Management status of blue swimming crab (*Portunus pelagicus* Linnaeus, 1758) based on EAFM in the coastal of Pangkep Regency, South Sulawesi

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Abstract. The Blue Swimming Crab (BSC) is the main export commodity of Indonesia and one of the BSC agribusinesses in the coastal waters of the Pangkep Regency. However, in recent years, BSC agribusiness in this region has been estimated to be unsustainable. The purpose of this study is to formulate the management of BSC (*Portunus pelagicus*) resources with the Ecosystem Approach to Fisheries Management (EAFM) in the coastal of the Pangkep Regency.

The average value score in the BSC management domain is in the medium category (resource, habitat, economic, and institutional domains); the fishing techniques domain is in the good category, while the social domain is in the poor category. In general, the status of BSC fisheries management is categorized as medium (value = 194.25), therefore it can still be developed and improved. To repair the BSC fisheries management for gradually, tactical decisions were made to enhance the indicator conditions. To make the fishery activities sustainable, recommendations to improve the condition of the BSC fisheries in the Pangkep Regency include strengthening the supervision, improving the seagrass cover, improving coordination among institutions on the BSC fisheries management, and increasing stakeholder participation in the effort to manage the BSC fisheries.

Keywords: blue swimming crab (BSC); EAFM; Pangkep Regency; tactical decisions.

1. Introduction
Blue swimming crab (BSC) (*Portunus pelagicus* Linnaeus, 1758) is a fisheries resource with crucial economic value [1] and a high export market [2], which is exported mainly to the US [3], Singapore [4], Japan [5], and Netherlands [6]. The BSC export volume in 2017-2019 was 27.792 tonnes with an export value of US$ 472 million [7]. This species is widely dispersed in Indonesia, spreading from the western coast of Sumatera to the northern coast of Java [4], the southern and eastern coasts of Kalimantan, the southern part of Sulawesi, and the western area of Papua [8]. So far, to meet market demand, fishermen still rely on catches directly from nature [6] using traps and gill nets [9]. There had been no aquaculture activity as it was still in the research process and the best aquaculture technique has not been found [3]. If this condition continues, it is feared that overfishing will occur which will reduce the crab population in natural waters.

Pangkep Regency is an archipelago in the South Sulawesi that makes BSC one of its leading commodities. The potential of BSC resources is not distributed evenly in the waters of the Pangkep Regency due to the differences in aquatic environmental conditions [10]. Statistical data from the Pangkep Regency Fisheries Service [7] shows that BSC production has fluctuated over the last 4 years.
In 2015 the production of BSC reached 1,567.3 tonnes. In 2016 it increased to 2,041.8 tonnes and in 2017 it decreased to 2,015 tonnes. Then the production of BSC decreased very significantly in 2018 to 943.7 tonnes. This is presumed to be the result of overexploitation due to high market demand [11] and rising product prices that stimulate fishermen to exploit these resources [12]. High demand can cause BSC catching activities to be uncontrollable, including fishermen’s activities catching BSC with a carapace width of less than 10 cm and egg-berried ones, which have been regulated by Regulation of the Minister of Marine Affairs and Fisheries number 17 of 2021.

Sustainable biological, social, and economic benefits [10] from renewable aquatic resources are the goals of fisheries management [13]. If BSC continues to be exploited without good planning [2] and sustainable capacity management [14], sooner or later the BSC resources will face the risk of extinction. Although renewable resources can be categorized as BSC resources, fishing activities that are extremely intensive and unmanaged can contribute significantly to resource depletion [6]. So far, fishermen only prioritize economic fulfilment without considering the habitat conditions and tend to ignore applicable regulations. Meanwhile, to achieve sustainable fisheries, it is necessary to manage the resources and maintain the health of their ecology. In addition, it is important to pay close attention to how the institutional functions in achieving fisheries sustainability are needed.

Regarding the phenomenon of BSC utilization which is increasing and leads to symptoms of resource decline, it is necessary to have a management policy that covers all aspects of ecology, socio-economics, and institutions. This study is a multidimensional study carried out the Ecosystem Approach to Fisheries Management (EAFM) which includes the management of fish resources, habitats, and ecosystems, fishing techniques, social, economic, and institutional. Therefore, this study aims to assess the management status and provide management recommendations based on the factors that influence the condition of sustainable BSC fisheries in the coastal of Pangkep Regency through EAFM. The results of this study are expected to improve the use BSC resources in the waters of the Pangkep Regency optimally while maintaining a balance between ecosystem health and community economic goals.

