Present status of grouper fisheries at waters of Kotania Bay, Western Seram District Maluku Province

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Abstract. Study on present status of groupers fishes at waters of Kotania Bay was conducted from 2016 to 2017. Survey and Participatory Rural Appraisal (PRA) method were used to collect and examine data and information concerning species potential and utilization of these species. The result shows that there are 35 species of grouper fishes inhabit Kotania Bay waters. From six genera recorded, *Epinephelus* found to have more varieties species richness compared to other five genera. In general, main habitat of adult grouper is coral reef, whilst mangrove and seagrass are habitat for nursery and grow out. The potency of the *Epinephelus, Cephalopholis* and *Plectropomus* genus tend to decrease started in 2000 up to 2017. At the same period, the production of these genera was also declined. Species potency and production declined was attributable to habitat (coral reef) degradation and high fishing intensity as a result of high market demand. Hand line, bottom long line and trap net are general fishing gear used in harvesting of theses fishes. Fishing activities took place all year round except for bottom long line which only lasted from June to October (East monsoon). Spatial fishing ground distribution is predominantly at coral reef ecosystem of Kotania Bay.

1. Introduction

Kotania bay is one of the unique bay in Western Seram District which has five small islands and three ecosystems of tropical region i.e. coral reef, seagrass bed and mangrove. This bay becomes spawning and feeding ground as well as shelters for many species of economically important finfish and shellfish [1]. Thus, Kotania bay has a great potential to become habitat for high diversity and abundance of marine biota. Some previous studies showed that Kotania bay had variety of marine resources such as fishes [2], crustaceas, echinoderms [3] and molluscs [4]. However, due to population growth and continuous exploitation of marine resources, it seems that these resources have declined and their habitat decreased.

Fish in coral reef can be categorized into three groups namely target species, major species and indicator species [5]. One of the popular and important target reef fish in Kotania Bay is groupers. Exploitation of groupers in this area has been done for long time by artisanal fishers using simple gears and only based on their experience. In the recent year, exploitation of groupers has increased due to the market demand and high value of grouper. As the results, their population becomes decreased and their habitat becomes damaged due to utilization of destructive fishing gear. In addition, lack of government awareness of socialized fishery regulation make traditional fishers in this area do not know how to exploit and utilize their resources environmentally and sustainably.

Study on groupers fishery in Kotania Bay is lacking. Therefore, this research was carried out to study present status grouper fishery which consists of species richness, spatial distribution of fishing ground as well as fishing gear, utilization pattern and fishing season. Based on the results, proposed strategy management for grouper fishery will be formulated.

2. Methodology

This research was conducted in Kotania Bay, Western Seram District, Maluku Province, Indonesia (Figure 1) from September 2016 to July 2017. Data of fishing ground, fishing activities (types and number of fishing gear as well as fishing frequency), species richness and total individual of grouper caught were obtained through survey on 34 fishing sites. Furthermore, Participatory Rural Appraisal (PRA) method [6] through Focus Group Discussion (FGD) with fishers in villages of Osi island, Kotania and Wael were conducted to get data and information on opinion and condition of grouper fishery, participative mapping of grouper fishing, distribution of fishing gear and fishing season. Data and information on utilization of grouper were also collected through a questionnaire distributed to 10% of fishers in those villages.

