



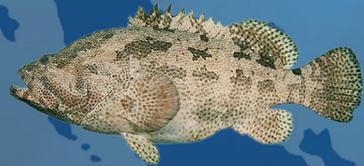
Cephalopholis sonnerati



Cromileptes altivelis



Ephinephelus coioides



Epinephelus fuscoguttatus



Epinephelus polyphekadion



Plectropomus aerolatus



Plectropomus laevis



Plectropomus leopardus



Plectropomus maculatus

ACADEMIC PAPER ON “RESTRICTING THE SIZE OF GROUPERS (SERRANIDAE) EXPORTED FROM INDONESIA IN THE LIVE REEF FOOD FISH TRADE”

Coastal and Marine Resources Management
in the Coral Triangle-Southeast Asia (TA 7813-REG)

Technical Report



ACADEMIC PAPER ON “RESTRICTING THE SIZE OF GROUPERS (SERRANIDAE)
EXPORTED FROM INDONESIA IN THE LIVE REEF FOOD FISH TRADE”

FINAL VERSION



Faculty of Marine Science and Fisheries
Hasanuddin University

FOREWORD

Indonesia is the largest exporter of live groupers for the live reef fish food trade. This fisheries sub-sector plays an important role in the livelihoods of fishing communities, especially those living on small islands. As a member of the Coral Triangle Initiative (CTI), in partnership with the Asian Development Bank (ADB) under RETA [7813], Indonesia (represented by a team from Hasanuddin University) has compiled this academic paper as a contribution towards sustainable management of live reef fish resources in Indonesia.

Challenges faced in managing the live grouper fishery and trade in Indonesia include the ongoing activities and practices which damage grouper habitat; the lack of protection for grouper spawning sites; overfishing of groupers which have not yet reached sexual maturity/not reproduced; and the prevalence of illegal and unreported fishing for live groupers. These factors have resulted in declining wild grouper stocks. The Aquaculture sector is, at least as yet, unable to replace or enable a balanced wild caught fishery, and thus there is still a heavy reliance on wild-caught groupers. Government statistics are poor in coverage and quality, making it difficult to implement site or species-based management.

One important consideration is that groupers are protogynous sequential hermaphrodites, experiencing sex reversal from female to male at a certain life stage. Thus overfishing of juveniles can cause imbalanced sex ratios and/or reduction in average size. This is one of the reasons why there is widespread agreement that the most appropriate strategy for initial short term government policy intervention is to establish minimum allowable landing size limits (MLS) for grouper fisheries as well for groupers exported from the Republic of Indonesia.

The drafting of this academic paper went through several stages, from initial preparations and scoping through a desk (literature) study, in-depth analysis, and finally the development of a policy concept. The draft concept was socialised and discussed with relevant stakeholders at national and sub-national (regional) levels, through Focus Group Discussions (FGD) held in five places (Jakarta, Surabaya, Makassar, Bali and Selayar), followed by a discussion with the National Working Group (NWG) on capture fisheries at the Ministry for Marine Affairs and Fisheries (MMAF), Indonesia. Thus, this academic paper accommodates regional and national aspirations.

As an initial step, provisional a grouper size limit regulation has been drafted setting provisional MLS values for 10 grouper species frequently traded in the LRFFT in Indonesia. It is considered that this measure is necessary as a first step towards promoting the recovery of Indonesian grouper populations. Setting minimum landing size limits should reduce the take of juveniles and promote the reproduction and recruitment of wild grouper stocks, thus maintaining or even increasing the production of groupers from Indonesia.

The drafting of this National Policy on "Restricting the size of groupers (Serranidae) from Indonesia exported in the live reef food fish trade" could not have been completed without the support of many agencies and individuals. We therefore take this opportunity to express our respectful and profound gratitude to all who assisted in any way with the drafting and production of this paper, in particular:

- The Asian Development Bank (ADB) RETA [7813] Team
- Prof. Dr. Ir. Jamaluddin Jompa, M.Sc.
- Dr. Nadiarti, M.Sc.
- Miftakhul Khasanah, S.Pi.



We hope that this policy paper will serve to guide Indonesian national policy and programs to support a sustainable live reef food fish trade.



I. INTRODUCTION

A. Background

Indonesia is a major producer of fish for the live reef food fish trade (LRFFT), especially groupers (Muldoon, G. *et al. Mostly Legal, But Not Sustainable How Airlines Can Support Sustainable Trade in Live Reef Food Fish*. [2016]). According to Food And Agriculture Organization (FAO) data for the period 2011-2015, Indonesia contributed 26.5% of the world grouper catch (Amorim, P. & Westmeyer, M. Snapper and Grouper: SFP Fisheries Sustainability Overview. *Sustain. Fish. Partnersh. Found.* 18 [2015]). The Indonesian live grouper trade tends to be highly profitable, with B/C ratios as high as 1.25 and payback periods of less than a year (Afero, F., Miao, S. & Perez, A. A. Economic analysis of tiger grouper *Epinephelus fuscoguttatus* and humpback grouper *Cromileptes altivelis* commercial cage culture in Indonesia. *Aquac. Int.* 18, 725–739 [2010]). However it should be noted that most live groupers exported from Indonesia are still wild-caught (SEAFDEC. *Activity Report: Live Reef Food Fish Trade Intergovernmental Forum Live Reef Food Fish Trade Intergovernmental Forum*. [2013]) (Table 1). Furthermore, juvenile fish are commonly caught and traded¹.

Table 1. Main grouper species traded in/from Indonesia in 2017

| No. | Species | Source | | | Sold | | |
|-----|----------------------------------|----------|------------------------|-------------|-------|------------|--------|
| | | Cultured | Cultured / wild-caught | Wild-caught | Fresh | Live/Fresh | frozen |
| 1 | <i>Plectropomus aerolatus</i> | | | V | | V | |
| 2 | <i>P. leopardus</i> | | | V | | V | v |
| 3 | <i>P. mucolatus</i> | | | V | | V | |
| 4 | <i>Epinephelus fuscoguttatus</i> | | v | | | V | v |
| 5 | <i>E. polyphemadion</i> | | | V | | V | |
| 6 | <i>E. coicoides</i> | | v | | V | | |
| 7 | <i>Cromileptes altevis</i> | | v | | | V | v |
| 8 | <i>P. oligachantus</i> | | | V | | V | |
| 9 | <i>E. boenak</i> | | | V | V | | |
| 10 | <i>E. tauvina</i> | | | V | V | | |
| 11 | <i>E. merra</i> | | | V | V | | |
| 12 | <i>P. laevis</i> | | | V | | V | |

Source: adapted from data in Indonesian Government Statistics on Export Trade (2010-2016) & SEAFDEC (2013) (SEAFDEC. *Activity Report: Live Reef Food Fish Trade Intergovernmental Forum Live Reef Food Fish Trade Intergovernmental Forum*. [2013]).

One of the problems within the Indonesian live grouper trade is that, in order to catch live groupers, many fishermen engage in poison fishing, mostly using potassium cyanide; this practice is proven to cause substantial damage to corals and other animals, and to the entire coral reef ecosystem². Furthermore, the premium price paid for "plate sized" fish¹ often drives

¹ Muldoon, G. *et al. Mostly Legal, But Not Sustainable How Airlines Can Support Sustainable Trade in Live Reef Food Fish*. (2016).

Graham, Y. J. S. T. J. D. T. R., Phillips, M. G. J. M. M. J. & Yeeting, M. A. R. A. S. B. *While Stocks Last: The Live Reef Food Fish Trade*. (2003).

² Erdmann, M. V & Pet-Soede, L. How fresh is too fresh? The live reef food fish trade in Eastern Indonesia. *SPC Live Reef Fish Inf. Bull.* #3 41–45 (1997).

fishermen to target quite small, often immature groupers for the live reef fish food trade. Most groupers are protogynous sequential hermaphrodites, with larger (older) dominant individuals undergoing a sex change from female to male³ and the majority of fish caught are female. Thus the practices of targeting smaller individuals can result in an imbalanced sex ratio, and/or sex-change at younger age/smaller size. In turn, these impacts can have deleterious effects on bloodstocks quality and size leading to reduced gamete abundance and size, and thus to fewer, potentially lower quality individuals in subsequent generations.

