Management Status of the Lobster (*Panulirus* spp.) Fisheries Based in Prigi Bay, Trenggalek, East Java: A Human Dimension of Ecosystem Approach

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ABSTRACT

The lobster (*Panulirus* spp.) is an important fisheries commodity in Indonesia for local and international markets. The fishing pressure has been significantly increasing, mostly in overexploited states, which will threaten the sustainability of fisheries. The decree of the Minister of Marine Affairs and Fisheries of the Republic of Indonesia, Number 16/PERMEN-KP/2022, focusing on controlling the lobster distribution and legal catch size, is an important management measure by the Indonesian government to protect stock depletion and to achieve the sustainability of the fishery. Meanwhile, socio-economic and institutional aspects play crucial roles in sustainable lobster fisheries. Thus, the ecosystem approach to fisheries management (EAFM) has been widely considered in integrated fishery management status evaluation. This study aimed to assess the management status of the lobster fishery based in Prigi Bay, Trenggalek Regency, East Java. Three aspects of EAFM, i.e. social, economic, and institutional, were used for this study. A field survey and direct interviews with key stakeholders at the study site have been conducted to collect the data. A multi-criteria analysis and composite index were used to analyze the data. This study revealed that: (1) the conflicts between compressor diving to fish lobster and conventional fishing gears (nets and traps) have no resolution yet; (2) there is no local knowledge (customary) implemented for lobster fishery management; (3) income of the household lobster fishers exceeds the East Java Province Minimum Wage (UMP); (4) the lobster fisheries management plan (RPP) in Indonesia is not available yet, particularly in this study area. Finally, based on the aggregate assessment of EAFM, the lobster fishery in Prigi Bay is in a “good” management status. The existing management measures for the lobster fishery in this area should be maintained and improved for the low-score indicators.

INTRODUCTION

The lobster is an important economic fisheries commodity traded in both domestic and global markets. According to the Indonesia National Statistics Agency in the year 2020, there was an increase in lobster export value and volume by 199.03 and 67.93%, respectively. Lobster is one of the priority fisheries commodities that has been managed...
by the decree of the Minister of Marine Affairs and Fisheries (MMAF) of the Republic of Indonesia, Number 16/MMAF/2022, particularly to regulate the legal size and distribution. The high economic value of lobsters and market demand for these fishery products has led to a significant increase in the fishing pressure on lobster resources (WWF, 2015). Most of the lobster market is supplied by capture fisheries, as FishStat FAO data reported that from 2010 to 2018, 99.69% of global lobster production contributed from capture fisheries.

According to MMAF Decree Number 19/MMAF/2022, the utilization level of lobsters in the Indonesian Fisheries Management Area (FMA 573) has been considered to have an over-exploited status with the utilization rate of $E=2.0$. It has the highest utilization level in Indonesia compared to other FMAs. This status indicates that the exploitation rate has been higher than the stock's ability to recover. Several studies confirmed that lobster stock resources have been susceptible to overfishing (Ernawati et al., 2014; Chodrijah et al., 2018; Damora et al., 2018; Zairion et al., 2018; Suman et al., 2019; Kintani et al., 2020).

The Prigi waters are one of the fishing centers of the lobster fishery in FMA 573. The production volume of lobsters has declined in the last ten years. According to the Marine and Fisheries Agency of Trenggalek Regency, the lobster catch volume decreased by 2.3 tons from 4.6 tons in year 2011 to 1.3 tons in 2013. The latest data from 2021 to 2022 showed a further decline of 3.3 tons. The decline in lobster production volume is due to the high fishing intensity in this fishing area. Indeed, this study also indicates a decreasing lobster catch, a decline in the size of the catch, and the fishing ground moving farther from the fishing base. Meanwhile, the market demand for lobsters continues to rise, increasing the pressure on the resource stocks.

Fisheries represent an economic system that utilizes fish resources. The fisheries activities are strongly related to socio-economic and institutional conditions (FAO, 2003b; Charles, 2023). In terms of social aspects, disparities in capacity among fishing methods (gears) promote conflicts among fishers. In this study area, significantly high catch volume of compressor diving fishers compared to conventional fishing gear of lobster nets and traps, leads to conflicts with conventional fishing gear (nets and traps). The elevated catch of compressor diving results in higher incomes than lobster net and trap fishers. Resolving socio-economic conflicts depends on stakeholders engagement. The socio-economic aspects in fisheries management fundamentally involve regulating human behavior through governance to achieve management objectives.

