large individuals. However, the high percentage of the immature fish in the catch suggest that age-structure of the population has been severely affected by heavy fishing pressure. Protecting the spawning aggregations is critical to avoid population crash. The two sites earmarked in Faafu Atoll as grouper no-take zones should be implemented as soon as possible as the first step towards protecting spawning aggregations. Additional sampling and surveys have to be carried out to find the extend and timing of the spawning aggregations.
- **Establishment of an export-quota system** for those species which are exported in large numbers, i.e. *A. rogaea*, *A. leucogrammicus*, *C. argus*, *C. miniata*, *E. flavocaeruleus*, *E. fuscoguttatus*, *E. spilotoceps*, *P. areolatus*, *P. laevis*, *P. pessuliferus* and *V. louti*
- **Establishment of a minimum size on catch:** Export of the under-sized individuals should be banned. The minimum size may be determined based on their theoretical maturity size. The different grouper species found in the Maldives have been categorized into 4 main categories based on size (Shakeel, 1996). The smallest grouper in each category can be used to establish the minimum size limit for that category based on the maturity length of that grouper. Fishing of groupers smaller than these

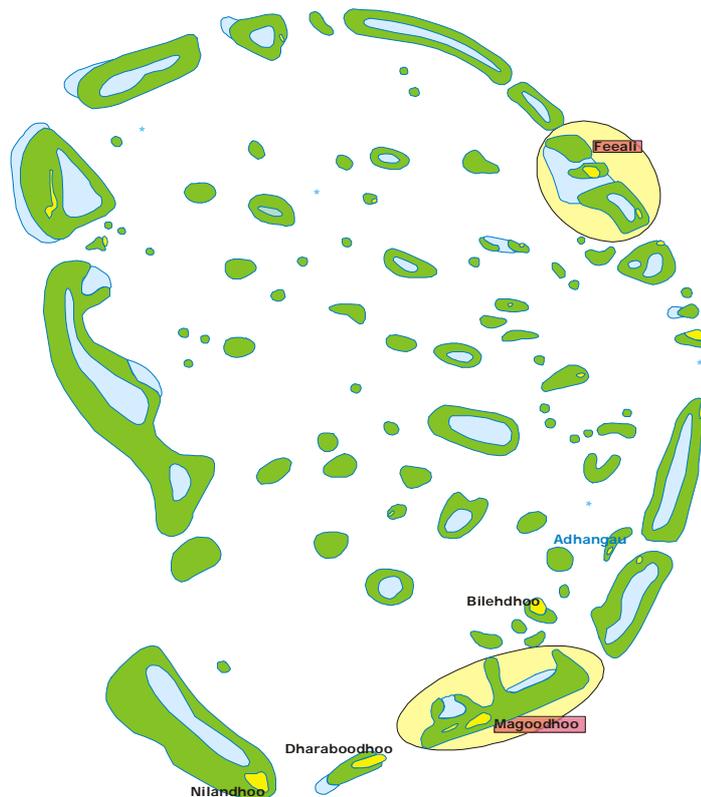
minimum sizes should be banned. Enforcement of this measure could be done at the export points through Customs officials.

- **Aquaculture of groupers:** Establishment of an aquaculture industry is a high priority of the government. To this end a 'Mariculture Development Project Feasibility Study' has been conducted with assistance from Kuwait Fund. The study is being approved by MoFAMR and the Project Appraisal Committee at the Ministry of Planning and National Development.
- **Strengthening of catch and effort data collection:** The current level of catch and effort data collection is not adequate for monitoring and assessment requirements of the resource. There are serious flaws in the information being collected on the forms. The current arrangement of fishermen completing the catch forms may not work without adequate monitoring and follow up. An alternative method for data collection may be through exporters or buyers. Exporters and buyers could be encouraged to submit their daily purchase sheets on a monthly basis.
- **Community awareness and management:** Management and the necessary regulatory enforcement may be achieved through building awareness of the fishers about the resource. The ADB RETA project's recommendation emphasizes the need for community involvement in the marine resource management and the eventual devolutions of the regulatory and enforcement authority to the community level. Way of implementing these recommendations has to be sought.
- **Training of MRC staff:** MRC has insufficient skilled staff and resources to carry out the work required for regular monitoring and assessment of the grouper resource. Further postgraduate training on quantitative methods of resource assessment and evaluation is required.

