



Sustaining grouper populations: eafm-based evaluation in the marine ecosystem of Sabang, Aceh

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ABSTRACT

Sabang as the westernmost region of Indonesia and bordering the Indian Ocean and the Malacca Strait has fishery potential that must be maintained so that it is sustainable. Good management of grouper fish (*Epinephelus* sp.) resources is a solution so that fishery potential remains sustainable, one of which is the ecosystem approach. So far, many studies related to grouper management based on an ecosystem approach have been carried out in several regions in Indonesia, but none have focused on fisheries in Sabang. Therefore, this study aims to assess the status of grouper resource management, provide management recommendations and disseminate the results of the assessment of grouper resource management status in Sabang. This research was conducted from July to August 2022, located in Sabang, Aceh. Observation and direct interviews were conducted to collect the data and then analyzed by a multi-criteria analysis with composite index development. Based on the value of these indicators, it shows that the domain of grouper fish resources in Sabang caught using the hand line is good category with a green flag model and a composite value of 82. This means that the management of grouper fish resources in Sabang has not been running optimally. So, it is necessary to improve fisheries management in several aspects to support sustainable fisheries management.

Introduction

The Grouper is an important economic fish that can be found in Sabang City, where the coastal waters, especially Sabang Bay, are highly suitable for marine aquaculture including grouper cultivation, supporting both biodiversity and local livelihoods (Sutaman *et al.*, 2023). The number of groupers caught by the characteristics of the waters with coral reefs that are in accordance with the grouper's habitat. Grouper fish are the most caught fish besides Tuna, Coral and Tongkol (DKP, 2021). However, if it is not managed properly, it will increase the availability of fish stocks in Sabang City. In line with this, there is a need for fisheries management with an ecosystem approach. However, if it isn't managed properly, it will increase the availability of fish stocks

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Management with an ecosystem approach is an approach that seeks to balance diverse social goals, taking into account and uncertainty inherent in biotic, biotic, and human resources as components of ecosystems and their interactions and an integrated approach to fisheries within ecological boundaries that means managing fisheries not only based on stock availability, but also considering ecosystem health, stakeholder engagement, and institutional governance to ensure long-term sustainability (Pomeroy *et al.*, 2019; Purnama *et al.*, 2023). This approach has been tested in Indonesia, such as in Karimunjawa and Lake Batur, showing the need for adaptive management, participatory processes, and addressing economic and institutional

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gaps (Kirana *et al.*, 2016; Kaban *et al.*, 2024). Through the analysis of this EAFM indicator, it's hoped that it can provide an overview of the status and condition of fisheries in an area, such as grouper (*Epinephelus sp.*), by evaluating multiple dimensions like habitat quality, fishing gear selectivity, stakeholder involvement, and institutional governance. For example, EAFM assessments in Bontang and Sangihe Islands have shown that although some domains, such as the social or regulatory framework, may perform adequately, others like habitat protection or policy enforcement still face significant challenges (Nadiarti *et al.*, 2021; Dumas *et al.*, 2024). These insights help in identifying specific areas for improvement in sustainable fisheries management.

So far, the management of fish resources using EAFM indicators has been widely carried out (DKP, 2021; Edwarsyah, 2017; Miswar *et al.*, 2018; Miswar *et al.*, 2019; Nadiarti *et al.*, 2021). While no one has focused on grouper fisheries, especially in the City of Sabang, so with the help of this research, it can become a pilot project for the City of Sabang and an example for other districts in Aceh Province. This is especially relevant considering that Weh Island, located within Sabang, has high biodiversity and is an important site for reef fisheries targeting groupers, yet comprehensive management strategies based on the ecosystem approach remain limited (Yulianto *et al.*, 2013). By implementing an EAFM-based model, Sabang could set a precedent for other coastal areas in Aceh, especially given the region's documented grouper diversity and suitability for aquaculture development (Fadli *et al.*, 2022; Sutaman *et al.*, 2023).

Materials and Methods

Location and time of research

The focus of the research location is the PPI (Fish Landing Base) Pasiran in Sukakarya District, Sabang City. The time of research will be carried out in 1 year starting from January to December 2022.

Data analysis

Indicator research was CPUE (Catch Per Unit Effort) indicators, the fish length, proportion of juveniles caught, catch species composition, and range collapse, and ETP (Endangered, Threatened, and Protected) species (Mukminin *et al.*, 2022; Hilyana *et al.*, 2021; Ismal *et al.*, 2022; Pomeroy *et al.*, 2013; Yanti *et al.*, 2022).

Primary data were obtained through direct measurement of fish in the field, interviews, and

distributing questionnaires. Interviews were conducted with several parties such as fishermen, Panglima Laot, and crew members at PPI Pasiran in Sukakarya District, Sabang City. The number of fishermen based at PPI Pasiran is 589 people including 390 permanent fishermen and 199 part-time fishermen (DKP, 2021). The number of respondents selected was 59 people, which was obtained from 25% of the total respondents (Pinello *et al.*, 2017).

