

# **Review of the Maldivian Grouper Fishery and Export Industry**

**Shahaama A. Sattar, Ahmed Najeeb, Mariyam Shidha Afzal, Fahmeeda Islam,  
Elizabeth Wood**

**Darwin Reef Fish Project / Marine Research Centre / MCS UK**

**September 2011**



## Table of Contents

Executive Summary.....	4
1. Introduction .....	5
2. Grouper fishery .....	8
3. The export industry.....	9
3.1. Export companies and Grouper cages .....	9
3.2. Buying and Stocking .....	10
3.3. Packing and Export.....	11
4. Methodology.....	13
4.1. Data collection and Analysis .....	13
5. Results .....	16
5.1. Qualitative analysis of fishermen opinion .....	16
5.2. Quantitative analysis.....	17
Species composition .....	17
Catch and effort .....	20
Size composition measurements.....	21
Grouper exports and income generated .....	26
6. Conclusions .....	32
6.1. Qualitative survey .....	32
6.2. Quantitative survey.....	33
7. References: .....	35
Acknowledgements.....	36

## List of Figures

Figure 1 Grouper export destinations (Source: MoFA, unpublished data).....	12
Figure 2 Species composition of catch on the fishing trips undertaken with grouper fisherman.....	17
Figure 3 Species composition of all groupers sampled during the survey trips to the purchase cages.....	18
Figure 4 Species composition of groupers sampled at the cages, broken down into samples from the four different cages visited during the survey period.....	19
Figure 5 Comparison between species composition of catch in 2003 and 2010 .....	20
Figure 6 Comparison of mean length of groupers in the unexploited stock (sampled by fishing trials conducted by MRC teams) and exploited stock (sampled from fishing trips and fish cages) (Sample numbers in parenthesis's are for total numbers of individuals represented by 11 species shown in the graph).....	21
Figure 7 Variation in mean lengths of the commonly exploited species sampled at the 4 cage locations .....	22
Figure 8 Size composition of the sampled stock in 2010 and 2003 - <i>A. rogera</i> .....	23
Figure 9 Size composition of the sampled stock in 2010 and 2003 - <i>A. leucogrammicus</i> .....	23
Figure 10 Size composition of the sampled stock in 2010 and 2003 - <i>C. argus</i> .....	24
Figure 11 Size composition of the sampled stock in 2010 and 2003 - <i>C. miniata</i> .....	24

Figure 12 Size composition of the sampled stock in 2010 and 2003 - <i>E. fuscoguttatus</i> .....	24
Figure 13 Size composition of the sampled stock in 2010 and 2003 - <i>E. spilotoceps</i> .....	25
Figure 14 Size composition of the sampled stock in 2010 and 2003 - <i>P. areolatus</i> .....	25
Figure 15 Size composition of the sampled stock in 2010 and 2003 - <i>P. laevis</i> .....	25
Figure 16 Size composition of the sampled stock in 2010 and 2003 - <i>P. pessuliferus</i> .....	26
Figure 17 Size composition of the sampled stock in 2010 and 2003 - <i>V. louti</i> .....	26
Figure 18 Export quantities of fresh/chilled and live groupers (1994 - 2010) (Source: MOFA, Basic Fisheries Statistics) .....	27
Figure 19 Species composition reported in grouper proforma for live exports .....	28
Figure 20 Species composition reported in grouper proforma for fresh chilled exports .....	28
Figure 21 Total value obtained from grouper exports (1994-2010) and % contribution by this value to income earned from all marine exports (Source: MoFA, Basic Fisheries Statistics) .....	29
Figure 22 Trends shown by unit value of grouper exports from 1994 – 2010 (Source: Basic Fisheries Statistics, MoFA).....	30
Figure 23 Total value and rate per individual (species wise) of grouper exports for the year 2010 - FC: Fresh chilled, L: Live.....	30
Figure 24 Trends in exports of species exported fresh/chilled.....	31
Figure 25 Trends in exports of main species which are exported live (Note the discontinuous Y axis, due to absence of data from 2007 and 2008).....	31

## List of Tables

Table 1 Grouper species observed and catalogued in the Maldivian waters and their status as in the IUCN Red list as of April 2011. Species which are in critical stages, globally and which are exploited in the Maldives are highlighted in red. ....	5
Table 2 Characteristics of the grouper fishery in 1994, 2005 and 2011 .....	8
Table 3 Grouper cages currently operational in the Maldives (updated in August 2011) .....	9
Table 4 Grouper categories used by export companies for buying purposes .....	10
Table 5 Species categories and rates currently used by the exporters when purchasing from fishermen (updated in August 2011) .....	11
Table 6 Commonly exported species of groupers, export method and rates .....	12
Table 7 Number of grouper fishing vessels reported from the target atolls chosen for the project ...	14
Table 8 Details of trips undertaken with fishermen .....	14
Table 9 Details of cage sampling trips conducted .....	15
Table 10 Maturity lengths and immature percent represented in the catch of commercially important grouper species .....	22

## Executive Summary

The grouper fishery in the Maldives has undergone several changes since the last review which was carried out by the Marine Research Centre from 2002-2005. While the method of fishing and main groups of fishermen active in the fishery have remained almost the same, the size and quantity of catch have undergone several changes as evidenced by the results of this review.

The current review of the grouper fishery, by the Marine Research Centre was started in 2010, together with the Darwin Reef Fish project, which is a four year collaborative project between the Marine Research Centre and the Marine Conservation Society of UK (funded by the Darwin Initiative). The review collected both qualitative and quantitative data of the fishery as well as data on the export industry. Fishermen interviews were conducted in the four atolls chosen as target atolls for the project, as well as at the cages. Length frequency sampling was conducted during cage sampling trips and fishing trips, while export statistics were based on those reported by the Ministry of Fisheries and Agriculture.

Major findings of this review show a shift in size distribution of the ten most commonly exploited species, to smaller size classes, with this effect being more prominent for the live export grouper species. Secondly, significant decreases in mean lengths were observed for these ten species, in comparison to that reported in the review by Sattar and Adam (2005). Additionally, 69% of individuals which belong to these ten species are now being caught prior to them reaching their theoretical maturity lengths as reported by Shakeel (1996). Species composition of catch has remained more or less the same though species such as *Epinephelus fasciatus*, which was previously unexploited, are now being caught in large quantities.

Export data show decreasing export of live groupers, while fresh chilled grouper exports are seen to be on an increase. While the live groupers fetch the higher price and are more valuable in the market, the decreasing trend is indicative of their decreased availability. This was also verified during fishermen interviews where they reported to not being able to get the same quantities of these high valued species such as *Epinephelus fuscoguttatus*, *Plectropomus areolatus*, *P. laevis* and *P. pessuliferus* as in the previous years. Although species-wise data is being collected through the grouper proforma, issues which have arisen due to inaccurate reporting have led to scepticism towards this information.

A draft management plan has been formulated based on the findings of the current review and earlier surveys of the fishery and abundance and spawning aggregation identification interviews. The management plan will be presented to all stakeholders, via the means of a workshop and finalised through a participatory approach. Measures to be finalised will depend on feedback from the workshop as well as ease and efficiency of implementation and enforcement of finalised measures.

## 1. Introduction

The grouper fishery in the Maldives has reached a crucial stage in its exploitation, where management is not simply an issue of something that is required for the fishery, but something, which at this stage is critically needed. Exploitation of groupers in the Maldives started in the 1980s on a small scale. A market oriented fishery started in the early 1990s, due to interest from the Asian market. Since then the grouper fishery has escalated, spreading throughout the Maldives, with the export market being the sole source of demand. A relatively small number of groupers are also taken by fishermen who target a range of reef and pelagic species to cater for the domestic market, particularly tourist resorts.

Groupers are a popular food fish in South East Asia, as well as Europe and the United States (US). The Times Union (2007) reports that in the US, a whole Grey grouper (*Mycteroperca microlepis*) weighing about 18 pounds (8.2kg) sells for US\$ 92 per individual from seafood distributors while a grouper sandwich plus a side of french fries, sell for approximately US\$ 15 per plate. Dishes which previously used to feature groupers are deemed less favourable, once this dish is re-created with a cheaper option of white fish. All the above facts point to the high demand placed on this family of fish. And this is from a single market, i.e. the US. These species are in even more demand in South East Asian markets, where high value, live groupers such as *Epinephelus fuscoguttatus* and *E. polyphkadion* fetch US\$ 49 to US 56 per kilo in the market (Fish Marketing Organization, Hong Kong, website accessed May 2011). Unfortunately, it is also these high valued species such as *E. fuscoguttatus*, *E. polyphkadion* and those belonging to the *Plectropomus* genus which are listed as “Near threatened” or “Vulnerable” in the IUCN red list (IUCN Red list, accessed in April 2011).

Groupers belong to the family Serranidae, Subfamily Epinephelinae and over 100 species of groupers are known worldwide. Maldives has approximately 40 – 45 species of groupers, 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 Table 1 of this report.

**Table 1 Grouper species observed and catalogued in the Maldivian waters and their status as in the IUCN Red list as of April 2011. Species which are in critical stages, globally and which are exploited in the Maldives are highlighted in red.**

English Name	Scientific Name	Dhivehi Name	IUCN Status
Red mouth grouper	<i>Aethaloperca roga</i>	Ginimas faana	DD
Slender grouper	<i>Anyperodon leucogrammicus</i>	Boalhajehi faana	LC
Peacock hind	<i>Cephalopholis argus</i>	Mas faana	LC
Golden hind	<i>Cephalopholis aurantia</i>	Ran faana	DD
Leopard hind	<i>Cephalopholis leopardus</i>	Raiy thiki faana	LC
Coral hind, Vermilion seabass	<i>Cephalopholis miniata</i>	Koveli faana	LC
Sixblotch hind	<i>Cephalopholis sexmaculata</i>	Landaa faana	LC
Tomato hind	<i>Cephalopholis sonnerati</i>	Veli faana	LC
Strawberry hind	<i>Cephalopholis spiloparaea</i>	Naaringu faana	LC
Darkfin hind	<i>Cephalopholis urodeta</i>	Kanfaiy kalhu faana	LC

Areolate grouper	<i>Epinephelus areolatus</i>	Thijehi faana	LC
White-spotted grouper	<i>Epinephelus caeruleopunctatus</i>	Hudhu lah faana	LC
Brown-spotted grouper	<i>Epinephelus chlorostigma</i>	Kulhandhuru faana	LC
Black-tip grouper, Red banded grouper	<i>Epinephelus fasciatus</i>	Raiy galhi faana	LC
Blue and Yellow grouper	<i>Epinephelus flavocaeruleus</i>	Dhon Noo faana	LC
Brown-marbled grouper	<i>Epinephelus fuscoguttatus</i>	Kas faana	NT
Giant grouper	<i>Epinephelus lanceolatus</i>	Mudu faana	Vul
Long-spine grouper, Streaky spot grouper	<i>Epinephelus longispinis</i>	Kooru faana	LC
Snubnose grouper, Big spot grouper	<i>Epinephelus macrospilos</i>	Fijehi faana	LC
Honeycomb grouper	<i>Epinephelus merra</i>	Lah faana	LC
Netfin grouper, Honey fin grouper	<i>Epinephelus miliaris</i>	Kurehi faana	LC
Comet grouper	<i>Epinephelus morrhua</i>	Dhunthari faana	LC
White blotched grouper	<i>Epinephelus multinotatus</i>	Baafothi faana	LC
Eight bar grouper	<i>Epinephelus octofasciatus</i>	Kalhu faana/Ah galhi faana	
White streaked grouper	<i>Epinephelus ongus</i>	Kirulhi faana	LC
Camouflage grouper	<i>Epinephelus polyphekadion</i>	Kula faana	NT
Red tipped grouper	<i>Epinephelus retouti</i>	Dhon faana	DD
Four-saddle grouper	<i>Epinephelus spilotoceps</i>	Asdhaanu faana	LC
Greasy grouper	<i>Epinephelus tauvina</i>	Londhi faana	DD
Masked grouper	<i>Gracila albomarginata</i>	Boakuda faana	DD
Squairetail coral grouper	<i>Plectropomus areolatus</i>	Olhu faana	Vul
Black-saddled coral grouper	<i>Plectropomus laevis</i>	Kula olhu faana / Kandu rasgefaanu	Vul
Roving coral grouper	<i>Plectropomus pessuliferus</i>	Dhon Olhu faana	NT
White edged Lyretail	<i>Variola albimarginata</i>	Kandu raiy haa	
Moontail sea-bass, Yellow edged Lyretail	<i>Variola louti</i>	Kandu haa	LC

\*DD – Data Deficient, LC – Least Concern, NT – Near Threatened, Vul – Vulnerable

It is evident that populations of the high valued species of groupers such as *E. fuscoguttatus*, *E. polyphekadion* or the species of *Plectropomus* genera are in a critical condition, hence being given the status of “Near threatened” or “Vulnerable” (Table 1). The IUCN Red List is based on global assessments and it cannot be necessarily assumed that local Maldives populations of these species would fall into the same categories. However, the assessments do give a very clear indication of the vulnerability of these high value species to over-exploitation and they also act as a warning of what can happen when fisheries are not regulated. This further underlines the importance of conservation and management of these valuable resources, both for the wellbeing of the ecosystem, and the users of this resource, as a source of food, income and enjoyment.

