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Status of Blue Swimming Crab (*Portunus pelagicus*) Management in Pasuruan, Indonesia: An Ecosystem-Based Approach

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ABSTRACT

This study aimed to evaluate the management status of blue swimming crab (*Portunus pelagicus*) fisheries in Pasuruan Regency, Indonesia, using the Ecosystem Approach to Fisheries Management (EAFM). Unlike conventional fisheries management that tends to focus on stock exploitation or economic returns alone, the EAFM integrates ecological, technological, economic, social, and institutional dimensions to promote sustainability. Primary data were obtained from structured surveys and interviews with 92 fishers and one fisheries official, while secondary data included catch volumes, fishing trips, fleet numbers, and market prices. A multi-criteria analysis (MCA) approach was used to assess 21 indicators across six EAFM domains. The results showed that the overall fisheries management status falls into a moderate category, with an aggregate composite value of 51.4 (on a scale of 1 to 100). The habitat and social domains were in good condition, while the fisheries resources, fishing technology, and institutional domains were moderate. The economic domain was rated poor, mainly due to low fisher income and high dependence on fluctuating catch volume. It is concluded that improvements are needed, particularly in economic and institutional domains. Recommendations include enforcing size and spawning protections, enhancing stakeholder education, regulating fishing efforts, adjusting gear selectivity, strengthening fisher associations, and establishing a comprehensive crab fisheries management plan. These measures are expected to support sustainable and equitable fisheries development and inform future policy directions at local and national levels.

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INTRODUCTION

Constitution of the Republic of Indonesia No. 31 of 2004 in conjunction with Law No. 45 of 2009 concerning Fisheries confirms that fisheries management is defined as all efforts, including the integrated process of information collection, analysis, planning, consultation, decision-making, allocation of fish resources, and implementation and enforcement of fisheries laws and regulations, carried out by the government or other authorities are directed at achieving the continuity of aquatic biological resource productivity and agreed objectives.

According to **Charles (2001)**, fisheries system management cannot be separated from three components that influence each other, namely (1) the component of resources and ecosystems; (2) the component of fisheries resource utilisation for the social and economic interests of the society, and (3) the component of fisheries governance itself.

In relation to these three dimensions, current fisheries management still does not consider the balance of the three, where the importance of utilization for the socio-economic welfare of the community is greater than the health of the ecosystem **(Budiarto *et al.*, 2015)**. In other words, the approach taken is still partial and not integrated within the boundaries of the ecosystem that is the container of fish resources as a management target. In this context, an integrated approach through an ecosystem approach to fisheries management is very important.

Rajungan (*Portunus pelagicus*) is one of the high economic fishery commodities **(Putri *et al.*, 2013; Ernawati *et al.*, 2014; Kembaren & Surahman, 2018; Razek *et al.*, 2019)**. Additionally, it became one of Indonesia's main export commodities to America in the form of crab meat **(Jacoeb *et al.*, 2012)**. Other export destination countries are Singapore, Japan, and the Netherlands **(Aminah, 2010; De Fretes *et al.*, 2019)**. Based on published data, the export volume of crab was 28,806 tonnes, with an export value of USD 482,810,262 **(BPS, 2023)**. Export data for 2022 showed that the crab species group (crab and king crab) ranked fifth in terms of export volume of capture fisheries products, but in terms of value ranked fourth. Export data in 2019 also shows that the export volume of the crab/crab species group (crabs and king crabs) is only 1/7 of the export volume of the tuna and similar groups, but the export value is 1/2 of the export value of the tuna and similar groups **(BPS, 2020; DJPDSPKP, 2020)**. The high demand for crab for the export market has led to an increase in fishing activities which affects the pressure on the sustainability of crab resources is getting bigger. This condition is marked by an alleviation in fishing productivity accompanied by the reduction of size of crab caught in several areas that are the center of crab fishing in Indonesia **(Ernawati *et al.*, 2015; Muawanah *et al.*, 2017)**.

The waters of Pasuruan Regency have the characteristics of problems in management of crab fisheries, namely the increasingly limited crab resources and the relatively growing number of fishing fleets. This condition can result in over fishing of

crab resources. The occurrence of over fishing is not only caused by the high number of crab fishing fleets but also allegedly as a result of fishing patterns that do not pay attention to the biological phases of crab derived from uncontrolled crab fishing activities, including fishermen catching crabs with a carapace width of less than 10cm and crabs laying eggs. The causes of the above include fishermen's knowledge of how to preserve crab resources which is still very minimal, so they do not know how to catch and handle crabs that are environmentally friendly and sustainable.

