Management of demersal fish of Kotania Bay, Western Part of Seram, Maluku Province, Indonesia

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Abstract. Research to study demersal fish in Kotania Bay was conducted from June 2017 to August 2018. The results showed that demersal fish species fished in Kotania Bay consisted of 99 species from 6 families namely Serranidae, Lutjanidae, Scaridae, Lethrinidae, Mullidae and Labridae. The most abundant species groups were species of family Serranidae and Lutjanidae (35 and 25 numbers of species respectively). Demersal fish species are mainly used for human consumption and the caught tend to have high value, therefore, fishers in Kotania Bay exploited the demersal fish intensively. Several important species of family Serranidae and family Lutjanidae are the most abundant fish species in the caught, but some of demersal fish in Kotania Bay are now overexploited, this trend has appeared since the year 2000’s. Low fish catch and income of most fishers along coast of Kotania Bay and in addition to their reliance on fishing as a livelihood, has contributed to continued overexploitation. Fishing activities of demersal fish in Kotania Bay depend on monsoon, and the high catch of fish was in January, February, and March (4,560, 4,200 and 3840 kg respectively). Regarding to the overfished of demersal fish in Kotania Bay, therefore, are recommended some forms and regulations of management for demersal fisheries recovery and sustainability, such as restrictions fishing gears, collaboration stakeholders between levels of management, control of demersal fish utilization, alternative livelihood for fishers, protection habitat of fish through conservation and rehabilitation program, and encouraging co-management.

1. Introduction
Kotania Bay, Western Seram, Maluku Province, Indonesia is a productive waters dominated by coral reef, seagrass and mangrove ecosystems. Some locations in the Kotania Bay waters are indicated as habitat for economically important fish, including demersal fish spawning. There are six locations on the front of the bay which are dominated by coral reefs and economical fish found in these locations are demersal fish from the family of Serranidae, Lutjanidae, Lethrinidae, Mullidae and Scaridae. While the five locations on the inside of the bay are also a habitat for fish that are ready to spawn. In the edge zone found high coral (knobs) where fishes from the adult family of Serranidae clustered including a group of fish ready to spawn [1, 2].

Since demersal fish species are mainly used for human consumption and the caught tend to have high value, therefore, fishers in Kotania Bay exploited the demersal fish intensively. The high value of fish and the large market demand as well as the people living on the coast of the Kotania Bay tend to depend on the livelihoods as fishermen for generations so that the catch tends to decrease from year to year, both in size and the number of catches. Fishermen communities in the bay of Kotania waters use various types of fishing gear to catch demersal fish, such as bottom trolling line, bottom long-line, trap
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net, bottom gill nets, fixed guiding barrier and lifting net, but sometimes people still use bombs and
cyanides to get catches easily. The utilization of fisheries resources in a way that is not responsible,
and the absence of rules that can be used to protect fish resources, can reduce the population of larvae,
juveniles and adult fish themselves. The high pressure on demersal fisheries resources can reduce the
fish population [3]. Therefore this research was conducted to find a management formula by analyzing
the socio-economic conditions of the community, habitat, catch, the species and amount of fish caught,
fishing gears used, which is expected to be used to develop management strategies.

2. Methodology
This research was carried out in Kotania Bay, western Seram, Indonesia (Figure 1) from June 2017 to
August 2018. Hydrological parameters data such as temperature was measured using CTD, Salinity
using Refractometer, while the acidity level (pH) was measured using a pH meter, water brightness
was measured using Secchi disc, while dissolved oxygen was measured using DO Meter. Fish larvae
were collected using larval net, which towed horizontally. Data of Seagrass and mangrove ecosystems
were obtained through primary and secondary data. Data on the socio-economic conditions of the
people in the Kotania Bay coastal area, habitat, catches, and types of fish caught were carried out
through the Focus Group Discussion with fishermen from villages of Osi and Wael, including public
opinion on the condition of demersal fisheries in the waters of Kotania Bay. Likewise, the data is
complemented by using interviews and questionnaires. Secondary data is obtained through literature
studies and from relevant agencies in the western Seram Regency.

Further, the types of demersal fish caught were identified according to [4], [5], [6], [7] and [8].
Demersal fish management strategies are formulated taking into account habitat, socio-economic
conditions, catches, species and amount of fish caught, fishing equipment used and relevant fisheries
regulations.

Figure 1. Map of sampling sites
2.1. Habitat of Fish
The Focus Group Discussion (FGD) approach by using the PRA Method adopted from [9], and the Participatory Mapping technique [10] are used to capture various data and information from groups of fishermen in Wael and Osi Island villages, e.g. habitat of mature fish that are ready to spawn, habitat for fish, fishing areas, species richness and abundance of individual fish caught. Field checks on data and information from FGD and Participatory Mapping were carried out with a rapid analysis approach through field observations. Data and information on the potential (population) of adult economic fishes is obtained through the Underwater Visual Census (UVC) method proposed by [11] and were taken from 11 sampling sites.