Sattar and Adam (2005) detail the identification characteristics, biology and ecology of groupers. Key characteristics of importance are outlined below:

- Biology: long lived, normally solitary and sedentary, protogynous hermaphrodites (change sex from female to male), late age-at-maturation and hence sex change
- Ecology: live in coral reefs and stony environments, at depths of 0 to 200 m, occasionally 500 m (Heemstra et. al. 1993).
- Diet: Top predators, feed on fish and invertebrates such as large crustaceans and cephalopods.
- Reproduction: spawn during full or new moon (species dependent) in aggregations, sites for which at times are quite far from their home range; Groupers tend to return to the same site repeatedly for spawning. This spawning activity may last a few weeks and at times may be spread over several months. This makes groupers highly conspicuous to fishermen and susceptible to being caught in large quantities. Sadovy (2002) highlights the case of *Epinephelus striatus* in the Caribbean where the number of spawning fishes declined and aggregations ceased to form with increasing fishing pressure. *E. striatus* is listed as endangered on the IUCN (World Conservation Union) Red List of Threatened Species (<http://www.iucn.org>, Website accessed, May 2011).

The sex change strategy, long life, aggregation behaviour and the fact that they take bait readily, makes grouper populations highly susceptible to overfishing. Coleman et al. (1996) studied the effects of fishing on spawning aggregations of groupers (e.g. *Mycteroperca microlepis*) in eastern Gulf of Mexico. Their results revealed changes to population demographics such as decreased sizes of fish caught and decreased sizes at sex change as well as decreased male to female sex ratios (Coleman et al. 1996).

Studies on grouper fisheries in the Maldives began in the early 1990s (Van Der Knaap et. al 1991, Anderson, et. al. 1992, Shakeel 1994). Shakeel (1994) made management recommendations which if they had been implemented and enforced at the time would have helped to conserve grouper stocks. Sattar and Adam (2005) provided further information and data on grouper fisheries and reviewed various methods of data collection then employed by the Ministry of Fisheries and Agriculture and shortcomings of these methods. They also made management recommendations but none have, as yet, come into existence.

The Darwin Reef Fish Project, which is a collaborative effort between the Marine Conservation Society (UK) and Marine Research Centre, funded by the Darwin Initiative aims to study and analyse the grouper, reef and aquarium fisheries of the Maldives and to produce management plans for these fisheries. The study on the grouper fishery has focused on the following atolls and fishermen from these atolls:

- Baa Atoll
- Kaafu Atoll
- Vaavu Atoll
- Faafu Atoll

These atolls were chosen on the basis of them being the atolls of most prominence in the fishery, in terms of fishermen and fishing areas.

The objective of this study is to review the existing grouper fishery (especially targeting the fishery and fishermen of the above atolls) and grouper export industry of the Maldives. This is to assess the

fishery and to provide advice on sound management strategies for the implementation of a pilot grouper management plan. Based on the performance of this pilot project and in consultation with stakeholders, similar management strategies, with necessary revisions, will be implemented at a national scale to manage the grouper fishery. Data collection methods and the constraints faced in collecting and analyzing the data will be highlighted.

## 2. Grouper fishery

Shakeel (1994) and Sattar and Adam (2005) give a detailed outlook of the grouper fishery and export industry in the Maldives. These reports look at both industries at the time of their formation. The reports also provide details of various fishing methods employed at the time, as well as fish purchasing, processing and packing procedures in the export industry. Hence, rather than describing all aspects of the fishery and export industry, this report looks at areas of the fishery which have gone through important changes. Table 2 below highlights the main changes in the fishery which have occurred over the period elapsed since the beginning of the export oriented grouper fishery (for further details, please refer to Shakeel (1994) and Sattar and Adam (2005)).

**Table 2 Characteristics of the grouper fishery in 1994, 2005 and 2011**

	<b>Shakeel (1994)</b>	<b>Sattar and Adam (2005)</b>	<b>2011</b>
<b>Fishing atolls</b>	Initially central atolls	Kaafu, Alifu, Vaavu and Faafu Atolls	Throughout Maldives especially Raa, Baa, Kaafu, Alifu Alifu, Vaavu, Faafu, Gaafu Alifu, Gaafu Dhaalu, Laamu Atolls
<b>Origin of fishermen</b>	Faafu and Meemu	Raa, Alifu Dhaalu, Faafu	Raa, Baa, Vaavu, Faafu Atolls
<b>Fishing trip details</b>	Day trips within atolls	Day trips/week long trips	Week to month long trips away from home island, fishing from various atolls
<b>Cage locations</b>	Roam with the fishermen	Haa Dhaalu, Kaafu, Vaavu, Meemu, Faafu, Thaa, Laamu, Gaafu Dhaalu Atolls	Haa Dhaalu, Shaviyani, Baa, Kaafu, Vaavu, Faafu, Gaafu Dhaalu Atolls (But also have collecting vessels which visit atolls where fishermen are present)
<b>Fishing vessels</b>	Rowing boats/sailing or mechanized trolling boats	Mechanised boats	Mechanised boats some quite large and well maintained due to greater distances travelled
<b>Fishing methods</b>	Baited hand lines (without weight lead on line)	Baited drop lines, Visually aided snorkelling with baited drop line	Mainly visually aided snorkelling with baited drop lines, Baited drop lines from boat to some extent
<b>Daily catch</b>	100-170 groupers/day/boat	40-50 groupers/day/boat	~90 groupers/day/boat



### 3. The export industry

#### 3.1. Export companies and Grouper cages

At present there are seven main companies actively involved in the grouper export business. Together they have 17 grouper cage complexes and holding facilities located throughout the Maldives (some seasonal). Locations of these cages are listed in table 3. The companies also have collecting vessels whose movements depend on the movement of the fishermen and the presence/absence of a cage in the atoll being targeted. These collecting vessels purchase the groupers caught by the fishermen and bring them to either their cage or set up in Male' atoll, for easy packing and export. Sattar and Adam (2005) show the structure of a standard grouper cage complex and explain how it is set up.

**Table 3 Grouper cages currently operational in the Maldives (updated in August 2011)**

Company name	No. of Holding facilities	Cage locations	
		Atoll	Island
Xcess logistics Pvt Ltd	1	B	Goidhoo
Aqua Life Investment Pvt Ltd	1	Th	Vilufushi
Sea Partners Maldives	5	K	Bangaafaru
		ADh	Mahibadhoo
		GDh	Thinadhoo
		Sh	Komandoo (during NE monsoon)
		K	Hulhumale' (holding facility)
Global Fresh Choice Pvt Ltd (Vara Maldives Pvt Ltd)	5	Th	Vilufushi
		F	Feeali
		R	Maduvvari
		K	Bangaafaru
		K	Hulhumale' (holding facility)
Marine Coral Maldives Pvt Ltd	2	K	Gaagandu
		V	Keyodhoo
Marea Maldives Pvt Ltd	2	F	Feeali
		K	Bangaafaru
Aquaculture?	1	HDh	Makunudhoo

Meetings have been carried out with the different export companies involved in the grouper trade during the course of the project. All exporters were in favour of a managed fishery, and agree that the best form of management would be size restrictions on catch and exports of groupers. However, they also stressed the importance of all exporters agreeing to stop the purchase of smaller individuals even in the face of competition.

### 3.2. Buying and Stocking

The buying price of a fish varies with size and species. While Sattar and Adam (2005), reports that size categories used by the different companies were quite similar, the current review shows quite a number of differences between the size categories used by the various companies, and at times by cages of the same company at different locations. The size categories were seen to be modified to accommodate the grouper sizes commonly being sold to the cages (that is with a decrease in size of grouper, length classes were adjusted to cater for this decrease). Furthermore, rates paid by the companies for the different size categories were seen to vary considerably from one exporter to the other, especially in the face of competition between exporters during times of low supply. One of the most obvious points noted in the current review was the purchase by the export companies of large number of individuals of small sizes (see section 5.2 for a comparison with sizes taken in 2005). This proved to be an incentive for fishermen to take individuals of size classes which were previously unexploited, hence leading to the exploitation of the juveniles of certain species. Table 4 below outlines a summary of categories used by exporters for buying purposes.

**Table 4 Grouper categories used by export companies for buying purposes**

Species category	Rate	Sizes	Weight (kg)	Company 1	Company 2	Company 3	Company 4
Molhu (All spp. belonging to <i>Plectropomus</i> genera)	/ind.	XL	>5	✓	✓	✓	✓
	/ind.	LL	2 to 5				✓
	/ind.	L	>0.5	✓	✓	✓	✓
	/ind.	M	0.2 to 0.5 or 0.4 to 0.5	✓		✓	✓
	/ind.	S	0.3 to 0.4	✓		(✓)	✓
	/ind.	B	>0.25	✓	✓	(✓)	
Kas (All spp. belonging to <i>Epinephelus</i> genera)	/kilo	XL	>5	✓	✓	✓	✓
	/ind.	LL	2 to 5			✓	✓
	/ind.	L	>1 or 0.75 - 2	✓	✓	✓	✓
	/ind.	M	0.5 to 0.75 or 0.7 to 1	✓	✓	✓	✓
	/ind.	S	0.3 to 0.5 or 0.4 to 0.7	✓	✓	✓	✓
	/ind.	B	>0.25	✓		(✓)	
Big spot ( <i>E. macrospilos</i> )	/ind.	L	>1			(✓)	✓
	/ind.	S	0.3 to 1				✓
Kanduhaa ( <i>V. louti</i> )	/ind.	L	>1	✓	✓	✓	✓
	/ind.	S	<0.2 or 0.3 to 1	✓	✓	✓	✓
Kudhi raiy/Rock Cod (All spp. belonging to <i>Cephalopholis</i> genera except <i>C. argus</i> )	/ind.			✓	✓	✓	✓
Boadhigu ( <i>A. leucogrammicus</i> )	/ind.			✓	✓	✓	✓
Kalhu faana ( <i>C. argus</i> )	/ind.			✓	✓	✓	✓
Ginimas faana ( <i>A. rogae</i> )	/ind.			✓	✓	✓	✓

**Notes:** ✓ indicates occurrence of the size classes, while (✓) Indicates partial occurrence, i.e. some cages of that company has the mentioned size classes while the other cages do not have these rates

The above table shows the various size classes used to categorise groupers, when being purchased from the fishermen. This is based on information collected from the export companies during the field surveys conducted to the different cages. However, at the most recent meeting held with the exporters it was realized that exporters no longer use the B, S and M size classes and all individuals smaller than 5 kg, of the *Epinephelus* and *Plectropomus* genera were bought at the prices paid for individuals of the L or M size category. Hence no matter how small an individual, it is considered to be of the large size and paid the same price, which is inevitably the prevalent incentive for fishermen to keep on exploiting the smaller sized individuals. Rates of purchase from fishermen for the various species and size classes are shown in table 5. These were the rates obtained towards the end of the survey and show the absence of prices for Small and Baby sizes categories.

**Table 5 Species categories and rates currently used by the exporters when purchasing from fishermen (updated in August 2011)**

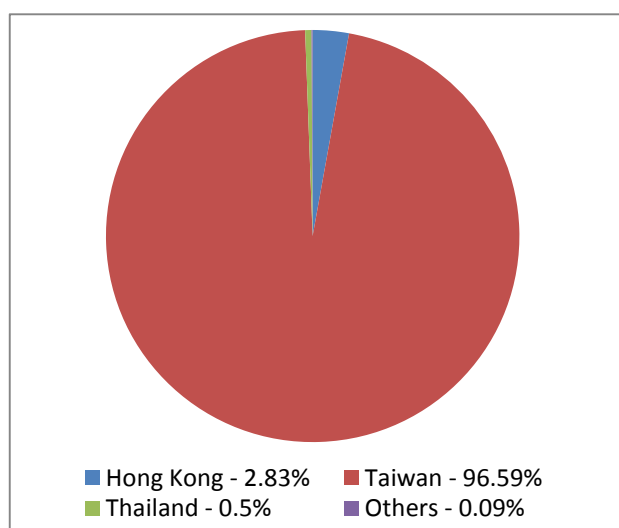
Species category used by exporters	Size class	Rate range (MVR)
Trout (All species belonging to <i>Plectropomus</i> genus)	XL > 5kg	150 to 300 /ind
	Large	100 to 140 /ind
	Medium	70 to 140 /ind
	Small	NA (same rate as 'Large')
	Baby	NA (same rate as 'Large')
Marble (All species belonging to <i>Epinephelus</i> genus)	XL	40 to 55 /kg
	L	95 to 130 /ind
	M	60 to 130 /ind
	Small	NA (same rate as 'Large')
	Baby	NA (same rate as 'Large')
Mix (All size classes have the same rate)	A. rogaa	5 to 20 /ind
	A. leucogrammicus	10 to 15 /ind
	C. argus	6 to 20 /ind
	C. miniata	6 to 30 /ind
	C. sexmaculata	6 to 30 /ind
	C. sonnerati	20 to 30 /ind
	V. albimarginata	25 to 50 /ind
	V. louti	25 to 50 /ind
	E. macrospilos	10 to 50 /ind

\*Note: 1USD = 15.42 MVR (as of September 2011)

### **3.3. Packing and Export**

As reported by Sattar and Adam (2005), the main export destinations still remain as Thailand, Taiwan and Hong Kong (Figure 1). However there is a big difference in the quantities now being exported to these 3 main destinations. While in 2005, Hong Kong dominated the export market and took approximately 55% of the exports, they currently take only 2.8% of the grouper exports. However, Taiwan which currently takes 96.6% of the exports only took 24% of the exports in 2005. Thailand, which in 2005 took 8% of the exports currently takes only 0.5% of all grouper exports (MOFA

unpublished data, 2010). The above is for fresh chilled exports. It should here be noted that Hong Kong dominates the live export market, taking almost 100% of the live exports.