Furthermore, the aquaculture sector has so far been unable to provide a sustainable solution for the live grouper trade. Reasons for the continued high dependency on wild-caught groupers include the low survival rate of hatchery-produced seed⁴, the high price of feed, and consumer preference for wild-caught over cultured groupers (Akhmad Kholil, personal communication, 2 June 2017).

Despite the naturally abundant grouper resources, without appropriate fisheries management the Indonesian grouper fisheries will not be sustainable⁵. Currently, the only government regulation regarding the fishery for live reef food fishes addresses the exploitation of the Napoleon wrasse (*Cheilinus undulatus*)⁶; however there are no regulations regarding the capture of and trade in live groupers. In view of the particular characteristics of groupers, limiting the allowable catch size is important to prevent the decline of wild grouper stocks. The importance and urgency of such a regulation, as an initial step towards conserving/maintaining Indonesian grouper stocks, is underlined by the results of research by Yvonne Sadovy (2013)⁷, including the fact that 73% of Indonesian grouper species are listed as Near Threatened in the IUCN (International Union for the Conservation of Nature) Red List.

B. Identification of Issues

Groupers are a group of carnivorous marine fishes living at depths of 0-200 m. Some of these species form spawning aggregations, and the majority are protogynous sequential hermaphrodites (female-male). During the spawning season and when feeding, groupers tend to rise to the surface layer, at depths of 1-10 m, at which times they are easily caught. The ease with which groupers can be caught when reproducing is one factor which can lead to wild populations becoming endangered⁸.

Research by Sadovy (from the University of Hong Kong), shows that, out of the 163 recognised grouper species which have been identified, 25% are threatened in the wild, leading to an urgent need for regulation of grouper fisheries⁸. Not only are 50% of groupers consumed wild caught, but in addition a significant proportion of the grouper "seed" used in aquaculture are

Pet-Soede, C. Options for co-management of an Indonesian coastal fishery. (Wageningen Universiteit, 2000).

Muallil, R. N., Mamauag, S. S., Cabral, R. B., Celeste-Dizon, E. O. & Ali??o, P. M. Status, trends and challenges in the sustainability of small-scale fisheries in the Philippines: Insights from FISHDA (Fishing Industries' Support in Handling Decisions Application) model. *Mar. Policy* 44, 212–221 (2014).

³ De Mitcheson, Y. S. Mainstreaming Fish Spawning Aggregations into Fishery Management Calls for a Precautionary Approach. *Bioscience* 66, 295–306 (2016).

⁴ Kohno, H., Ordonio-Aguilar, R. S., Ohno, A. & Taki, Y. Why is grouper larval rearing difficult?: an approach from the development of the feeding apparatus in early stage larvae of the grouper, *Epinephelus coioides*. *Ichthyol. Res.* 44, 267–274 (1997).

⁵ Cochrane, K. L. & Garcia, S. M. *A Fishery manager's Guide Book*. (The Food and Agriculture Organization of the United Nations and Wiley-Blackwell, 2007).

⁶ MMAF. *Penetapan Status Perlindungan Ikan Napoleon (Cheilinus undulatus)*. Keputusan Menteri Kelautan dan Perikanan Republik Indonesia (2013).

⁷ Sadovy de Mitcheson, Y. *et al.* Fishing groupers towards extinction: A global assessment of threats and extinction risks in a billion dollar fishery. *Fish Fish.* 14, 119–136 (2013).

⁸ Allen, G. *Marine Fishes of South East Asia*. 292 (1999).

actually wild-caught juveniles grown to market size in captivity (Graham, Y. J. S. T. J. D. T. R., Phillips, M. G. J. M. M. J. & Yeeting, M. A. R. A. S. B. *While Stocks Last: The Live Reef Food Fish Trade*. [2003]).

Indonesia is endeavouring to manage the fisheries for wild groupers. Several government regulations are relevant to or apply to grouper fisheries management. These include regulations on gear size and type as well as habitat protection. However there are still several issues or challenges facing grouper fisheries management in Indonesia, some of which are outlined below.

1. Habitat

a. Habitat Degradation and Destruction

The live reef fish trade in Indonesia began in the 1980's⁹. Research on the live reef fish trade in the Banggai Archipelago was first undertaken in 1990-1999. Based on research by Indrawan (1999), the use of potassium cyanide to catch live groupers and ornamental fishes began in 1994¹⁰. Cyanide and bomb fishing have been proven to be major causes of coral reef degradation in the Spermonde Islands (Pet-Soede, C. Options for co-management of an Indonesian coastal fishery. (Wageningen Universiteit, 2000). Similar problems have been reported from other countries within the Coral Triangle, Initiative (CTI) area, including Malaysia and the Philippines¹¹. Other human activities with increasingly widespread and/or severe (direct and/or indirect) impacts on grouper habitat include coral mining, mostly for building materials; a wide variety of destructive fishing methods other than the use of poisons or explosives (e.g. the use of blunt instruments such as crowbars in the collection of certain marine invertebrates such as abalone and tridacnid clams, especially *Tridacna crocea*); pollution from various sectors (e.g. agriculture; industry; mining; energy, including thermal pollution from power plant cooling water discharge; etc); sedimentation; coastal development (including reclamation), as well as the effects of global climate change and ocean acidification¹².

Habitat degradation is typically associated with small-scale fisheries and most often occurs in remote locations, where fishing communities can be highly dependent on the live reef fish trade¹³. The use of cyanide to catch fish can cause swift and high mortality of coral (and other) larvae¹⁴; furthermore, the damage to key grouper habitat (in particular coral reef ecosystems) can be significant, including damage to grouper spawning grounds if used to catch fish in spawning aggregations¹⁵.

⁹ Lau, P. & Jones, R. The Hong Kong trade in live reef fish for food. *Live Reef Fish 1997–2000* (1999).

¹⁰ Johannes, R. E. SPC Live Reef Fish Information Bulletin #6 - December 1999. (1999).

¹¹ Fabinyi, M. Illegal Fishing and Masculinity in the Philippines A Look at the Calamianes Islands in Palawan. *Philippine Stud.* 55, 509–529 (2007).

Chen, J. & Ng, S. Regulating the Humphead Wrasse (*Cheilinus undulatus*) Trade in Sabah, Malaysia. *AMBIO A J. Hum. Environ.* 38, 123–125 (2009).

¹² Moore, A. *et al.* Reefs at risk in Central Sulawesi, Indonesia - status and outlook. 7–11 (2008).

Hoegh-Guldberg *et al.* *The Coral Triangle and Climate Changes*. (WWF Australia, 2009).

¹³ Sucoko, R. A. A Politic of Seafood Savers on Live Reef Food Fish (a Case Study in Wakatobi Regency, Southeast Sulawesi). (Bogor Agricultural University, 2013).

¹⁴ Westmacott, S., Cesar, H., Pet-Soede, L. & Linden, O. Coral bleaching in the Indian Ocean: socioeconomic assessment of effects. *Collect. Essays Econ. Coral Reefs* 94–106 (2000).

¹⁵ Sadovy de Mitcheson, Y. *et al.* Fishing groupers towards extinction: A global assessment of threats and extinction risks in a billion dollar fishery. *Fish Fish.* 14, 119–136 (2013).

Sadovy de Mitcheson, Y. & Colin, P. L. *Reef fish spawning aggregations: biology, research and management*. (Springer, 2011).

MacNeil, M. A. *et al.* Recovery potential of the world's coral reef fishes. *Nature* 520, 341–344 (2015).

b. Low Level of Protection for Habitat

As one of the CTI countries, with a national MPA target of 30% of Indonesian seas, Indonesia should be capable of protecting coral reef habitat¹⁶. However the formation of spawning aggregations by many grouper species makes them easy to catch in large numbers, mostly before they have spawned, and thus renders them intrinsically vulnerable to over-fishing during their spawning season(s)⁹. This is one reason that grouper stocks can become overfished within a short time period, resulting in "boom and bust" fisheries. Isolated marine protected areas without other supporting measures are unlikely to be effective in protecting most grouper populations. Furthermore, because grouper larvae are known to disperse over considerable distances (typically within radius of 20-100 km)¹⁷, sustainable management of grouper stocks is likely to require integration between conservation areas as well as between conservation and exploitation areas; for example, between the spawning grounds, nursery grounds, and fishing grounds of the grouper population(s)/stocks(s) of interest.