2. Material and method
2.1. Research site
The study locations are in 6 sub-districts of the Pangkep Regency in the South Sulawesi, which are Pangkajene, Bungoro, Labakkang, Ma'rang, Segeri, and Mandalle in figure 1. The research area is the locations of the crab collectors selected based on the collectors with the largest number of fishermen. The data collection was conducted from November 2018 to April 2019.

2.2. Data collection
Primary data was collected using on site, while secondary data was collected from data sources and information from previous study respondents. The observation method was applied as the basic method to see the condition of crabs and their habitats. The economic, social, technological, and institutional data were obtained through interviews with the respondents whose samples were taken using the purposive sampling method based on the data needs. Data collection was carried out based on the data needs in each domain. Fish resources use a fisher-based survey approach [15], whereas the purposive sampling is used in the habitat and ecosystem domains, fishing techniques, social, economic, and institutional domains by distributing questionnaires and conducting in-depth interviews with relevant respondents.

3. Ecosystem approach for fisheries management indicator analysis
The EAFM approach in Indonesia is slightly different from the EAFM guidelines based on FAO which is carried out with a linear mechanistic approach starting with scoping, determining strategic problems, identifying indicators, fisheries planning, implementation, and evaluation. EAFM in the Indonesian context is seen as a comprehensive approach, starting from the identification of key indicators of EAFM implementation. A good indicator is an indicator that meets several criteria, which are measurable, precise, consistent, and sensitive [16]. Indicators are needed to assist the ecosystem approach to fisheries
management by giving information on the state of the ecosystem, its extent and efforts, and management progress. The numbers and types of indicators used may vary between management areas depending on the resources available for monitoring and enforcement, as well as actual conditions and potential fishing impacts [17].

The indicator approach for limited data is one of the best ways to manage fisheries [18]. The assessment of indicators for fisheries management has several objectives, namely sustainable use, economic benefits, protection of resources, and management of fishing activities [19]. The development of EAFM performance indicators to support the development of regulations related to coastal and small island management and fisheries, both of which support an EAFM, has been a major EAFM activity in Indonesia [20]. In Indonesia, it EAFM has 32 indicators that cover six domains: habitat and ecology, fish resources, fishing technology, economy, social and institutional factors [21].

In this study, the EAFM is analyzed using an indicator approach. An indicator is a tool or method for measuring, indicating, or referring to something larger or smaller than the desired size [22]. Each indicator has different criteria, reference points, and assessment weights. The criteria for each indicator, score, and assessment refer to the Fishery Management indicator module with the Ecosystem Approach
[16], also stated in the Decree of the Directorate General of Capture Fisheries Number 18/2014 concerning Technical Guidelines for Indicator Assessment for Fisheries Management with an Ecosystem Approach. The criteria and weights for each indicator contained in the EAFM module are then adjusted to the conditions of the research location. Assessment of fishery management status uses a composite analysis of indicators from each domain by calculating their respective weights and scores, then visualized using flag modelling techniques [16] (figure 2).

The EAFM indicator assessment uses a multi-criteria analysis approach to establish a set of criteria as a basis for analyzing the performance of fisheries management areas with an ecosystem approach in fisheries management through the development of a composite index using flag modeling technique. The first stage of analysis is carried out by determining criteria for each indicator of each EAFM domain (fish resources, habitat, fishing techniques, social, economic, and institutional). Afterward, determine the scoring (\( S_{ai} \)) for each indicator in each domain using a Likert score (ordinal based 1,2,3). After that, determine the weight for each indicator based on the rating (\( W_{i} \)) for each indicator. The weights are determined according to the level of influence of the indicator in the domain. The weighting is set on a scale of 1 to 10.

Composite assessment on each domain (\( C_{at-i} \)) with a simple formula:

\[
C_{at-i} = S_{ai} \times W_{i} \tag{1}
\]

where \( C_{at-i} \) is the total EAFM value of one indicator in the domain; \( S_{ai} \) is attribute score of number \( i \); \( W_{i} \) is attribute weight of number \( i \). The composite value is determined from the average value of all studied domains. The next step is to develop an aggregate composite index for all domains (\( D_{j} \)) in the research unit with the following function model:

\[
C_{j} = f (D_{j}, S_{ai}, W_{j}) \tag{2}
\]

where \( D_{j} \) is the arithmetic mean of the domain of number \( j \) of the total multiplication of \( S_{ai} \) (the indicator score number \( i \) of the domain number \( j \)); and \( W_{i} \) is the indicator ranking weight of number \( i \) for domain of number \( j \).