Estimated density and potential (potency and biomass) of economical adult fish use a model from [11] and [12]. Fluctuations in species richness and economic potential (population) of fish between sampling sites and habitat were tabulated and presented in tables and discussed. Based on field checks and observations of adult fish which are ready to spawn and the habitat are mapped as habitat distribution map on the bay of Kotania.

2.2. Socio-Economic of Fishermen
Participatory Rural Approach (PRA) is an approach used to apply participatory decision-making techniques in resource management [13, 14]. The location (habitat) of adult fish, catching areas is determined through PRA activities and the "Community Mapping" approach. Socio-economic survey of the community was taken by purposive sampling. Data collection on respondents was conducted by interview (FGD / Focus Group Discussion).

3. Results and Discussion

3.1. Profile of the Kotania Bay Waters
Determination of the conservation area of the Marine Nature Park (TWAL) of Marsegu Island and surrounding waters is set at 11,000 ha according to SK. Minister of Forestry and Plantation R.I. Number 114 / Kpts-II / 1999 in [15] Kotania Bay area is divided into five zones, namely core zones, utilization zones, protection zones, traditional use zones, and rehabilitation zones, especially mangrove ecosystems [15]. While BKSDA Maluku, mapped the Marsegu Island Natural Tourism Park and the surrounding waters (Kotania Bay) with a system block, namely: Protection Blocks, Rehabilitation Blocks, Traditional and limited Utilization Block.

Problems and type of threat of Kotania Bay as marine and fisheries-related conservation and sustainability of marine resources as a major problem in the management and development of water conservation are (1) the use of excess biological resources, (2) the use of techniques and fishing gear that damages the environment, (3) changes and physical degradation of habitats, (4) the conversion of protected areas be designated other development, and (5) global climate change and natural disasters. Communities in coastal area of Kotania Bay utilize coral reefs and mangroves for the benefit of building houses and other interests, so the extent of coral reefs and mangroves decreases in quality.

3.2. Ecological Criteria
3.2.1. Biodiversity. Mangrove species diversity index values ranged between $H = 1.31$-$1.78$, then the status of mangrove species diversity is classified as medium ($H > 1$-$3$), with a score of 2 and this value is in the appropriate class. The mangrove species diversity index throughout Kotania Bay is $H = 1.61$, so the status of mangrove species diversity is classified as moderate ($H > 1$-$3$), with a score of 2 and mangrove ecosystems is in the class suitable for conservation.

Seagrass Species Diversity index values ranged between $H = 1.21$-$1.92$, so that it is included in the Medium Status category ($H > 1$-$3$), with a score of 2 and is in the corresponding class. Seagrass Species Diversity Index for Kotania Bay is $H = 1.38$, so the diversity status of Seagrass Species is in the Medium category ($H > 1$-$3$), Score 2 and is in the class Suitable for conservation.
The species diversity status of reefs in the Kotania Bay is high (H> 3), which is H’ = 3.12-3.54, this value have a Score of 3 and is in the Very Suitable class, while the coral reefs species diversity status in the three reef locations is in the Medium category (H> 1-3), that is H’ = 1.96-2.76, with a score of 2 and is in the appropriate class. The coral species diversity values index for the entire of Kotania Bay is H’ = 3.26, this value is in the score High Status (H> 3), the score 3 and is in class Very Suitable for conservation.

In general, the biodiversity of mangrove ecosystems, seagrass beds and coral reefs in Kotania Bay is H’ = 2.31. Thus, the status of the biodiversity of the three tropical aquatic ecosystems in Kotania bay region is categorized as Moderate (H’> 1-3), with a score of 2 and is in the class suitable for conservation.

3.2.2. Ecosystem conditions (status). The condition of the seven mangrove locations with the value of percent coverage ranged between 79 - 91% and was in Very Good condition (PC> 75%), so that the score is 3. A mangrove location with percentage of coverage ranged between 50% - ≤75%, and was in Good condition, with a score of 2. Overall, the percentage coverage of mangrove reached the value of 81.6%, and is in Very Good condition (PC> 75%), with score 3 and the value classified as Very Suitable for conservation.

Six locations of seagrass beds in Kotania Bay waters have a percent coverage value ranging from 75.42-94.25%. It can be said that seagrass beds are in a healthy condition (PC ≥ 60%), so that the score is 3 and classified as very suitable for conservation. Condition of four coral reef locations in the Kotania Bay have a percentage coverage > 75% (Very Good), with a score of 3. A total of six coral reef locations with percent coverage ranged between 50% - ≤75% (Good condition). The score is 3 and two other locations have percent coverage <50% (Moderately Damaged), the score is 1. In general the percentage coverage of coral reached a value of 58.1%. This value shows that the coral reefs in the Kotania Bay was in good condition (50% - ≤ 75%), with a score of 2. However, some of reef locations was in the upper limit of reef conditions or was in Medium Damaged category.