The dynamics in crab management cannot be separated from the tropical ecosystem complexities that have become one of the characteristics of tropical ecosystems. In this context, the management of crab fisheries, whose ultimate goal is to provide optimal socio-economic benefits for the community, cannot be separated from the dynamics of the ecosystem that is the living medium for the crab resource itself. **Garcia and Cochrane (2005)** provide a simple model of the complexity of crab resources that makes an integrated ecosystem-based approach very important. A simple model of the interaction between components in the ecosystem encourages the importance of applying an ecosystem approach to fisheries management (EAFM).

Studies on fisheries management with an ecosystem approach are important in strategic planning that focuses more on the formulation of strategies to achieve the goals set in the policy plan **(Budiarto *et al.*, 2015; Ninef *et al.*, 2019; Yuliana *et al.*, 2019; Alsolami *et al.*, 2020)**, but have not been carried out on crab fisheries specifically. Studies on crab fisheries management are still carried out partially **(Hamid *et al.*, 2017; Muawanah *et al.*, 2017; Ekawati *et al.*, 2019; Susanto *et al.*, 2019)**. According to **Charles (2001)**, sustainable use of fisheries resources requires the precautionary principle, where management should include management of bioecological, fishing technology, social, economic, and institutional aspects. Therefore, the first step that needs to be done is to assess the current status/condition and potential sustainability of crab resources from fishing activities that cover these six aspects with an ecosystem approach that refers to **FAO (2003)**, **Garcia and Cochrane (2005)** and **McClanahan *et al.* (2014)**. This study aimed to assess the management status of crab fisheries in Pasuruan Regency using the Ecosystem Approach to Fisheries Management (EAFM).

MATERIALS AND METHODS

Time and place of research

The research was conducted in Lekok, Kraton and Nguling sub-districts of Pasuruan Regency, East Java Province, from July 2023 to October 2023. These sub-districts were chosen as research sites because they are the catching and landing areas for crab, although there is no regular data collection on crab fisheries production. The research location was chosen purposively based on the consideration that Pasuruan Regency is one of the production areas of crab with fishing trap. Evidence that this region

is a center for crab fishing is that there are 1,095 crab fishers in the region **(Dinas Perikanan Kabupaten Pasuruan, 2023)**, and there are 9 middlemen collecting fishers' catches every day. Administratively, the research location is shown in Fig. (1).

Data collection were conducted using a survey method with the help of structured questionnaires, in-depth interviews, observations, and literature studies. The types of primary data collected related to age, education level, business experience, total income, perceptions of crab management (resources, habitat, crab fishing techniques, crab utilisation conflicts, crab management policy), while secondary data included previous research results, amount and value of crab production.

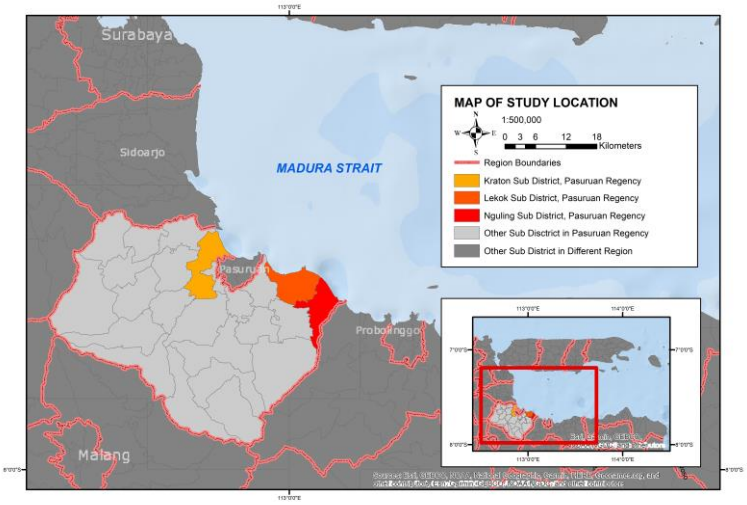

Fig. 1. Map of the study area

Respondents in this study were small-scale fishers with 1-3 GT fleets using trap fishing gear with a population of 1,095. Of the total population, 92 people were used as respondents for interviews in this study. Determination of the number of samples using the Taro Yamane formula:

$$n = \frac{N}{1+N(e)^2} \qquad (1)$$

Description:

n : The number of samples selected

N : Total population

e : Error rate (10%)

Based on the formula above, the sample calculation is as follows:

$$n = \frac{1095}{1+1095\,(0{,}10)^2}$$

$$n = \frac{1095}{11{,}95}$$

$$n = 91{,}63 \approx 92 \text{ people}$$

Analysis of the management status of crab fisheries was conducted using the EAFM analysis method. This analysis was conducted through an indicator approach and the assessment was conducted using 21 indicators grouped into 6 domains, namely: fish resources, habitat and ecosystem, fishing technology, economic, social, and institutional. Each indicator has different criteria and assessment weights.