The total of each assessed indicator is then analyzed using a simple composite analysis based on the arithmetic mean, which is then displayed in the form of a flag model. The composite index is the conversion value of the total value of each domain. The total value of the multiplication of the EAFM components is converted on a scale of 100-300. Conversion is used to help to classify an EAFM domain.

### Table 1. Composite value classification and model visualization.

| Composite value | Flag Model | Description |
|-----------------|------------|-------------|
| 100 – 167       | Poor       | Poor        |
| 168 – 234       | Medium     | Medium      |
| 235 – 302       | Good       | Good        |

Source: Attachment to the Decree of the Directorate General of Capture Fisheries Number 18/2014 (modified).

### Table 2. Composite analysis of fish resource domains.

| Domain         | Indicator                              | Score | Weight | Value | Status |
|----------------|----------------------------------------|-------|--------|-------|--------|
| BSC resources  | CPUE trend last 4 years                | 2     | 40     | 80    | Medium |
|                | BSC size trend                         | 1     | 20     | 20    | Poor   |
|                | Proportion of BSC caught <10cm CL      | 2     | 15     | 30    | Medium |
|                | Catch species composition caught        | 3     | 10     | 30    | Good   |
|                | Range collapse of BSC resource         | 1     | 10     | 15    | Poor   |
|                | ETP species caught                      | 3     | 5      | 15    | Good   |
|                | Average                                | 2     | 100    | 190   | Medium |

Table 2. Composite analysis of fish resource domains.
The scale conversion value of each domain is obtained by calculating the minimum and maximum total scores for each indicator, which are then divided into three classes. The calculation of the scale conversion value follows the formula:

\[
N_{k-1} = \frac{C_{at-1 \text{max}} - C_{at-1 \text{min}}}{3}
\]

where: \(N_{k-1}\) is scale conversion value; \(C_{at-1 \text{min}}\) is minimum value of one attribute/indicator in the domain obtained if all attributes/indicators have a score of 1; and \(C_{at-1 \text{max}}\) is maximum value of one attribute/indicator in the same domain obtained if all attributes/indicators have a score of 3.

The status of the indicator is determined from the composite value. The better status of the indicator, the greater the value is, so that the value contributes greatly to the achievement of EAFM. The composite value is obtained by multiplying the score with the weight of each indicator.

Afterward, sum all the composite indicator values for each domain. Subsequently, the value of the indicator is summed with the value of the other indicators in each domain to make a composite index value. This composite index value will be grouped into three categories of criteria and displayed using the flag model (table 1).

### 4. Result and discussions

#### 4.1. Domain and indicator of BSC management

The assessment of the condition of the crab fishery in the Pangkep Regency with the EAFM indicator uses six domains, which include the domain of fish resources, habitat and ecosystem, fishing techniques, economy, social, and institutions with several indicators in it. There are several measurements of each indicator in each domain, namely: good condition, indicated in green; medium condition, indicated in yellow; poor condition, indicated in red.

#### 4.1.1. Fish resource domain

The indicators used in the BSC resource domain consist of 6 (six) indicators, which are catch per unit effort (CPUE); BSC size; the proportion of caught BSC; species composition; endangered, threatened, protected species (ETP); and range collapse. The analysis shows that the BSC resource domain is in the poor category. Indicators in the good category are caught species composition and ETP species. Indicators in the medium category are standard CPUE and the proportion of crabs caught < 10 cm carapace length, while the indicators in the poor category are the trend of BSC...
size and range collapse of the BSC resources. Based on the EAFM analysis, the results of the composite analysis of the fish resource domain (SDI) are presented in table 2.

Based on the existing data, and if the number of fishing gears is assumed the same, then it is found that the CPUE for last 4 years decreases by 9.60% per year. This means that the CPUE category slightly decreased as it was less than 25%. Furthermore, the carapace sizes of the caught BSC varied between 54 mm to 156 mm for males and 63 mm to 157 mm for females. The highest number of catches is in the size of 102 mm to 109 mm. This is different from previous research, which got the highest catch at 112-123 mm in size [3]. From this statement, it is indicated that there has been a decreasing trend in the size of the crabs. Based on the measurements, 39.42% of the catch is below 10 cm in size, and 2.5% is egg berried BSC. The catch composition by the fishermen is dominated by almost 100% BSC using traps and trammel net. According to the local fishermen, there were only 5 to 10 catches other than the BSC like little fish, shrimp, etc. In addition, ETP species have never been found in the fishermen’s catches.