Percent coverage of mangroves was 82.8%, seagrasses was 61.85% and corals were only reached a value of 58.2%. In general, the percent coverage of the three major ecosystems of tropical waters in Kotania Bay was 67.5%. Thus, the value showed that the three main ecosystems was > 50 - <75%. This value reflect that the three ecosystems in Kotania Bay surrounding waters is classified as Medium, with a score of 2 and it can be defined as appropriate area for conservation.

3.2.3. Naturalness. In accordance with the existing conditions of the three major tropical water ecosystems and approaches in determining the naturalness of ecosystems/habitats, the nature of the three main ecosystems of tropical waters in Kotania Bay are as follows:

- Estimated mangrove areas that have been damaged due to maximum utilization and natural damage are around 90 ha, while the total area of mangrove ecosystem in Kotania Bay reaches 1020.26 ha. Thus, the natural value of (Or) mangrove ecosystem is 91%, and its status included in natural criteria (Or> 75%), with a score of 3.
- Estimated seagrass ecosystems damaged by anthropogenic and natural activities in Kotania Bay, reach 5 ha out of 55.53 ha. Thus the natural value of the seagrass ecosystem is 91%, the status is classified as natural (Or> 75%), with a score of 3.
- Based on the results of the analysis of image data and field reviews, coral reef ecosystems that have been damaged due to utilization pressure and natural factors can be estimated around 80 ha, while the area of the coral reef ecosystem is 735.98 ha. Thus, the natural value of coral reef ecosystem in Kotania Bay waters is 89.13%, the status is included in a natural criteria (Or> 75%), with a score of 3.
- The value of the main ecosystem in Kotania Bay is 90.38%, and is classified as natural, with natural values (Or)> 75%, and a score of 3.
3.2.4. Ecological linkages. The ecological linkages analyzed in the study are based on the relationships between ecosystems in Kotania Bay, and are based on the parameters of fish. The parameter of fish size between the main ecosystems shows the level of association of fish groups in each ecosystem. Theoretically and on the ground facts, this relationship occurs due to the purpose of fish in the main ecosystem to find food, spawn and take refuge.

The calculation of this parameter gives an illustration that according to the association value of fish to each ecosystem (Vea), it tends to be different. The results of identification of the total species of fish (364 species) [1] found in each major ecosystem were found in the species of reef fish, seagrass and mangrove fish that were carried out in each ecosystem, especially due to the effects of tides (Table 1).

Table 1. Ecological linkages according to fish group associations in the main ecosystem of Kotania Bay

| Fish Group  | Number of Species | Fish Association for ecosystems |
|-------------|-------------------|---------------------------------|
|             | Coral Reef Vea<sub>cr</sub> Seagrass bed Vea<sub>sb</sub> Mangrove Vea<sub>m</sub> Vel |
| Coral fish  | 196               | 196 1 | 24 1 | 36 1 | 3 |
| Seagrass fish | 53               | 26 1 | 53 1 | 30 1 | 3 |
| Mangrove fish | 63               | 15 1 | 27 1 | 63 1 | 3 |
| Total       | 312               | 237 3 | 109 3 | 129 3 | 9 |
| Percentage (%) | 76.10           | 33.33 | 34.94 | 33.33 | 41.35 | 33.33 | 100 |

Note: Vea (Value of Ecosystem Association); Vel (Value of Ecological Linkages)
<sub>cr</sub> (coral reef); <sub>sb</sub> (seagrass bed); <sub>m</sub> (mangrove)

These results illustrate the distribution of a value of 1, as a representation of the presence of reef fish that have a major habitat on coral reefs, seagrass fish that have a major habitat in seagrass beds, and mangrove fish that have a primary habitat in mangroves. The ecological linkage value (Vel) shown by nine illustrates the level of ecological linkages in Kotania Bay based on the level of association of fish groups in each ecosystem by 100%. Thus, the status is in the assessment criteria ≥75-100%, where the ecosystem component is Ecologically Related so that the assessment is in Score 3.

3.2.5. Representation. Representative parameters were assessed by considering the ecosystem in the Kotania Bay region. There are six types of ecosystems (habitat), namely mangroves, seagrass beds, coral reefs, gosong, lagoon and Saaru. On the contrary, in the Kotania Bay region there are 8 types of ecosystems, because in addition to the six ecosystems, there is a terrestrial ecosystem of Seram Island and the ecosystem of Kotania Bay. Thus, the representativeness (Pr) of the regional ecosystem to the Kotania Bay region is 75%, the Status is represented (Pr Pr 75%), with a score of 3.