**Figure 1 Grouper export destinations (Source: MoFA, unpublished data)**

The previous mode of export of live groupers was sea freight, via special collecting vessels which travelled throughout the Maldives, once every two months or so. However, recent investigations reveal that companies now use various different modes of export of live groupers; namely sea freight, air freight in Styrofoam boxes with anaesthetic compounds and air freight in containers/bins developed for the shipment of live organisms, supplied with oxygen and water. Being able to air freight the live groupers, means that the exporters are able to ship them off two to three times a week. This ultimately creates a greater demand for the more valuable and desirable “live – export” category species.

In 2003, MRC started collecting species-wise export data of groupers from the three export companies which were active then. This 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. However, issues with how these proforma have been filled out have led to difficulties in assessing the data to the most accurate level, due to certain species being lumped together in the proforma and being reported as one species. Table 6, shows the commonly exported species which were reported, the category they are exported in (live or fresh/chilled) and the average price per individual during export, based on data from 2010 from all companies.

**Table 6 Commonly exported species of groupers, export method and rates**

Scientific name	English Name	Dhivehi Name	Live or Fresh chilled	Rate/individual (MVR)
<i>A. rogae</i>	Redmouth grouper	Ginimas Faana	FC	28.5
<i>A. leucogrammicus</i>	Slender grouper	Boalhajehi faana	FC	24.2
<i>C. argus</i>	Peacock Hind	Mas faana	FC	40.7
<i>C. miniata</i>	Coral Hind	Koveli faana	FC	24.6
<i>E. areolatus</i>	Areolate grouper	Thijehi faana	FC	23.9
<i>E. fasciatus</i>	Black tipped grouper	Raiy galhi faana	FC	81
<i>E. flavocaeruleus</i>	Blue and Yellow grouper	Dhon Noo faana	FC	48.5
<i>E. fuscoguttatus</i>	Brown Marbled grouper	Kas faana	FC/L	25.7 / 94.5

<i>E. lanceolatus</i>	Giant grouper	Mudu faana	L	747.9
<i>E. macrospilos</i>	Big spot grouper	Fijjehi faana	FC/L	31.9 / 77.1
<i>E. merra</i>	Honeycomb grouper		FC	9.7
<i>E. polyphekadion</i>	Camouflage grouper	Kula faana	FC	8.3
<i>E. spilotoceps</i>	Four-saddle grouper	Asdhaanu faana	FC/L	36.4 / 31.4
<i>P. areolatus</i>	Squartetail grouper	Olhu faana	FC/L	56.8
<i>P. laevis</i>	Black-saddled coral grouper	Kandu rasgefaanu	FC/L	54.7 / 80.1
<i>P. pessuliferus</i>	Roving coral grouper	Dhon Olhu faana	FC/L	45 / 66.2
<i>V. albimarginata</i>	White edged lyretail	Kandu raiy haa	FC	27.5
<i>V. louti</i>	Moontail sea bass	Kanduhaa	FC	39.8

\* Note: 1 USD = MVR 12.85 (2010)

Prior to making any conclusions from the above data, the issues faced with the reporting of this data should be kept in mind. These are issues which need to be corrected in the future so as to obtain the most species specific and accurate data to correctly analyse the fishery and export industry. The above table shows a few interesting points. First, *E. fasciatus* which was previously hardly exploited in the Maldives now has the highest rate per individual amongst those that are exported fresh chilled. However a closer look at the data showed that this species was identified as being exported by only one company in a single shipment. Hence the possibility of this being an error is also quite high. Secondly the separate rate for *E. areolatus* was later reported to possibly being the rate for *C. miniata*, confusion regarding which arose due to the way the proforma had been filled in by the exporter. Thirdly, although large quantities of *P. areolatus* are taken by exporters for live export, only one company had noted this species as being exported live. However their proforma did not list the rate of export for this species. Lastly, *E. lanceolatus* which is listed as “Vulnerable” in the IUCN Red List is also exported from the Maldives at rates as high as MRF 747 per individual (approx. USD 58 per individual). Individuals of this species are on occasion seen in the grouper cages. As stated by Sattar and Adam (2005), it is very important to investigate the status of this species in the Maldives in order to establish the most relevant management strategy for this species (<http://www.iucn.org>, website accessed August 2011).

## 4. Methodology

### 4.1. Data collection and Analysis

As a first step of the review, MRC collected data from all Atoll offices, to determine the number of vessels in each atoll which was targeting groupers. Results of this desktop survey showed that 149 vessels from 10 atolls and 25 islands were carrying out grouper fishing, at least on a part time basis. From our chosen atolls, we then identified the main islands where grouper fishing was carried out and number of vessels in each of these islands. These results are shown in table 7 below.

**Table 7 Number of grouper fishing vessels reported from the target atolls chosen for the project**

<b>Atoll</b>	<b>Island</b>	<b>No. of vessels</b>
Vaavu	Keyodhoo	4
	Felidhoo	5
	Rakeedhoo	2
Faafu	Feeali	16
	Bilehdhoo	15
	Magoodhoo	8
	Dharanboodhoo	4
	Nilandhoo	7
Baa	Kendhoo	5
	Dharavandhoo	3
	Fulhadhoo	6
	Fehendhoo	1
	Goidhoo	2

Data collection for this review was done in the project areas of Vaavu, Faafu, and Kaafu atolls, as well as in Gaafu Dhaalu atoll, where fishermen of Faafu atoll fish on a regular basis. Whilst our project area also involves Baa atoll, we were unable to collect any length samples from the atoll itself due to the absence of a purchasing cage in the atoll. All groupers which were being caught from the atoll, were collected by the companies using their collection vessel which visits Baa atoll when fishing within the atoll is good. Attempts to join the export companies on these trips to collect from the atoll were unsuccessful. Additionally, at the time of surveying, fishermen from the atoll were mainly targeting fishing grounds in Malé atoll and Ari atoll. Length sampling was mainly done at the cages in the above mentioned atolls, though some length sampling was also conducted on the fishing trips joined. The tables 8 and 9 give details of sampling trips undertaken with fishermen and at the grouper collecting cages.

**Table 8 Details of trips undertaken with fishermen**

<b>Survey Atoll</b>	<b>Survey Island</b>	<b>Origin of fishermen</b>	<b>Number of trips</b>	<b>Length of each fishing trip (days)</b>	<b>Area of fishing</b>
V	Felidhoo	V. Felidhoo	4	1	Vaavu Atoll
V	Keyodhoo	V. Keyodhoo	2	1	Vaavu Atoll
K	Male'	B. Fulhadhoo	2	3	Ari Atoll

Sampling on board the fishing vessel was done while the fishing was being conducted by the fishermen or when the catch was being unloaded and sold to the cage. Each time a fisherman brought a basket back to the boat, the individuals were identified to the species level and their length (fork length) measured in centimetres before the individual was thrown into the boat hold. This enabled us to obtain site specific length frequency data for these trips. In the instances where this was not possible, individuals were identified and measured when they were being sold to the cage. Other information collected on these trips include the time spent fishing, area of fishing and

bait haul, number of fishermen, quantities of each species caught on each trip and income earned per trip.

Sampling at the cage was done over a number of days. While some companies were very willing for us to sample all their purchase, others were more hesitant, especially with sampling of the live exports. Attempts were made to get a representative sample of the catch, when it was brought to the cage by the fishermen, though most times this was only possible for the fresh/chilled exports which once sorted by the cage employees were brought to us in baskets for length measurements. We were able sample the live exports on an occasional basis, though rarely as these were thrown straight into the cages once sorted by the cage employees. Hence although our fresh/chilled exports can be sorted by the vessel, the same is not true for the live exports, as on occasion length samples of these were taken on a separate day when the fish were washed at the cages (necessary for disease prevention). Furthermore, as a result of these issues our samples are not representative for the high valued live export species such as *E. fuscoguttatus* and *P. areolatus*. Other information obtained on the sampling trips at the grouper cages include fishing information from the fishermen and purchase records for all the vessels which came to the cage on that particular day. This enabled us to collect information on the total quantity of groupers bought to the cage on each day of sampling, even if not species-wise.

**Table 9 Details of cage sampling trips conducted**

Atoll	Cage location	Cage owner	No. of sampling trips	Total no. of vessels sampled
V	Outside V. Keyodhoo	Marine Coral	6	19
F	Near Feeali	Marea Maldives	5	41
GDh	Near Thinadhoo	Sea Partners	3	8
K	Gaagandu	Marine Coral	1	1
K	Bangaafaru	Sea Partners	7	10
K	Bangaafaru	Marea Maldives	2	12
K	Bangaafaru	Vara Maldives	1	1

Qualitative data on fishermen's views and how they feel regarding the current grouper fishery was also collected during consultations with the fishermen from the atolls of the project area. While consultations with fishermen from Vaavu and Faafu atoll were done in groups, fishermen of Baa atoll were consulted individually. We found that when interviewed individually fishermen were more prepared to reveal their actual thoughts regarding the current status of the fishery and admit a decline in the fishery, whereas in a group, peer-pressure was seen to affect the thoughts and responses. Although this was expected, the issue of time and the large sample number in some atolls constrained our survey methodology. A summary of fishermen's thoughts towards the fishery and management are shown in section 5.1.

## 5. Results

### 5.1. Qualitative analysis of fishermen opinion

Consultations with the grouper fishermen of Vaavu, Baa and Faafu atolls were held during the survey trips, to assess their views and opinions on the current status of the fishery and whether management was needed or important for this resource. Fishermen were also asked, what management practices, in their opinion would be the most effective in making the existing grouper fishery in the Maldives a sustainable fishery.

While consultations in Faafu and Vaavu atoll were held as group consultations, consultations with the fishermen of Baa Atoll were held individually. Overall, fishermen were divided in their opinions of the current status of the fishery, where when asked in a group all reported no changes to the fishery, both in terms of quantity and size of catch. However, the same group when interviewed individually revealed the opposite, which is that there is a decline in the fishery, both in terms of quantity being caught and averages sizes of the individuals being caught. This was verified by the fishermen who had been interviewed individually in the first instance.

During the course of the consultations, fishermen revealed that they were now unable to get large quantities of and larger sized individuals of the high valued grouper species such as *E. fuscoguttatus* and those species belonging to the *Plectropomus* genera. These were now mainly being caught during the breeding seasons when the larger individuals aggregated to spawn. Although these species used to be the main target species of this fishery, this trend has now shifted and fishermen are targeting all species of groupers, even the low valued ones, which are now being paid much high prices by the exporters.

Fishermen also reported that exporters are now paying higher prices for groupers of all species, where individuals of the smaller size classes are now being paid prices which would earlier have been paid for individuals of that species which belonged to the larger size classes. This is another indirect indication of the declining health of the fishery as this shows that the grouper stocks are undergoing major changes to their size classes.

All fishermen were aware of the effects of continued exploitation of stocks in one area, as fishermen were reporting to having changed their fishing locations, on their own, once the catch from the area they had been visiting started to decline. Their main reason for this shift was the declining catch due to continued exploitation.