Different results where the highest catch was 112-123 mm in size in the same location of this research [3]. From this, it is indicated that there has been a decreasing trend in the size of the BSC. BSC caught in the coastal waters generally have a carapace width range of 8 cm to 13 cm with an average weight of ± 100 grams, while BSC caught in deeper waters have a carapace width range of 12 cm to 15 cm with an average weight of ± 150 grams [23].

4.1.2 Habitat and ecosystem domain. The ecosystem and habitat domain consist of 5 (five) indicators including water quality, seagrass, mangrove, special habitats and climate change. Mangrove and seagrass ecosystems are nursery, feeding, and spawning ground (special habitat) for BSC [24]. Water quality for the survival of BSC in the water temperature range from 17°C to 30°C, with an optimal salinity of 25.0% to 34.0%. The optimum pH level of sea water for crab life is 7.0 to 8.5 and the dissolved oxygen level is still tolerable at 4.0 ppm to 5.0 ppm with the best conditions on average 8 ppm [25].

Habitat and ecosystem domains belong to the medium category. Indicator with good categories is the status of mangrove ecosystems. Indicators in the medium category are water quality, special habitats, and climate change. While the indicator with the poor category is the status of the seagrass ecosystem. The composite results of the ecosystem and habitat domains are presented in table 3.

Ecosystem condition is the matter that needs to be considered in fisheries management to keep the fish resources sustainable, which includes water quality, seagrass, and mangroves ecosystems. The seagrass ecosystem condition is one of the poorest because its current cover is only 15%. This is presumed as the result of the many activities carried out in the seagrass area, one of which is the port activities where ships make stopover. In addition, the beach area is close to settlements and most people still often throw garbages into rivers or the sea. Meanwhile, the mangrove ecosystems are still in good condition that showing coverage of 98%.

4.1.3 Fishing techniques domain. The fishing technique domain includes destructive fishing indicators, fishing capacity, and selectivity of fishing gear. Fishing capacity is the ability of a number of catch effort to produce fish production [26], while the selectivity of fishing gear is the ability of fishing gear to obtain certain fishing targets according to the type of fish, size or gender (or a combination of that) during the fishing process, and allow all bycatch (unwanted catch) can escape unharmed [27].

The fishing technique domain is categorized as the best of all domains. Indicators with good conditions are fishery capacity and effort as well as fishing selectivity. The indicator with medium condition is destructive fishing. The condition of BSC fishing techniques in the waters of the Pangkep Regency is provided in table 4.

The fishing gears used by BSC fishermen in the Pangkep Regency are trammel net and traps, which are environmentally friendly fishing gear [28] so that they have high selectivity [27]. There are still some fishermen from outside the area that catch BSC in Pangkep waters using destructive fishing gear such as mini trawls. The occurrence of this is allegedly due to a lack of supervision by the authorities. Local fishermen themselves have realized how important it is to use environmentally friendly fishing
gear so that the crab fishery can be sustainable. The results of the analysis show that the ratio of fishing capacity and effort is 1.56, which means the business generates profits [29] so that it is feasible to run [30].

4.1.4 Social domain. Indicators in the social domain include stakeholder participation, fisheries conflicts, and local knowledge. The social domain is the domain with the worst conditions. Indicators in moderate conditions are stakeholder participation and utilization of local knowledge. Meanwhile, the fisheries conflicts indicator is in poor condition. The social conditions of crab-catch activities in the waters of Pangkep Regency are provided in table 5.
The role of stakeholders is very important in BSC fishing activities. Lack of stakeholder participation causes conflicts to occur frequently. Conflicts that usually happen are conflicts among fishermen due to fighting over the fishing grounds (resource conflict) and fishing gears conflicts. Fishery conflicts can also occur due to policy conflict in the same area or conflicting activities among sectors. The fishermen in the Pangkep Regency are mostly aware of the importance of maintaining the crab resources and their ecosystems, to keep the fishery activity sustainable. They are also aware of the prohibitions and regulations in catching crabs. However, they tend to ignore the regulations to maximize the fulfillment of their economic needs. As a result, fishermen do not care about other aspects but the economy. If this continuously happens, certainly, the crab fishery will not be sustainable.

4.1.5 Economic domain. The indicators in the economic domain consist of asset ownership, income, and the level of demand. The condition of the economic domain is categorized as medium. The level of demand indicator is in good condition. The indicator in the medium condition is the asset ownership, while the indicator in the bad condition is the fishery household income. The results of the composite analysis of economic domain indicators are presented in Table 6.