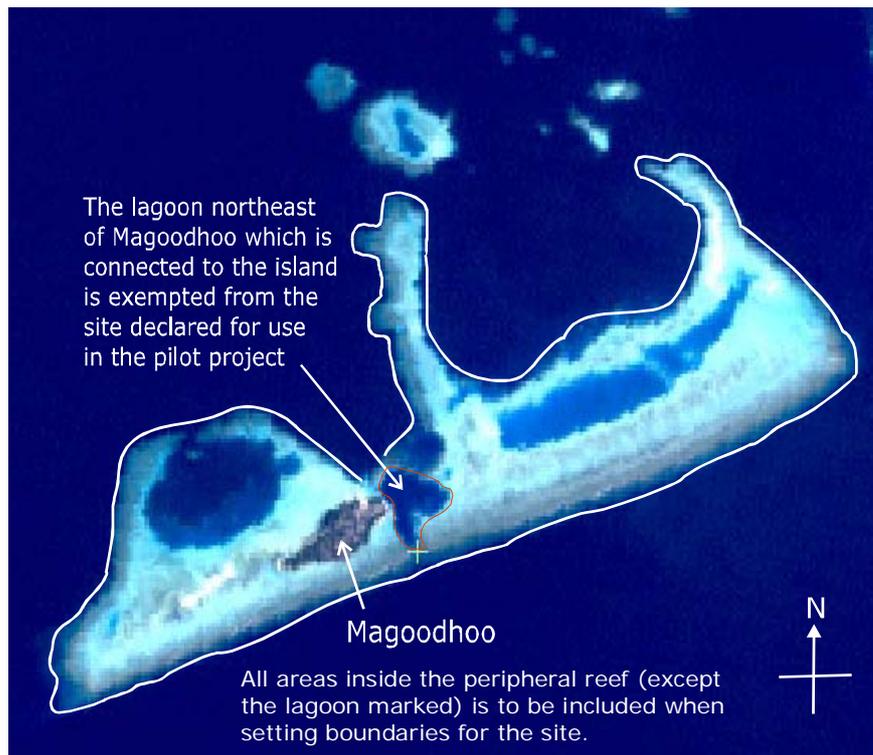
## 9. Grouper Management Plan for Faafu Atoll

Management Action 2 of the Integrated Coastal Zone Management Plan formulated at the end of the ADB-RETA project 5974 focuses on promoting the sustainable utilization of the grouper resources. Under this action a pilot project that will be carried out to establish a stock assessment of the grouper resources in Faafu Atoll has been formulated and named "*Grouper Management plan for Faafu Atoll*". Two sites in Faafu Atoll (Figures 19, 20 and 21) have been chosen for the use of this project:

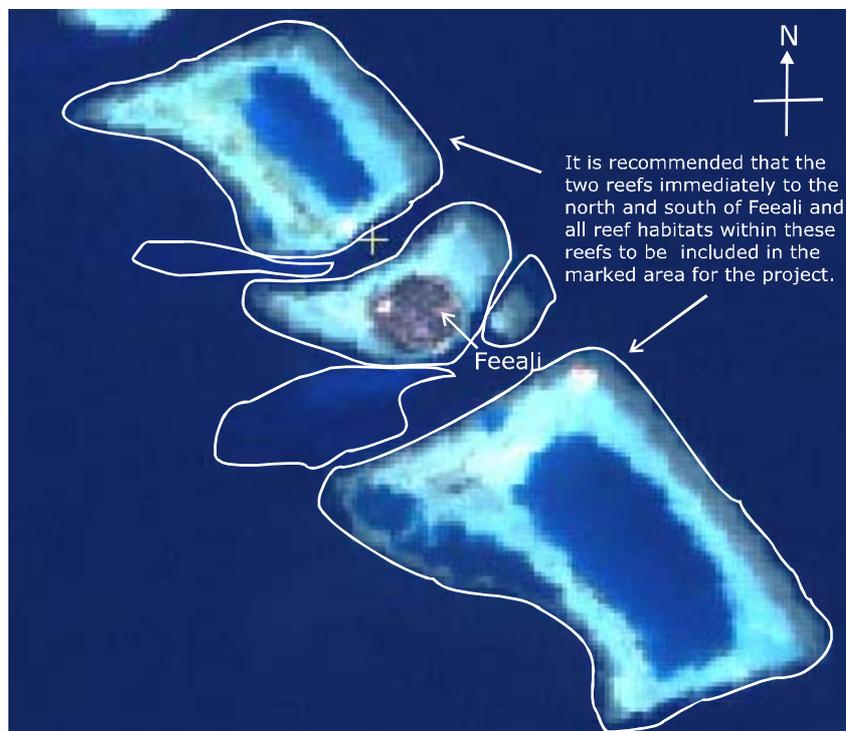
- a. All the reef habitats that fall within the peripheral reef associated with Magoodhoo, including the reef slopes, lagoons, shallow reefs, patch reefs, bottom reefs, etc. except the small lagoon North East of the island which is connected to the island.
- b. All the reef habitats that fall within the peripheral reef associated with Feeali, and the reef associated with the island.