Table 1. Criteria for each EAFM indicator

Indicator	Criteria	Value (%)
Domain of fisheries resource		
Catchability of folding fishing trap gear for crab	1 = average catchability of: < 0.078 (tails/plant); < 14.1 (g/plant). 2 = average catchability of: 0.078 - 0.102 (tails/trap); 14.1 - 19.0 (g/trap/plant). 3 = average catchability of : > 0.102 (tail/trap); > 19.0 (g/trap/plant)	45
Trend in fish size	1 = trend in average size of crab caught is getting smaller; 2 = size trend is relatively constant 3 = size trend is getting bigger	25
Crab resource utilisation rate	1 = overfishing exploitation rate (E > 0.5) 2 = under-exploitation rate (E < 0.5) 3 = stable exploitation rate (E = 0.5)	18
Species composition of the catch	1 = less proportion of target (<15% of total volume) 2 = target proportion equal to nontarget (16-30% of total volume) 3 = target proportion more (>31% of total volume)	12
Domain of Habitat		
Waters quality	1 = very high temperature and salinity (temperature and salinity > t and ‰ optimum) 2 = very low temperature and salinity (temperature and salinity < t and ‰ optimum) 3 = temperature and salinity tend to be optimum for the growth / life cycle of crabs (27 - 30 ° C and 30 - 35 ‰)	40
Knowledge of the distribution of crab in waters	1 = unknown (less than 50% of stakeholders know) 2 = known (more than 50% of stakeholders know) but not well managed 3 = known (more than 50% of stakeholders	30

Indicator	Criteria	Value (%)
	know) and well managed	
Crab abundance by depth	1 = number of crab individuals caught < 17 individuals 2 = number of crab individuals caught between 17 - 33 individuals 3 = number of crab individuals caught > 33 individuals	30
Domain of Fishing Techniques		
Modification of fishing gear	1 = > 50% size of species target < Lm 2 = 25-50% size of species target < Lm 3 = < 25% size of species target < Lm	70
Level of capture selectivity	1 = non/lack of selective gear use > 75%; 2 = moderate use of non/lack of selective fishing gear (50-75%); 3 = non/lack of selective gear use < 50%.	30
Domain of Economy		
Asset ownership	1 = asset value reduced (more than 50%) 2 = asset value remains (reduced/increased <50%) 3 = asset value increased (> 50%)	45
Fishery household income	1= less than the average MSE 2 = equal to the average minimum wage 3 = > average minimum wage	30
Demand level	1 = high (all sizes and weights of crab sold/accepted by collectors/miniplant) 2 = medium (a maximum of 50% of the catch that is less than the minimum catch size is accepted by the collector/miniplant) 3 = low (only certain width and weight sizes are accepted by the collector/miniplant)	25
Domain of Social		
Participation of stakeholder	1 = < 50% 2 = 50-100% 3 = 100%	40
Fishermen conflicts	1 = >5 times/year 2 = 2-5 times/year 3 = < 2 times/year	35
Community perceptions of crab	1 = low (community does not know at all/less than 50% know)	25

Indicator	Criteria	Value (%)
fisheries management	2 = aware (>50% aware/know), but not yet applied in the utilisation of crab resources 3 = understand and have been utilised in the utilisation of crab resources	
Domain of Institutions		
Knowledge of and adherence to the principles of responsible fisheries in fisheries management that have been established both formally and non-formally	Formal 1 = ≥ 5 violations of the law occurred in fisheries management; 2 = 2-4 times law violation occurred; 3 = < 2 times of law violation Non-formal 1 = more than 5 violations information, 2 = more than 3 violation information, 3 = no offence information	30
Completeness of the rules of the game in fisheries management	1 = no regulations until fisheries management regulations covering two domains are in place; 2 = regulations are available that cover fisheries management for 3 - 5 domains; 3 = complete regulations are available to support fisheries management of 6 domains	28
Fisheries management plan	1 = no enforcement of the rules of the game; 2 = there is enforcement but it is not effective; 3 = there is enforcement of the rules of the game and effective 1 = there is no Fisheries management plan; 2 = there is a Fisheries management plan but it has not been fully implemented; 3 = there is a Fisheries management plan and it has been fully implemented	20
Level of synergy of fisheries management policies and institutions	Institutions 1 = conflict between institutions (policies between institutions have different interests); 2 = communication between institutions is not effective; 3 = synergy between institutions is good Policy 1= there are conflicting policies; 2 = policies do not support each other;	12