To achieve sustainable fisheries management requires up-to-date and sufficient data and information. However, the availability of scientific data and information are limited in the study area. In fact, since the implementation of the MMAF Decree No 17/MMAF/2021, and then revised by MMAF Decree Number 16/MMAF/2022, there have been no studies focusing on evaluating the status of lobster fisheries management in Prigi water.
This research was conducted by means of an integrated approach that involved fishery resource, socio-economic, and institutional aspects in the frame of the EAFM (Ecosystem Approach to Fisheries Management). Basically, EAFM consists of three main aspects as fisheries system of Charles (2023), namely the natural system, human system, and governance system. The human system is a condition in which all members of society can determine and meet their needs and have a large range of choices to meet their potential (FAO, 2003a). According to FAO (2009), the human system should consider: (1) the power relations between different groups of stakeholders; (2) the aquatic ecosystem services; (3) the legal, policy, and institutional legal frameworks; (4) the socio-economic context of the fishery system, including employment and livelihoods, the economic status of the fisheries, trade and global market, distributional and equity issues, poverty and vulnerability, and gender.

Previously, the studies on lobster fisheries in Prigi have been conducted partially, focusing on resource aspects such as scalloped spiny lobster restocking (Nurfiarini et al., 2016), feeding habits (Wijaya et al., 2018), lobster stock estimation, and utiliz levels of lobsters (Nurfiarini & Wijaya, 2019) and species diversity (Setyanto & Halimah, 2019; Setyanto et al., 2019). Based on the EAFM approach evaluation, this study provides recommendations for management measures to achieve sustainable lobster fisheries in Prigi Bay.

MATERIALS AND METHODS

Data collection

This research was conducted in January 2023 at Prigi Bay, Trenggalek, East Java (Fig. 1). Data were collected through direct surveys and interviews, statistical data on lobster fisheries from the Provincial Marine and Fisheries Agency, and literature studies. Respondents were selected using purposive sampling. Respondents included lobster fishers, lobster collectors, fishing community leaders, officials of the Trenggalek Marine and Fisheries Agency (DKP), Pelabuhan Perikanan Nusantara/Nusantara Fishing Port (PPN) Prigi and the Marine and Fisheries Resources Surveillance (PSDKP). The respondent sample consisted of 23 lobster fishers, three fish collectors, and three government officials (DKP, PPN, PSDKP).

There are three domains (aspects) of EAFM used in this study: social, economic, and institutional. Data collection and data analyses in this study were conducted following the guidance of the "Module of Ecosystem Approach to Fisheries Management Indicator" regulated by the Directorate of Fish Resources, Directorate General of Capture Fisheries, Ministry of Maritime Affairs and Fisheries (NWG EAFM, 2014).
The economic domain consists of 3 indicators: (1) asset ownership, (2) Fisher Household Income (RTP), and (3) savings ratio. Asset ownership indicator was measured based on the assets owned by lobster fisher over a 3-year period. Fisher's income indicator resulted from the data of the monthly income of lobster fishers. The fishers' income data were then compared with the East Java Provincial Minimum Wage (UMP) for Trenggalek Regency area. The savings ratio indicator was derived from the total income and expenditures of the fisher. This ratio was then compared with the standard of loan interest rate of the National Central Bank (Bank Indonesia).

The social domain consists of 3 indicators: (1) stakeholders participation, (2) fisheries conflicts, and (3) local community knowledge of fisheries management. Stakeholders participation indicator was measured by the frequency of stakeholders active participation in fisheries management activities. Fisheries conflict indicator was measured by the total frequency of conflict in fish resource utilization per year in the fisheries. Local community knowledge utilized for fisheries management was measured by the availability and effectiveness of local knowledge in the lobster fisheries resource management.