3.2.6. Uniqueness. Regarding the uniqueness, the front part of Kotania Bay contains the Pasi ecosystem (catching area on Sink Saaru). Sink Saaru is a habitat of red snapper (<i>Pristipomoides</i> spp, <i>Aphareus</i>, <i>Aprion</i>) and yellow tail fish or Lalosi Papang (<i>Caesio cuning</i>), Grouper, and Lencam. In addition to these habitats, Kotania Bay has a number of 11 small and medium coastal lagoons, and four very small islands. This uniqueness is only found in several regions in Indonesia, especially in Eastern Indonesia (including Maluku Province), so that the status is included in quite unique, which is found in several regions in the same biogeographic region, with a score of 2.
3.2.7. Productivity. The potential of mangrove fish ranges from 22.63 to 48.56 kg / ha (an average of 31.23 kg / ha). Based on criteria for assessing mangrove fish productivity, productivity (kg / ha biomass) of mangrove fish and their average value are in high productivity status (> 20 kg / ha), with a score of 3 and productivity status of mangrove fish included in the Very Suitable class.

The potential of seagrass fish ranged from 16.81 to 20.36 kg / ha (mean 18.87 kg / ha). In accordance with the criteria for evaluating the productivity of seagrass fish, the productivity of seagrass fish and the average value of seagrass fish are in high status (> 10 kg / ha), with a score of 3.

The potential of reef fish ranges from 600 - 8030 kg / ha (an average of 3730 kg / ha). Based on the determination of the criteria for fish productivity on coral reefs, the productivity of reef fish between reef stations and the average in the Kotania Bay is at a high productivity status (> 1200 kg / ha), with a score of 3 and very suitable.

3.2.8. Migratory area. The front water area of Kotania Bay is a migration area for Decaptrus spp, Euthynus, Katsuwonus pelamis, and Sting ray fish. In addition, the bay waters have become migration areas of marine mammals, such as whales and dolphins in the front of Kotania Bay. Thus, the status of the waters of Kotania Bay is as Migratory Region of many types of fishes and marine mammals (> 1), with a score of 3.

3.2.9. Typical / rare / unique / endemic and protected fish habitat. Regarding the habitat of endangered and protected fish, seagrass beds and surrounding waters serve as a habitat for protected dugongs and turtles, so their status is one or two types of typical / rare / unique / endemic fish (score 2). In addition, seagrass ecosystems, coral reefs and surrounding waters, and lagoons become habitats for protected biota groups, namely Dugong, Napoleon fish, Manta Rays, Sea Turtles, and Clams, which are protected (> 2), with a score of 3.

3.2.10. Fish spawning area. According to the results of participatory mapping, there are no Spawning Aggregation Ground (SPAGs) areas in the waters of Kotania Bay, but based on the results of ichthyoplankton analysis (density of eggs and fish larvae), the coral reef and lagoon ecosystems in Kotania Bay become fish spawning areas. This area is categorized as status of fish spawning areas, because in two ecosystems as spawning areas, with a score of 2.

3.2.11. Nursery Ground. The existence of seagrass, mangrove, coral reefs and lagoon ecosystems is a nursery ground area for various species of fish. Kotania Bay waters have mangrove, seagrass, coral reefs and lagoon ecosystems as fish nurturing areas, including larvae and juvenile Siganids (Siganus sp) in seagrass, larva and juvenile of reef fish in seagrass beds and coral reefs, and fish larvae in ecosystems lagoon. Therefore, the status is as nursery areas, with a score of 3.

3.2.12. Profile of the community of Kotania Bay coastal area. Based on the Focus Group Discussion (FGD) with the Participatory Rural Approach (PRA) method conducted at the SBB Regency Fisheries Office, village of Taman jaya, Kotania, Eti and Piru, various data and information about the social, economic and cultural conditions of the community can be collected. It found that the management efforts that are environmentally friendly are hardly obeyed by the fishing community in Kotania Bay, so there are still many practices that use resources that are not environmentally friendly. The development of a large population in the coastal villages of Kotania Bay as well as the problem of decreasing income from fishing and cultivation efforts led to an increase in the social economic problems of the local community. This social issue, will be able to put considerable pressure on the environmental conditions and coastal fisheries resources. While the rate of environmental degradation in coastal areas has resulted in a decline in the quality and quantity of fisheries resources. These data relate to parameters of community support, potential conflicts of interest, potential threats to the ecosystem and resources of Kotania Bay, local wisdom, the importance of Teluk Kotania fisheries, recreational and tourism potential, aesthetics, and difficulty of reaching locations.
According to [14] the people of Teluk Kotania generally have a livelihood as fishermen carried out for generations (94.29%). Most fishermen from the village of Osi island (54.29%), then followed by the village of Wael (41.43%) and from other villages (4.28%). The education of fishermen on the coast of Teluk Kotania is mostly only at elementary level (92.86%). Fishing gear used by fishermen in Kotania Bay is bottom gill net, bottom trolling, bottom long line, trap net, fixed guiding barrier and lifting net. In addition to the problems of ecosystem degradation, conflicts over space use, because there are no documents on zoning plans that function to regulate the use of space. Efforts are implemented in order to restore the condition of fisheries resources, habitat and environmental conditions around the waters, as well as social conditions of communities around Kotania Bay. This research recommend the policy on the management of Kotania Bay through the Academic paper on the Zoning Plan (Rezonation) and the Management Plan for the Coastal and Small Islands of Kotania Bay. Beside that issues, fisheries management is the most important issue concerning on sustainable development of fisheries in Kotania Bay.