According to the global nongovernment organization (NGO) Science and Conservation of Fish Aggregations (SCRFA), it is estimated that 55% of major fish spawning aggregation sites (SPAGS) are still unknown, while 25% are declining, 4% have been lost, 13% appear stable, and only 3% are increasing or recovering. There are at least 43 spawning aggregation sites (SPAGS) reported in Indonesia¹⁸, of which 41 are reportedly used by groupers of six species from two genera in the Family Serranidae. These are: *Epinephelus corallicola*, *Epinephelus fuscoguttatus*, *Epinephelus lanceolatus*, *Epinephelus polyphekadion*, *Plectropomus areolatus*, and *Plectropomus leopardus*. Unfortunately, to date only four of these 43 SPAGS have been afforded any protection by local governments. These are situated in the Wakatobi National Park¹⁹ and the Komodo National Park²⁰.

2. Groupers

a. Threatened status of Indonesian groupers in the LRFFT

High value groupers traded live as food fish come under seven categories. Amongst them are species in high, medium and low value categories (**Table 2**). Comparing the price of groupers in Indonesia with the conservation status of each species in the International Union for the Conservation of Nature (IUCN) Red list (**Fig. 1**), it can be seen that in general the higher priced species are also under higher levels of threat.

Table 2. Grouper species commonly traded in the LRFFT in Indonesia (ranked by value)

| English name | Scientific Name | Bahasa Indonesia | Value (US\$/kg) |
|-----------------------|---|-----------------------|-----------------|
| Leopard coral grouper | <i>Plectropomus leopardus</i> ²¹ | Sunu merah/ Tung sing | 30-150 |
| Humpback grouper | <i>Cromileptes altivelis</i> ²² | Kerapu bebek/tikus | 28-100 |

¹⁶ Allen, G. R. & Werner, T. B. Coral reef fish assessment in the 'coral triangle' of southeastern Asia. *Environ. Biol. Fishes* 65, 209–214 (2002).

¹⁷ Green, A. L. *et al.* Larval dispersal and movement patterns of coral reef fishes, and implications for marine reserve network design. *Biol. Rev.* 90, 1215–1247 (2015).

¹⁸ Russell, M. W. *et al.* Status Report World 's Fish Aggregations 2014. 2–4 (2014).

¹⁹ Balai Taman Nasional Wakatobi. Informasi Taman Nasional Wakatobi. 1–12 (2007).

²⁰ Pet, J. S., Mous, P. J., Muljadi, A. H., Sadovy, Y. J. & Squire, L. Aggregations of *Plectropomus areolatus* and *Epinephelus fuscoguttatus* (groupers, Serranidae) in the Komodo National Park, Indonesia: Monitoring and implications for management. *Environ. Biol. Fishes* 74, 209–218 (2005).

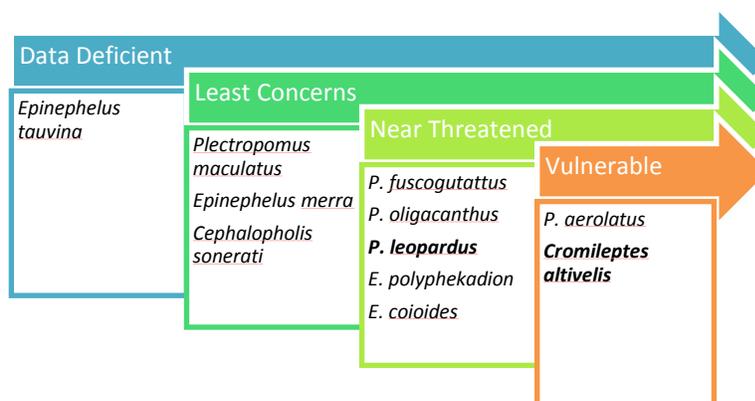
²¹ Sadovy, Y. J. *Leopard Coral Grouper (Plectropomus leopardus)*. (2000).

²² Sadovy, Y., Thierry, C., Choat, J.H. & Cabanban, A.S. *Cromileptes altivelis*. e.T39774A10264681 (2008).

| | | | |
|-----------------------|--|----------------------|-------|
| Areolate grouper | <i>Plectropomus aerolatus</i> | Sunu hitam/ Sai sing | 15-60 |
| Chinese footballer | <i>Plectropomus laevis</i> | Sunu raja | 15-60 |
| Brown marbled grouper | <i>Epinephelus fuscoguttatus</i> ²³ | Kerapu Macon/Muara | 8-30 |
| Spotted coral grouper | <i>Plectropomus maculatus</i> | Sunu bone/ Tai sing | 8-30 |
| Highfin coral grouper | <i>Plectropomus oligacanthus</i> ²⁴ | Sunu cambang | 8-30 |
| Small-toothed cod | <i>Epinephelus polyphkadion</i> | Kerapu batik | 8-30 |
| Tomato rockcod | <i>Cephalopholis sonnerati</i> | Kerapu karet merah | 8-30 |
| Estuary cod | <i>Epinephelus coioides</i> | Kerapu titik | 8-30 |

The high level of exploitation has not only caused declines in the abundance of populations of many grouper species, but in some cases has even resulted in the extirpation of certain species from habitat where they were originally known to occur, as reported for *Epinephelus polyphkadion*²⁵. Attention should be focussed on the protection of groupers not only as a group but as individual species, as each species has particular characteristics which need to be considered. For example, *E. fuscoguttatus* has a much faster growth rate than *C. altivelis*. However in some cases, conservation measures can be aimed at several species at once. For example, three grouper species (*Epinephelus fuscoguttatus*, *Epinephelus polyphkadion* and *Plectropomus aerolatus*) tend to share the same spawning aggregation sites and can even spawn simultaneously²⁶.

Figure 1. IUCN Red List (2017) status of eleven groupers commonly traded in Indonesia



b. Capture of immature groupers

²³ Sadovy, Y. & Cabanban, A. S. *Epinephelus Fuscoguttatus*. (1999).

²⁴ Cabanban, A. S., Sadovy, Y. & Samóils, M. *Plectropomus oligacanthus*. 8235, (2015).

²⁵ Sadovy de Mitcheson, Y. *et al.* Fishing groupers towards extinction: A global assessment of threats and extinction risks in a billion dollar fishery. *Fish Fish.* 14, 119–136 (2013).

²⁶ Sadovy de Mitcheson, Y. & Colin, P. L. *Reef fish spawning aggregations: biology, research and management*. (Springer, 2011).

Pet, J. S., Mous, P. J., Muljadi, A. H., Sadovy, Y. J. & Squire, L. Aggregations of *Plectropomus areolatus* and *Epinephelus fuscoguttatus* (groupers, Serranidae) in the Komodo National Park, Indonesia: Monitoring and implications for management. *Environ. Biol. Fishes* 74, 209–218 (2005).

Pet, J. S. *et al.* Introduction to Monitoring of Spawning Aggregations of Three Grouper Species from the Indo-Pacific. A Manual for Field Practitioners. (The Nature Conservancy Coral Triangle Center, 2006).

The price of groupers tends to be highest for plate sized fish, weighing 500-1000 g²⁷. However, some species have not reached first maturity (as females) or have not yet undergone sex reversal (to male) at this size (**Table 3**). Interviews with fishermen in Selayar revealed that they generally chose to sell fish outside the plate-sized range (100-450 g and >1000 g) as (dead) fresh fish rather than live. Unfortunately, around 50% of their catch tended to consist of juvenile fish which had never had a chance to spawn, let alone undergo sex reversal²⁸. Without any limit on the size of groupers which can be taken from the wild, there is a high risk of gender imbalance in grouper populations²⁹. Such a situation may cause individuals to change sex early while still small, leading to a situation where grouper populations are comprised of smaller and smaller fish⁹. This situation points to a need to regulate grouper fisheries as a whole, rather than simply setting limits on groupers traded and exported in the LRFFT.