Majority of the fishermen interviewed were in favour of a management plan, BUT only if it is properly implemented and enforced. If such a plan was to be in place, fishermen were willing to give their support so as to ensure the sustainability of the grouper resource and their livelihoods. Fishermen are aware that management is needed for the fishery to be sustainable and while some felt that management measures should only apply to exporters, others identified management measures which they felt would work best. These include:

- Size limits on catch and exports
- Time area closures of spawning grounds to protect the breeding population
- Ban on grouper fishing, purchase and export during spawning seasons



- Catch quotas/vessel
- Regular monitoring of cages
- Grouper culture to aid the natural stocks
- Increased awareness on the importance of management

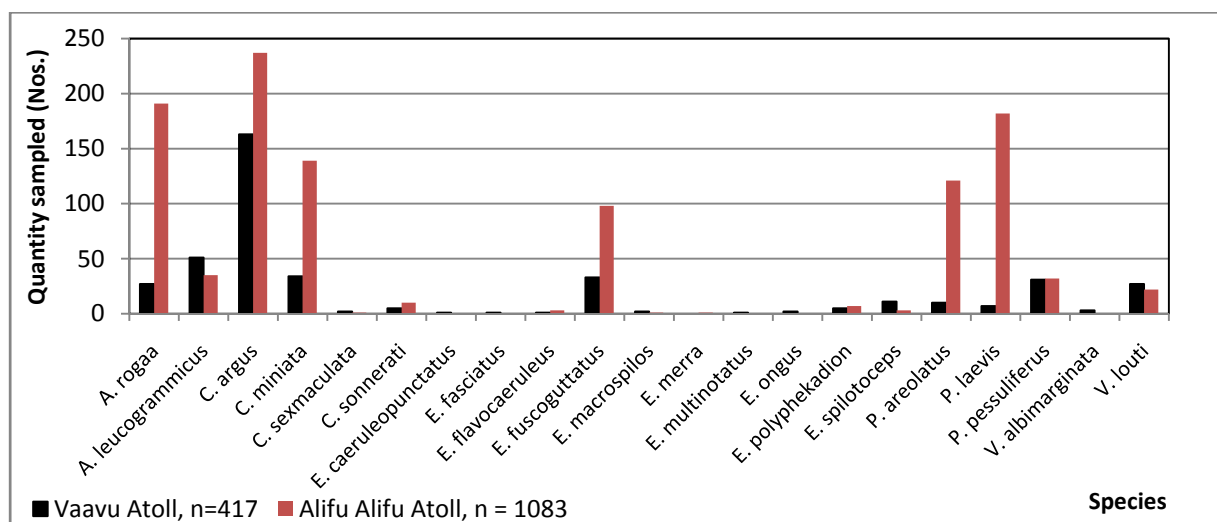
Fishermen also felt that penalties for offenders should clearly be defined in the management plan so as to serve as a source of discouragement for repeated events of that nature. Some penalties identified include:

- Advice on the first instance
- Substantial fine for 2<sup>nd</sup> time offenders
- Bigger fine or heavier punishment for 3<sup>rd</sup> time offenders

## 5.2. Quantitative analysis

### Species composition

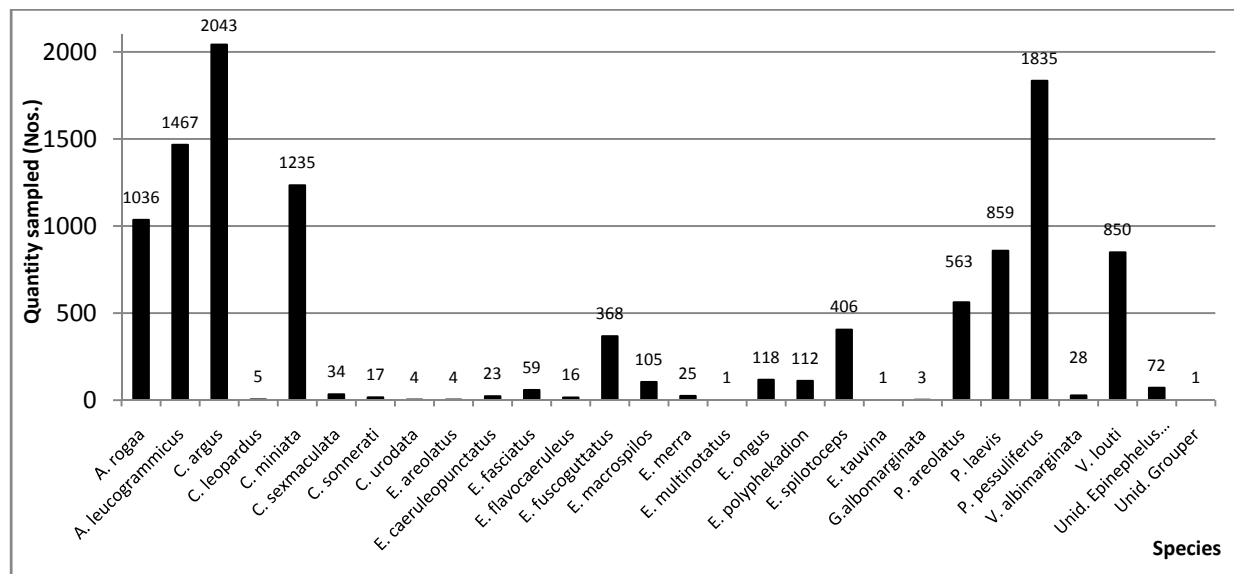
A total of 12,796 individuals of groupers were sampled during the current survey period, both on the fishing trips and cage sampling trips. A total of 21 species were observed on the fishing trips in Vaavu and Alifu Alifu Atolls, while 26 (plus 2+ species of unidentified groupers) species were observed on the cage sampling trips. Figure 2 shows the species composition of catch from the fishing trips. *C. argus* formed the major part of the catch in both atolls, while species such as *A. rogae*, *E. fuscoguttatus*, *P. areolatus* and *P. laevis* were caught in significantly greater quantities in Alifu Alifu Atoll.



**Figure 2 Species composition of catch on the fishing trips undertaken with grouper fisherman**

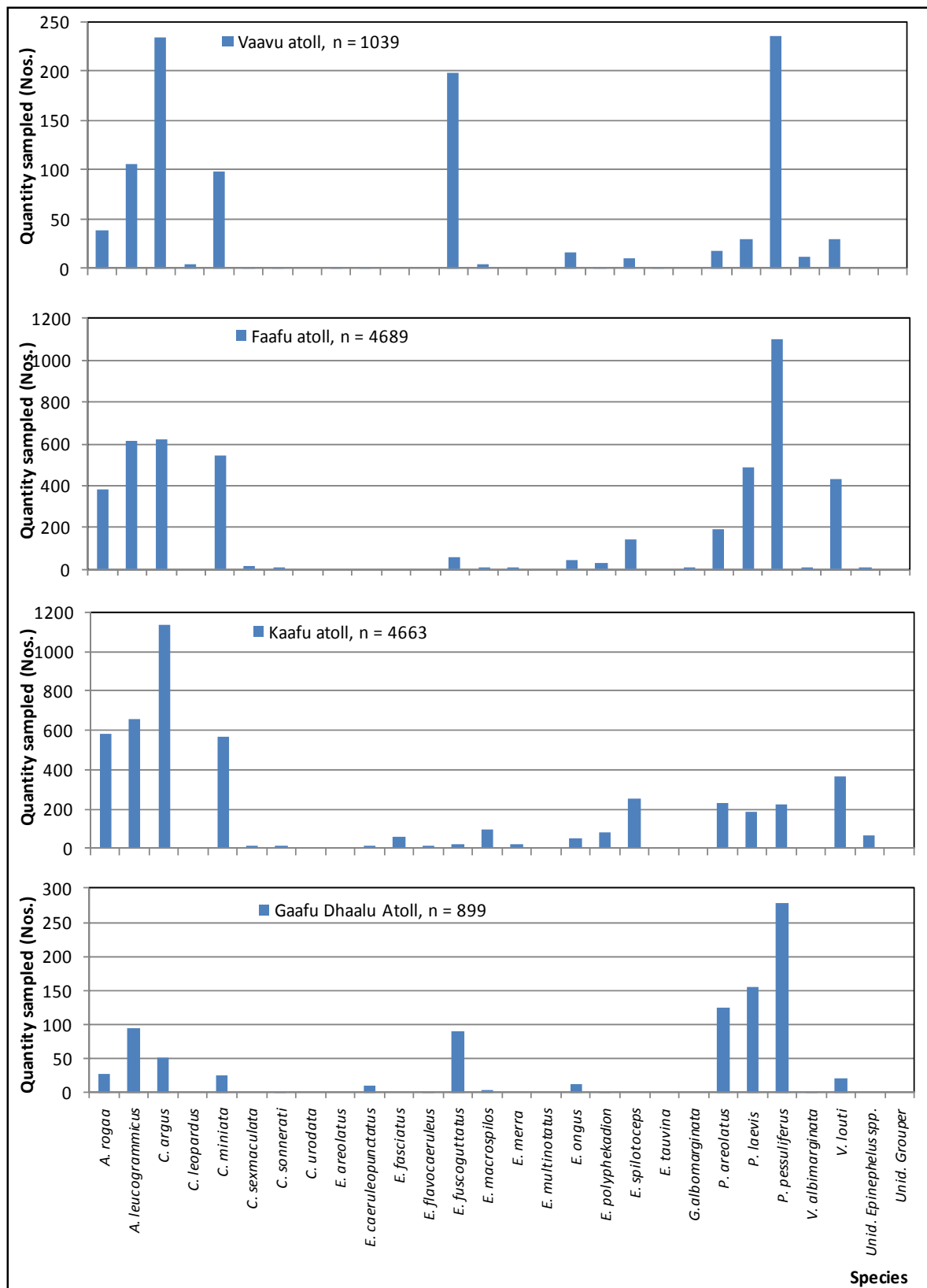
A look at data from the cage sampling surveys (n= 11290) shows a similar species composition with the same species dominating the samples (Figure 3). *C. argus* was seen to dominate the samples, followed by *P. pessuliferus*, *A. leucogrammicus*, *C. miniata* and *A. rogae*. Species which are exported fresh/chilled contributed approximately 65% to total samples from the cage, thus validating the data reported in the Basic Fisheries Statistics, which shows fresh/chilled exports contribute more to exports than species which are exported live. However, our sampling of live export species,

especially *E. fuscoguttatus* was also limited due to hesitancy from the side of fishermen and exporters as well. Due to this difficulty, it should be noted that species numbers cited in this report, for those species which are exported live are not representative of the actual catch.



**Figure 3 Species composition of all groupers sampled during the survey trips to the purchase cages**

A depiction of the breakdown of this cage sampling data, to data from the different atolls where sampling was carried out is shown in figure 4.

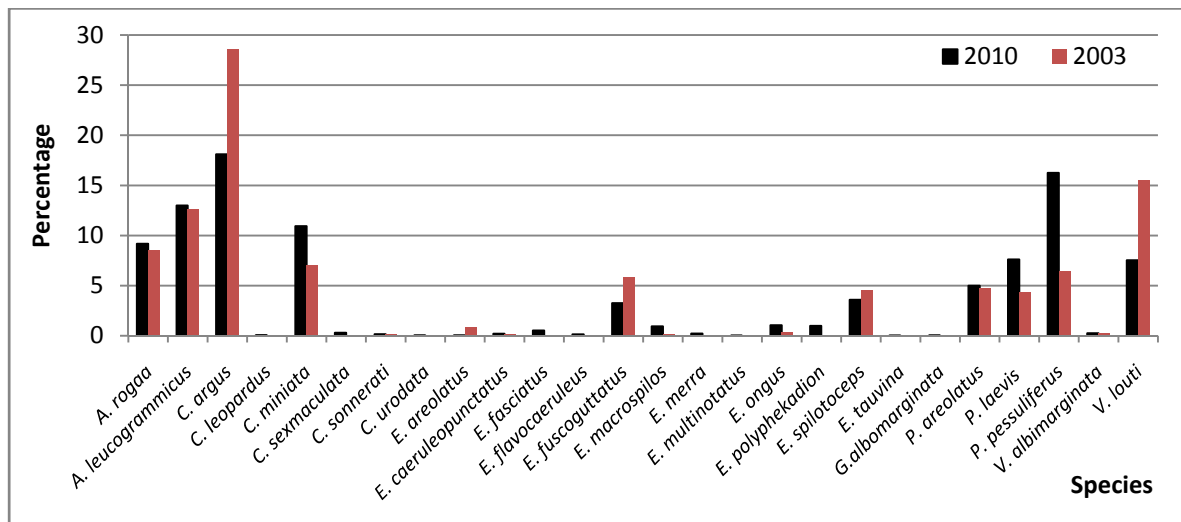


**Figure 4 Species composition of groupers sampled at the cages, broken down into samples from the four different cages visited during the survey period.**

Overall, all atolls show similar trends with species such as *A. roga*, *A. leucogrammicus*, *C. argus*, *C. miniata*, *P. pessuliferus* and *V. louti* being observed in greater quantities in comparison to the other

species. The chart shows a difference in quantities of *E. fuscoguttatus* (in respect to other species) in the four atolls, with this species being quite dominant in Vaavu atoll samples, to reasonably common in Gaafu Dhaalu Atoll samples, to almost negligible in comparison to other species in samples from Faafu and Kaafu atolls. However, this is an anomaly due to the lack of sampling of this species because of objections from the exporters and the fishermen.

Comparison between species composition of catch in 2010 and 2003 is shown in figure 5. The figure depicts percentages of each species sampled during the two survey periods and is a representation of the catch composition. Overall, commonly caught species have remained the same during the years, although quantities caught have varied. However, species such as *E. fuscoguttatus*, *V. louti* and *C. argus* were seen to contribute more towards the overall catch composition in 2003, than they do at present. On the other hand, *P. pessuliferus*, which now has a higher value than in 2003 are caught in greater quantities and contribute 2<sup>nd</sup> highest to the current catch composition. This species which previously was classed into S-XL and fetched prices ranging from MRF 10 – MRF 150 now fetches MRF 60 per grouper as the lowest price for a medium individual (S size category no longer applies for this species).