3.2.13. Habitat of Fish. Coastal waters are an important habitat for fish, because these waters provide food and are a place of refuge so that it becomes a suitable place for the growth and development of fish. The area along the coast of Kotania Bay in the West Seram, Maluku Province is a unique coastal area because three tropic important ecosystems coexist in an area, such as coral reefs, seagrasses and mangrove ecosystem, therefore, these areas have a high diversity of biota [16]. According to [14], the coral reef area of Kotania Bay covered an area of 1059,442 ha. Kotania Bay surrounding water has 67 coral species [17]. Fish resources on coral reefs are reef fish, both ornamental fish and consumption fish.

Mangrove forest ecosystems are reported to be expanding, because in 1972 the area covered 779 ha, in 1986 was 1,071 ha and in 1993 it covered the area of 1,171 ha. However, in the year of 1997-1998 was only cover the area of 1,146 ha [15]. [1] also found that three species of fish larvae including larvae of Serranidae were between area of seagrass and mangrove ecosystem. Recent study of seagrass beds in Kotania Bay [14] found that seagrass covered an area of 823,615 ha and have a high diversity and abundance of fish species. The abundance of fish in seagrass beds in Osi and Marsegu Island was collected for about 207 species [16]. [1] found that fish larvae from the Serranidae family are abundant in lagoons around seagrass beds. It is also mentioned by [18] that seagrass beds are also a habitat for larval of coral reef fish living due to food availability and nursery habitat.

Through Focus Group Discussions with fishermen groups of Wael and Osi Island villages whose livelihoods are 94.29% as fishermen and experienced in catching demersal fish in Kotania Bay, indicated that several locations in the bay as a habitat for spawning. In accordance with the information compiled from the Focus Group Discussion, it can be said that the condition of the habitat of demersal fish distributed at the six sampling sites, which are in the front of the Kotania Bay. Based on the results of focus group discussions and participatory mapping, it can be identified that out of 11 sampling sites, there were six sites in the bay are the habitat of spawning ground (Figure 2). The existence of adult fish spawning sites is closely related to habitat as a place to protect, seek food and perform their reproductive processes.

The results show that habitat at locations 1-6 (Figure 3) located on the front of Kotania Bay is dominated by coral reefs. These six locations have a high wealth of adult fish species and a large population (potential). Adult fish groups in these six locations are dominated by demersal fish as carnivorous fish with a large number of species such as the family Seranidae (grouper), Lutjanidae (snapper), Lethrinidae (lencam). In addition, planktivorous fish with large populations were found, such as the herbivorous fish groups of Scaridae family (parrot fish) found to be dominant in coral reef habitat in other five locations.

Through rapid observation and analysis, the condition of coral reefs from 1-6 sampling sites is in the medium, good and very good category. In the coral reef zone, high coral reefs (knobs) are found and surrounded by various species and groups of fish of adult size. According to the results of the focus group discussions, experienced fishermen said that fish were adults, including groupers to
spawning in coral reef areas, especially around the high coral reefs. The results of field checks proved that the six locations surrounded by coral reef and therefore, with these characteristics can be said as micro habitats for mature fish, including groupers that are ready to spawn.

3.2.14. Species diversity. There were about 99 species of demersal fish come from six family such as Serranidae, Lutjanidae, Scaridae, Lethrinidae, and Labridae. The most abundant species groups were species of family Serranidae and Lutjanidae (35 and 25 numbers of species respectively). Table 2 shows the species of demersal fish caught in the waters of the bay of Kotania, is belongs to family Serranidae. Most of them are from the genera of *Ephinephelus* and the least are from the genera of *Variola*, *Anyperodon* and others. However, in general it can be concluded that demersal fish species found in the waters of Kotania Bay are Serranidae 35 species, Lutjanidae as many as 25 species, Scaridae 15 species, Lethrinidae 12 species, Mullidae 8 species and Labridae as many as 4 species.

3.2.15. Habitat Distribution of Mature Demersal Fish. The results show that at stations 1-6 (Fig. 2) which at the front of the bay has a high demersal fish species richness and great potential. The adult fish group in these 6 stations was dominated by fish from the family of Serranidae, Lutjanidae and Lethrinidae. Fish from the family of Scaridae were also found to be dominant in all six stations. Through quick observation, the condition of coral reefs is in the medium, good and very good category. In the coral reefs, high coral reefs (knobs) are found inhabited by various species of adult fish with high economic value.
Based on the results of the focus group discussions with fishermen and the results of observations, it can be said that demersal fish spawning habitat is on coral reefs scattered on the front of the bay. In connection with this, to guarantee the existence, quality and sustainability of coral reef functions and their specific characteristics as spawning habitats, it is necessary to carry out fishing management on coral reefs. The description above indicates that 11 stations (Fig. 2) are spawning habitats. So that there is a need for recommendations for local governments and relevant stakeholders to determine the eleven stations as management zone of spawning grounds of demersal fish and its management plan.