Table 3. Reported sizes of some grouper species at first maturity (as females) and after sex reversal (as males) (FishBase)

| Species | Size at sex reversal | Size at maturity (as females) | Size at maturity (as males) |
|-----------------------------------|----------------------|-------------------------------|-----------------------------|
| <i>Plectropomus leopardus</i> | 23-62 cm | 35 - 38 cm (1.7 kg) | 70-75 cm |
| <i>Cromileptes altivelis</i> | 45 cm (>1.5 kg) | 36 cm (1 kg) | 48 cm (2.5 kg) |
| <i>Plectropomus aeorolatus</i> | 32 cm (0.5-0.8 kg) | 29 – 40 cm (0.3-1.2 kg) | 41 - 46 cm (1-1.5 kg) |
| <i>Plectropomus fuscoguttatus</i> | (5-6 kg) | 61 cm (4-6 kg) | 120 cm (6 –7 kg) |
| <i>Plectropomus maculatus</i> | - | 31 - 36 cm | 120- 125 cm |
| <i>Plectropomus laevis</i> | - | 46.2 cm | 100-125 cm |
| <i>Plectropomus oligacanthus</i> | - | - | - |
| <i>Epinephelus polyphkadion</i> | - | - | - |
| <i>Cephalopholis sonnerati</i> | - | - | - |
| <i>Epinephelus coioides</i> | (5 - 6 kg) | 55 cm (3-4 kg) | (6– 9 kg) |

Source : FishBase (<http://www.fishbase.org>).

c. Lack of Database

Data on groupers held by various government agencies is highly variable, in terms of species names as well as spatial and temporal coverage, taxonomic resolution and scope, as well as the values recorded for particular parameters. For example, data on grouper catch differ substantially between Marine and Fisheries Services, Fish Quarantine Offices, and exporters. In addition to different methods and procedures, the enumerators recording data are often

²⁷ Graham, Y. J. S. T. J. D. T. R., Phillips, M. G. J. M. M. J. & Yeeting, M. A. R. A. S. B. *While Stocks Last: The Live Reef Food Fish Trade*. (2003).

²⁸ Anderson, W., & Gilbert, M. *How Much is an ECOSYSTEM Worth? ASSESSING THE ECONOMIC VALUE OF CONSERVATION*. (IUCN, The Nature Conservancy. & The World Bank, 2005).

²⁹ Shapiro, D. Y. Differentiation and evolution of sex change in fishes: a coral reef fish's social environment can control its sex. *Bioscience* 37, 490–497 (1987).

unskilled in grouper species recognition, perhaps not surprisingly in view of the high number of grouper species with distributions in Indonesian waters³⁰.

The lack of standardised data sets is a major obstacle to the implementation of quota-based fisheries management by the Indonesian government³¹. Furthermore, establishing the true status of wild grouper stocks is complicated even further by the ambiguity inherent in the trade. Several Indonesian and local names may be used for one species; conversely, one name can be used for several species (e.g. *sunu* for *Plectropomus leopardus*, *Plectropomus oligacanthus*, *Plectropomus aerolatus*). Keeping track of trends in market demand over time is also difficult with incomplete and/or inaccurate data. A new one-way data (or one portal) system is in the pipeline, and expected to improve future data collection, and thus contribute to improved grouper management.

3. Human Activity

a. Illegal Unreported and Unregulated Fishing (IUUF)

The prevalence of IUUF contributes to the increasingly rapid decline in certain fish stocks³². For example, the operation of fish carrier vessels from Hong Kong in Indonesian waters has led to considerable loss of revenue from the live reef food fish trade in groupers. Despite the promulgation of Ministerial Regulation No. 15 of 2016³³ on Live Fish Carrier Vessels by the Minister for Marine Affairs and Fisheries, there are still many instances of IUUF, and in particular many illegal fishing practices are still rife.

Measures which need to be taken by the government to address illegal fishing include the provision of proper port infrastructure and ensuring that technical staff have the skills and resources to implement measures designed to prevent illegal fishing. Some regulations are still vague or difficult to enforce and require clarification and/or reinforcement, for example through the drafting and promulgation of standard operational procedures (SOP) covering the species caught, catch origin (fishing ground) and volume by species. Such procedures could help to avoid misrepresentation or fraud, theft and corruption. Additionally, for all companies involved, the licence and other ships documents should be carefully checked³⁴.

b. Aquaculture is not a solution to problems with the sustainability of the LRFFT

Indonesia is one of the countries which has succeeded in developing the culture of several species of grouper. The Gondol Mariculture Research Centre has successfully developed full-cycle culture for three species: *Epinephelus fuscoguttatus*, *Cromileptes altivelis* and *Plectropomus leopardus* with average survival rates of 30% for *E. fuscoguttatus*, but only 2% for *P. leopardus*. Despite an annual production capacity of 2.5 billion grouper seed in Bali alone by 2016 (Harbin Yake, personal communication, 2 June 2017), the domestic aquaculture sector has been unable to absorb the production from just the one hatchery (Gondol). The majority of seed produced are sold to aquaculture businesses in Malaysia, Taiwan and the Philippines.

³⁰ Hernández Aguado, S., Segado Segado, I. & Pitcher, T. J. Towards sustainable fisheries: A multi-criteria participatory approach to assessing indicators of sustainable fishing communities: A case study from Cartagena (Spain). *Mar. Policy* 65, 97–106 (2016).

³¹ Marine Research Centre Maldives & Marine Conservation UK. Management Plan For The Maldives Grouper fishery. (2011).

³² Belhabib, D., Koutob, V., Sall, A., Lam, V. W. Y. & Pauly, D. Fisheries catch misreporting and its implications: The case of Senegal. *Fish. Res.* 151, 1–11 (2014).

³³ MMAF. *KAPAL PENGANGKUT IKAN HIDUP*. (2016).

³⁴ Brack, A. D. International agreements Lessons from international agreements. *5*, 240–246 (2016).

The provisions of the recent law on live fish carrier vessels (No 32/KEPMEN-KP/2016), which increased the quota for the transport of live fish produced through aquaculture, has not yet had the anticipated positive impact as a stimulant of the aquaculture sector, and in particular the culture of groupers for the LRFFT. Reasons for this include the many challenges faced by grouper farmers, such as the low survival rate of seed released into the sea³⁵, the high price of feed, and the lack of market demand for farmed groupers.

C. Goal and Use of the Academic Paper Drafting Process

Goal. The goal of the Academic Paper drafting process was to provide a scientific basis for the promulgation of legislation to limit the size of groupers caught and exported in the LRFFT in Indonesia.³⁶

The aim of such a regulation would be to help ensure the sustainability of fisheries to supply the LRFFT. In addition, imposing a strict limit on the allowable size for grouper exports would contribute to the protection of grouper species as well as protecting and ensuring the economic stability of small-island fishing communities.

Use: the drafting of this Academic Paper is the first step towards conserving Indonesian grouper resources through maintaining the status of wild grouper stocks and preventing the (local) extinction of grouper species.

D. Methodology

This paper was compiled in order to provide background information and guidance on the need and potential mechanisms for regulating the live grouper fishery, specifically through limiting the allowable catch size for groupers, specifically those with a high market value as live reef fish. The paper was compiled using the following methods:

- **Desk Study**

A literature review covering scientific papers, legislation/legal instruments, documents (grey literature), books, and mass media. Primary legislative instruments included:

- Government Regulation No. 60/2007 on the Conservation of Fish Stocks
- Law No. 31/2004 (Amended by Law No. 45/2009) on Fisheries
- Law No. 27/2007 (Amended by LAW No. 1/2014) On Coastal and Small Island Management
- Law No. 5/1990 On the Conservation of Living Resources and Ecosystems
- Regulation of the Minister for Marine Affairs and Fisheries No. 37/KEPMEN-KP/2013 on Establishing the Status and Protection of the Napoleon Wrasse (*Cheilinus undulatus*).
- Regulation of the Minister for Marine Affairs and Fisheries No 32/2016 (Amended by No 15/KEPMEN-KP/2016) on Live Fish Carrier Vessels

³⁵ Kohno, H., Ordonio-Aguilar, R. S., Ohno, A. & Taki, Y. Why is grouper larval rearing difficult?: an approach from the development of the feeding apparatus in early stage larvae of the grouper, *Epinephelus coioides*. *Ichthyol. Res.* 44, 267–274 (1997).