The BSC fishing activity in Pangkep Regency uses several assets such as boats, machines, fishing gear, and others that support catching. Based on interviews, assets tend to be fixed because if something is damaged, it will be repaired or replaced. In addition, the average income of fishermen is IDR 2,253,125. The current minimum wage in Pangkep Regency is IDR 2,941,000, so that the average income of fishermen from crab fisheries is smaller than the minimum wage. There are still many fishermen only rely on the results of the sale of the crab catches to fulfill the household economic needs. Therefore, it is possible to suggest other suitable alternative livelihoods to increase the fishermen's income, such as seaweed cultivation.

4.1.6 Institution domain. Institution domain indicators include compliance with formal and informal rules, completeness of regulations and law enforcement, decision-making mechanisms, fisheries management plan, policy and institutional synergies, and stakeholder capacity. The institutional domain belongs to the medium category where the capacity of stakeholder indicator is in good condition. Indicators in the medium conditions are the completeness of the rules of the game in fisheries management, fishery management plan, and the level of policy and institutional synergy. While compliance with responsible fisheries principles and decision-making mechanisms indicator belongs to the bad condition. The measure of the success of an institutional mechanism is if it can be implemented into a system and run effectively [9]. Institutional conditions on crab catching activities in the waters of the Pangkep Regency are provided in Table 7.

The fishermen's compliance with the rules for catching crabs is still lacking, which is assumed to be due to the lack of supervision of the relevant institutions. In addition, the punishment in the decision-making for the violations that occur is not firm, so that there is no deterrent effect on the person concerned. The existence of delineated areas of authority between the provincial and regency offices of Marine Affairs and Fishery makes it rather difficult to enforce the rules because the distance from the provincial office to the regency is quite far, so that it cannot carry out daily supervision. Meanwhile,
fishermen go to the sea every day for the whole year. This needs special attention so that law enforcement can be carried out optimally.

4.2 Status of BSC management with flag modeling technique

The assessment of the condition of the BSC fishery in Pangkep Regency with EAFM indicators uses six domains, which include the domains of fish resources, habitats and ecosystems, fishing techniques, economics, social, and institutions with several indicators. In this study, 26 indicators were used to represent the characteristics of the crab fishery business in the Pangkep Regency. The results of the analysis show that the BSC resource domain is in the medium category (table 8).

Better results with EAFM can be achieved with the assistance of knowledge from multiple sources [31]. Overall, the practice of implementing BSC EAFM in the Pangkep Regency is in the medium category. Frequent conflicts among fishermen in BSC catching activities lead to poor conditions in the social domain. Then the high activity of catching BSC needs special attention even though overall, the domain of fish resources is in the medium category. High fishing activity causes a decreasing trend in the size of the BSC catch. Management of BSC habitat, especially seagrass, is important in that the nursery area for crab life support is maintained. In addition, integration between policies and institutions is one of the things that needs special attention to enforcement the law against an infringement to be optimized. These all things are the main priorities in improving the management of crab fisheries in the Pangkep Regency.

4.3 Efforts to improve BSC management

The status of fishery management needs to be improved so that it becomes good. One of the efforts is to formulate and implement tactical management decisions to improve the current performances [22]. The results of the assessment of the EAFM indicators on the BSC fishery in the Pangkep Regency depict the current state of the BSC fisheries management. The next step that must be taken is to prepare the tactical management steps (tactical decisions) to improve the condition of the indicators. The tactical steps taken are compiled based on the evaluation results of the composite index of indicator assessment in each domain by taking into account the sustainability status of fisheries management in the three zones. The management is carried out on indicators that are considered important with high weight values, which have values below the reference point. The tactical steps taken are to prepare the recommendations for the activities to be carried out in order to improve the condition of the indicators that are classified as bad (red), to improve the conditions of the indicators that are classified as medium (yellow), and to maintain the condition of the indicators that are classified as good (green).

The results of the EAFM indicator assessment on the crab fishery in the Pangkep Regency depict the current state of BSC fisheries management. The next step that must be taken is preparing the tactical management steps (tactical decisions) to improve the condition of the indicators. The tactical steps taken are to prepare the recommendations for the activities to be carried out in order to improve the condition of indicators that are classified as bad (red), to improve the conditions of indicators that are classified as medium (yellow), and to maintain the condition of indicators that are classified as good (green). The recommendations for the management of BSC fisheries to be carried out on the indicators to be improved are listed in the following table 9 to table 11.