Table 2. List of Demersal Fish 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 leoparadus*               | Leopard rock cod         | Kerapu       |
| 7  | *Cephalopholis miniata*                  | Coral rock cod           | Kerapu Tungsing|
| 8  | *Cephalopholis nigripinnis*              | Black-finance 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 eurythouraus*               | Cloudy rock cod          | Kerapu       |
| 19 | *Epinephelus fuscoguttatus*              | Flower cod               | Kerapu Macan |
| 20 | *Epinephelus lanceolatus*                | Giant grouper            | Kerapu Kertang|
| 21 | *Epinephelus macrospilos*                | Snubnose rock cod        | Kerapu Loreng|
| 22 | *Epinephelus 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 Loreng|
| 27 | *Epinephelus tukula*                     | Potato cod               | Kerapu       |
| 28 | *Plectropomus areolatus*                 | Square-tail coral trout  | Kerapu Sunu  |
| 29 | *Plectropomus laevis*                    | Footballer cod           | Kerapu Sunu  |
| 30 | *Plectropomus leopardis*                 | 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*                          | Lyre-tail cod            | Kerapu Lodi  |
| 36 | *Gnathodentex aurolineatus*              | Striped large-eye Bream  | Tambak pasir |
| 37 | *Lethrinus erythropterus*                | Longfin Emperor          | Lencam       |
| 38 | *Lethrinus harak*                        | Thumbprint Emperor       | Lencam       |
| 39 | *Lethrinus lentjan*                      | Purple-headed Emperor    | Lencam       |
| 40 | *Lethrinus microdon*                     | Smalltooth Emperor       | Lencam       |
| 41 | *Lethrinus nebulosus*                    | Spangled Emperor         | Lencam       |
| 42 | *Lethrinus obsoletus*                    | Orange-striped Emperor   | Lencam       |
| 43 | *Lethrinus olivaceus*                    | Lethrinid                | Lencam       |
| 44 | *Lethrinus rubrioperculus*               | Spotcheek Emperor        | Lencam       |
| 45 | *Lethrinus xanthochelus*                 | Yellowlip Emperor        | Lencam       |
| No. | Scientific Name                  | Common Name                        | Local Name      |
|-----|----------------------------------|------------------------------------|-----------------|
| 46  | *Lethrinus ornatus*              | Ornate Emperor                      | Lencam          |
| 47  | *Monotaxis grandoculis*          | Lethrinid                           | Ambangan        |
| 48  | *Aphareus rutilans*              | Small-toothed Jobfish               | Kurisi perak    |
| 49  | *Aprion virescens*               | Green Jobfish                       | Ikan agam       |
| 50  | *Etelis carbuclus*               | Ruby Snapper                        | Kakap merah     |
| 51  | *Lutjanus biggutatus*            | Two spot Banded Seaperch            | Kakap merah     |
| 52  | *Lutjanus bohar*                 | Red Bass                            | Kakap merah     |
| 53  | *Lutjanus carponotatus*          | Stripey Seaperch                    | Kakap merah     |
| 54  | *Lutjanus decussatus*            | Checkered Seaperch                  | Kakap merah     |
| 55  | *Lutjanus ehrenbergii*           | Black-Spot Snapper                  | Kakap           |
| 56  | *Lutjanus fulviflamma*           | Black-Spot Snapper                  | Ikan tanda      |
| 57  | *Lutjanus fulvus*                | Yellow-margined Seaperch            | Badur           |
| 58  | *Lutjanus gibbus*                | Paddietail                         | Janaha          |
| 59  | *Lutjanus kasmira*               | Indian Seaperch                     | Cawene          |
| 60  | *Lutjanus lemniscatus*           | Dark-Tailed Seaperch                | Kakap merah     |
| 61  | *Lutjanus malabaricus*           | Saddle-Tailed Seaperch              | Kakap           |
| 62  | *Lutjanus malabaricus*           | Saddle-Tailed Seaperch              | Kakap           |
| 63  | *Lutjanus monostigma*            | One spot Seaperch                   | Kelaluh         |
| 64  | *Lutjanus semicinctus*           | Black-Banded Seaperch               | Gorara          |
| 65  | *Lutjanus rufolineatus*          | Yellow-Lined Seaperch               | Badur           |
| 66  | *Lutjanus russelii*              | Moses Perch                         | Gorara          |
| 67  | *Lutjanus timorensis*            | Timor Seaperch                      | Kakap merah     |
| 68  | *Lutjanus vitta*                 | Striped Seaperch                    | Mala            |
| 69  | *Lutjanus sp*                    | Snapper                             | Kakap           |
| 70  | *Pinjalo pinjalo*                | Pinjalo                             | Pinjalo         |
| 71  | *Pristipomoides multidens*       | Gold-Banded Jobfish                 | Kakap merah     |
| 72  | *Cheilinus chlorourus*           | Yellow-Dotted Maori Wrasse          | Kakatua putih   |
| 73  | *Cheilinus fasciatus*            | Scarlet-Breasted Maori Wrasse       | Dea Dean        |
| 74  | *Cheilinus undulatus*            | Double-Headed Maori Wrasse          | Napoleon        |
| 75  | *Chaerodon anchorago*            | Anchor Tuskfish                     | Gigi anjing     |
| 76  | *Cetoscarus bicolor*             | Red-Speckled Parrotfish             | Kakatua         |
| 77  | *Leptoscarus vagiensis*          | Blue-Spotted Parrotfish             | Kleng           |
| 78  | *Chlorurus bleekeri*             | Bleeker’s Parrotfish                | Kakatua         |
| 79  | *Chlorurus sordidus*             | Green-Finned Parrotfish             | Kakatua         |
| 80  | *Chlorurus capistratoides*        | Parrotfish                          | Kakatua         |
| 81  | *Hyposcarus longiceps*           | Long-nosed Parrotfish               | Kakatua         |
| 82  | *Scarus dimidiatus*              | Saddled Parrotfish                  | Kakatua         |
| 83  | *Scarus forsteni*                | Whitespot Parrotfish                | Kakatua         |
| 84  | *Scarus ghobban*                 | Blue-Barred Parrotfish              | Kakatua         |
| 85  | *Scarus niger*                   | Swarthy Parrotfish                  | Kakatua         |
| 86  | *Scarus quoyi*                   | Quoy’s Parrotfish                   | Kakatua         |
| 87  | *Scarus rivulatus*               | Surf Parrotfish                     | Kakatua         |
| 88  | *Scarus rubriolaceus*            | Ember Parrotfish                    | Kakatua         |
| 89  | *Scarus spinus*                  | Greensnout Parrotfish               | Kakatua         |
| 90  | *Scarus schlegeri*               | Schlegel’s Parrotfish               | Kakatua         |
| 91  | *Mulloidichthys cyclostomus*     | Gold-saddled Goatfish               | Biji nangka     |
| 92  | *Mulloidichthys flavolineatus*   | Stripe Goatfishyellow               | Biji nangka     |
| 93  | *Mulloidichthys vanicolensis*    | Yellowfin Goatfish                  | Biji nangka     |
| 94  | *Parupeneus barbiceps*           | Dash-dot Goatfish                   | Biji nangka     |
| 95  | *Parupeneus bifasciatus*         | White-Shouldered whiptail           | Biji nangka     |
| 96  | *Parupeneus indicus*             | Indian Goatfish                     | Biji nangka     |
| 97  | *Parupeneus multifasciatus*      | Banded Goatfish                     | Biji nangka     |
| 98  | *Parupeneus trifasciatus*        | Mullids                             | Biji nangka     |
| 99  | *Parupeneus trifasciatus*        | Mullids                             | Biji nangka     |
3.2.16. Demersal Fish and the Fishing Gear Used. Based on community mapping with fishermen groups in Osi and Wael Villages, data on the fishing gear based on demersal fishing gear was obtained. The four fishing gears used to catch demersal fish are bottom long line, bottom gill nets, bottom trolling line, and fixed guiding barrier especially for grouper fish with high economic value of Rp. 350,000 - 570,000 / kg (live demersal fish) and Rp. 30,000 - Rp. 60,000 / kg (dead demersal fish).