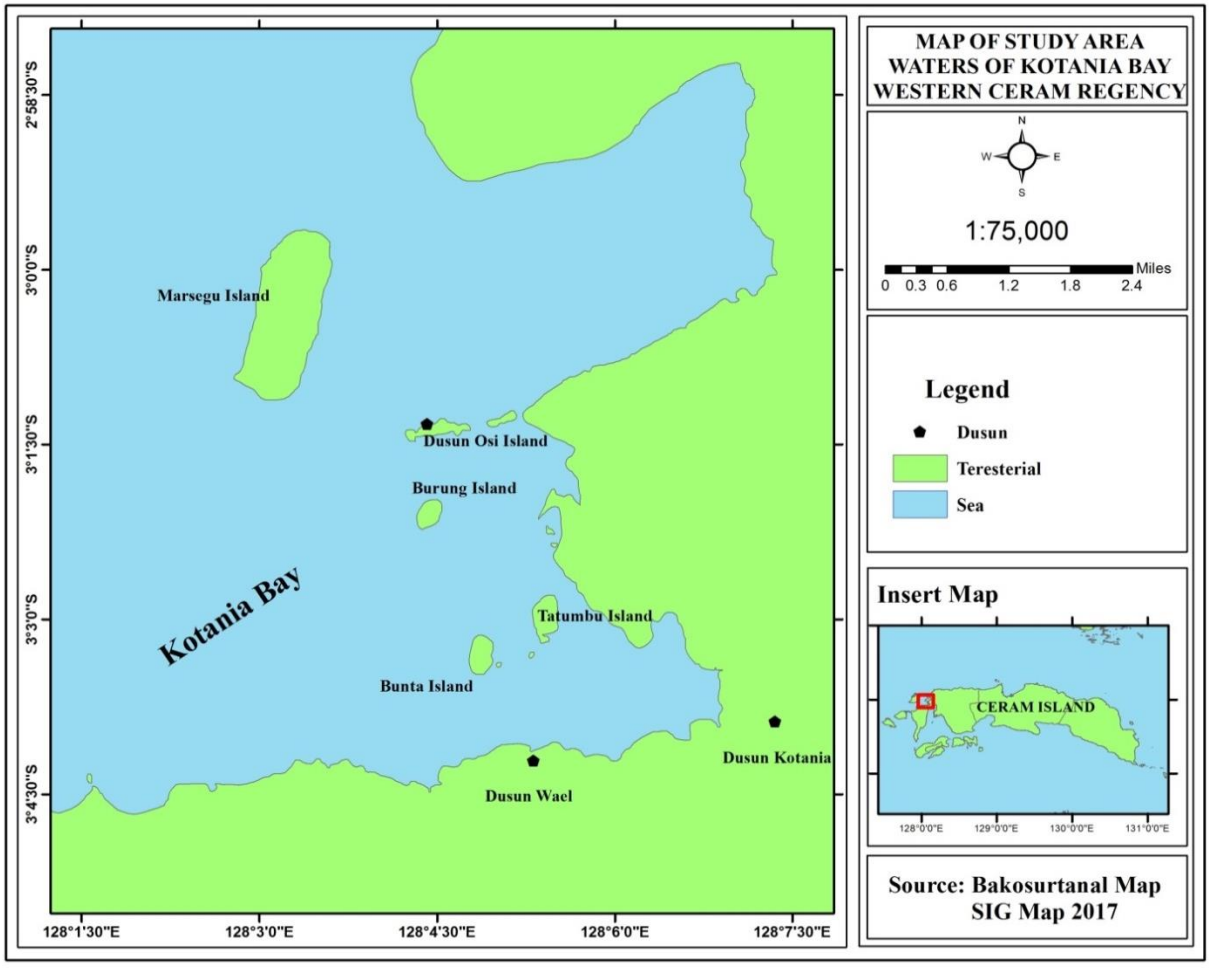

Figure 1. Map showing Kotania Bay

Species of grouper caught by local fishers were identified according to [7], [8], [9], [10] and [11]. Catch data of each species and its production tendency was tabulated, presented in graph and explain descriptively. Data and information on this fish concerning its distribution was also displayed according to its fishing ground. The pattern of grouper utilization, fishery progress and fishing season was described through participatory mapping according to [12]. Grouper fishery strategy and

management plan was established using alternative method with consideration of problems associated with exploitation of this fishery

3. Results and Discussion

3.1. Species Richness of Groupers

There were 35 species of grouper found during the study in Kotania Bay (Table 1). The high diversity of grouper found in Kotania Bay is not surprising because this bay is was well known as migration area for reef fish including groupers. It can be seen in Table 1 that grouper belong to Serranidae family consists of six genera i.e. *Epinephelus, Cephalopholis, Cromileptes, Plectropomus, Anyperodon* and *Variola.* Genus of *Epinephelus* has more species, followed by *Cephalopholis* and *Plectropomus* while *Variola, Anyperodon* and *Cromileptes* genera have fewer species.