The institutional domain consists of 6 indicators: (1) compliance with responsible fisheries principles, (2) completeness regulations, (3) decision-making mechanisms, (4) fisheries management plans, (5) policy and institutional synergy, and (6) stakeholders capacity. Measurement of these indicators were conducted by interviews with fishing community leaders, DKP and PSDKP. The interviews gathered information on the number and intensity of violations, implemented management regulations, decision-makers involved in fisheries management measures, training and activities to enhance stakeholders competencies. Additionally, interviews with lobster fishers were conducted to assess the impact of the government's extension and capacity-building programs.
Data analyses

Indicator assessment

The indicators for each aspect were analyzed by a multi-criteria analysis (MCA) approach using a Likert-scale based on composite scores of ordinal 1, 2, and 3. The stages of assessment were: (1) identifying the criteria for each indicator; (2) scoring for each performance indicator (Ordinal-based Likert score 1, 2, 3); (3) determining the weight of each indicator; (4) determination of index value; and (5) determination of composite value. The index value for each indicator was calculated using the formula (NWG EAFM, 2014):

\[ \text{Index value} = \text{score} \times 100 \times \text{weight} \]  

(1)

The composite value was calculated using the formula (NWG EAFM, 2014):

\[ NK_i = \frac{C_{at-i}}{C_{at-max}} \times 100 \]  

(2)

Where,

- \( NK_i \) = Composite value in the \( i^{th} \) aspect
- \( C_{at-i} \) = Total value of all indicators in the \( i^{th} \) aspect
- \( C_{at-max} \) = Maximum value among all indicators in the \( i^{th} \) aspect

<table>
<thead>
<tr>
<th>No</th>
<th>Indicator</th>
<th>Criteria</th>
<th>Weight</th>
</tr>
</thead>
</table>
| 1  | Asset ownership | 1= Decrease in asset value (over 50%)  
2= Stable asset value  
3= Increase in asset value (above 50%) | 35 |
| 2  | Household fishers income and UMP (Provincial Minimum Wage) | 1 = < UMP  
2 = Equal to average UMP  
3 = > UMP | 20 |
| 3  | Saving ratio | 1= < interest rate  
2= Equal to interest rate  
3= > interest rate | 45 |
| 1  | Stakeholders participation | 1= < 50%  
2= 50-100%  
3= 100% | 40 |
| 2  | Fisheries conflict | 1= > 5 times/year | 35 |
The composite values analysis result is presented as a flag model (Error! Reference source not found.). The flag model depicts the condition of fisheries management in categories such as excellent, good, moderate, poor, and bad.


Table 2. Composite score and criteria for fisheries management condition (management status)

<table>
<thead>
<tr>
<th>Composite score</th>
<th>Flag model</th>
<th>Description (Status)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-20</td>
<td>Red</td>
<td>Bad</td>
</tr>
<tr>
<td>21-40</td>
<td>Yellow</td>
<td>Poor</td>
</tr>
<tr>
<td>41-60</td>
<td>Yellow</td>
<td>Moderate</td>
</tr>
<tr>
<td>61-80</td>
<td>Green</td>
<td>Good</td>
</tr>
<tr>
<td>81-100</td>
<td>Green</td>
<td>Excellent</td>
</tr>
</tbody>
</table>

Source: (NWG EAFM, 2014)

RESULTS

Evaluation of lobster fisheries management status

1) Economic aspect

The result of analysis of the composite score for the economic aspect was 88.33%, recording a “very good” category (Table 3). The indicator of productive asset ownership among lobster fishers in Prigi Bay was relatively stable over the past three years. There has been no addition of fishing vessels or boat engines, only an increase in fishing gear assets due to the replacement of damaged gear. About 23% of the fisher respondents have increased their productive assets resulting from the lobster fishing activities. The additional fisher assets were: fishing gears, smartphone, refrigerators, motorcycles, home renovations, and additional business capital.

The indicator of fisheries household income relative to the Provincial Minimum Wage (UMP) was a “good” category. According to the East Java Governor's Decree Number 188/889/KPTS/013/2022, the minimum wage for Trenggalek regency in 2023 was IDR 2,139,426.01. The analysis for this indicator showed that 95% of lobster fisher's household income was higher than the UMP.

Fishers in Prigi Bay use two types of fishing gear to catch the lobster, i.e.: lobster nets and lobster traps (local name is 'krendet'). Additionally, there were fishers who originated from other area, e.g. from West Nusa Tenggara Province lobsters catch in the Prigi Bay using compressor diving techniques. The fishers income resulting from the lobster capture using lobster nets was about IDR 150,000-300,000/trip, while using 'krendet' lobster traps was about IDR 500,000-700,000/trip. Meanwhile, the income of the compressor diving fisher was about IDR 5,000,000-7,000,000/trip. The frequency trips for lobster net and 'krendet was 10 trips/month. The frequency trip of the compressor diving fishers was about 3 trips/week (12 trips/month), with 1-2 diving sessions per trip. This research did not account for income outside the lobster fishing.