The most demersal fish catches for 1 year are in January, February and March (4560, 4200 and 3840 kg respectively). The fewest were in August and September (2880 and 2360 kg respectively). Changes in numbers of fishing catches in each month occur because of the number of different fishing trips in month and the change of seasons. The change of seasons from transition season II to the east season resulted in very choppy conditions and fishermen nearly could not carry out fishing activities. Another reason demersal fish is difficult to catch because the distribution and the population is relatively small. One of protected demersal fish was caught by fishermen were Napoleon fish (*Cheilinus* spp). They caught Napoleon fish because of the high value of price and fishers did not know of any prohibition or explanation that napoleon fish was protected fish.

The utilization pattern for the caught of demersal fish is for benefit of their own consumption (75%) and for sale (25%). The sales process takes place locally or through fishermen collectors to be traded in Ambon or other areas.

![Figure 3](image)

**Figure 3.** Map of Demersal Fishing Grounds and Fishing Gears Used

The operating times of the four fishing gear are presented in Table 3. The data in Table 3 shows the Bottom Trolling fishing gear is operated throughout the year, while the Bottom long line and bottom gill net is not operated during the east season (June-September). This condition is due to the choppy waters during the east season period.

Through community mapping activities with fishermen groups in Wael and Osi Villages, the fishing data obtained as well as the fishing area in the Kotania Bay can be mapped in Figure 3. The
fishing track or area is mapped based on four (4) types of fishing gear, namely bottom trolling, Bottom Gill Nets and Bottom Long Line. The bottom long line catchment area is generally located in coral reef habitats, Bottom gill nets are generally operated in seagrass meadows, while Bottom trolling are generally operated on the habitat of fringing reefs and submerged coral reefs (Apron Reef) and the Fixed guiding barrier operated in coral habitats and mixed coral and seagrass beds.