Table 1. Checklist of grouper species at Kotania Bay waters

No	Scientific Name	Common Name	Local Name
1	*Anyperodon leucogrammicus*	White-lined grouper	Kerapu
2	*Cephalopholis aitha*	Rusty rock cod	Kerapu
3	*Cephalopholis argus*	Peacock rock cod	Kerapu Loreng
4	*Cephalopholis boenak*	Dusky-banded cod	Kerapu
5	*Cephalopholis cyanostigma*	Blue-spotted rock cod	Kerapu
6	*Cephalopholis leopardus*	Leopard rock cod	Kerapu
7	*Cephalopholis miniata*	Coral rock cod	Kerapu Tungsing
8	*Cephalopholis nigripinnis*	Black-finange rock cod	Kerapu
9	*Cephalopholis sexmaculata*	Saddled rock cod	Kerapu Sunu
10	*Cephalopholis spiloparaea*	Orange rock cod	Kerapu
11	*Cephalopholis sonnerati*	Tomato rock cod	Kerapu Sunu
12	*Cephalopholis urodeta*	Flag-tail rock cod	Kerapu
13	*Cromileptes altivelis*	Barramundi cod	Kerapu Tikus
14	*Epinephelus bontoides*	Dusky rock cod	Kerapu
15	*Epinephelus coioides*	Brown-spotted grouper	Kerapu Muara
16	*Epinephelus corallicola*	Coral rock cod	Kerapu Loreng
17	*Epinephelus cyanopodus*	Purple rock cod	Kerapu
18	*Epinephelus erythrourus*	Cloudy rock cod	Kerapu
19	*Epinephelus fuscoguttatus*	Flower cod	Kerapu Macan
20	*Epinephelus lanceolatus*	Giant grouper	Kerapu Kertang
21	*Ephinephelus macrospilos*	Snubnose rock cod	Keapu loreng
22	*Ephinephelus maculatus*	Marbled rock cod	Kerapu Loreng
23	*Epinephelus melanostigma*	Black-spotted grouper	Kerapu
24	*Epinephelus merra*	Honeycomb rock cod	Kerapu Loreng
25	*Epinephelus ongus*	White-speckled rock cod	Kerapu Hitam
26	*Epinephelus quoyanus*	Long-finned rock cod	Kerapu Loresng
27	*Epinephelus tukula*	Potato cod	Kerapu
28	*Plectropomus areolatus*	Square-tail coral trout	Kerapu Sunu
29	*Plectropomus laevis*	Footballer cod	Kerapu Sunu
30	*Plectropomus leopardus*	Leopard coral trout	Kerapu Tungsing
31	*Plectropomus maculatus*	Spotted coral trout	Kerapu Lodi
32	*Plectropomus oligacanthus*	Vermicular trout	Kerapu Sunu
33	*Plectropomus pessuliferus*	Violet coral trout	Kerapu Sunu
34	*Variola albimarginata*	Lyre-tail cod	Kerapu
35	*Variola louti*	Common Lyre-tail cod	Kerapu Lodi

Serranidae family is one of the reef fishes group which has high number and important species in coral reef. According to Allen and Adrim (2003) [13], there were 102 species of Serranidae in Indonesia waters. Meanwhile, [9] found 55 species of grouper inhabit coral reef of Indonesia. Based on that statement, it can be concluded that 30.4 - 59.6% of grouper in Indonesia waters can be found in coral reef of Kotania Bay.

Based on fishing sites in Kotania Bay, Marsegu island had the highest species richness of groupers (20 species) compared to Buntal island to Burung island (17 species) and Osi island (16 species). The higher species richness of grouper in Marsegu island is supported by wider area and better condition of coral reef which can be categorized as good to excellent that make this island as ideal habitat for reef fishes. According to Nybakken (2001) [14], high diversity of reef fishes in coral reef is caused by its variety of habitat which consists of coral with many hollow and crevices, sand and different zones.