Prigi Bay fishers have additional income sources from agricultural activities, such as cultivating cloves, durian, and coconuts. The average income from cloves and durian was about IDR 10 million per season, while from coconuts, it is about IDR 3 million per year.
The savings ratio indicator was higher than the interest rate, indicating that the prosperity level of the fisher is “relatively good”. About 91% of fishers have the capacity to save their income due to the higher income compared to expenditures. However, they were lacking the willingness to save their income or to own a low saving culture.

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Score</th>
<th>Index value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asset ownership</td>
<td>2</td>
<td>70</td>
</tr>
<tr>
<td>Household fisheries income</td>
<td>3</td>
<td>50</td>
</tr>
<tr>
<td>Saving ratio</td>
<td>3</td>
<td>135</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>265</td>
</tr>
<tr>
<td>Aspect maximum value</td>
<td></td>
<td>300</td>
</tr>
<tr>
<td>Aspect composite value</td>
<td></td>
<td>88.33</td>
</tr>
</tbody>
</table>

**Table 3.** Composite assessment results of economic aspect

2) **Social aspect**

The composite score for the social aspect was 71.66% or in a “good” category (Table 4). For the stakeholders' participation indicator, all stakeholders have actively participated in lobster fisheries management efforts in Prigi Bay. According to the respondent, some activities should be conducted to support resource management efforts, including extension and dissemination in aspect of resource management, coral reef conservation, protection of mangrove ecosystem, eco-friendly fishing gear, and banning to use the potassium cyanide. Training or capacity building technique is mandatory for constructing lobster gillnet and repairing boat engine. Additionally, monthly equipment and vessel inspections at PPN Prigi should be regularly conducted. Fisheries extension officers (FEOs) are involved in every meeting organized by the fisher's groups. Stakeholders participating in lobster fisheries management were: regency and provincial Marine and Fisheries Agency (DKP), fisheries extension officers (FEOs), Marine and Fisheries Resource Surveillance Agency (PSDKP), marine police, fishers, leaders of fisher groups, Community Surveillance Group (Pokmaswas), prosecutors, and harbor master (‘syahbandar').

For the lobster fisheries conflict indicator in Prigi, conflicts occurred in 2020-2021 involving the prosecutor's office. Fishing gear conflict emerged between compressor diving and conventional fishers (lobster nets and lobster traps). Mediations were conducted at the city and provincial government levels to resolve these conflicts. However, conflict resolution program still needs to be regularly conducted. The conflicts are mostly due to social jealousy due to income disparities.

For the indicator of utilizing local knowledge for lobster resource management, there was no local knowledge (customary) implemented for lobster fishery management in Prigi Bay. Moreover, there was no customary fisheries law in the area. On the other hand, most fishers comply with regulations concerning the lobster legal size (MMAF Decree No 16 year 2022).
Table 4. Composite assessment results of social aspect

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Score</th>
<th>Index value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stakeholder participation</td>
<td>3</td>
<td>120</td>
</tr>
<tr>
<td>Fisheries conflict</td>
<td>2</td>
<td>70</td>
</tr>
<tr>
<td>Local knowledge</td>
<td>1</td>
<td>25</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>215</strong></td>
</tr>
<tr>
<td><strong>Aspect maximum value</strong></td>
<td></td>
<td><strong>300</strong></td>
</tr>
<tr>
<td><strong>Aspect composite value</strong></td>
<td></td>
<td><strong>71.66</strong></td>
</tr>
</tbody>
</table>

3) Institutional aspect

The composite score for the institutional aspect was 79.36% or a “good” category (Table 5). Related to the indicator of compliance with responsible fisheries principles, no information on law violations was recorded in the last 5 years. Although data from the Trenggalek District Fisheries Agency (DKP) and the Marine and Fisheries Resource Surveillance Agency (PSDKP) indicated no violation, field observations revealed that destructive and illegal fishing practices occurred. Illegal fishing involves compressor diving fishers, posing risks to diver safety. Destructive fishing refers to capturing lobsters using potassium cyanide. When compressor divers catch the lobsters during the daytime, cyanide use is suspected.

The indicator of the availability of regulations in Prigi covers three domains. Two regulations contribute to regulatory completeness, i.e. MMAF Decree No. 16/MMAF/2022 and Act (UU) No. 45/2009. In the MMAF Decree No. 16/MMAF/2022, Article 9, paragraph 1 covers two aspects: the fisheries resources aspect (legal catch sizes) and the institutional aspect (distribution supervision). Meanwhile, the Indonesian Fisheries Act (UU) No 45 year 2009 prohibits using compressors diving for fishing, covering the fishing technique aspect. The management of lobster fisheries in Prigi is regulated by national government laws, as there is no local government regulation in place.