**Figure 19:** Map of Faafu atoll showing the designated sites for the Grouper Management Plan (highlighted in red).



**Figure 20:** Proposed sites in *F. Magoodhoo*



**Figure 21:** Proposed sites in *F. Feeali*

The boundaries for these 2 sites will be set with the use of bathymetric charts and depth contours of the ocean.

1. The main objectives of this pilot project are:

- ✚ Ban all types of fishery from the 2 selected sites, in order to achieve the natural grouper stocks;
- ✚ Improve the status of all coral reefs and their resources in Faafu Atoll in general and specifically in the locations identified in this plan;
- ✚ Encourage conservative use of biodiversity in Faafu Atoll in general and especially in the locations identified in this plan;
- ✚ Facilitate alternative income generating activities. Facilitate better income opportunities, with the use of the atolls' marine resources in a sustainable manner.

**Note:** *It is proposed that the ban on all types of fishery in these sites implemented for a period of 5 years. However, in instances where it is for the use of the island community, permission maybe obtained from the concerned island office to carry out the fishery inside the lagoon. Diving for tourism or research purposes may also be carried out in these areas, as long as there is no damage to the environment.*

\*1.1. The following criteria will be used to assess achievement of the objectives:

- Increased population abundance and structure of selected key indicator species of grouper in the identified locations;
- Improved habitat conditions and fish-species diversity and abundance;
- Reduced income poverty in Faafu Atoll communities

\*1.2 Indicators to assess biological outcomes on identified grouper species as a result of the management practices used in the project:

- Increased mean age and size of selected key indicator species of grouper in the identified locations;
- Increased abundance (number and density) of selected key indicator species of grouper in the identified locations;
- Increased size of spawning stock of selected key indicator species of grouper in the identified locations; and
- Increased reproductive output at age of selected key indicator species of grouper in the identified locations

\*1.3 Indicators used to assess biological outcomes in the identified locations other than those on grouper species as a result of management measures in this Plan are:

- Enhanced habitat complexity
- Enhanced fish species diversity and abundance;
- Enhanced community complexity; and
- Improved populations of fishing-affected species.

\*1.4 Indicators used to assess economic and social outcomes are:

- Increased income to Faafu Atoll communities from fisheries (excluding grouper fisheries) and non-fisheries sectors;
- Enhancement of the social well-being of local communities; and
- Increased income to Faafu Atoll communities who depend on grouper fishery for their income.

\*1.5 Performance measures and biological indicators stated above will be reviewed in 2004 based on monitoring and research protocols developed by Ministry of Fisheries, Agriculture and Marine Resources using base line studies at the identified locations.

\*1.6 Key indicator species used to assess biological outcomes will be identified and reference points will be established using base line studies carried out by the Ministry of Fisheries, Agriculture and Marine Resources at the identified locations.

*\* All indicators as given in MoFAMR (2003d)*

The implementation of the project will be carried out under the supervision of a selected committee. The committee will be composed as follows:

- All members of the Faafu Atoll Development Committee
- One representative from Ministry of Atolls Development
- Two representatives from Ministry of Fisheries, Agriculture and Marine Resources
- One fishermen from each island in Faafu Atoll

The committee will be chaired by Ministry of Fisheries, Agriculture and Marine Resources.

First review of this project was scheduled to be held prior to the end of 2004. Further reviews was to be carried out once in every 2 years. These reviews were to be done during the first 6 months of the year.

The lead role in the implementation of this project will be played by the Ministry of Fisheries, Agriculture and Marine Resources and was to be concluded by the end of 2004.

At the conclusion of this pilot project it was decided that the Grouper Management Plan was to be implemented nationally on a long term basis based upon the results obtained from the Faau Atoll Project.