Indicator	Criteria	Value (%)
	3 = policies support each other	
	1 = does not exist	
The existence and role of crab associations	2 = exists but has not played a role 3 = exists and has played a role for the crab fishing community	5
	1 = does not exist	
The existence and role of the crab forum	2 = exists but has not played a role 3 = exists and has played a role for the crab fishing community	5

Source: Modification of **Adrianto *et al.* (2005, 2014)**, **Zhang *et al.* (2009)** and **Kim and Zhang (2011)**.

Analysis using a multi-attribute/criteria approach (EAFM) through the development of this composite index **(Adrianto *et al.*, 2005)** will reflect the linkages between ecosystem management and fisheries management, with the following steps:

1) Scoring (S_{ai}) for each i-th indicator in each domain using Likert scores (ordinal-based 1, 2, 3) in accordance with the performance of the crab fisheries unit and the criteria set for each domain.
2) Determine the weight for each indicator based on the rank (W_i) for each i-th indicator in each domain. The weight is determined according to the degree of influence of the attribute in the domain (0 to 100).
3) Identify the level of connectivity (density) between domains and indicators by determining the dominant score (D_i) from the results of cognitive mapping of linkages between indicators. The value of D_i (i-th indicator density score) can be identified from the number of line linkages that enter the indicator.
4) Perform composite assessment on each jth domain (Cat-1) with a simple formula:

$$C_{at-1} = S_{ai} \times W_i \times D_i \qquad (2)$$

5) Develop an aggregate composite index for all domains (D_j) in the crab fisheries unit/fisheries management area with the following function model: Develop an aggregate composite index for all domains (D_j) in the crab fisheries unit/fisheries management area with the following function model unit/fisheries management area with the following function model

$$C\text{-}_{WPPi} = f\ (D_j, S_{ai}\ ; W_i; D_i) \qquad (3)$$

or formula base for aggregate composite analysis is

$$C\text{-}_{WPPi} = Ave\ D_j = (S_{ai}\ ; W_i; D_i) \qquad (4)$$

Where: Ave Dj = the arithmetic mean of the jth domain of the total multiplication between Sai (score value of the i-th indicator of the j-th domain); Wi (ranking weight of the i-th indicator of the j-th domain); and Di (density score of the i-th indicator).

Each indicator assessed was then analyzed using a simple composite analysis based on arithmetic mean which was then displayed in the form of a flag model diagram, with the criteria presented in Table (2). The composite index is the conversion value of the

total value of each EAFM domain. The total value of the multiplication of EAFM components was converted on a scale of 1 to 100. The scale conversion value of each domain was calculated using the formula:

$$N_{k\text{-}i} = \frac{Cat-i}{Cat-1max} \; x \; 100 \quad (5)$$

Where, $C_{at\text{-}1}$ = the total EAFM score of an attribute/indicator in the domain; and $C_{at\text{-}1max}$ = the maximum score of an attribute/indicator in the domain obtained if all attributes/indicators have a score of 3.

Table 2. Visualization of flag model for EAFM indicators

Score Value	Composite value	Color	Description
1,00 – 1,50	1,00 – 39,99		Poor/Lack
1,51 – 2,50	40,00 – 59,99		Medium
2,51 – 3,00	60,00 – 100,00		Good

Source : **(Adrianto *et al.*, 2014)**

RESULTS AND DISCUSSION

Domain of fisheries resource

The results of the habitat domain analysis show that the composite value of 3,330 and the average indicator score of 2.00 are in the medium (yellow) category (Table 3).

Table 3. Assessment of fisheries resouce domain

	1*	2*	3*	4*	Total
Result	Average catchability was : 0.078 - 0.102 (number/trap); 14.1 - 19.0 (g/trap/setting)	Trend of average size of caught blue swimming crab getting smaller	Exploitation rate over catch (E > 0,5)	Greater proportion of targets (>31% of total volume)	
Score	2	1	2	3	2.00
Value	45	25	18	12	100
Grade	1,800	450	540	540	3,330

Notes:* 1) Catchability of folding trawl gear for crab; 2) Trends in fish size; 3) Crab resource utilization rate, and 4) species composition of the catch.