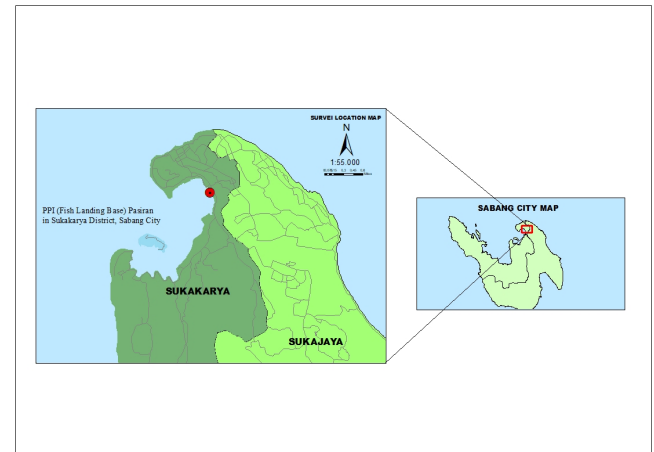


Figure 1. Maps of research location.

Grouper measurements in the field were carried out by measuring the total length and fork length. Analysis of the data used to assess indicators in the fish resource domain using the Multi-Criteria Analysis (MCA) approach using Likert scores (1, 2, and 3) to find the composite value.

Table 1. Limitations of Composite Values of Fish Resources Domains

Value	Flag model	Description
1 - 20		Bad
21 - 40		Not Good
41 - 60		Moderate
61 - 80		Good
81 - 100		Very good

This method aligns with the standardized assessment tools used in Indonesia's EAFM framework, which employs composite scoring systems to integrate biological, ecological, and governance factors for evaluating the sustainability of fisheries, including data-limited species like groupers (Ditya *et al.*, 2022; Dharmawan *et al.*, 2022). By combining field biometric data and perception-based scoring, this approach allows for more holistic

decision-making under data-poor conditions common in small-scale fisheries. The composite value is then visualized with the flag model.

Results

Based on the results of the study, the Catch Per Unit Effort CPUE value of grouper in the city of Sabang for the last 5 years (2017-2021) has increased every year, so the CPUE criterion was given a score of 3 (figure 2).

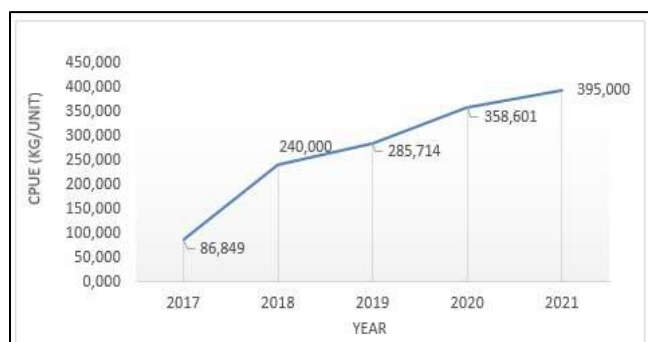


Figure 2. Graphic of CPUE

There are 210 groupers found in the waters of Sabang.

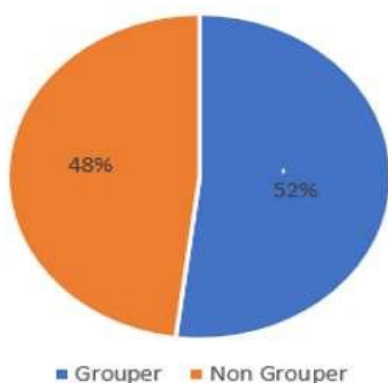


Figure 3. Composition of Grouper and non-grouper.

The observed grouper size ranges from a minimum of 15 cm to a maximum of 30 cm. The size of the first fish to mature gonads ranged from 19-52.2 cm. However, studies on different species of groupers in Indonesian waters show that the size at first maturity can vary significantly depending on species and region. For example, the *Cephalopholis miniata* from northern Aceh matures at approximately 20.5 cm total length (Fadli et al., 2022), while *Epinephelus areolatus* has been reported to reach sexual maturity at 23 cm for females and around 29 cm for males (Sitepu., 2016). Similarly, *Plectropomus leopardus* specimens were found to only have mature gonads when exceeding 35 cm in length, suggesting that

maturity onset is species-specific and often delayed in high-value coral groupers (Andamari et al., 2007).

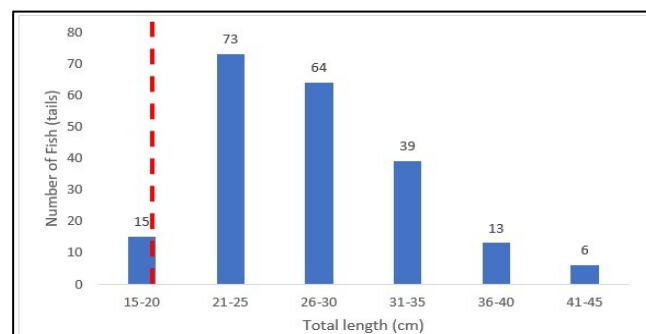


Figure 4. Chart of fish size trend.