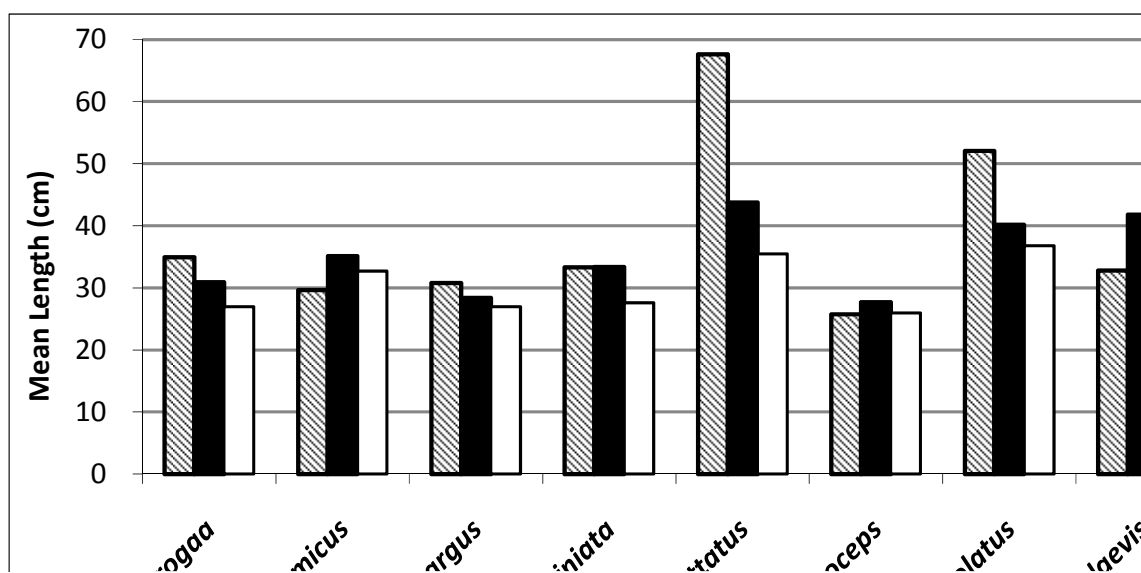
**Figure 5 Comparison between species composition of catch in 2003 and 2010**

### *Catch and effort*

During the field surveys conducted for the current study, general information was collected from all vessels that came to sell their catch to the cages where length frequency sampling was conducted. Information collected include details of fishing trip, such as area of fishing, time spent fishing, bait and gear used and number of fishermen. Based on this data, the catch per unit effort in terms of number of groupers caught per line per day hour of fishing came to an average of 0.75, while CPUE per day of fishing came to approximately 90 groupers. Although CPUE is higher, there has been a change in species with the high valued target species such as *E. fuscoguttatus* being caught in lesser quantities and smaller sizes.

### Size composition measurements

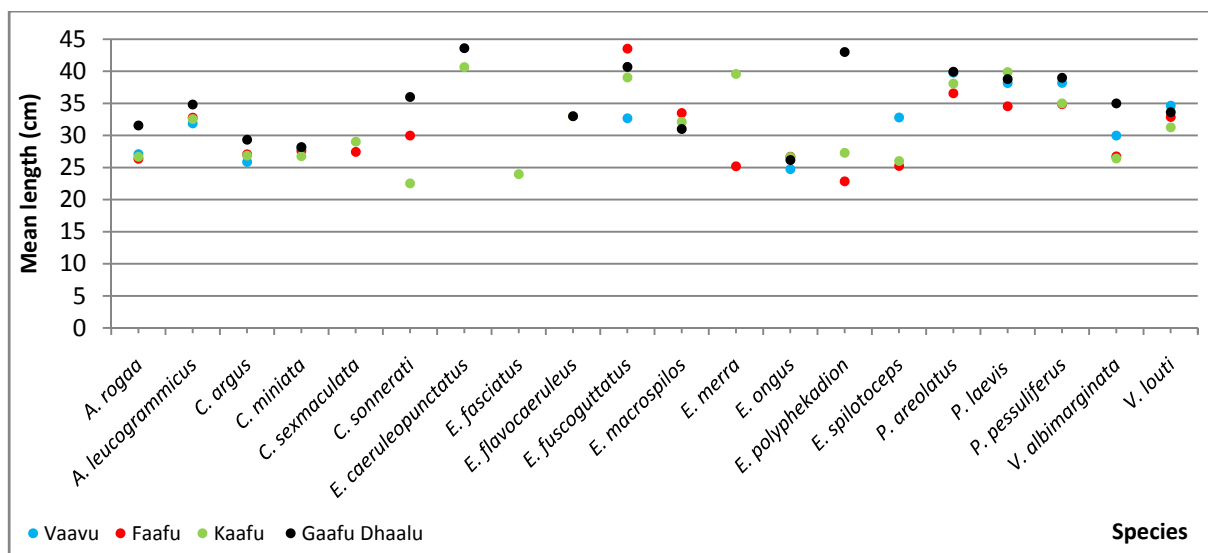
Length samples of groupers sampled from the cages during the current period of data collection is compared with the data collected in 2002-2004 and length samples collected by MRC as early as 1987 - 1991 (Van Der Knaap et al., 1991, Anderson et al., 1992). The mean length of the most commonly caught grouper species before and after the initiation of commercial exploitation of the resource is compared in Figure 6.



**Figure 6 Comparison of mean length of groupers in the unexploited stock (sampled by fishing trials conducted by MRC teams) and exploited stock (sampled from fishing trips and fish cages) (Sample numbers in parenthesis's are for total numbers of individuals represented by 11 species shown in the graph)**

Length sampling of groupers were taken during the field survey trips (both fishing and cage sampling). A total of 12,797 individuals, belonging to more than 20 species of groupers were sampled and identified to the species level and measured for size during the current survey. However, we faced problems when it came to length measurements of the species which were exported live such as *E. fuscoguttatus*, as both fishermen and cage owners were hesitant let us handle these individuals, citing possible distress to the fish as the reason. It should be noted though that in all the past surveys, to date no issues has arisen due to the groupers being handled by us during the survey period.

The above graph shows that the mean lengths of commonly exploited species of groupers caught now is less than that of individuals of these species caught before the fishery intensified. Mean lengths of individuals of these species is also currently less than that of those individuals sampled in the 2003 survey. A T-test for significance showed that the difference between mean lengths of individuals caught in 2003 and 2010 are significant for all species, indicating a significant decrease in length over the last seven years. This decreasing trend in size was also reported by fishermen during the consultation interviews (refer section 5.1). A look at mean lengths of samples from the different atolls show no significant variation in the mean length for most species, though for almost all species, mean lengths of individuals caught in Faafu atoll and the central region (more heavily exploited areas) are smaller than that of individuals sampled in Vaavu and Gaafu Dhaalu atolls (Figure 7).



**Figure 7 Variation in mean lengths of the commonly exploited species sampled at the 4 cage locations**

The most frequently caught groupers are shown in Table 10 which also details the maximum length obtained during the survey trips compared with that reported in literature. Average size of high valued species such as *E. fuscoguttatus* and *P. laevis* and most commonly taken size of *P. areolatus* are seen to be smaller than their theoretical maturity lengths indicating that a proportion of these stocks are being taken prior to them reaching their maturity and hence prior to breeding. The maximum total lengths are as reported in Fishbase (website accessed August 2011) 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 10 Maturity lengths and immature percent represented in the catch of commercially important grouper species**

Species	Sample Size, n	Ave. length (cm)	Length range (cm)	Max. total length reported in literature (cm)**	Theoretical maturity length (cm)***	Percent immature
<i>A. roga</i> *	1254	26.96	16 - 45	60	30.0	74.32
<i>A. leucogrammicus</i>	1552	32.7	17 - 49	65	32.5	51.48
<i>C. argus</i> *	2443	26.97	15 - 48	60	30.0	79.70
<i>C. miniata</i>	1408	27.61	13 - 43	45	22.5	8.52
<i>E. fuscoguttatus</i> *	499	35.69	19 - 102	120	60.0	96.38
<i>E. spilotoceps</i>	420	25.95	15 - 58	35	17.5	0.48
<i>P. areolatus</i>	693	36.77	21 - 79	73	36.5	56.28
<i>P. laevis</i> *	1046	36.28	20 - 88	125	62.5	98.85
<i>P. pessuliferus</i> *	1897	36.18	19 - 89	120	60.0	99.00
<i>V. louti</i> *	898	32.03	19 - 59	83	41.5	88.75

\* Ave. size of these species when sampled is below their theoretical maturity lengths

\*\* Source: Fishbase (website accessed August 2011)

\*\*\* Source: Shakeel, 1996

Results show that 69% of the individuals belonging to the most commonly exploited species are caught prior to then reaching their theoretical maturity lengths. This is in comparison to the 43% of immature individuals reported in Sattar and Adam (2005). As evident from the table above, for 8 of these 10 species more than 50% of the catch is composed of immature individuals, while for 3 of the high valued species, namely *E. fuscoguttatus*, *P. laevis*, and *P. pessuliferus*, more than 90% of the catch is composed of immature individuals. Even the low valued species which are mainly exported fresh chilled such as *A. rogae*, *C. argus* and *V. louti* are seen to have high exploitations of immature individuals (74.32%, 79.70% and 96.38% respectively).

Size composition graphs for the 10 most common species of groupers are shown in Figures 8 – 17. The red arrow indicates the theoretical length at maturity.

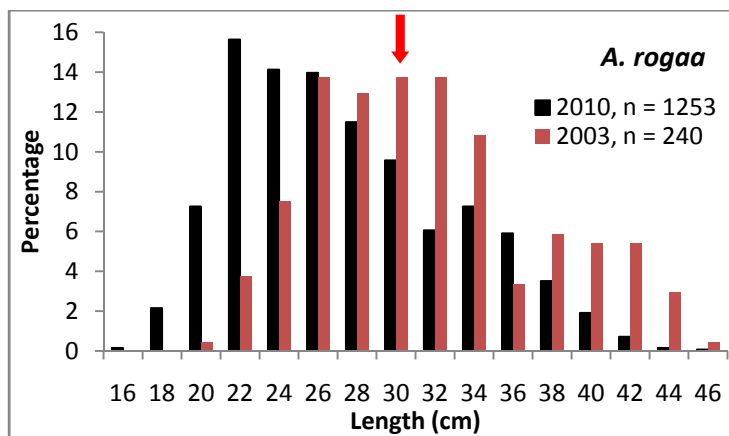


Figure 8 Size composition of the sampled stock in 2010 and 2003 - *A. rogae*

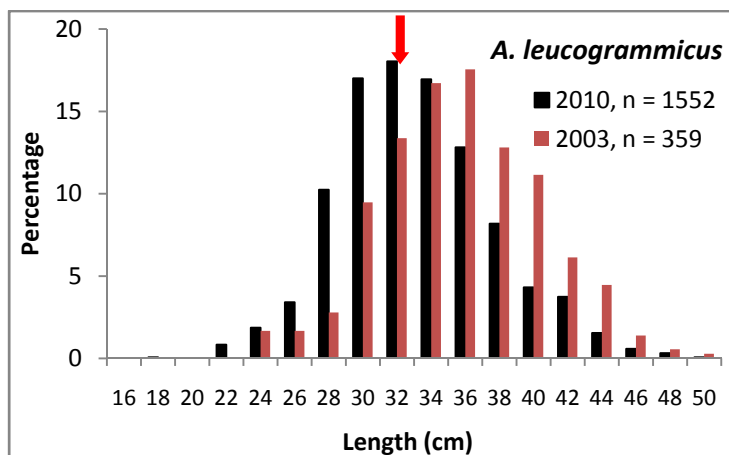


Figure 9 Size composition of the sampled stock in 2010 and 2003 - *A. leucogrammicus*

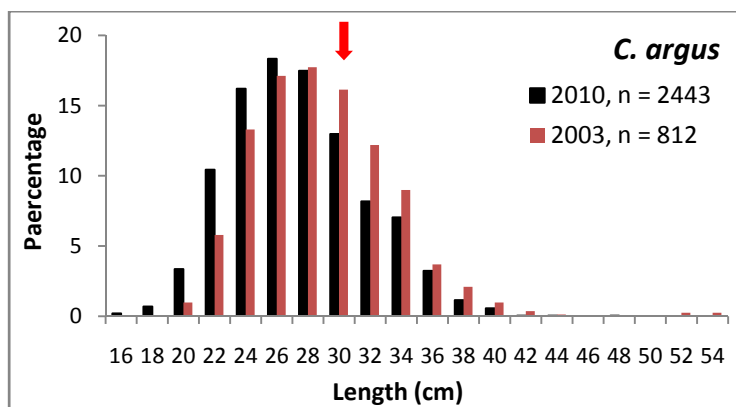


Figure 10 Size composition of the sampled stock in 2010 and 2003 - *C. argus*

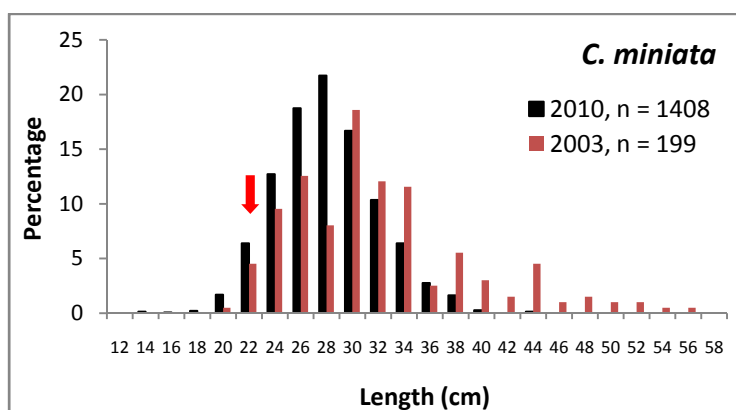


Figure 11 Size composition of the sampled stock in 2010 and 2003 - *C. miniata*

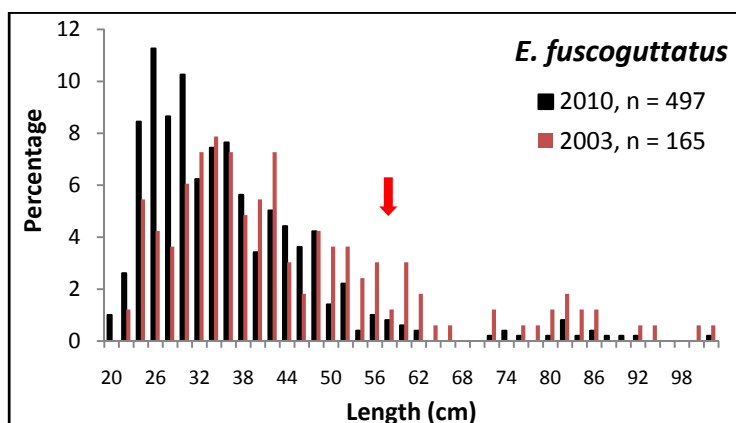


Figure 12 Size composition of the sampled stock in 2010 and 2003 - *E. fuscoguttatus*