The indicator of catch species composition was categorized as good. The results of observations on the species composition of the catch showed that the percentage composition of the catch of fish trap was dominated by crab at 85%, while the bycatch was around 15%, consisting of snails (10%) and fish (5%). **Ernawati *et al.* (2014)** stated that the composition of crab catches in Pati waters in the east season was 90%, while in the west season, it was 60% of the total volume of catches. The composition of fish trap catches that landed in Alasdowo was dominated by the type of blue swimming crab

(*Portunus pelagicus*) at 97.6% followed by crucifix crab (*Charybdis feriviatus*) at 1.07% and others at 1.33%.

The indicator of catchability of folding traps for crab and the indicator of the level of resource utilization of crab are in the medium category. The results of the calculation of the proportion between abundance and the number of traps set per unit time showed that the average catchability of folding traps per planting was 0.085 fish/trap or 15.2 grams/trap/setting. On average, Pasuruan Regency crab fishermen carry and install 328 units of folding traps, and the results of interviews with fishermen show that the number of boats and traps per boat is increasing every year. This indicates that, in order to achieve a profitable catch, fishermen had to increase their fishing effort. The exploitation rate of crab in the waters of Pasuruan Regency is 0.31 (E<0.5), indicating that the level of crab utilization is under capture **(Ernawati *et al.*, 2014)**.

The crab size trend indicator is in the poor category. Based on interviews with respondents, it is known that the average size of crab carapace width caught five years ago reached 100-200mm. Based on sampling at the research site, the smallest female carapace width (L_{min}) was 97.7mm and the largest female carapace width (L_{max}) was 142.8mm, while the male L_{min} was 92.7mm and L_{max} was 135.8mm. Carapace width tended to diminish by almost 2.3% compared to carapace width about five years ago at the smallest size. The smallest female weight (W_{min}) was 68 grams, and the largest weight (W_{max}) was 264 grams, while the male W_{min} was 57 grams and W_{max} was 200 grams. Variations in crab size according to **Zairion *et al.* (2015)** can be caused by sex, age, parasites and diseases, water quality, food availability, or loss of limbs.

Domain of habitat

The results of the habitat domain analysis showed that the composite value of 4,500 and the average indicator score of 2.33 were in the medium (yellow) category (Table 4).

Table 4. Assessment of habitat domain

	1*	2*	3*	Total
Result	Optimum temperature and salinity (27 - 30 °C and 30 – 35 ‰)	More than 50% of stakeholders are aware and well managed	Number of blue swimming crab caught >33	
Score	3	2	2	2.33
Value	40	30	30	100
Grade	2,040	1,260	1,200	4,500

Description:* 1) Water Quality; 2) Knowledge of crab distribution in the water, and 3) Abundance of crab by depth.

Indicators of water quality and crab abundance were categorized as good. The temperature at the sampling site ranged from 27.9-33.3°C, while salinity ranged from 23-

30‰. **Ernawati *et al.* (2014)** showed that the temperature conditions (29-20ºC) and salinity (30-32‰) in the northern waters of Java and surrounding areas are still included in the optimum range for living crabs. According to **Ikhwanuddin *et al.* (2012)**, the optimum temperature and salinity for the growth and development of *Portunus pelagicus* larvae in laboratory scale are 30ºC and 30ppt. Research results in the Indian Ocean sub-continent showed that the optimum temperature and salinity for crab development ranged from 28-30ºC and 30-35ppt, respectively **(Ravi & Manisseri, 2013)**. **Potter and De Lestang (2000)** also suggested that the greatest abundance of crabs in their research in southwestern Australia, namely in the Leschenault estuary was found in relatively high salinity and water temperature (30-35ppt and >25ºC).

The indicator of knowledge about the distribution of crabs in the waters is in the medium category. This result shows that most stakeholders know the habitat of crabs but do not know about the life cycle of crabs. Nowadays, there has been no special management of crab habitat in the waters of Pasuruan Regency. The indicator value of crab abundance in the waters of Pasuruan Regency is in the medium category because the average abundance of crabs caught is around 25 fish per catch (17-33 fish per catch), and the proportion of male crabs caught is more than females.

Domain of fishing techniques

The results of the economic domain analysis show that the composite value of 5,340 and the average indicator score of 3.00 are in the good (green) category (Table 5).

Table 5. Assessment of fishing techniques domain

	1*	2*	Total
Result	<25% size of species target < Lm	Use of non-selective fishing gear < 50%	
Score	3	3	3.00
Value	70	30	100
Grade	3,360	1,980	5,340

Description:* 1) Fishing gear modification and 2) Fishing selectivity level.