The implementation of law enforcement has yet to be effective. Although there are equipment (PSDKP and Marine Police vessels) and personnel (PSDKP, Marine Police, Navy) involved in enforcement efforts, not all cases can be addressed. The enforcement methods applied involve warnings and admonitions. In the indicator of decision-making mechanisms, it is considered good as it involves all stakeholders. The decision-making mechanism, involving all stakeholders, operates effectively. In one case, a conflict between gillnet fishers and compressor diving fishing occurred, resulting in an agreement on an operation time for each fishing gear. The agreement to conflict resolution has been fully complied by the compressor diving fishers, who conduct lobster fishing only at night.

Related to the management of lobster fisheries, the Fisheries Management Plan (FMP/RPP) for lobsters in Indonesian waters has yet to be officially available. The
government has issued regulations, such as MMAF Decree No. 16/MMAF/2022 as one of the management measures to manage lobster fisheries. Furthermore, the FMP is essential to achieve responsible lobster fisheries. The document draft of the FMP for lobsters fishery in Indonesia is in the formulation process.

It is considered “fairly good” in the indicator of the policy and institutional synergy level. Following the local government regulation, the change in authority for fisheries management from the district government to the provincial government has significantly affected the lobster fisheries management in the study area. The Trenggalek District Fisheries Agency (DKP) has no authority to manage the marine fisheries. The district governance need directions from the provincial and central government authorities. Thus, the activities and government program for lobster fisheries have been significantly decreased. The change in authority has caused a gap in actions between the district and provincial governments, leading to less effective synergy.

In the stakeholder capacity indicator, it is considered a “good” category. The local government conducts socialization and training to support the fisher's capacity and knowledge. The content of the capacity building should be as follows: the legal fishing size of lobsters; the prohibition of using destructive, illegal, and environmentally unfriendly fishing gears; coral reef and mangrove conservation. The training covers: net installation, boat engine repair, catch handling, and fish product processing. The result of socialization and training programs have been beneficial and implemented by fishers. However, the illegal fishing practice, particularly catching the juvenile lobster, is lower than the legal size due to economic reasons. Improving fisher's capacity and knowledge is expected to increase their awareness of the sustainability of lobster resources, particularly for their prosperity.

Table 5. Composite assessment results of institutional aspect

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Score</th>
<th>Index value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compliance with responsible fishing principles</td>
<td>3</td>
<td>75</td>
</tr>
<tr>
<td>Availability of regulations</td>
<td>1.8</td>
<td>40</td>
</tr>
<tr>
<td>Decision-making mechanism</td>
<td>3</td>
<td>54</td>
</tr>
<tr>
<td>Fisheries management plan</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>Policy-institution synergy</td>
<td>2.5</td>
<td>28</td>
</tr>
<tr>
<td>Stakeholder capacity</td>
<td>3</td>
<td>27</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>238</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Aspect maximum value</th>
<th>Aspect composite value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>300</td>
<td>79.36</td>
</tr>
</tbody>
</table>

**Aggregate results of lobster fisheries management using EAFM**

The assessment scores for indicators in each aspect (economic, social, institutional) fall within the range of 1- 3. Indicators with values of 1 and 2 ‘need improvement’, while those with a value of 3 ‘should be maintained’.
Management Status of Panulirus spp. Fisheries Based in Prigi Bay, Trenggalek, East Java

1) Economic aspect

Two factors that influence lobster fisher's income are the lobster prices and additional sources of income. The species, size, and quality of the lobster determines the price of lobsters. Presently, at the lobster collector, the price of ornate spiny lobsters is IDR 1,000,000/kg, scalloped spiny lobsters is IDR 600,000/kg, and the price of other species is IDR 450,000/kg. Furthermore, the high price of the scalloped spiny lobsters, which are the dominant catch species in Prigi Bay, significantly contributes to the fisher's income.

2) Social aspect

3) Institutional aspect

The aggregate assessment of EAFM indicators of the three aspects (economic, social, institutional) indicates that lobster fisheries management based in Prigi Bay was in a “good” status. The assessment composite score was 79.78 (Table 6). The existing management measures for the lobster fishery in this area should be maintained and improved for the low score indicator.