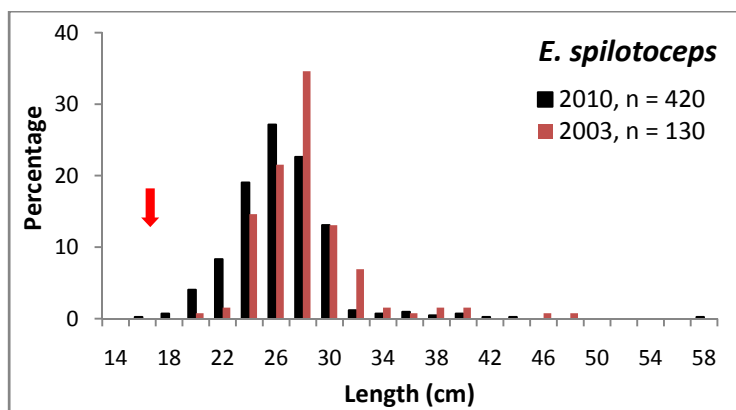


Figure 13 Size composition of the sampled stock in 2010 and 2003 - *E. spilotoceps*

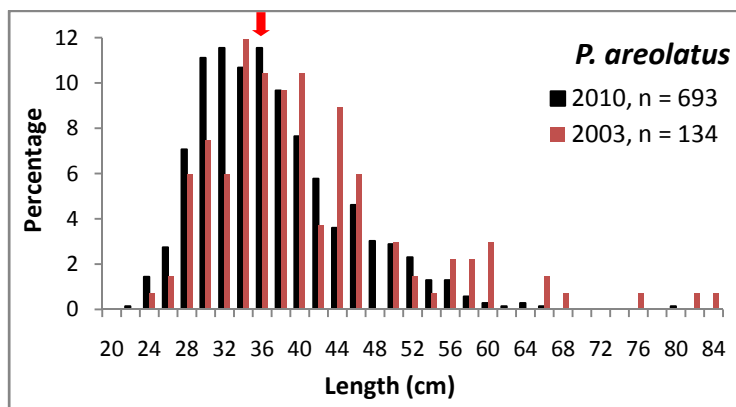


Figure 14 Size composition of the sampled stock in 2010 and 2003 - *P. areolatus*

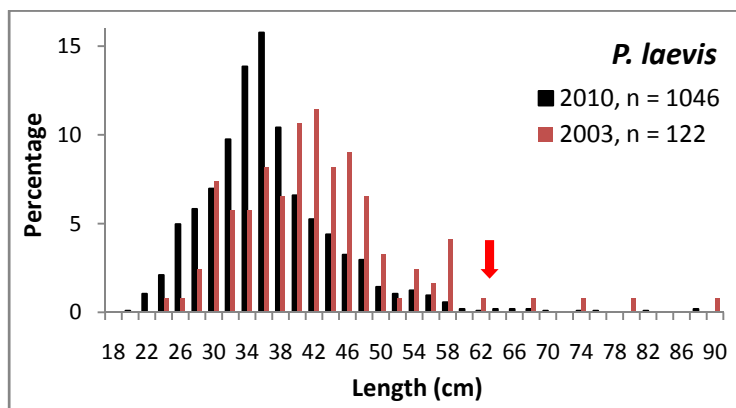


Figure 15 Size composition of the sampled stock in 2010 and 2003 - *P. laevis*

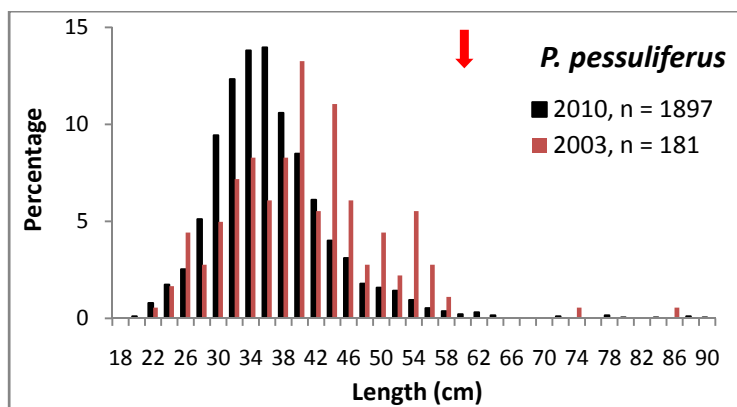


Figure 16 Size composition of the sampled stock in 2010 and 2003 - *P. pessuliferus*

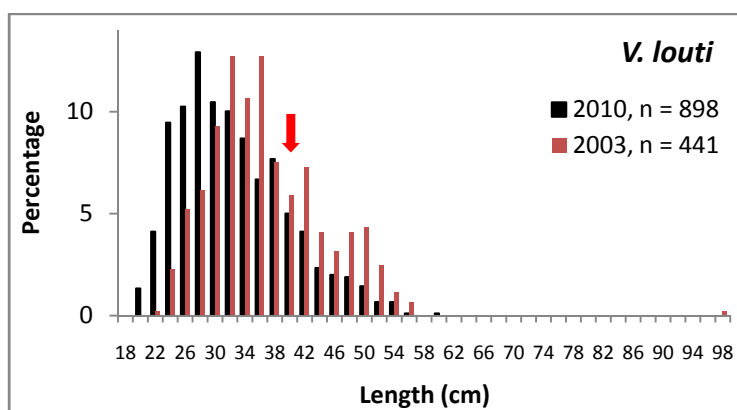
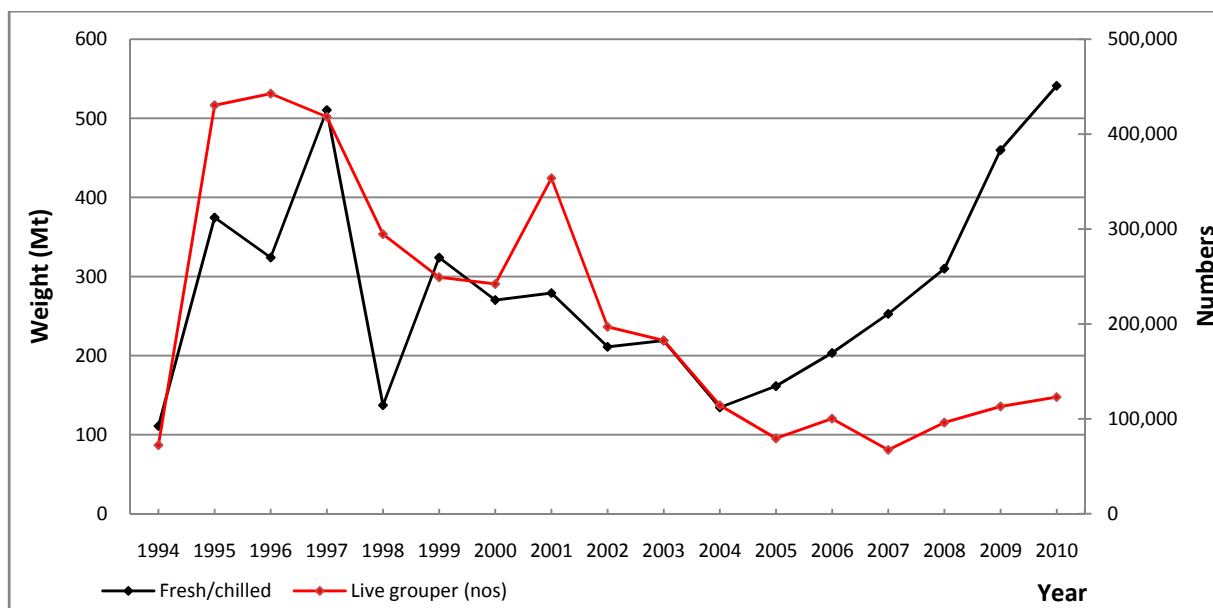


Figure 17 Size composition of the sampled stock in 2010 and 2003 - *V. louti*

The histograms show that, for almost all of the commonly exploited species, the size classes of individuals exploited in 2010 have shifted to the left, indicating that smaller sizes are being taken than in 2003. This is especially significant for the high valued species such as *E. fuscoguttatus*, *P. laevis* and *P. pessuliferus*. The most probable explanation for this shift is that the larger fish have selectively been removed by fishing. This trend is likely to have a number of impacts on grouper stocks and the sustainability of the grouper fishery. In particular, age and size at maturation are expected to change with the fish maturing earlier in response to social pressures. This in turn will affect the fecundity of the breeding population as fecundity is a function of length (Jennings et al., 2004). Lower fecundity inevitably means that the number of groupers produced at any one time is lower than that of an unexploited population. Eventually, all this translates into lower population regeneration rates.

#### Grouper exports and income generated

Economics, Research and Statistics Section of MoFA collects export data from Maldives Customs Services on a monthly basis. The data collected does not show the species being exported but shows the forms of export (i.e. Live, fresh-chilled, frozen, grouper fillets). This data is available in the Basic Fisheries Statistics book, which is published annually. The statistics collected has shown different trends for the different categories of grouper exported, which is depicted in figure 18, and shows the export trend of both fresh/chilled and live groupers between the years 1994 – 2010.

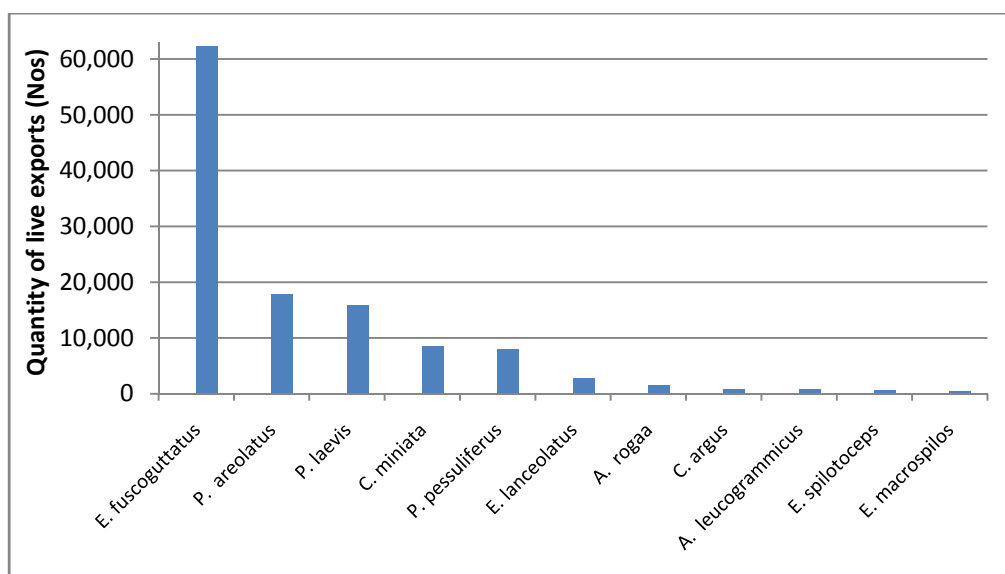


**Figure 18 Export quantities of fresh/chilled and live groupers (1994 - 2010) (Source: MOFA, Basic Fisheries Statistics)**

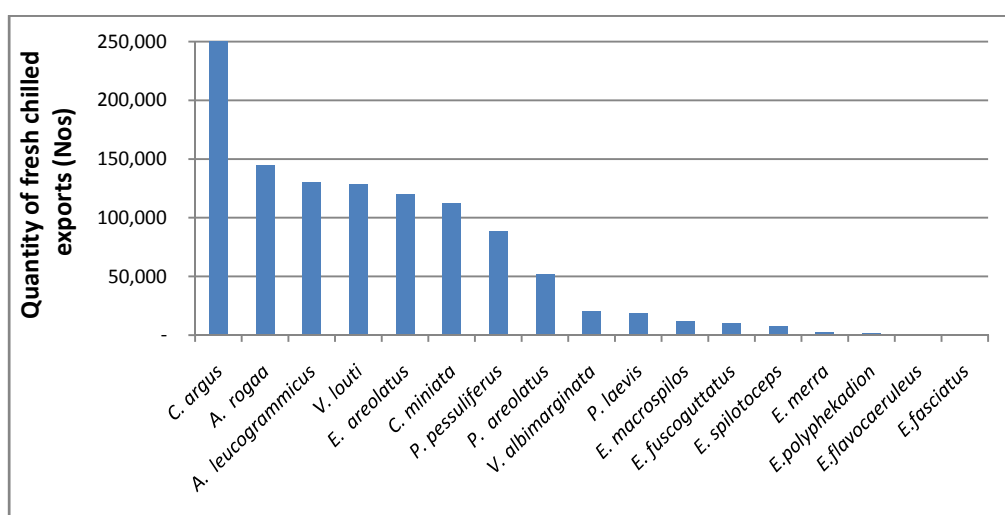
The above figure is a reflection of the international market as well as stock status, and shows a dramatic increase in the quantity of groupers exported from 1994 to 1995, when the fishery peaked in the Maldives. This correlates with a similar increase in the value obtained for the exports as seen in Figure 21.