The indicators of fishing gear modification and level of fishing selectivity are in the good (green) category. Observations showed that the average percentage of target crab carapace width less than Lm (< 107mm) in Pasuruan District waters was 23% and the use of less/non-selective fishing gear was <50% for crab fisheries in Pasuruan District waters. Crab fishing vessels in the waters of Pasuruan Regency are generally made of wood with a length of 7-16 metres, width of 1-2.5 metres and depth of 0.7-1.7 metres. The engine used was a diesel engine with a power of 6-24PK. Crab catching activities were carried out using fish trap fishing gear with a total of around 180-500 fish trap per fisherman. The operation of fish trap was done by 1-2 fishermen per boat. The length of operation was one day per trip (one day fishing). Folding fish trap was the dominant fishing gear used to catch crab in the waters of Pasuruan Regency. The size of the folding fish trap

was 41cm long, 28cm wide, and 16cm high. Folding fish trap was a selective fishing gear in its use. Crab fishing gear found in the waters of Pasuruan Regency consisted of high selectivity fishing gear such as folding fish trap and gill net (crab net).

Domain of eonomy

The results of the economic domain analysis showed that the composite value of 3,195 and the average indicator score of 1.33 were categorized as poor (red) (Table 6).

Table 6. Assessment of economy domain

	1*	**2***	**3***	**Total**
Result	Fixed asset value (less than 50%)	Less than the average minimum wage	High (all sizes and weights sold/accepted by collectors/miniplant)	
Score	2	1	1	1.33
Value	45	30	25	100
Grade	1,800	870	525	3,195

Notes:* 1) Asset ownership; 2) Fishery household income, and 3) Demand level.

The fishery household income indicator and the demand level indicator are classified as poor. The average income of crab fishermen in Pasuruan Regency is Rp. 1,105,366 per month, or still below the minimum wage of Pasuruan Regency. The level of demand for crab in Pasuruan Regency is high, as all sizes and weights of crab caught by fishermen are sold or accepted by collectors and miniplants, therefore this circumstance trigger overexploitation of crab in the waters of Pasuruan Regency. Types of crab and prices are kroyo/ninja crab Rp. 7,000-10,000 per kg, krekeh crab Rp. 5,000 per kg, large crab 150-200 gr Rp. 65,000-75,000 per kg, and small crab <150 gr Rp. 25,000 per kg. The asset ownership indicator is classified as medium. The average change in the value/number of assets of crab capture fisheries businesses in Pasuruan Regency remained relatively constant or growing by <50% per year when compared to the previous year. In general, the increase only occurred in the ownership of crab fishing gear in the form of folding fish trap.

Fluctuations in fish catches are influenced by the number of fishing efforts or trips made **(Ahmad, 2015; Situmorang *et al.*, 2018; Ishak *et al.*, 2020)**. Fluctuations in monthly fish catches are closely related to the fishing season. **Ahmad (2015)** stated that the fishing season is a condition where fishing activities are carried out more intensively compared to other periods of the year. The characteristics of fishermen are influenced by changes in weather or climate **(Gamito *et al.*, 2015; Rahim *et al.*, 2019)** and are affected by changes in the fishing season as well **(Rahim *et al.*, 2019; Rola *et al.*, 2018)**. This affects the catch hence it has an impact on business income **(Rahim *et al.*, 2018, 2019)** and their household economy **(Rahim & Hastuti, 2018; Rahim *et al.*, 2019)**.

Domain of social

The results of the social domain analysis showed that the composite value of 6,685 and the average indicator score of 2.33 were in the medium (yellow) category (Table 7). The indicator of fisheries conflict is classified as good, the indicator of stakeholder participation and the indicator of crab community perception of crab fisheries management are classified as moderate. According to **Sari *et al.* (2010)**, the high intensity of conflict is due to differences in fishing technology, limited territorial area, distribution of target species and the number of fishermen fighting over it. Stakeholder participation in the management of crab fisheries resources in Pasuruan Regency was 65.15%. Stakeholder participation in the preparation of crab management is quite high, ranging from business actors (Asosiasi Perikanan Rajungan Indonesia/APRI), fishermen, collectors, miniplants, universities, research institutions, and local government. The community of crab fishermen in Pasuruan Regency has 80% knowledge about crab management, but until now there is no form of application in the utilisation of crab resources. Conflicts of crab fishermen that occur in Pasuruan Regency are about 1-2 times/year, such as conflicts between minitrawl fishing gear and fish trap in the edge fishing area, and conflicts between fish trap fishermen and purse seine fishermen from outside Pasuruan.