3.2. Spatial Distribution of Groupers Fishing Ground

There were 36 sites for fishing ground of grouper identified during the research in Kotania Bay (Figure 2). The bottom substrate of those sites are dominated by coral reef, so distribution of grouper depend on distribution of coral reef as their habitat.

Spatial distribution map of fishing ground for grouper gives two important information about the utilization of grouper resource in Kotania Bay, i.e. distribution of fishing gear and distribution of species. It was identified through observation in fishing operation and participative mapping that hand line was used in most of the fishing ground. On the contrary, bottom long line, spear gun and harpoon were only used in the fishing ground close to the villages and those small islands in Kotania Bay.

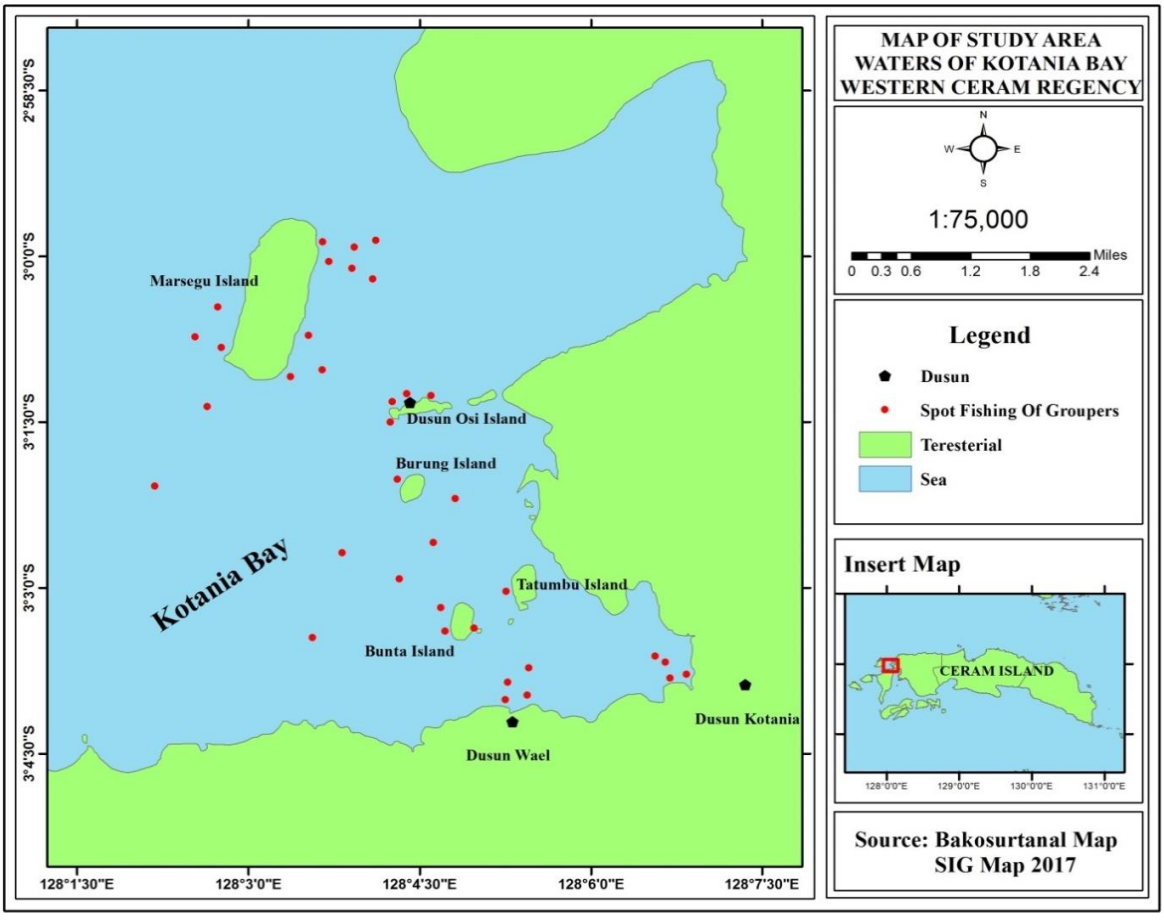

Figure 2. Map showing spatial distribution of gouper fishes fishing gound at Kotania Bay