The management recommendations that have been prepared require implementers and stakeholder coordination in the implementation so that they can achieve the desired EAFM principles. The priority is to strengthen the supervision of the fishermen to return the crab catches below 10 cm in size and the egg-berried crabs to the sea, to build good coordination among institutions on the management of crab fisheries, as well as to increase stakeholder participation in the crab fisheries management efforts.
Table 9. Recommendations for the management of BSC fisheries with an ecosystem approach in Pangkep Regency waters.

| Indicators | Actual value | Reference indicator | Recommendation |
|------------|--------------|----------------------|----------------|
| **BSC resources** | | | |
| 1. CPUE trend last 4 years | CPUE decreased by 9.6% annually | CPUE is stable or increased | • Limiting fishing activities from November - March |
| 2. BSC size trend | Size trend is getting smaller | Size trend is relatively fixed | • Control of fishermen’s catch |
| 3. Proportion of BSC caught <10cm CL | Many (39.42%) | a little (<30%) | • Monitoring of catch under 10cm CL |
| 4. Range collapse BSC resources | BSC are getting less | BSC is relatively fixed | • Regulation of the BSC fishing area |
| **Habitat** | | | |
| 1. Water quality | Moderately polluted, water quality is in accordance with the criteria | Not polluted, water quality is very suitable | • Prohibition of dumping garbage and waste into waters (rivers and seas) |
| 2. Seagrass ecosystem status | Cover less (15%), Moderate diversity | Medium cover, high diversity | • Rehabilitation of seagrass ecosystems |
| 3. Unique / special habitat | it is known that there are unique/special habitats but they are not managed properly | it is known that there are unique/special habitats and they are managed well | • Conduct research on special habitats and make zoning |
| 4. Climate change | There are studies on climate change, but they are not specific and are not followed by adaptation and mitigation strategies | There is a specific study of the impact of climate change on biota and followed by a mitigation adaptation strategy | • Conducting climate assessments on waters and biota and implementing mitigation of their impacts |
Table 10. Recommendations for the management of BSC fisheries with an ecosystem approach in Pangkep Regency waters.

| Indicators                                      | Actual value | Reference indicator | Recommendation                                                                 |
|------------------------------------------------|--------------|---------------------|-------------------------------------------------------------------------------|
| **Technology**                                 |              |                     |                                                                                |
| 1. Destructive fishing                         | 2            | 3                   | - Prohibition and enforcement of the use of trawling                          |
| Frequency of violations 5-10 cases a year      |              |                     |                                                                                |
| 2. Fishery conflict                            | 1            | 2                   | - Increase the role of fisheries supervisors and fishing groups to reduce conflict |
| Conflicts occur >5 times a year                |              |                     |                                                                                |
| 3. Utilization of local knowledge in BSC resource management | 2        | 3                   | - Increase public awareness through mentoring (counseling, socialization) about the importance of preserving the BSC. |
| There is knowledge but not effective           |              |                     |                                                                                |
| **Social**                                     |              |                     |                                                                                |
| 1. Stakeholder participation                   | 2            | 3                   | - Capacity building of human resources and involving the community in the management activities of the BSC |
| Stakeholder participation 50-100%              |              |                     |                                                                                |
| 2. Fishery conflict                            | 1            | 2                   | - Provide education to the community about the importance of managing the BSC |
| Average income of IDR 2,253,125                |              |                     |                                                                                |
| 3. Utilization of local knowledge in BSC resource management | 2        | 3                   | - Provide input for alternative livelihoods for fishermen to increase income, for example seaweed cultivation |
| There is knowledge and effective use           |              |                     |                                                                                |
| **Economy**                                    |              |                     |                                                                                |
| 1. Ownership of assets                         | 2            | 3                   | - Maintenance of fishery assets to facilitate the addition of assets           |
| No additional assets                           |              |                     |                                                                                |
| 2. Fishery household income                    | 1            | 2                   | - Provide input for alternative livelihoods for fishermen to increase income, for example seaweed cultivation |
| Average income of IDR 2,253,125                |              |                     |                                                                                |
Table 11. Recommendations for the management of BSC fisheries with an ecosystem approach in Pangkep Regency waters.