³⁶ This paper provides the basis for the development of a national policy for the sustainability of the live reef fish trade in Indonesia. It contributes to meeting Goal 2 of the National Plan of Action, Coral Triangle Initiative on Coral Reefs, Fisheries, and Food Security of Indonesia, particularly Action 2 on developing a national policy for the sustainability of the live reef fish trade.

- **Focus Group Discussion (FGD)**

Focus group discussions (FGDs) were held over the period 2015-2017 to enable discussion and public consultation. Participants included stakeholders involved in various aspects of the Indonesian live grouper fishery and trade, in particular fishermen, private sector actors, NGOs, national and local government agencies. The FGDs were held in a number of centres of the live grouper trade in Indonesia such as Jakarta, Bali, Makassar, Selayar, and Surabaya. An overview of these FGDs and other related meetings held over the period 2015-2017 is given below:

- **Focus group discussion in Bali**

A FGD was held in Bali on 26-29 June 2015. This FGD was attended by stakeholders such as the Class 1 Fish Quarantine in Bali, the Gondol Centre for Mariculture Research and Development, the Bali Local Trade Association, and two exporters (UD Pulau Mas, and CV Musi Jaya).

- **Focus group discussion in Surabaya**

This FGD was held in Surabaya on 30 June- 1 July 2015. FGD participants included stakeholders such as the Surabaya Class 1 Fish Quarantine, seafood restaurants, the Situbondo Centre for Brackish-water Aquaculture Research and Development/KJA- Situbondo).

- **Focus group discussions in Makassar**

FGDs were held in Makassar on 17 June 2015 and 22 April 2016. There were 25 participants representing local government agencies (Makassar City Marine and Fisheries Service, South Sulawesi Provincial Marine and Fisheries Service, and the Coastal and Marine Resource Management Agency - BPSPL), academics from several tertiary education institutions in Makassar, and NGOs (WWF and YKL).

- **Focus group discussion in Jakarta**

An FGD was held in Jakarta on 20-22 October 2015. Participants included representatives from the Directorate for the Surveillance of Marine and Fisheries Resources (DPSKP) of the Ministry for Marine Affairs and Fisheries (MMAF); the MMAF Quality Certification Centre; the Cengkareng Fish Quarantine Office; private sector companies CV. Alam Laut, PT. Multi Nusa, PT. Global Seafood; and the local NGO Destructive Fishing Watch (DFW).

- **Inception Meeting in Jakarta**

This inception meeting was held in Jakarta on 17 March 2017. The venue was the Gedung Mina Bahari IV, within the MMAF complex. The meeting was attended by representatives from the ADB- RETA 7813 project management team, academics from Hasanuddin University (UNHAS), as well as representatives from several directorates within the Indonesian Ministry for Marine Affairs and Fisheries. During the meeting, discussions centred on possible appropriate measures to produce legislation (regulations) to promote sustainable management of the live reef food fish in Indonesia.

- **Public Consultation in Makassar**

A Public Consultation and discussion session was held in Makassar on 3 May 2017, at the UNHAS Faculty of Marine Science and Fisheries. Participants included representatives from the South Sulawesi Class I Fish Quarantine,

tertiary education institutions in Makassar, the company CV. Samudra Indah, and the Maros Centre for Brackish-water Aquaculture.

○ **Focus group discussion in Selayar**

The FGD in Selayar was held in the Wisma Raihan, Jl. Muh. Kareng Bonto, Benteng, Selayar, on 15 May 2017. Participants included members of the Hasanuddin University (UNHAS) team, the Kepulauan Selayar District Marine and Fisheries Service, the Kepulauan Selayar District Planning and Development Agency (BAPPEDA), and the private sector..

○ **Public Consultation in Bali**

This Public Consultation in Bali was held in the Harris Residence Riverview Hotel, Jl. Raya Kuta, Kuta, Bali, on 2 June 2017. The participants included members of the Hasanuddin University (UNHAS) team, the Bali Provincial Marine and Fisheries Service, the Nature Conservation Agency (BKSDA) for Bali Province, the Marine Science and Fisheries Faculty of Udayana University (FKP UNUD), the NGO Nusa Dua Reef Foundation (NDRF), the Bali Class 1 Fish Quarantine, the Denpasar Coastal and Marine Resource Management Agency (BPSPL), and the company UD. Pulau Mas.

○ **Field Data Collection and Analysis**

Field data were collected through interviews with fishermen from various areas as well as the collection and analysis (visual and histological) of grouper gonad samples from Kwandang Bay, Gorontalo Province. The aim of this study was to assess the true gonad maturity levels of groupers being caught as a basis for the formulation and promulgation of legislation imposing minimum size limits for groupers.

II. THEORETICAL BASIS

A. Philosophical Basis

Indonesia is a maritime nation, the seas forming three quarters of her territory (5.8 million km²). Her tropical coastlines are the second longest coastlines of any nation in the world, after Canada. Indonesia extends from Sabang in the west to Merauke in the east, a distance equivalent to that between London and Bagdad. The distance from the Satal Islands in the north to Rote Island in the south is similar to that between Germany and Algeria.

The rich resources of the Indonesian seas hold great and varied potential for (economic) development. The official contribution of marine resources to GDP was valued at US\$28 billion in 1988, around 20 % of the total. This is less than the contribution of marine resources to the Korean economy in 1992, which was US\$147 billion or 37%, in a country with only 2,713 km of coastline. The value of fisheries exports in 1988 was US\$1.76 billion, with seaweed exports of US\$45 million, less than that of Thailand (US\$4.2 billion), a country with 2,600 km of coastline. If marine resources were exploited in an optimal fashion, these resources have the potential to make a substantial contribution to the repayment of Indonesia's overseas debts, as well as providing many basic services to coastal and small island communities. In addition to food security and livelihood opportunities, thriving marine and coastal ecosystems and associated resources can contribute to disaster risk reduction, climate change adaptation, and sustainable energy production.

Most marine resources are renewable (demersal and pelagic fish stocks, seaweeds and other living organisms), and could form the basis of sustainable economic development. The sustainable yield of Indonesia's marine fisheries in metric tons/year was calculated (in 2012) as 6.18 million for pelagic fishes, 1.78 for demersal fishes, 75,000 for coral reef food fish, 74,000 for penaeid shrimps, 4,800 for lobsters and 28,250 for squid.

Based on the considerations above, the Republic of Indonesia, in planning for the future of its citizens, especially from an economic point of view, is still predominantly agrarian in outlook, looking to the land, seas and skies as gifts from Almighty God, which play a vital role in building the equitable and wealthy nation to which we all aspire. Fisheries legislation in vigour, which should function as a tool for building this just and wealthy nation, has in fact often had the opposite effect.

Based on this situation, it has been considered necessary to formulate new fisheries sector policies to update the paradigm in vigour, and provide legal certainty for all Indonesian citizens. These new policies should enable the land, seas and skies to fulfil their functions as described above, in line with the needs of the citizens and the nation, while meeting all the demands and challenges of the current era in the agrarian context. In addition, national fisheries policies must support the aspirations of the Indonesian Nation in terms of Humanitarianism, National Pride, Democracy, Social Justice/Equity, and Belief in God Almighty; in particular, these policies should apply the principles expressed in article 33 of the Constitution, and the Guiding Principles of the Indonesian Nation expressed in the Political Manifest of the Republic of Indonesia on 17 August 1959, reinforced in the Presidential Address of 17 August 1960.

B. Legal Basis

Legal considerations include legislation and legal matters as well as the role of the law in the fisheries sector. These considerations are related to the role of the law/legal sector in development, both as a social control and as an instrument for dispute resolution. The role of the law in the fisheries sector is extremely important, as legal systems and regulations should provide certainty and fairness in this sector

In connection with these roles and functions of the law, there is clear guidance on legal matters related to the Indonesian fisheries sector in the Constitution (Undang-Undang Dasar of 1945). Article 33 paragraph (2) states that "Production sectors of national importance and which affect the life of many people are controlled by the state". This is followed by paragraph (3), as follows:

"The land and the seas and all the resources therein are controlled by the nation, to be used for the greater good of the people".