3.3. Fishing Gears of Grouper Fishes

There were seven fishing gears used by fishers in Kotania Bay to catch grouper namely bottom long line (BLL), hand line (HL), bottom trolling (BT), trap net (TN), bottom gill net (BGN), spear gun (SG) and harpoon (H). Grouper caught by those fishing gears varied in term of number of species (Figure 3) and a number of individual (Figure 4).

It can be seen in Figure 3 that bottom long line (BLL) caught the highest species of groupers, followed by hand line (HL), whilst spear gun (SG) and harpoon (H) caught the least species of groupers. On average, bottom long line also caught more individual of grouper, followed by hand line, while trap net and harpoon-caught less individual (Figure 4). The number of species caught by pots is moderately high, but the average number of individual caught in each fishing operation is low.

The bottom long line has great capacity to catch more groupers because each unit of this fishing gear has about 100 hooks and it can be operated in wider area of coral reef. Hand line is a traditional fishing gear and can be considered as friendly environmentally fishing gear. However, its capacity to catch grouper is quite high. Trap net is also a traditional fishing gear but it is considered as unfriendly environmentally fishing gear because its operation often damages coral reef.

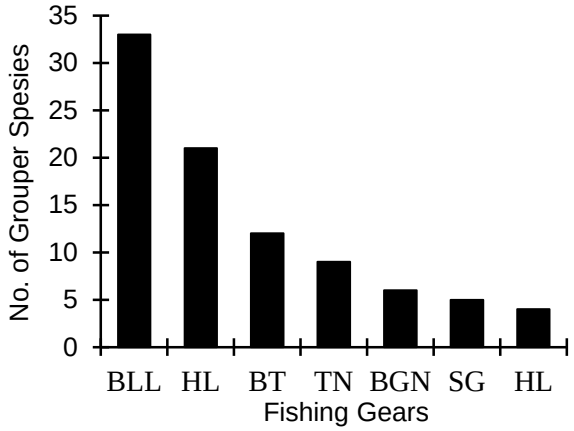

Figure 3. Number of grouper species for each fishing gear

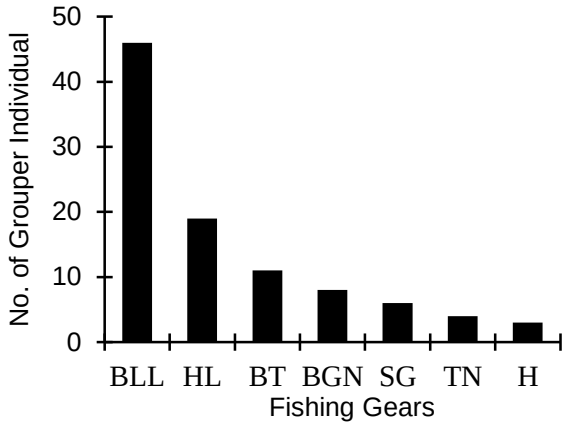

Figure 4. Number of grouper individual for each fishing gear

3.4. Tendency of Decreasing Number of Species and individual of Grouper

Results of the survey and FGD with fishers in Kotania Bay showed that the species number of groupers have decreased (Figure 5). In 2000's, fishers could catch as many as 47 species of groupers in this area which consisted of 25 species of *Ephinephelus*, 12 species of *Cephalopholis*, six species of *Plectropomus*, two species of Variola and one species for both *Cromileptes* and *Anyperodon.* Nowadays, the number of species for *Ephinephelus* and *Cephalopholis* genera in Kotania Bay are 14 and 11 species, respectively. So, during the last 17 years 12 species of groupers are extinct in this area i.e. 11 species of *Ephinephelus* and one species of *Cephalopholis*. Based on FGD with fishers, it was revealed that disappearance of some groupers especially genus of *Ephinephelus* is caused by degradation of coral reef due to fishing pressure and the use of destructive fishing method such as explosive and cyanide during the year 2000 to 2015.