| Indicators                                                                 | Actual value | Reference indicator | Recommendation                                                      |
|----------------------------------------------------------------------------|--------------|---------------------|---------------------------------------------------------------------|
| Institutional                                                             |              |                     |                                                                     |
| 1. Adherence to the principles of responsible fisheries                    | 1            | 2                   | • Improve law enforcement and sanctions in accordance with applicable regulations |
| 2. Completeness of the rules of the game in the management of BSC fisheries | 2            | 3                   | • Be more active in implementing regulations in accordance with existing regulations |
| 3. Decision-making mechanism                                               | 1            | 2                   | • Making standard operating procedures in making decisions on violations |
| 4. Fishery management plan                                                 | 2            | 3                   | • Implementation of BSC management in accordance with the existing fisheries management plan |
| 5. The level of synergy of fisheries management policies and institutions   | 2            | 3                   | • Improve communication and cooperation between central and local governments |

Indicators:
- Scoring: 1 to 3, where 1 is the lowest, 3 is the highest.
- Criteria:
  - 1. Formal violations occur >5 times a year, there is information on informal violations 2 times during the study.
  - 2. Formal violations occur 2-4 times per year, there is no information on violations.
  - 3. Complete regulation available to support 6 domains of EAFM, law enforcement process for all violations.
  - 4. There is a decision-making mechanism and it is fully implemented.
  - 5. Communication between institutions is not effective, policies between institutions do not support each other.
  - 6. Effective inter-agency communication and mutually supportive policies.
5. Conclusion
The status of BSC fishery management is generally classified in the medium category, where it can still be developed and improved. To gradually improve the management of BSC fisheries, it is recommended to strengthen the supervision of the fishermen so that they return the BSC catches below the size of 10 cm and the egg-berried crabs to the sea, to improve seagrass coverage, to improve the coordination among the institutions on BSC fisheries management, and to increase stakeholder participation in BSC fisheries management efforts.

6. Authorship contribution
Novita Dwi Yanti: writing - original draft; Yeyen Mardyani and Lindawati: writing and data analysis; Rahmat Kurnia and Ali Mashar: conceptualization, data curation, and methodology.

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References
[1] Siang R D and Nurdiana A 2015 Struktur biaya dan profitabilitas usaha miniplant rajungan (Portunus pelagicus) Jurnal Bisnis Perikanan 2 91–100 [in Indonesian]
[2] Adam, Firman and Anwar 2016 Model pengelolaan perikanan rajungan dalam meningkatkan pendapatan nelayan di Kabupaten Pangkep Jurnal Galung Tropika 5 203–209 [in Indonesian]
[3] Ihsan 2018 Size distribution and fishing season patterns of swimming crab (Portunus pelagicus) in the waters of Pangkep Distict-South Sulawesi Marine Fisheries 9 73–83
[4] Hutapea B K, Nugraha E,Prayitno H, Choeurudin H, Suharyanto, Sutisna D H, Effendy A and Bashit A 2019 Sustainability of blue swimming crab Portunus pelagicus commodity in Banten Bay, Indonesia AACL Bioflux 12 777–785
[5] Ekawati A K and Adrianto L 2019 Pengelolaan perikanan rajungan berdasarkan analisis spasial dan temporal bioekonomi di perairan pesisir Lampung Timur Jurnal Kebijakan Perikanan Indonesia 11 65–74
[6] Suman A, Hasanah A, Pane A R P and Lestari P 2020 Stock Status of blue swimming crab (Portunus pelagicus) in Tanah Laut, South Kalimantan, and its Adjacent Waters Indonesian Fisheries Research Journal 26 51-60
[7] Badan Pusat Statistik Kabupaten Pangkep 2019 Kelautan dan Perikanan dalam angka (Pangkep: Badan Pusat Statistik) p 293
[8] Sara L, Astuti O, Muzuni and Safilu 2019 Status of blue swimming crab (Portunus pelagicus) population in southeast sulawesi waters, Indonesia AACL Bioflux 12 1909–1917
[9] Budiarto A, Adrianto L and Kamal M 2015 Status pengelolaan perikanan rajungan (Portunus pelagicus) dengan pendekatan ekosistem di Laut Jawa (WPPNRI 712) Jurnal Kebijakan Perikanan Indonesia 7 9–24
[10] Ihsan, Wiyono E S, Wisuda S H and Haluan J 2015 Pemanfaatan sumberdaya rajungan (Portunus pelagicus) secara berkelanjutan di perairan Kabupaten Pangkep, Provinsi Sulawesi Selatan (Disertasi Bogor: Institut Pertanian Bogor) p 236 [in Indonesian]
[11] Kurnia R, Boer M, and Zairion 2014 Biologi populasi rajungan (Portunus pelagicus) dan karakteristik lingkungan habitat esensialnya sebagai upaya awal perlindungan di Lampung Timur Jurnal Ilmu Pertanian Indonesia 19 22–28 [in Indonesian]
[12] Budiarto A 2015 Pengelolaan perikanan rajungan dengan pendekatan ekosistem di Perairan Laut Jawa (WPPNRI 712) (Thesis Bogor: Institut Pertanian Bogor) p 92 [in Indonesian]
[13] Muawanah U, Huda H M, Koeshendrajana S, Nugroho D, Anna Z, Mira and Gofar A 2017 Keberlanjutan perikanan rajungan Indonesia: pendekatan model bioekonomi Jurnal Kebijakan Perikanan Indonesia 9 71–83 [in Indonesian]