This translates as stating that the land, seas and skies, and the natural resources they contain (including fish stocks) are controlled at the highest level by the Nation, representing the people as a whole. While the concept of "Control by the Nation" is further explained with reference to a number of Dutch terms: formulation of policy (*beleid*), promulgation of legislation (*regelendaad*), governance (*bestuurdaad*), management (*besherdaad*), and surveillance.

Another article in the Constitution which provides a legal basis is Article 27 (1) which states that all citizens are equal before the law, while the government is responsible for upholding the law and ensuring the rule of law with no exceptions.

Furthermore, as an entry point for the legal basis of national fisheries policy, the opening remarks of the Constitution state that the Government of the Indonesian Nation is responsible for the protection of all Indonesian citizens and the spilling of their life-blood, and for advancing

the common welfare, promoting education and intelligence, working with other countries towards global peace based on freedom, lasting peace and social equity.

C. Sociological Foundation

One social characteristic of the fishermen involved in the fishery for live groupers is that most live on small islands, often in relatively remote areas. Living in such remote areas means that these grouper fishermen are heavily dependent on the live reef fish trade to provide for their basic everyday needs. Most of these fishermen operate under a patron-client system; this system is one factor which, sometimes indirectly, can influence fishermen in the use of destructive fishing methods³⁷.

Ideally, size limits for groupers should be set by species, or for groups of grouper species with similar growth and reproductive patterns, and for some species should be population (stock) specific. However, not only are the detailed data for establishing such limits lacking for all but a few species/populations, but the human resources for implementing species-level regulations are also lacking. In particular, the taxonomic skills required to correctly identify grouper species (whether for recording/data collection purposes or for surveillance) are rare, and extensive capacity building would be needed prior to passing and implementing such regulations. Furthermore, the high dependency on marine resources in general, and groupers in particular, could lead to problems if the minimum landing size (MLS) for groupers was set based on size at first maturity for some of the larger species (e.g. *Plectropomus leopardus* and *Epinephelus coioides*), there would be a high risk of causing a massive decline in the live reef fish fishery and trade across Indonesia, likely to result in the closure of many LRFFT companies (Heru Purnomo, personal communication, 18 August 2017).

On the one hand, a minimum size limit regulation should have the potential to contribute to the prevention of (local) grouper species extinctions and the reversal of the decline in grouper stocks, while on the other, it should enable the communities (and other stakeholders in the LRFFT) to continue to make a living. However, a size limit which would continue to allow the harvesting of fish below the size-at-first maturity, and well below size at sex reversal, should only be considered as an initial or interim measure. In the longer term, such a regulation is unlikely to prevent the eventual collapse of the fishery unless it is backed up by appropriate supporting measures at local or regional levels, on a scale consonant with grouper species/species group stock distributions and connectivity patterns. These should include: (i) no-take-sites within exploited grouper population (stock) distributions, to ensure that some individuals will grow to adulthood, spawn, and replenish populations; (ii) complete protection of (known) spawning aggregation sites during spawning; and (iii) limited protection of known/suspected spawning habitat throughout the year (e.g. limited hook-and-line for subsistence and recreation).

The regulation must be implementable, striking a balance between socio-economic considerations and the biological needs to ensure the maintenance of thriving life reef food fish stocks in Indonesia. A 600 g minimum landing size (MLS) for groupers caught and traded in Indonesia is considered to represent an equitable balance between socio-economic welfare and sustainability concerns. There are high hopes that this regulation could be effectively implemented in Indonesia, as it arose from the aspirations expressed by stakeholders and the desire to prevent the loss of grouper stocks.

³⁷ Nurdin, N. & Grydehøj, A. Informal governance through patron-client relationships and destructive fishing in Spermonde Archipelago, Indonesia. *J. Mar. Isl. Cult.* 3, 54–59 (2014).

Despite the limitations of such a uniform size limit regulation in terms of long-term grouper fishery sustainability, the sociological impact of a successful implementation would be far-reaching. The very fact of having a widely-accepted limitation on a fishery renowned for being rife with IUUF practices should prepare the way for other innovations and greater control, including market chain integration and traceability. Psychologically as well as legally it should help pave the way for a shift from open access to some form of limited access or rights-based fisheries management regime, in synergy with related policies and measures such as protected areas and marine/coastal zonation plans.

III. EVALUATION AND ANALYSIS OF RELATED LEGISLATION

Over time, there have been changes in the way the live reef food fish trade has been managed in Indonesia. The trade in groupers from Indonesia began in 1985, and was originally centred on the Banggai Archipelago, Central Sulawesi. From there, the trade spread to South and Southeast Sulawesi as well as Maluku. The grouper trade grew in volume as stocks of the Napoleon wrasse dwindled due to overfishing³⁸.

There was a progressive shift from fresh (dead) groupers to the sale of groupers into the LRFFT from 1988 onwards. In the early years, fishermen from Hong Kong taught Indonesian fishermen how to catch fish using poison (potassium cyanide), locally called *bius*³⁹. In 1993 the Indonesian Government promulgated legislation forbidding the use of *bius* to catch fish, through Government Regulation PP No. 51 of 1993 on the Analysis of Environmental Impacts. However fishermen (and their bosses) paid little or no attention to this regulation, which was not effectively enforced (if at all). The widespread use of poison fishing caused extensive damage to coral reef ecosystems in many regions⁴⁰, resulting in reduced stocks of groupers in the wild. The development of aquaculture technology for *Epinephelus fuscoguttatus* and *Cromileptes altivelis* began in 1999 at research stations in several regions (especially Bali and Lampung). Around the same time the large-scale catch and sale of juvenile groupers became increasingly common^{43,41}.

In 2006 a Government Regulation forbidding habitat degradation or destruction was drafted, and incorporated into the Ministerial Regulation PP No. 60/2007^{44,42}. The government also made it obligatory for all fishermen to have a fishing licence, as set out under the Ministerial Regulation (Peraturan Menteri KP) Number: PER.17/MEN/2006. Designed to empower fishermen, many perceived this regulation as a burden which made fishermen's lives more difficult²¹. One weakness of this regulation is that fishing vessels under 5 GT did not need to be licensed (obtain a SIPI), which in effect meant that data on small-scale fisheries would not be recorded by the government. This data gap is a major obstacle in developing and implementing policies for managing the LRFFT, as most live reef fish are caught by fishers using vessels under 5 GT or in the 5-10 GT range.

In 2014, the Indonesian Ministry for Marine Affairs and Fisheries imposed a moratorium on the issuance of fishing licences to foreign flag fishing vessels operating in Indonesian waters

³⁸ Johannes, R. E. SPC Live Reef Fish Information Bulletin #6 - December 1999. (1999).

³⁹ Chen, J. & Ng, S. Regulating the Humphead Wrasse (*Cheilinus undulatus*) Trade in Sabah, Malaysia. *AMBIO A J. Hum. Environ.* 38, 123–125 (2009).

⁴⁰ Pet-Soede, C. Options for co-management of an Indonesian coastal fishery. (Wageningen Universiteit, 2000).

⁴¹ Notowinarno. Pengaruh Berbagai Kondisi Pencahayaan Terhadap Konsumsi Pakan, Pertumbuhan dan Kelangsungan Hidup Larva Kerapu Macan (*Epinephelus fuscoguttatus* Froskal). (Bogor Agricultural University, 1999).

⁴² De Alessi, M. & Alessi, M. Archipelago of Gear: The Political Economy of Fisheries Management and Private Sustainable Fisheries Initiatives in Indonesia. *Asia Pac Policy Stud* 1, 576–589 (2014).

(Ministerial Regulation Number 56/PERMEN-KP/2014), which was amended in 2015 (by Ministerial Regulation Number 10/PERMEN-KP/2015). This regulation included fish carrier vessels, and resulted in the closure of live reef fish holding businesses in many areas, as the Hong Kong carrier vessels were no longer visiting them to buy/collect fish. In addition to the use of poison (cyanide) for catching fish, the use of compressors in fishing was also forbidden under the Government Regulation on Outlawed Fishing Gear PP No 31 of 2004, and Ministerial Regulation regarding the Outlawing of Compressors as Auxiliary Fishing Gear (PER.02/MEN/2011)⁴⁴.