Based on checklist of Indonesian reef fishes and their distribution in Indo-Australian archipelago [12], it is predicted that 11 species of groupers namely *Cephalopholis polleni, Epinephelus areolatus, E. bleekeri, E. bilobatus, E. caeruleopuctatus, E. fasciatus, E. hexagonatus, E. malabaricus, E. polyphekadion, E. tauvina, E. undolosus, E. sexfaciatus* and *Plectropomus pessuliferus* have disappeared from Kotania Bay. Meanwhile, groupers species such as *Cromileptes altivelis*,

Epinephelus fuscoguttatus, E. lanceolatus, Plectropomus areolatus and *P. laevis* found in Kotania Bay are also considered as vulnerable grouper species by IUCN [15].

It was also revealed in the survey and FGD with fishers that declining of species number is followed by decreasing number of individual for six genera of groupers caught from the year 2000 to 2017 in Kotania Bay (Figure 6). Growing number of fishers as well fishing gears, increasing demand and higher price of groupers caused increasing fishing frequency or fishing intensity. For example, fishing intensity for grouper especially for Barramundi Cod (*Cromileptes altivelis*) in Kotania Bay is high because of its high price which is up to IDR 650,000/kg.

According to [16] and [17], decreasing number of species, as well as a number of fish caught by fishers, might be due to overfishing and degradation of habitat. It seems that decreasing number of species and individual of groupers in Kotania Bay is caused by overfishing and degradation of coral reef. Declining number of species and number of individual caused by overfishing could be overcome through management responses directed towards restricting catch [16] or reducing fishing effort (e.g. imposition of catch quotas, minimum size regulations, limited entry, temporary area closures and closed fishing seasons). Meanwhile, degradation of coral reef due to fishing pressure can be done through restoration or rehabilitation and protection of coral reef habitat [16] and [15]. Both approaches are important effort related to grouper fisheries management in Kotania Bay.