Table 7. Assessment of social domain

	1*	2*	3*	Total
Result	50-100%	More than twice/year	Understand (>50% understand know) not yet implemented	
Score	2	3	2	2.33
Value	40	35	25	100
Grade	2,240	3,045	1,400	6,685

Description:* 1) Stakeholder participation; 2) Fishermen conflict, and 3) Community perception of crab fisheries management.

Domain of institution

The results of the social domain analysis showed that the composite value of 3,768 and the average indicator score of 2.11 were in the medium category (yellow) (Table 8).

Table 8. Assessment of institution domain

	1*	2*	3*	4*	5*	6*	Total
Result	Formal <2 times and Non-formal	There is no regulation and enforcement is not optimal	There is no Fisheries Management Plan yet	Ineffective communication and mutually supportive policies	Exist but has not play a	Exist and play a role	

	>3-5 times				role		
Score	2,5	1,5	1	2,5	2	3	2.11
Value	30	28	20	12	5	5	100
Grade	1,500	798	400	570	200	300	3,768

Description:* 1) Knowledge and compliance with the principles of responsible fisheries in fisheries management that have been established both formally and non-formally; 2) Completeness of the rules of the game in fisheries management; 3) Fisheries management plan; 4) Level of synergy of fisheries management policies and institutions; 5) Existence and role of crab association, and 6) Existence and role of crab forum.

Indicators of knowledge and compliance with the principles of responsible fisheries in fisheries management that have been established both formally and non-formally, indicators of the level of synergy of fisheries management policies and institutions, and indicators of the existence and role of the crab forum are in the good category (green). Formal legal violations occur < 2 times each year, the most cases are violations of fishing lines. Non-formal violations such as violations of the agreement on the boundaries of the fishing area for minitrawl or purse seine fishing gear from outside Pasuruan Regency to the trap fishing area. Synergy between related institutions in crab management has been running, for example between the Pasuruan Regency Fisheries Service with APRI (Indonesian Crab Fisheries Association), research institutions, crab fishermen, collectors, miniplants routinely hold meetings to discuss sustainable crab fisheries management. At the field level, there is no conflict between institutions or stakeholders in the management of crab fisheries, but communication between institutions has not been effective enough. The Crab Fisheries Joint Business Group (KUB) forum has played a role in the management of crab fisheries in Pasuruan Regency, such as marketing information for the community of crab fisheries actors in the region.

The indicator of the completeness of the rules of the game in fisheries management, and the indicator of the existence and role of the crab association are in the medium category (yellow). Currently, the regulation related to crab management is the Decree of the Minister of Maritime Affairs and Fisheries Number 70/KEPMEN-KP/2016 of 2016 concerning the Management Plan for Crab Fisheries in the State Fisheries Management Area of the Republic of Indonesia. In Pasuruan Regency itself, there are no regulations that cover the dimensions of management according to the Ecosystem Approach to Fisheries Management (EAFM). There is already enforcement of the rules of the game but it cannot be implemented effectively due to limited equipment, limited human resources for supervisors, and a weak coordination system between related security agencies. Enforcement of the rules of the game, especially Permen KKP No. 17 of 2021 concerning Management of Lobsters (*Panulirus* spp.), Crabs (*Scylla* spp.), and Blue Swimming Crabs (*Portunus* spp.) in the Territory of the Republic of Indonesia is still limited to reprimands and guidance. According to **Gazali (2019)**, the available rules do

not necessarily guarantee the running of the rules properly but must still be followed and the implementation of law enforcement should run according to the function of the rules. The indicator of crab fisheries management plan is categorized as poor (red). This is because there is no management plan for crab fisheries in the waters of Pasuruan Regency.

Fisheries management can be effective depending on a strong understanding of social and institutional conditions to improve compliance **(Cinner *et al.*, 2012)**. The level of individual fishers, increasing their capacity and participation is an effort to increase support for sustainable management **(McClanahan *et al.*, 2014)**. In this condition, the adoption of management rules will go well due to the increased compliance in fisheries management. Efforts in identifying management problems and issues must be supported by institutional responses **(Makailipessy & Abrahamsz, 2023)**. On the other hand, efforts are needed to organize managers, and management actions. Meanwhile, the successful implementation of community development is highly dependent on the role of government and community **(Paulus & Sobang, 2014; Aprilianti *et al.*, 2015)**, therefore community involvement greatly affects the effectiveness of decision making, especially because the community is the main actor in fisheries management.