In 2016 the Government began to draft regulations on live fish carriers. A distinction was made between vessels carrying wild-caught fish and those carrying farmed fish in Ministerial regulation of the Minister for Marine Affairs and Fisheries No 32/2016 (see also No 15/KEPMEN-KP/2016). These regulations were expected to promote the growth of the aquaculture sector, and in particular to produce an increase in the production of farmed groupers, especially as the export quota for farmed fish had also been increased. However, as mentioned above, grouper farming in Indonesia has continued to stagnate, at least partly due to the lack of market enthusiasm for farmed grouper. Thus the LRFFT in groupers is still largely dependent on wild grouper stocks.

In view of the increasingly threatened status of several wild grouper species and stocks, as well as the heavy dependence of many fishermen on wild-caught groupers, there is an urgent need for action. The government needs to take swift and decisive action to avoid further declines in wild grouper stocks, including measures to regulate the catch of groupers traded in the LRFFT.

IV. DEFINITIONS, POLICY GUIDELINES AND SCOPE OF THE REGULATION

A. General rules on the terms and phrases used in drafting an academic paper

1. All parties include both individuals and corporate bodies.
2. A corporate body is an organised group of people or vested interests whether or not it has the status of a formal legal entity.
3. Fisheries comprises all activities related to the management and exploitation of fisheries resources and their environment, from pre-production, production, processing through marketing carried out within a fisheries business system.
4. Fisheries management includes all efforts by government or other authorities which are oriented towards ensuring the continued productivity of aquatic resources and other specific goals, included all process integrated within the collection of information, analysis, planning, consultation, decision-making, allocating fisheries resources and policy implementation, including law enforcement with respect to fisheries sector legislation and regulations.
5. The Fisheries Management Areas within the Republic of Indonesia, hereafter abbreviated as WPP NRI (WPP) comprise all fisheries management areas within the archipelagic waters, territorial seas, extended zone of influence and exclusive economic zone of Indonesia.
6. Fisheries resources include the stocks of all kinds of fish.
7. Fish are defined as all organisms spending all or a part of their life-cycle in an aquatic environment.
8. (Live) groupers are ten species of the Family Serranidae which are commonly sold live and have a high economic value
9. (Capture) fisheries include all activities carried out in order to catch fish from waters where they are not being cultivated, using any gear or method whatsoever, including activities associated with the use of vessels to carry, transport, store, handle, process or preserve the catch.
10. The minimum landing size (MLS) is the smallest size in terms of length and/or weight at which fish may be legally caught from the wild and/or exploited. .
11. The Minister is the Minister for marine Affairs and Fisheries.
12. The Director General is the Director General for Capture Fisheries.

B. Solutions to Address the Issues

There are several policy options/management tools which could be applied to the management of grouper fisheries in Indonesia at the present time, as follows:

- **The allocation of catch quotas on a regional basis**

The allocation of catch quotas at regional (e.g. Provincial) level would be one way to address the issue of overfishing within each designated area. Such a measure is widely considered to be necessary in order to achieve the goal of sustainable fisheries. However one major obstacle to an effective implementation of this fisheries management tool is the poor quality, insufficient resolution and/or lack of appropriate data (fisheries statistics) in Indonesia. When the one-way data system for all fisheries data (due to be initiated during 2017) is up and working, a quota system may become possible. Until then, without the necessary data, and with no way to trace the origin of particular fish or consignments, it would be extremely difficult, if not impossible, to implement an effective quota system (Gossen Sitanggang, personal communication, 17 March 2017).

- **Protection for spawning aggregation sites (SPAGS)**

Protection for spawning aggregation sites, commonly referred to as SPAGS, is one possible approach in the context of responsible (sustainable) fisheries management. Protecting SPAGS will have multiple benefits, contributing not only to sustaining or even recovery of specific grouper populations, but also to the food security and welfare of fishing communities. Although so far only two (reported) SPAGS in Indonesia are protected, the establishment of no take zones designated by the MMAF should also protect any spawning grounds within them, as one consideration when establishing no-take areas is SPAGS protection. However once a potential SPAGS has been identified, at least 5 years of monitoring data are needed to confirm the presence of a permanent/long-term spawning site. Thus the implementation of this approach requires considerable sums of money and professional skills at regional level, and should be considered as a medium to long term measure, with the potential to support and work in synergy with other management measures such as restrictions on allowable landing size, fishing effort, or on access to grouper fisheries

- **Limiting allowable catch size**

Regulations to limit allowable catch size were widely viewed as the easiest management option to implement in Indonesia by stakeholders involved in the consultation process (outlined in I Section D). As most groupers will undergo sex reversal some time after reaching maturity, the size limits need to be set in such a way as to avoid causing an imbalance between the sexes of wild grouper populations. This academic paper contains proposed limits, based on the (limited) biological data available, for ten grouper species which are commonly caught for the LRFFT (Appendix I and Appendix II), as the basis for an initial formal regulation on grouper size restrictions. Taking into account socio-economic considerations, a first step which could be implemented within a short time-frame would be to set one size limit for this group of species, most of which have relatively similar characteristics (Appendix II).

Eventually, regulation on grouper size restrictions should be based on the characteristics of each species and stock. It is strongly recommended that multi-disciplinary bio-ecological and socio-economic research be undertaken, including (but not limited to) the reproductive biology and ecology of the 10 groupers most commonly caught and traded in the LRFFT (Appendix I & II), including sizes at first maturity and sex-reversal; the identification of grouper SPAGS, connectivity, stock distribution and boundaries; the identification and characterisation of grouper fishers, fishing grounds, and trade networks. An overlay of these data sets would enable more comprehensive management measures in the EAFM context, including the refinement of size restrictions, spatial restrictions (e.g. SPAGS protection), and effort, output or access restrictions (e.g. regulations on fishing gear, quotas, and/or rights-based/limited entry grouper fisheries), as well as internationally-recognised certification of sustainable grouper fisheries.

This initial restriction on grouper size should be implemented as an interim management measure, while awaiting the results of further research to be undertaken in order to set minimum size limits based on grouper size at sex reversal by species and region. The regulation should be reviewed and evaluated at regular intervals, with provision for periodic amendments based on research and monitoring data. This measure is vital as a first step towards ensuring the continued

reproduction of wild grouper stocks. Setting a minimum landing size (MLS) should also reduce the volume of wild-caught juveniles, thus promoting recruitment to grouper stocks. This regulation will make a major contribution towards the recovery and maintenance of Indonesian grouper fisheries productivity in general, and in particular the production of high-quality Indonesian groupers destined for the LRFFT.

C. Sanctions

Fines will be imposed for the capture, landing, transport, trading or use of fish below the minimum landing size (MLS) established within the Indonesian fisheries management areas (WPP-NRI), as provided for under articles 100 and 100c in the law Undang-Undang Number 45 of 2009 on amendments to Undang-Undang Number 31 of 2004.

Fishermen committing a third infraction to this regulation will be liable to the seizure of certain assets/goods, such as fishing vessels (including the motor) and fishing gear, as provided for under articles 39 KUHP in the law Undang-Undang Number 45 of 2009 on amendments to Undang-Undang Number 31 of 2004.

V. CLOSING REMARKS

A. Conclusion

Based on the evaluation above, it can be concluded that the LRFFT in Indonesia is highly dependent on wild grouper stocks. Many grouper species and populations (stocks) are under severe threat and declining in abundance and/or quality (size). Some have been declared Near Threatened (IUCN Red List status), and without management action the conservation status of many grouper stocks will undoubtedly continue to decline. In future, management should be more holistic and take into consideration the reproductive biology of groupers as sequential hermaphrodites with sex reversal.

After evaluating the advantages of and potential challenges associated with several policy options, the regulation of minimum landing size is considered to be the most appropriate short-term (immediately applicable) strategy to avoid the continued decline of grouper stocks in Indonesia. This strategy should be kept simple, with periodic revisions based on-going research and monitoring. There is a clear need for further research at selected sites to establish appropriate minimum landing sizes (MLS) at species level.