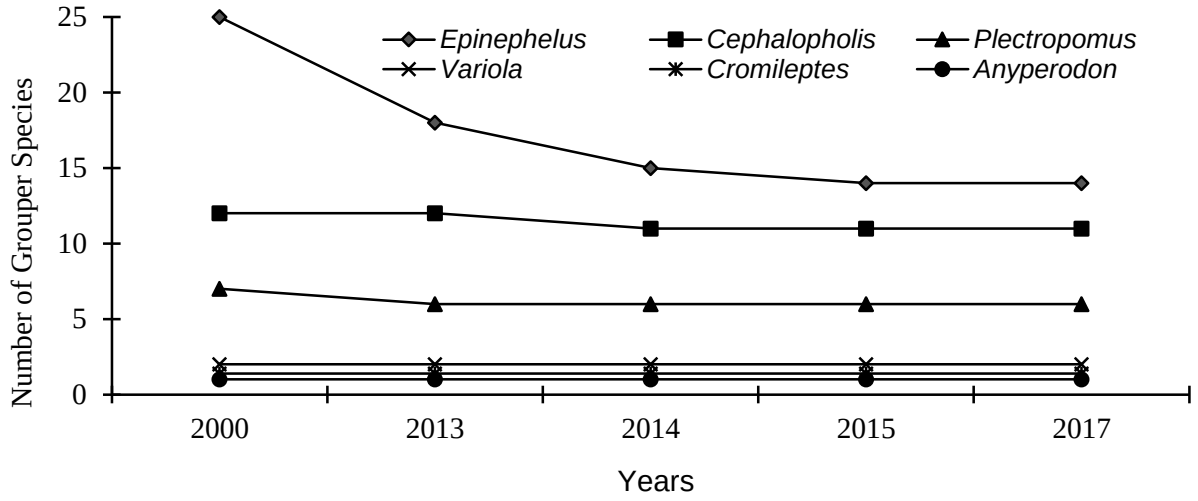

Figure 5. The species number of six grouper genera caught from year 2000 to 2017

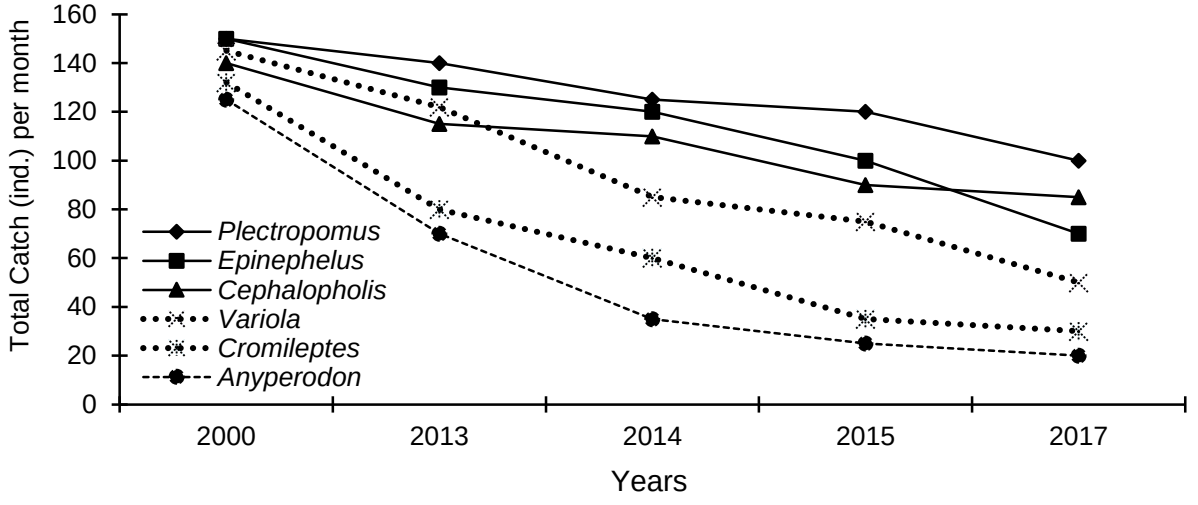

Figure 6. Number of individuals caught per month of six grouper genera from year 2000 to 2017

3.5. Progress in grouper fishery

Local fisher of Kotania Bay has exploit grouper as a source for self-consumption and economy purposes for a long time. Fishing practices of local fisher in Kotania Bay up to present time is considered as to be traditional fisheries, using simple fishing gears and technique.

Progress of grouper fisheries in term of gear type used and its number as well as price over period can be seen in Table 2. There is progress in this fisheries shown by steady increase of gear number, fisher and the price over time. In specific, trap net, spear gun and harpoon tend to decrease whilst bottom long line and hand line tend to increase and at the same time some fishers have use bottom trolling and bottom gill net as well.

Decrease in trap net may result from fisher understanding in the negative effect of this gear towards sustainability of coral reefs and its maintenance cost, whilst increase in hand line may cause by simple in operationalization, relatively easy in obtaining the material, cheap and easy to repair, ecological friendly as well as its productivity.

Destructive fishing (bomb and cyanide) have been used by some local fisher of Kotania Bay for quite some time. This type of fishing activity will certainly damage the coral reefs, kill finfish, shellfish and other organism associate with coral ecosystem [18]. Most of destructive fishing attributable to limited knowledge on sustainable fishery and less control from related fisheries management agency.