## 10. Acknowledgments

Numerous people have helped in writing this report. We would like to thank Hussein Zahir for his guidance in the field work, Dr. Abdullah Naseer, Hassan Shakeel and Zaha Waheed and Dr. Charles Anderson for their constructive comments on the draft report and for Mohamed Ahsan and Aishath Shahinda for their assistance with editing the photographic plates

The required data could not have been obtained without the support from the exporters and fishermen. We would like to note in particular Mr. Mohamed Mahir of Seaview Enterprises and Mr. Abdul Wahid from Marine X Plus as well as their staff at the grouper holding cages for their continuing support and assistance in conducting the field work. In addition we also thank the fishermen who have been very supportive of this work and who willingly took part in the surveys.

The field work was supported by the Asian Development Bank Project 5974 (Project on Coastal Marine Resource Management and Poverty Reduction in South Asia).

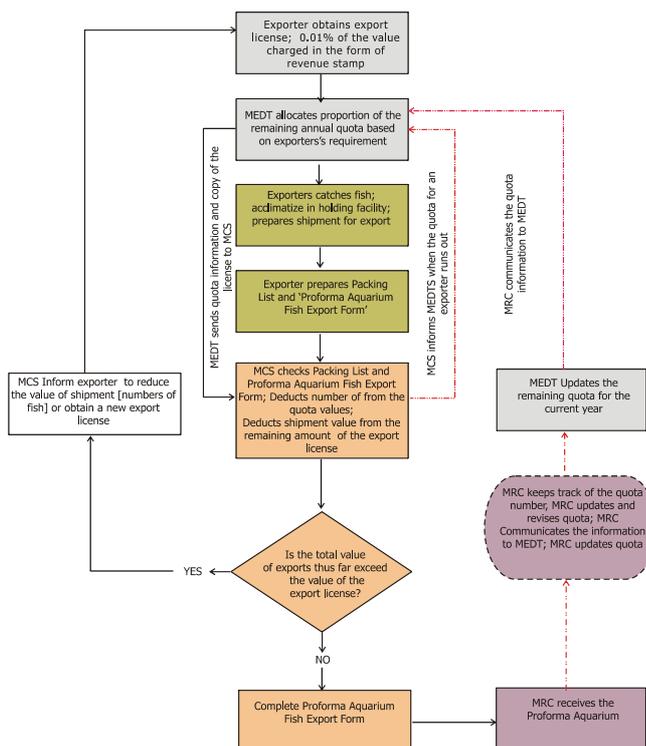
## 11: After Thought

The draft of this report was complete during August 2004. It should have been finalized and the findings disseminated much earlier. However, due to additional data and verification requirements the finalization of the report was delayed.

The data during 2004 showed that grouper catch is rapidly declining. Discussions with a major exporter revealed that export business was seriously affected by the events following the 26 December Tsunami. The few fishermen who are still active are being maintained by exporters offering high prices for their ever decreasing catch. These observations taken together with the groupers' life history it is imperative grouper abundance have declined to a level where management interventions are required urgently.

A possible and effective management action would be to impose a restriction on the amount of groupers that can be exported aimed at regulating total removal from the population. Similar to the quota for aquarium fishery a species specific quota for grouper can be introduced (Box 1). The quota shall, in the first instance, be based on precautionary principles using the best available information. Three management categories identified; a banned category, a quota category and a category that is not subjected to quota.

**BOX 1:** The export of aquarium fishery begins with an exporter obtaining an export license from the Ministry of Economic Development and Trade (MEDT). The license is value-based where the exporter determines the amount. A charge of 0.01% of the value of license, in the form of revenue stamp, is paid by the exporter. This could be considered as a resource rent. Currently there are no restrictions on the area in which fish can be caught. The nature of business dictates holding facilities is located close to Malé International Airport. As a result nearly all holding facilities are located either in Gaagandu or in K. Villingili ward.



This could be considered as a resource rent. Currently there are no restrictions on the area in which fish can be caught. The nature of business dictates holding facilities is located close to Malé International Airport. As a result nearly all holding facilities are located either in Gaagandu or in K. Villingili ward.

All aquarium fish species are coded; banned species, quota species and unrestricted species. MEDT allocates a portion of the quota based upon the requirement of the exporter.

The fish are caught using hand-held nets by SCUBA

divers. The species and the quantity caught is determined by their overseas clients' requirements or based upon species that they have quota for.

Fish are acclimatized and shipment prepared with detailed packing list (species and their numbers). Additionally a 'Proforma Aquarium Fish Export Form' is completed for each shipment (includes number and type of species and their value) which is declared at the MCS. At the time of each shipment MCS deducts the declared value of the shipment from the remaining value of the export license. On reaching license limit MCS informs MEDT whereby the exporter renews the export license. Proforma Aquarium Fish Export Forms are regularly sent to MRC by MCS. Currently there is no mechanism to regularly send back the information to MEDT to revise the remaining amounts in the quota. This role could be filled either by MRC or from the MCS.