Table 3. The operating time of fishing gears used by fishermen and their catches

| No | Fishing Gears       | Month | Catch            |
|----|---------------------|-------|-----------------|
| 1  | Bottom Long line    | 1 2 3 | v v v v         |
| 2  | Bottom Gill Net     | 1 2 3 | v v v v v       |
| 3  | Bottom Trolling     | 1 2 3 | v v v v v v v   |
| 4  | Fixed Guiding Barrier | 1 2 3 | v v v v v v v   |

3.2.17. The Management of Demersal Fish. A protected area must be guaranteed its existence from unlimited resource utilization. The basic principle for the purpose of protection is conservation, where conservation can be defined as the management of human use of Kotania Bay ecosystems to obtain sustainable benefits for the present generation while maintaining its potential for future generations' needs and ideals [20]; [21]. The prospect of collaborative management in Indonesia tends to be seen only by the many prominent roles of government in various businesses that are natural resource management such as oil and gas, forests, environment, including currently marine biological resources, because these natural resource management efforts are income for the central government. According to [22], there are three things that determine the variety of forms of collaborative management (co-management) and its hierarchy, namely: (1) the role of government and society in decision making, (2) form of management duties and functions should be managed jointly by the government and the community or distributed between the two parties, (3) the steps of management process including management cooperation has to be realized. Therefore, the management of demersal fish in Kotania Bay must be designed in accordance with the conditions of the region and the economic conditions of the community.

The desired policy direction in the sense of regional autonomy is that the cooperative co-management portion may be greater which places the community and government in the same or equal position. Therefore, [23] said that every activity from planning, implementation to monitoring and evaluation is carried out jointly by the parties. The principle of partnership is intended to ensure that the implementation of fisheries resources conservation is based on cooperation agreements between stakeholders related to the conservation.

Problems and forms of serious threats to the fisheries and marine sector related to the sustainability and sustainability of marine biological resources as a major problem in the management and development of marine conservation include: (1) over-utilization of biological resources, (2) the use of fishing techniques and equipment that damage the environment, (3) changes and physical degradation of habitat, (4) pollution, (5) introduction of foreign species, (6) conversion of protected areas into other development designations, and (7) global climate change and natural disasters [24]. Therefore, in planning demersal fish management in Kotania Bay, a form is needed that can overcome various restrictions on the use of fish resources, land conversion, habitat destruction and activate local-traditional customary institution.

4. Conclusion
A total of 11 locations in the Kotania Bay waters have specific habitat characteristics and are mapped as spawning habitats of mature economical fishes that are ready to spawn. Six spawning habitats from fish species of carnivorous, planktivorous and economically mature herbivores ready to spawn are
coral reefs scattered on the front of the bay. Seagrasses and mangroves in five locations scattered on the inside of the bay are spawning habitats of economically mature fish species of demersal fish.

Kotania Bay waters have 191 economical adult fish species from 68 genera and 23 families. Grouper (Serranidae family) and group of snapper fish (Lutjanidae family) with important economic value have a high number of species. Coral reef habitats scattered in front of the bay have a high number of economical adult fish species. Since long time, groupers have been targeted by fishermen in the Kotania Bay, and the intensity of their catches continues to increase, so that within the last 17 years around 11 species of groupers can be said to have been lost, and only 36 species are still found in the bay.

The wealth of adult economic fish species in 250 m², individual density (m²) and population size (potential) is high in coral reef habitats scattered in the front or outside of Kotania Bay Economical adult fish species with high potential in coral reef habitats are species of fish that live in groups and have large populations. Groupers as economical fish have high economic value in price, have a low individual density and population (potential) in 12 habitats (locations) in Kotania Bay. The main livelihoods of the people on the coast of Kotania Bay are fishermen. The number of fishermen with 6-20 years of business experience is high. Income of 69% of Wael Village fishermen are Rp. 50,000,000. Six types of traditional fishing gear are operated by fishermen in Kotania Bay to catch demersal fish and other economical fish can be seen in Figure 3, that reflect the area and type of fishing gears used in Kotania Bay.

It is recommended that priority matters be urgently carried out, with reference to the prevailing laws and regulations, such as:

• Fishing activities is only used at the location of the distribution of adult fish, and does not interfere with the location of the distribution of eggs, larvae and juvenile fish. This recommendation statement must be accompanied by supervision by the Relevant Agency or Agency in the Regional Government that has an autonomy related to this matter.

• Restrictions on catches (size and amount) or reduce effort (number of catches), closure of capture areas temporarily and even closure of fishing season for demersal fish

• Habitat of fish resources that are degraded due to fishing pressure, should be rehabilitated and protect or protection of habitat should be still in the category of Good and Very Good.

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