Table 2. Progress of grouper fisheries at Kotania Bay

Year Period	Type of Fishing Gears	Number of Fishing Gears	Number of Fishers	Price (IDR/kg)	Remarks
1990's	Hand Line	35 units	20 persons	5000	Increasing market demand Prices depend on species and size of groupers
	Bottom Long Line	3 units	3 persons		
	Trap Net	30 units	10 persons		
	Harpoon	10 units	10 persons		
	Spear Gun	8 units	8 persons		
	Bomb and cyanide	★	★		
2000's	Hand Line	40 units	30 persons	50000 – 350000	
	Bottom Long Line	5 units	5 persons		
	Trap Net	30 units	10 persons		
	Harpoon	7 units	7 persons		
	Spear Gun	6 units	6 persons		
	Bomb and cyanide	★	★		
2017	Hand Line	45 units	35 persons	100000 – 650000	
	Bottom Long Line	15 units	10 persons		
	Bottom Trolling	11 units	11 persons		
	Bottom Gill Net	12 units	12 persons		
	Trap Net	20 units	8 persons		
	Harpoon	4 units	4 persons		
	Spear Gun	2 units	2 persons		
	Bomb and cyanide	-	-		

Note: ★ unknown quantity - unused (Source: Respondents 2017)

3.6. Grouper fishing Calendar

Information on grouper fishing calendar obtained through focus group discussion and participatory mapping is shown in Table 3. Six fishing gears *i.e.* bottom bill net, bottom trolling, trap net, harpoon and spear gun can be operated through all seasons (West and East monsoon) even on rough weather. Meanwhile bottom long line can be operated between June to October (East monsoon) when weather is calm.

Table 3. Fishing season calendar of grouper at Kotania Bay waters

Monsoon and Fishing Gears	MONTH												Remarks
	J	F	M	A	M	J	J	A	S	O	N	D	
Season													
West Monsoon	*	*									*	*	Wavy waters
Transition season I			*	*									Transition season
East Monsoon					*	*	*	*					Waters quite calm
Transition season II									*	*			Transition season
Fishing Gears													
Hand Line	*	*	*	*	*	*	*	*	*	*	*	*	Every month Operation
Bottom Long Line						*	*	*	*	*			Operated when sea calm
Bottom Gill Net	*	*	*	*	*	*	*	*	*	*	*	*	Every month Operation
Bottom Trolling	*	*	*	*	*	*	*	*	*	*	*	*	Every month Operation
Tram Net	*	*	*	*	*	*	*	*	*	*	*	*	Every month Operation
Spear Gun	*	*	*	*	*	*	*	*	*	*	*	*	Every month Operation
Harpoon	*	*	*	*	*	*	*	*	*	*	*	*	Every month Operation

3.7. Grouper fisheries management strategy

Utilization and management of coastal waters by local fisher of Kotania Bay are not following sustainable fisheries management. This in turn will affect sustainability of grouper fisheries and coral reefs as habitat for this fish. Therefore there is a need to establish management plan and strategy in order to sustain both the fish and its habitat. Some recommendations are conservation and rehabilitation of groupers habitats, groupers resource utilization, groupers resource governance, restocking and culture of grouper fishes, as well as awareness and empowerment of fishermen.

4. Conclusions

There are 35 species of groupers which belonging to six genera namely *Epinephelus, Cephalopholis, Cromileptes, Plectropomus, Anyperodon* and *Variola* found during the study in Kotania Bay. Those species are exploited by artisanal fishers using traditional fishing gears such as hand line, bottom trolling, trap net, spear gun, harpoon, bottom long line and bottom gill net at 36 fishing spots. Almost all fishing gears can be operated year round, while bottom long line can only be operated during east monsoon. The number of species as well as the number of individual of groupers caught in Kotania Bay have declined due to overfishing and degradation of coral reef. Approaches that could be proposed to solve those problems are restriction catch as well as fishing gear and rehabilitation as well as protection of coral reef as an important habitat for groupers. There is progress in grouper fisheries shown by steady increase in fishing gear number, fisher and the grouper price over time. Some alternatives management strategies could be recommended to maintain species potency performance and grouper fisheries sustainability are conservation and rehabilitation of groupers habitats, groupers resource utilization control, groupers resource governance, restocking and culture of grouper fishes, as well as awareness and empowerment of the fishermen in Kotania Bay.

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