Following is tentative quota for groupers that was set based upon the average catches of 2002, 2003 and 2004. Similar to the aquarium fishery three categories have been identified; an export banned category, a category which has quota and a category that has no export restrictions. The quota limits may be revised based up the results of an encounter surveys on popular fishing areas which could easily be done by MRC.

### Banned species

Code no.	Name of the Species <sup>3</sup>	Scientific Name
GRP-A-001	Mudu faana	<i>Epinephelus lanceolatus</i>

### Species subjected to a quota

Code no.	Name of the Species	Scientific Name	Quota
GRP-B-001	Ginimas Faana	<i>Aetheloperca rogae</i>	50,000
GRP-B-002	Boalhajehi faana	<i>Anyperodon leucogrammicus</i>	35,000
GRP-B-003	Asdhaanu faana	<i>Epinephelus spilotecps</i>	8,000
GRP-B-004	Kas faana	<i>Epinephelus fuscoguttatus</i>	50,000
GRP-B-005	Thijjehi faana	<i>Epinephelus areolatus</i>	5,000
GRP-B-006	Kula faana	<i>Epinephelus polyphkadion</i>	1,000
GRP-B-007	Dhon noo faana	<i>Epinephelus flavocaeruleus</i>	500
GRP-B-008	Dhon olhu faana	<i>Plectropomus pessuliferus</i>	15,000
GRP-B-009	Kula olhu faana	<i>Plectropomus laevis</i>	30,000
GRP-B-010	Olhu faana	<i>Plectropomus areloatus</i>	10,000
GRP-B-011	Boakuda faana	<i>Gracila albimarginata</i>	10,000
GRP-B-012	Kandu haa	<i>Variola louti</i>	30,000
GRP-B-013	Kandu raivy haa	<i>Variola albimarginata</i>	10,000
GRP-B-014	Koveli faana / Bulhala faana	<i>Cephalopholis miniata</i>	10,000
GPR-B-015	Mas faana	<i>Cephalopholis argus</i>	20,000
GRP-B-016	Ran faana	<i>Cephalopholis aurantia</i>	700

<sup>3</sup> Names taken from the Grouper Poster prepared by MRC.

## Unrestricted Species

Code no.	Name of the Species	Scientific Name	Quota
GRP-C-001	Kooru faana	<i>Epinephelus longispinis</i>	--
GRP-C-002	Kulhadhuru faana	<i>Epinephelus chlorostigma</i>	--
GRP-C-003	Kurehi faana	<i>Epinephelus miliaris</i>	--
GRP-C-004	Hudhu lah faana	<i>Epinephelus caeruleopunctatus</i>	--
GRP-C-005	Raiy galhi faana	<i>Epinephelus fasciatus</i>	--
GRP-C-006	Fijjehi / Boduthiki faana	<i>Epinephelus macrospilos</i>	--
GRP-C-007	??	<i>Epinephelus melanostigma</i>	--
GRP-C-008	Lah faana	<i>Epinephelus merra</i>	--
GRP-C-009	Dhunthari faana	<i>Epinephelus morrhua</i>	--
GRP-C-010	Baafothi faana	<i>Epinephelus multinotatus</i>	--
GRP-C-011	Kalhu / Ahgalhi faana	<i>Epinephelus octofasciatus</i>	--
GRP-C-012	Kiruli faana	<i>Epinephelus ongus</i>	--
GRP-C-013	??	<i>Epinephelus poecilonatus</i>	--
GRP-C-014	Dhon / Raiy thundu faana	<i>Epinephelus retouti</i>	--
GRP-C-015	Londhi faana	<i>Epinephelus tauvina</i>	--
GRP-C-016	Raiy thiki faana	<i>Cephalopholis leopardus</i>	--
GRP-C-017	Landa faana	<i>Cephalopholis sexmaculata</i>	--
GRP-C-018	Veli faana	<i>Cephalopholis sonnerati</i>	--
GRP-C-019	??	<i>Cephalopholis boenak</i>	--
GRP-C-020	Naarngu faana	<i>Cephalopholis spiloparaea</i>	--
GRP-C-021	Kanfaiy kalhu faana	<i>Cephalopholis urodeta</i>	--

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