One of the most interesting and important points to be seen in figure 18, is the trend shown in the export of live groupers. Live exports reached a peak of over 400,000 annually between 1995 and 1997, but then by 2004 had declined to a quarter of this number. However, live exports have been on an increasing trend since 2007 though the rate of increase is very slow compared to that for the fresh/chilled exports over the same period. The recent increasing trend in live exports could be attributed to a number of factors, one of which is the ability to export live groupers via air freight in oxygenated fish bins.

A look at the species-wise data reported in the grouper proforma show that live exports are mainly composed of the higher values species such as *Epinephelus fuscoguttatus* and those of the *Plectropomus* genera while the fresh chilled exports are mainly composed of the low valued species (Figures 19 and 20).

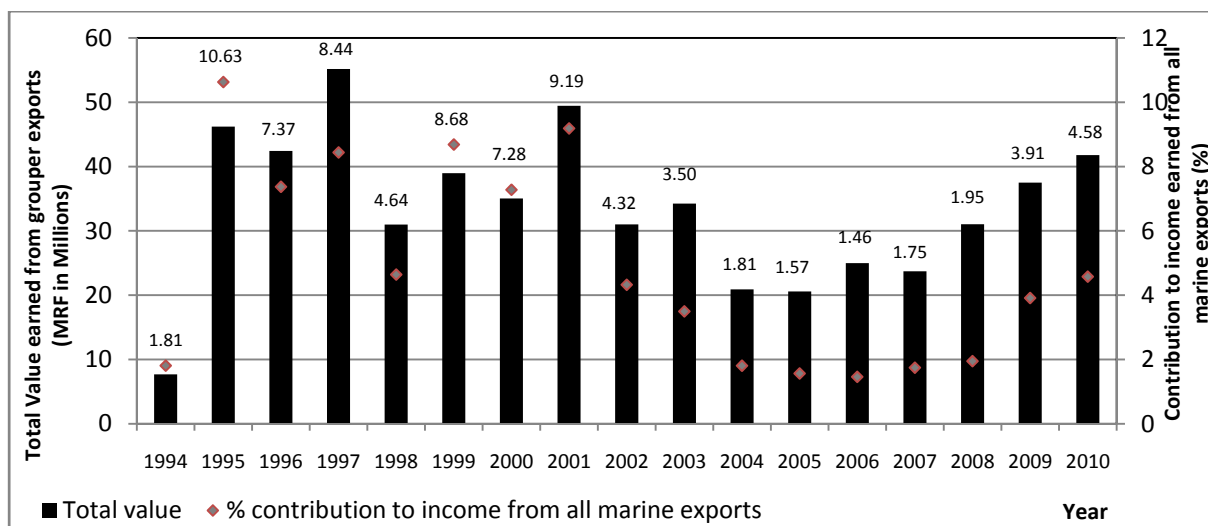


**Figure 19 Species composition reported in grouper proforma for live exports**



**Figure 20 Species composition reported in grouper proforma for fresh chilled exports**

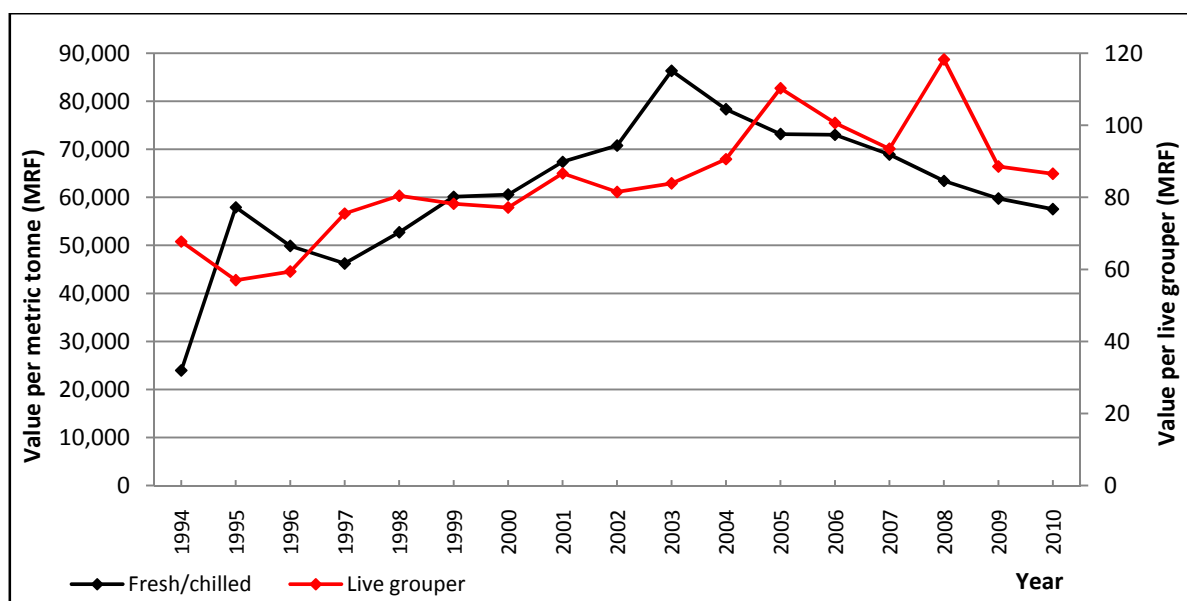
The species compositions which have been formed based on the data reported in the grouper proforma have to be considered with some scepticism due to the issues with reporting, which have been discussed in section 3.3.



**Figure 21 Total value obtained from grouper exports (1994-2010) and % contribution by this value to income earned from all marine exports (Source: MoFA, Basic Fisheries Statistics)**

Total value or income earned from fresh chilled and live grouper exports since the peak of the fishery, to date show a fluctuating trend, where peak income earned was seen for the year 1997 (Figure 21). However, the greatest contribution to income earned from all marine exports, by grouper exports value was observed in 1995, with a contribution of 10.63%. The fluctuating trend in value of exports showed its lowest point in 2005, with a slow increase since then, although contribution by income earned from grouper exports now contribute much less to that from all marine exports, than it did in the earlier years of the fishery.

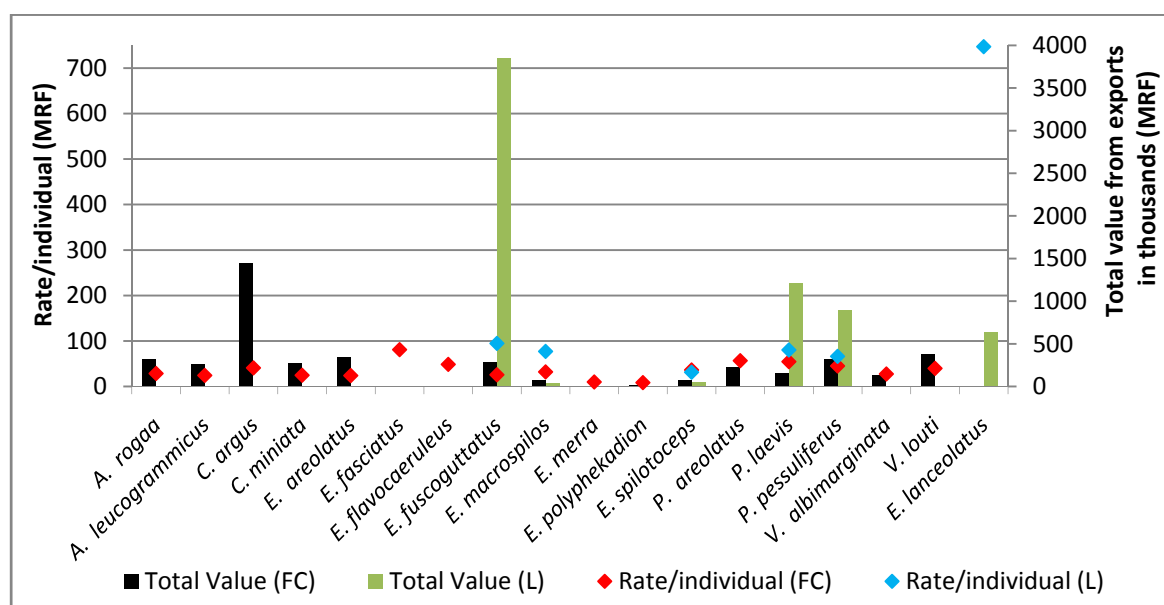
A look at unit value of exports for both fresh/chilled and live exports (Figure 22) show that MRF earned per metric tonne of fresh/chilled exports or MRF earned per live grouper is currently on a declining trend, though both values were on a steady increase in the earlier years of the fishery. Although unit price per metric tonne of fresh/chilled exports has been on a continuous declining trend since 2003, it is interesting to note that the corresponding export quantities of fresh/chilled exports has been on an increasing trend since 2004. This may be explained by changes in the balance of species being exported. Exports comprise a mix of species of different values as seen in table 3. It is possible that the declining value of exports is due to changes in the balance of species in the consignments with a shift towards the more low-value species.



**Figure 22 Trends shown by unit value of grouper exports from 1994 – 2010 (Source: Basic Fisheries Statistics, MoFA)**

The declining trend in market value of live groupers is not reflected in the purchase rates which are paid by exporters. Exporters are currently paying more than the values depicted in figure 22 (as seen in table 5), for live individuals, which is indicative of the demand for this valuable family of fish. Species such as *E. fuscoguttatus* and *E. polyphekadion*, which are exported live, are sold in the Hong Kong Markets for an average of USD 34 and USD 36 per kilo respectively, with prices going as high as USD 54 and USD 61 respectively (Fish Marketing Organization, Hong Kong, website accessed 8<sup>th</sup> August 2011).

Species-wise total value earned and rate per individual of fresh chilled and live exports are shown in figure 23.



**Figure 23 Total value and rate per individual (species wise) of grouper exports for the year 2010 - FC: Fresh chilled, L: Live**

Overall total value earned from live export species and rate per individual of live export species is higher than that for fresh chilled export species. Interestingly enough value of exports from fresh chilled exports was greater than that for live exports in the data reported in the Basic Fisheries Statistics for the year 2010.

A look at trends in species wise exports as reported in the grouper proforma from the year 2003 to 2010 shows species such as *E. fuscoguttatus* which are preferred in the live markets are decreasing in the fresh/chilled export shipments, while increasing numbers of this species are being exported in the live shipments (Figures 24 and 25). However, it should be noted here that some exporters report to lumping together all species which belong to the *Epinephelus* genus as one species and reporting it as *E. fuscoguttatus*. Issues with reporting of export data through the proforma, which was earlier discussed need to be resolved before we can get a clearer and more accurate picture of species trends in exports.