The results of the calculation of domain composite values show that the composite values range from 3,060-6,685 with an aggregate composite value of 51.4. The maximum composite value of the EAFM domain is 8,700 and this value can be achieved if all indicators get the maximum score of 3. The results of the analysis of the aggregate composite value and the average indicator score for the entire EAFM domain show that the management of crab fisheries in Pasuruan Regency is classified as a medium category. The contribution of the economic domain in the management of crab fisheries in Pasuruan Regency is low. This is mainly because most of the indicators in the economic domain are below the reference point. In an effort to improve the management of crab fisheries, the improvement of economic domain indicators is a priority. The habitat domain and social domain are the domains with the best value compared to other domains, indicating that the management of crab fisheries from habitat and social aspects is good enough but needs to be improved as well as the fish resources domain, fishing techniques domain, and institutional domain.

To further enhance the scope of ecosystem-based fisheries management, it is suggested that future studies be extended beyond the assessment of the blue swimming crab (*Portunus pelagicus*) to include both native and non-native freshwater fish species with significant economic value, not only for consumption but also for ornamental purposes. Several native Indonesian species have already been recorded, such as the vulnerable freshwater goby *Sicyopus auxilimentus* **(Hasan *et al.*, 2021)**. Economically important non-native species have also been documented, including *Arapaima gigas* **(Fadjar *et al.*, 2019)**, the alligator gar **(Hasan *et al.*, 2020)**, the red devil cichlid *Amphilophus labiatus* **(Jatayu *et al.*, 2023)**, the swordtail fish (*Xiphophorus helleri*)

(Islamy *et al.*, 2025), *Gambusia affinis* or the western mosquitofish **(Syarif *et al.*, 2025)**, and the midas cichlid **(Islamy *et al.*, 2025)**. In addition to the finfish, other aquatic biota such as the mangrove snails have been inventoried **(Islamy & Hasan, 2020; Isroni *et al.*, 2023)** in addition to that aquatic plants have also been studied for their biodiversity and ecological roles **(Islamy *et al.*, 2024)**. These species should be considered in future assessments under the EAFM framework to promote a more holistic understanding of ecosystem dynamics and to support sustainable fisheries development not only in marine but also in freshwater and estuarine ecosystems, as demonstrated in the present study on the crab fisheries of Pasuruan Regency.

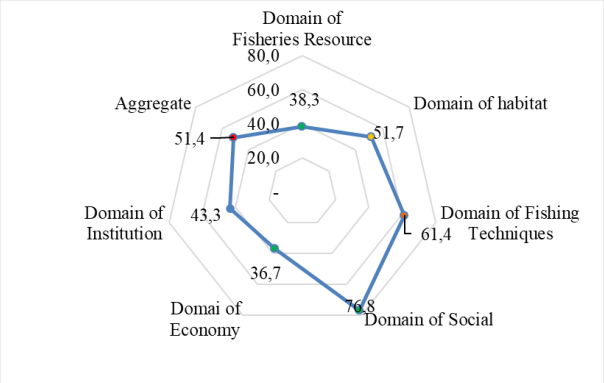

Fig. 2. Diagram of the composite value of each domain in the blue swimming crab management in Pasuruan Regency

CONCLUSION

The study has revealed that the overall status of the blue swimming crab (*Portunus pelagicus*) fisheries management in Pasuruan Regency is categorized as moderate, based on an aggregate composite value of 51.4. It was found that the habitat and social domains are in good condition, while the fisheries resource, fishing technique, and institutional domains were assessed as moderate. The economic domain, however, was identified as poor, indicating that crab fishing activities have not significantly improved fishers' incomes relative to the regional minimum wage.

The findings imply that while certain ecological and social aspects of management have been moderately addressed, substantial gaps remain in the economic and institutional domains. These shortcomings reflect the need for more effective governance mechanisms and income-boosting interventions.

To enhance fisheries management, it is recommended that enforcement of minimum size limits and protection of egg-bearing crabs be strengthened at all supply chain levels. Community understanding of sustainable crab management should be increased through targeted education and outreach programs. Offshore fishing efforts during the lean season should be regulated, and trap mesh sizes should be adjusted to align with legal size

standards. The role of crab associations and forums should be expanded to monitor compliance and resolve conflicts. Economic sustainability is expected to be improved by promoting value-added processing of crab products and implementing firm sanctions for regulation violators. Furthermore, the development and implementation of a comprehensive crab fisheries management plan, supported by systematic resource data collection, are strongly advised.

Through this study, a structured assessment using the EAFM framework has been provided, offering valuable insights to policymakers and stakeholders. It is anticipated that the results will support the formulation of more sustainable, inclusive, and ecosystem-based fisheries management strategies for Pasuruan and similar coastal regions.

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