The size of the grouper that has size above the L_m value is 93% while below the L_m value is 7%. This shows that the fish caught are fit for catching, meaning that the proportion of juveniles caught is relatively low. Furthermore, based on the data obtained from the total production of grouper fish, which was 359,694 kg, the catch species composition indicator was given a score of 3, because the proportion of target fish was 52% higher than the non-target fish (48%). This balance aligns with the principles of the Ecosystem Approach to Fisheries Management (EAFM), which emphasizes maintaining ecosystem balance by minimizing the catch of juveniles and ensuring the majority of the catch consists of mature individuals (Jabbar et al., 2018). Additionally, the balanced species composition reflects a sustainable practice as suggested in EAFM guidelines, where catches dominated by target species above maturity size contribute to long-term stock resilience (Hutubessy et al., 2014; Hutubessy & Mosse., 2015).

Interviews with 18 fishermen in Sabang City indicate that there is no formal system for determining fishing locations. Instead, fishermen tend to operate in areas close to their previous fishing spots. This localized fishing pattern reflects common behavior among small-scale fishers in Indonesia, who often rely on traditional knowledge, social interactions, and familiar territories rather than formal spatial planning or scientific guidance for selecting fishing grounds (Madsen et al., 2022). This behavior is usually influenced by cost-efficiency, access to information, and trust in local knowledge networks, which tends to restrict movement and leads to consistent use of known fishing spots (Firdaus et al., 2021). The fishing

distance is from 0.5-10 nautical miles from the TPI, so that the criteria for range collapse of fish resources was given a score of 3. This short-range fishing activity is generally considered sustainable under the Ecosystem Approach to Fisheries Management (EAFM), as it reduces the risk of habitat disruption and overexpansion of fishing grounds. Furthermore, the limited fishing range supports the stability of local fish populations by maintaining consistent catch patterns and reducing pressure on distant, potentially vulnerable habitats (Fitri *et al.*, 2023). According to EAFM guidelines, when fishing is conducted close to port and within well-established grounds, it is often associated with better management oversight and easier monitoring, which justifies a high score for range stability (Winarno & Salsabila, 2024).

Table 2. Limitations of Composite Values of Fish Resources Domains

No.	Criteria	Score	Bobot	Value
1.	CPUE Trend	3	40	12000
2.	Fish size trend	1	20	2000
3.	Proportion of juvenile fish caught	2	15	3000
4.	Catch species composition range collapse fish	3	10	3000
5.	Resources	3	10	3000
6.	ETP species	3	5	1500
Composite value				82

Interviews with 18 fishermen indicate that Endangered, Threatened, and Protected (ETP) species are rarely caught. On average, these species are released back into the sea rather than retained. So that the ETP species indicator is given a score of 3 because it is not taken to be eaten or traded. This aligns with best practices under the Ecosystem Approach to Fisheries Management (EAFM), where the protection of Endangered, Threatened, and Protected (ETP) species is prioritized to support biodiversity conservation and maintain ecological balance. Proper handling and release practices observed among fishers in Sabang reflect a growing awareness and application of conservation values in small-scale fisheries, similar to findings in other regions such as Lombok Strait and Sawu Sea Marine Park (Putra *et al.*, 2020; Ninef *et al.*, 2018). In aggregate, the indicator value in the fish resource domain is in the high category, each indicator has received a

good score of 3 points, while the fish size indicator has scored 2. Even though it is in good condition, management efforts are still needed in order to maintain this good condition.

Discussion

This is in line with several studies emphasizing that high scores in EAFM indicators—especially in the fish resource domain—should not lead to complacency, but rather prompt continuous improvement efforts through adaptive management, especially in areas like size composition, which often indicates fishing pressure on juveniles (Ditya *et al.*, 2022). Moreover, proactive steps are recommended even under “good” status categories to avoid shifting toward moderate or poor categories due to changing environmental and socio-economic conditions (Nadiarti *et al.*, 2021).

Table 3. Following are the results of the grouper

Domain	Composite Score	Flag Model	Description
Fish resource	82		Good

The final score obtained from both fish resource management domains is categorized as good which 82 in the implementation of EAFM. A score in this range indicates that most key indicators—such as catch composition, fish size, species selectivity, and ETP species management—are being managed in alignment with EAFM principles. Similar high-scoring assessments have been reported in other Indonesian fisheries, such as in inland fisheries across five districts, where the fish resource domain was also classified as 'good', highlighting the success of applying structured, indicator-based evaluations in fisheries management (Ditya *et al.*, 2022). However, sustaining this condition requires continuous monitoring and adaptive management to respond to environmental and socio-economic changes (Nadiarti *et al.*, 2021).

Conclusion

The status of grouper resource management in Sabang waters was included in the 'high' category, which is 82%, meaning that it is in good condition but requires careful management efforts to maintain this condition. This classification reflects well-established management indicators such as catch composition, fish size structure, and protection of ETP species, which are core components in the Ecosystem Approach to Fisheries Management (EAFM). The goal is to maintain or improve the

condition through enhanced monitoring, community involvement, and evidence-based management practices.

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