B. Specific Policy/Action Recommendations

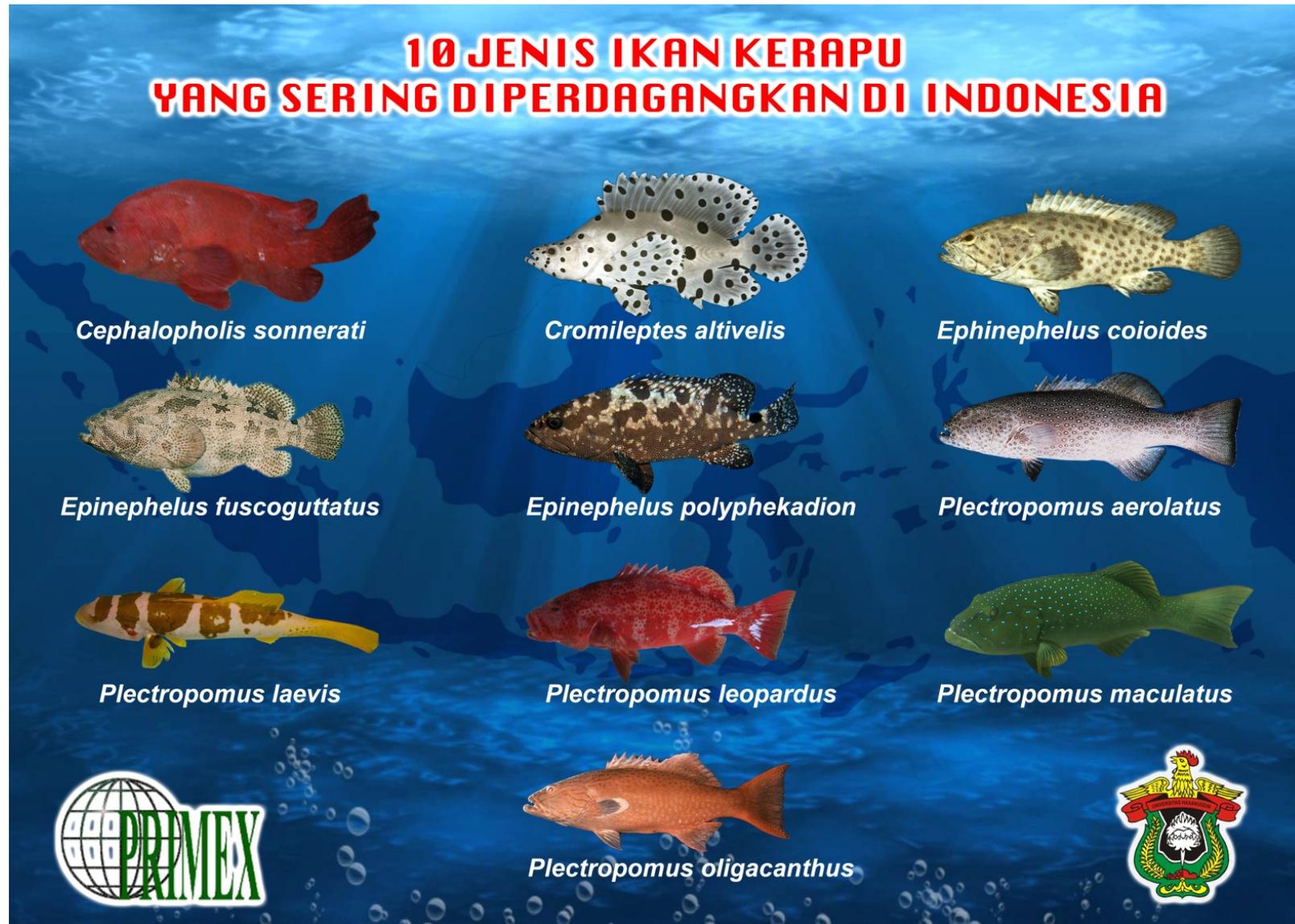
A regulation to establish a minimum landing size (MLS) of 600g for ten of the most commonly caught groupers traded in the LRFFT in Indonesia should be promulgated in the shortest possible time frame. Drafts for two policy (regulation) options (Ministerial Decree and Ministerial Regulation) are attached to this paper, as Annexes I and II, respectively. These MLS limits should apply to all fishermen operating within Indonesian waters, and should be applied to the listed groupers, whether live or dead, in order to prevent/reduce the sale of immature (juvenile) wild-caught groupers the LRFFT as well as through traditional markets/market chains and to domestic restaurants. Provisions for monitoring and evaluation need to be included in the regulation and implemented. It will be necessary to ensure socialisation of the regulation to all relevant stakeholders, and effective implementation, including the training of key personnel, routine monitoring, as well as effective surveillance and enforcement systems.

This regulation on allowable catch size is a **temporary measure**, which should remain in force until there are sufficient data to establish MLS limits by species and stock. Multi-disciplinary

research to fill gaps in the (bio-ecological and socio-economic) knowledge required to design and implement more detailed size restrictions and complementary management measures should be considered a priority. Successful implementation of this regulation will require the support and active participation of many stakeholders, especially those who currently reap the benefits from these resources. It is hoped that all elements of the community will take part in the surveillance of compliance with this regulation (in its initial and subsequent amended forms), so that grouper stocks supplying the LRFFT can swiftly begin to recover and be sustained long-term.



Ten Grouper Species commonly traded in Indonesia



Annex 2

Recommended minimum landing sizes⁴³

Recommended minimum landing sizes (length and/or weight) for groupers caught in or exported from the territory of the Republic of Indonesia, based on available data regarding grouper reproduction (first maturity and sex reversal)

| No. | SPECIES NAMES | | | MLS | REFERENCE DATA | | HABITAT |
|-----|-----------------------|----------------------------------|-----------------------|--------|----------------|--------------------|---|
| | COMMON NAME | SCIENTIFIC NAME | INDONESIAN NAME | | W | LENGTH Lm (Female) | |
| 1 | Leopard coral grouper | <i>Plectropomus leopardus</i> | Sunu merah/ Tung sing | 600 g | 35-38 cm | 70-75 cm | Reef-associated; oceanodromous; brackish; marine; depth range 3-50 |
| 2 | Humpback grouper | <i>Cromileptes altivelis</i> | Kerapu bebek/tikus | 600 g | 36 cm | 48 cm | Reef-associated; brackish; marine; depth range 1-20 m |
| 3 | Areolate grouper | <i>Plectropomus areolatus</i> | Sunu hitam/ Sai sing | 600 g | 29-40 cm | 41-46 cm | Lagoon and seaward reefs, in areas with rich coral growth. Most frequently encountered in channels along the front reef, depth 1-20 m |
| 4 | Brown marbled grouper | <i>Epinephelus fuscoguttatus</i> | Kerapu Macan Muara | 1000 g | 61 cm | 120 cm | Occurs in lagoons, pinnacles, channels, and outer reef slopes, in coral-rich areas with clear water, depth 1-60 m |
| 5 | Spotted coral grouper | <i>Plectropomus maculatus</i> | Sunu bone/ Tai sing | 600 g | 31-36 cm | 120-125 cm | Reef-associated; brackish; marine; depth range 5 - 100 m |
| 6 | Chinese footballer | <i>Plectropomus laevis</i> | Sunu raja | 600 g | 46,2 cm | 100-125 cm | Marine; reef-associated; depth range 4 - 100 m |
| 7 | Highfin coral grouper | <i>Plectropomus oligacanthus</i> | sunu cambang | 600 g | - | - | Reef-associated; oceanodromous; brackish; marine; depth 5-147 m |
| 8 | Small-toothed cod | <i>Epinephelus polyphekadion</i> | Kerapu batik | 600 g | - | - | Usually found in coral-rich areas of lagoons and outer reefs; in caves and areas with large crevices to swim through, depth 1-46 m |
| 9 | Tomato rockcod | <i>Cephalopholis sonnerati</i> | Kerpu karet merah | 600 g | - | - | Marine; reef-associated; non-migratory; depth range 10 - 150 m |
| 10 | Estuary cod | <i>Ephinephelus coioides</i> | Kerapu titik | 800 g | 55 cm | - | Reef-associated; brackish; marine; depth range 1 - 100 m |

⁴³ The minimum sizes listed here are recommended but should be used with care in the whole of Indonesia because growth and maturity of groupers are variable among sites are species (see Report on the Histological Analysis of Groupers in Kwandang Bay, Gorontalo Utara District, prepared under the ADB RETA 7813 Project). The minimum size limits will change as new data on the biology of groupers become available in specific fishery management areas.