[14] Nurdin M S, Bakri E, Haser T F and Hasanah N 2020 The relationship between blue swimming crab (Portunus pelagicus) abundance and environmental parameters in Spermonde Archipelago Tomini Journal of Aquatic Science 1 8–15

[15] Dumas P, Leopold M, Frote L and Peignon C 2012 Mud crab ecology encourages site-specific approaches to fishery management Mud crab ecology encourages site-specific approaches to fishery management Journal Sea Research 67 1-9

[16] Adrianto L, Habibi A, Fathurudin A, Azizy A, Susanto H A, Musthafa I, Kamal M M, Wisudo S H, Wardiatno Y, Raharjo P et al 2014 Modul indikator untuk pengelolaan perikanan dengan pendekatan ekosistem (Jakarta: Kementerian Kelautan dan Perikanan) p 174 [in Indonesian]

[17] Jennings S 2005 Indicators to support an ecosystem approach to fisheries Fish and Fisheries 6 212-232

[18] Ye Y, Cochrane K and Qiu Y 2011 Using ecological indicators in the context of an ecosystem approach to fisheries for data-limited fisheries Fisheries Research 112 108–116

[19] Pelletier D, Claudet J, Ferraris J, Benedetti-Cecchi L and Garcia-Charton J A 2008 Models and indicators for assessing conservation and fisheries-related effects of marine protected areas Canadian Journal Fisheries Aquatic Science 65(4) 765–769

[20] Muawanah U, Yusuf G, Adrianto L, Kalthier J, Pomeroy R, Abdullah H and Ruchimat T 2018 Review of national laws and regulation in Indonesia in relation to an ecosystem approach to fisheries management Marine Policy 91 150–160

[21] Hutubessy B G and Mosse J W 2015 Ecosystem Approach to Fisheries Management in Indonesia: Review on Indicators and Reference Values Procedia Environment Science 23 148–156

[22] Gavaris S 2009 Fisheries management planning and support for strategic and tactical decisions in an ecosystem approach context. Fisheries Research. 100 6–14

[23] Juwana S and Romimohtarto 2000 Rajungan: perikanan, cara budidaya dan menu masakan (Jakarta: Djambatan) p 48 [in Indonesian]

[24] Bengen D G 2001 Sinopsis Ekosistem dan Sumberdaya Alam Pesisir dan Laut (Bogor: Institut Pertanian Bogor) p 72 [in Indonesian]

[25] Kementerian Kelautan dan Perikanan 2016 Keputusan Menteri Kelautan dan Perikanan Republik Indonesia Nomor 70 Tahun 2016 tentang Rencana Pengelolaan Perikanan Rajungan di Wilayah Pengelolaan Perikanan Negara Republik Indonesia (Jakarta: Kementerian Kelautan dan Perikanan) p 47 [in Indonesian]

[26] Nelwan A 2011 Kapasitas penangkapan ikan pelagis kecil di perairan pantai barat sulawesi selatan Fisheries Scientiae 1 117-137 [in Indonesian]

[27] FAO 1995 Code of Conduct for Responsible Fisheries (Rome: FAO Fisheries Department) p 24

[28] Sima A M, Djayus Y and Harahap Z A 2014 Identifikasi alat tangkap ikan ramah lingkungan di Desa bagan Asahan Kecamatan Tanjung Balai Aquacoastmarine 2 48-60 [in Indonesian]

[29] Sisdijatmiko 1990 Kajian Dasar Pengantar Teori Ekonomi Mikro (Jakarta: Rineka Cipta) p 61 [in Indonesian]

[30] Hernanto F 1998 Ilmu Usaha Tani (Jakarta: Penerbit Swadaya) p 200-222 [in Indonesian]

[31] Röckmann C, van Leeuwen J, Goldsborough D, Kraan M and Piet G 2015 The interaction triangle as a tool for understanding stakeholder interactions in marine ecosystem based management Marine Policy 52 155–162