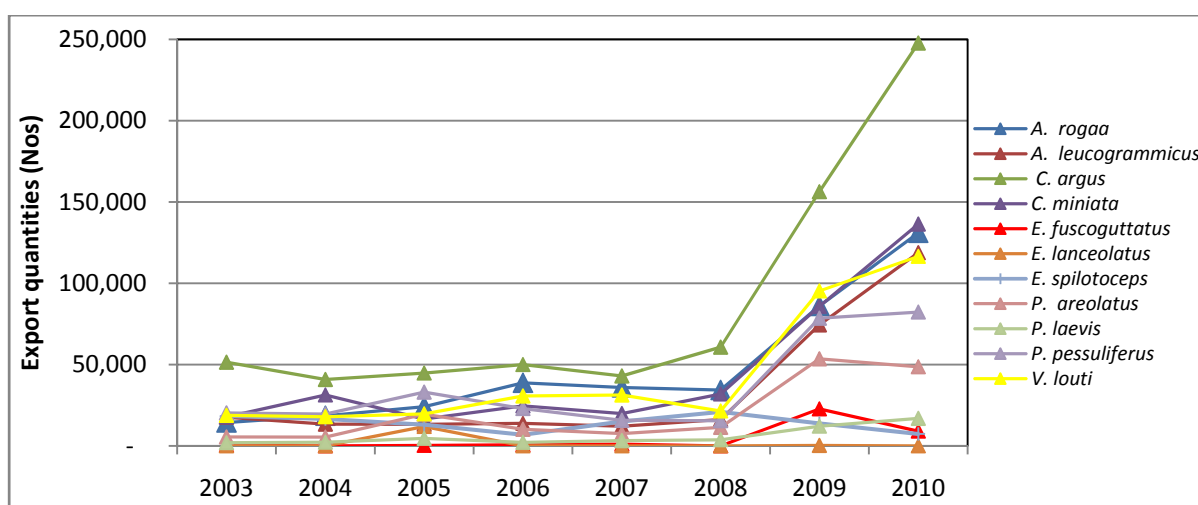


Figure 24 Trends in exports of species exported fresh/chilled

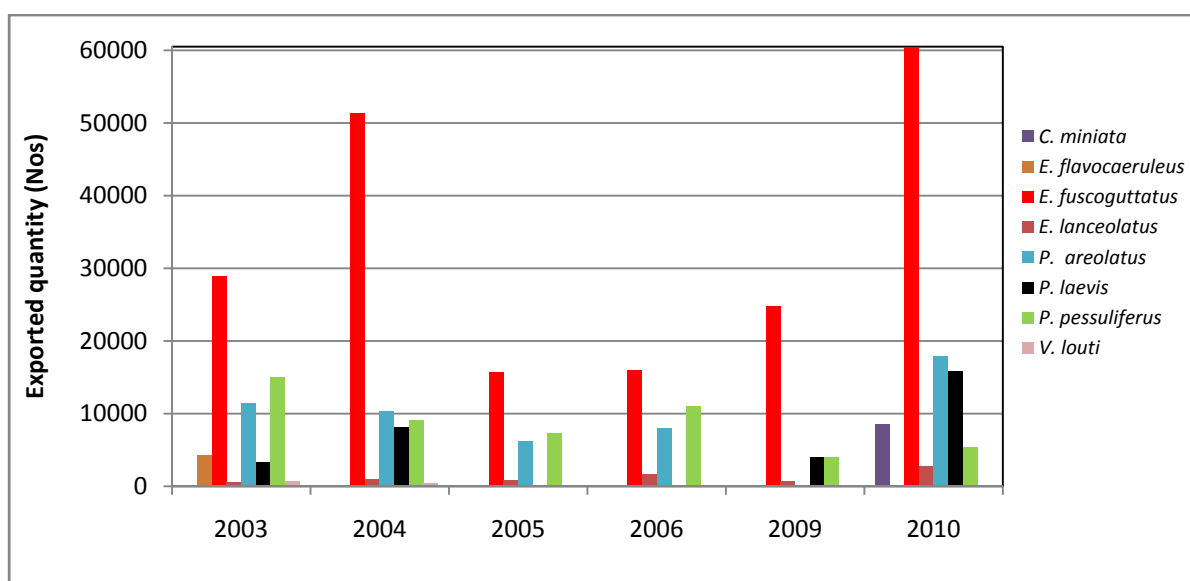


Figure 25 Trends in exports of main species which are exported live (Note the discontinuous Y axis, due to absence of data from 2007 and 2008)

## 6. Conclusions

Grouper fishery in the Maldives is still intensively carried out by specialized fishermen who target various species of groupers, especially those of the high valued species. Six of the grouper species which are commonly seen and caught from the Maldivian waters are listed in the IUCN Red List as either Near Threatened or Vulnerable. While the IUCN Red List assessment is based on a global scale, the inclusion of these species in this list is an indication of the vulnerability of these species to heavy exploitation.

The fishery in the Maldives is highly targeted and fishing method very selective, given the fishermen are in the water with their baited lines and baskets, looking for groupers. This enables them to target individuals of specific species and sizes, which would bring them a larger income. Fishermen have reported to targeting groupers of the high valued categories, which are exported live, such as *E. fuscoguttatus*, *E. polyphekadion*, *P. areolatus*, *P. laevis* and *P. pessuliferus*. Fishermen also report to targeting spawning aggregations of *E. fuscoguttatus* and *P. areolatus*, many of which are known by most grouper fishermen. A separate survey done through IUCN funding to identify reef fish spawning aggregations revealed that 87.5% of the interviewees were aware of the phenomenon of spawning aggregations and were able to identify a total of 175 sites where they have seen these aggregations. Such a targeted fishery, especially one which targets spawning aggregations of the species should be managed through various methods of fisheries management to ensure its sustainability.

The current survey looked at the grouper fishery carried out by fishermen of Baa, Vaavu and Faafu atolls. In addition to sampling the catch and getting quantitative information from the grouper cages, fishermen were also interviewed on their perspectives of the grouper fishery and the current situation.

### 6.1. Qualitative survey

Main findings from the fishermen consultations revealed that majority of the fishermen had noticed a decrease in the fishery, in terms of quantity and size of individuals being caught, especially of the high valued species. Fishermen revealed that although their target species were of those belonging to the high valued categories, they now catch all species of groupers due to the decreased availability of high valued species.

Fishermen report that prices paid by exporters have increased over the past few years, with most exporters now paying higher prices for the smaller sized individuals. Most exporters do not have a “Small” category in their purchase, but start with “Medium” size category. Most fishermen report to now catching individuals weighing less than 300 g, because exporters are now purchasing these smaller individuals. This was verified during the meetings held with the exporters to get their thoughts and ideas towards a management plan. This is again an indirect indication of the decreased availability of larger individuals.

Areas of fishing as reported by fishermen have shifted from their own atolls, to other atolls, some further away from their homes. Main reason for shifting of fishing grounds was cited as the decreased availability from an area after a period of intensive fishing in the area. Fishermen stated



that once the area was left unexploited for a period of time, they were then able to get better catch quantities from these areas afterwards. This is indicative of the fact that fishermen themselves are aware of the concept of 'temporal fishing closures' for areas and were themselves practicing this management measure voluntarily.

While fishermen were in support of a management plan, they were sceptical about the effectiveness of the plan and its implementation and enforcement. Majority of fishermen interviewed were in favour of a properly implemented and enforced plan which would take into account management measures which considers all aspects of the fishery.

Exporters were also in favour of a management plan, especially one which considers size restrictions on catch and exports as a part of its management measures. They were supportive of a plan and felt that it could work if all exporters were willing to work together and take a united front, especially when it comes to restricting the purchase of smaller sized individuals.

## **6.2. Quantitative survey**

The quantitative component of the survey looked at the fishing and export industry. Fishing data was sampled through, length measurements of the catch which was caught by fishermen and sold to the export cages.

Composition of species caught in the fishery was similar to what was seen in the catch composition in the earlier survey (Sattar and Adam, 2005). One of the more noticeable differences was the larger quantities of *P. pessuliferus* in the sample of 2010, than of 2003, which could be attributed to the higher prices now being paid for this species. Catch composition on the fishing trips with fishermen from Vaavu and Baa atoll (fishing in Alifu Alifu Atoll) showed difference in species composition of catch, whereby low valued species formed the greater part of the catch from Vaavu atoll, whilst high valued species formed the greater part of the catch of the Baa atoll fishermen.

CPUE for current survey was higher than that reported by Sattar and Adam (2005). However, it should be kept in mind that this high value is composed of greater quantities or low valued species and smaller individuals of the high valued species. Fishermen report that effort required to obtain a good quantity of high valued species is now much higher than previously.

The most noticeable finding in the current survey was the decrease in mean size of all commonly exploited species of groupers. All species were seen to have decreased in their mean lengths in comparison to what they were in the initial survey which was conducted prior to the start of the export oriented fishery. Furthermore, they were also seen to have decreased significantly in size in comparison to the catch sampled in 2003. Size selective fisheries have been seen to have this effect on the populations, whereby populations evolve to sizes smaller than what they used to be, hence showing truncated size distributions (Coleman et al. 1996).

The second critical finding was that 69% of the mostly commonly exploited species, especially the high valued species such as *E. fuscoguttatus*, *P. areolatus*, *P. laevis*, and *P. pessuliferus* were now being caught at or prior to them reaching their theoretical maturity lengths. This indicates that 69% of all groupers belonging to the commonly exploited species were being caught at the size of first reproduction or prior to them having the opportunity to breed. This fact together with the decrease

in size and thus decreased fecundity, and the spawning aggregation targeted fishery, would quite possibly result in lower population numbers as has been seen in other parts of the world (Sadovy, 2002). Furthermore, decreased stock biomass due to fishing decreases the reproductive capacity of the stock. This is especially true for protogynous species such as groupers where decreased reproductive capacity of stock is seen even at very low fishing mortalities (Huntsman and Schaaf, 1994).

Although a preliminary look at the catch rates per trip and quantities of grouper caught by fishermen do not necessarily show a declining fishery, detailed analysis of sizes show the opposite trend. This is further verified by trends in exports. The export industry of groupers which were in the earlier days more focused on the export of live groupers, now shows a different trend whereby the quantities of live exports are on a fluctuating decreasing trend, whereas the export of fresh/chilled groupers are on a steady increase. Live exports are composed of the higher valued species, while the low valued, smaller sized groupers less preferred by the market form the fresh/chilled exports. The decrease in exports of live groupers is indicative of the decreased availability of these species (and size categories), which is consequently being compensated by the increasing export of fresh/chilled groupers. Furthermore, groupers are now contributing much less to the overall income from marine exports. In 1995, when export of groupers hit its peak, groupers contributed 10% to income earned from export of marine products, while in 2010 they contributed only 4.6% to total income generated from marine exports. This could be a cumulative effect of factors such as the high quantities of tuna and tuna products being exported as well as the decrease in quantities of live groupers being exported.

As evident from this study and the stakeholder consultations, the Maldivian grouper fishery is on a declining trend, especially when taking into consideration the availability and export of live groupers. This is evidence of that fact that the current grouper fishery cannot be sustained without proper management. This is further supported by evidence from other parts of the world, such as the Caribbean, where the Nassau grouper populations were heavily affected due to intensive fishing pressure, especially on the spawning aggregations.

## 7. References:

- Anderson, R. C., Waheed, Z., Rasheed, M. and Arif, A. (1992) Reef Fish Resources Survey in the Maldives – Phase II, BOBP/WP/80, 54pp
- Fishbase website, accessed August 2011 ([www.fishbase.org](http://www.fishbase.org))
- Fish Marketing Organization (Hong Kong) ([www.fmo.org.hk](http://www.fmo.org.hk), website accessed May 2011)
- The Florida Times Union (13 February 2007) You ordered grouper.... (News Article) ([http://jacksonville.com/tu-online/stories/021307/met\\_7863256.shtml](http://jacksonville.com/tu-online/stories/021307/met_7863256.shtml))
- Heemstra, P.C and Randall, J.E. (1993) FAO species catalogue. Vol. 16. Groupers of the world (Family Serranidae, Subfamily Epinephelinae). An annotated and illustrated catalogue of the grouper, rockcod, hind, coral grouper and lyretail species known to date. Rome, FAO. 382pp, 522 figs with 31 colour plates
- Huntsman, G. R. and Schaaf, W. E. (1994) Simulation of the impact of fishing on reproduction of a protogynous grouper, the Graysby. *North American Journal for Fisheries Management* **14**
- IUCN (2010) IUCN Red List of Threatened Species. Version 2010.4. <[www.iucnredlist.org](http://www.iucnredlist.org)>. Downloaded on 03 April 2011.
- Jennings, S., Kaiser, M. J. and Reynolds, J. D. (2004) Marine Fisheries Ecology. Blackwell Publishing: Oxford, UK
- MoFAMR (1995) Fisheries Statistics of Maldives 1990 – 1994, EPCS, Ministry of Fisheries, Agriculture and Marine Resources, Male', 24pp
- MoFA (1996-2011) Basic Fisheries Statistics 1995-2010, EPCS, Ministry of Fisheries and Agriculture, Male', 18pp
- Randall, J.E, (1992) Diver's Guide to Fishes of Maldives, Bishop Museum, Honolulu, Hawaii, 193 pp. with plates
- Sadovy, Y. (2002) Biological Considerations related to the Live Reef Food Fish Trade, Paper presented in Workshop on the Live Reef Fish Trade in the Pacific Region, Hong Kong
- Sattar, S. A. and M. S. Adam (2005) Review of Grouper Fishery of the Maldives with additional notes on the Faafu Atoll Fishery. Marine Research Centre, Male', Maldives. 54 pp
- Shakeel, H. (1994) Study of Grouper Fishery and Live Grouper Holding Operations in the Maldives, Marine Research Section, Maldives, 49pp
- Shakeel, H. (1994) Grouper fishery: Benefits, threats and Challenges, Rasain 14, Ministry of Fisheries, Agriculture and Marine Resources, Maldives, 211pp

Shakeel, H. and Ahmed, H. (1996) Exploitation of Reef Resources, grouper and other food fishes in the Maldives, Workshop on Integrated Reef Resources in the Maldives, BOBP/REP/76, 312pp

Van Der Knaap, M., Z. Waheed, H. Shareef and M. Rasheed (1991). Reef fish resources survey in the Maldives. Reef fish Research and Resources Survey. B. O. B. Programme. Madras, Bay of Bengal Programme/ FAO: 60 pp.

## **Acknowledgements**

The authors would like to express their gratitude to all those who have assisted with their work and in achieving the results of this review. Special thanks go to the field/research team at the Marine Research Centre, DRFP and contracted staff who participated in all field trips and assisted with the data collection. Our gratitude to Dr. Mohamed Shiham Adam for taking the time to read through this review and provide us with his thoughts. A broad thank you to all staff at MRC and MoFA who assisted us in the various aspects of the work.

Special thanks to Dr. Hussein Rasheed Hassan, Hussein Sinan and Mohamed Muthalib of the Fisheries Management Agency, MoFA, for their guidance and assistance during various stages of the review.

We also wish to thank all the fishermen and exporters who helped us along the way and collaborated with us during the project. We hope such collaborations will continue in the future, so as to achieve a sustainable fishery, for the benefit of all involved.

Last but not least, a thank you for all the assistance provided by the Atoll/ Island offices (now councils). This was received with much appreciation and we hope you will continue to support us in our work in the future.