Table 6. Assessment results of lobster fisheries management status in Prigi Bay

<table>
<thead>
<tr>
<th>Aspects</th>
<th>Composite score</th>
<th>Flag</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social</td>
<td>71.66</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Economic</td>
<td>88.33</td>
<td>Excellent</td>
<td>Excellent</td>
</tr>
<tr>
<td>Institutional</td>
<td>79.36</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Aggregate</td>
<td>79.78</td>
<td>Good</td>
<td>Good</td>
</tr>
</tbody>
</table>

DISCUSSION

Evaluation of lobster fisheries management status using EAFM

1) Economic aspect

Two factors that influence lobster fisher's income are the lobster prices and additional sources of income. The species, size, and quality of the lobster determines the price of lobsters. Presently, at the lobster collector, the price of ornate spiny lobsters is IDR 1,000,000/kg, scalloped spiny lobsters is IDR 600,000/kg, and the price of other species is IDR 450,000/kg. Furthermore, the high price of the scalloped spiny lobsters, which are the dominant catch species in Prigi Bay, significantly contributes to the fisher's income.
income (Setyanto & Halimah, 2019). Meanwhile, factors influencing fisher's income are fishing ground distance, fishing trip duration, weather, and wave conditions (fishing difficulty) (Mardhatillah et al., 2023). Additional source of income for the lobster fishers comes from the agriculture sector, which is suitable for growing in the Prigi with mountains and coastal topography areas. Fishers conduct agricultural activities as an additional source of income, such as cloves, durian, and coconuts plantation (Akbarsyah et al., 2017).

Compressor diving fishers can catch larger size of lobsters compared to other fishing gear (Gordula et al., 2022). The lobster caught by compressor diving during the peak season and in good weather conditions can reach up to 50kg/trip (equivalent to IDR 5,000,000- 7,000,000), while in bad weather conditions, they get only 10kg/trip. Thus, the income of the compressor diving fishers is significantly higher than that of the conventional fishing gear fishers. The compressor is a diver’s device, which has been considered illegal because it is unsafe for the diving fisher. The compressor used is mostly a tire patch tube. Exhaust gases from the combustion process are stored in the compressor, causing the fisher to inhale the combustion products (carbon monoxide/CO, nitrogen dioxide/NO2). Consequently, the divers suffer with symptoms such as headaches, dizziness, reduced hearing, chest pain, joint/muscle pain, and nosebleeds (Affan et al., 2022).

Despite the lobster fishers have relatively high income, they lack of saving culture. The lifestyle of the fishers appear extravagant during the peak fishing season, and they are not willing to save their income, while during the famine season, they often borrow from the middlemen for their household needs. Therefore, efforts need to enhance fisher awareness of financial management, particularly the importance of saving (Retnowati, 2011).

2) Social aspect

The level of stakeholder engagement plays a crucial role in the success of fisheries management. The higher the level of stakeholders engagement, the greater the likelihood of successful fisheries management (NWG EAFM, 2014). Stakeholder participation could be increased by implementing co-management (FAO, 2003b). The synergy among stakeholders is important to avoid conflicts. Conflicts among fishing gears in Prigi Bay are primarily due to disparity income. The conflicts emerge from technological disparities that provoke competition, leading to a tendency to catch as much fish as possible (Charles, 2023). These conflicts persist since conventional lobster fishers cannot match their competitors in terms of skills and capital (Retnowati, 2011). Another factor in the ecosystem approach to lobster fisheries management in Prigi Bay is the lack of local knowledge (customary law). The success of fisheries management is also measured by the availability and effectiveness of local knowledge (NWG EAFM, 2014).

3) Institutional aspect
The institutions framework plays a crucial role in sustainable fisheries governance. The harmonization among EAFM components as the main goal of the governance systems is measured by ecosystem health and the well-being of actors involved in fisheries management (FAO, 2003b). Illegal lobster fishing activities are still observed in the Prigi Bay, even though they might not be officially recorded. The government needs to enhance surveillance and law enforcement measures. Furthermore, the strengthening collaboration among stakeholders is mandatory to monitor the utilization of lobster resources (FAO, 2003; Mulyana, 2018). Decision-making should be formulated based on the aspirations of fishers and other stakeholders through collaborative agreements. Thus, government decisions can be effectively implemented (Nugraheni, 2016).

As an official guideline for the sustainable management of lobster fisheries, a management plan is required by all parties, as in the case of the blue swimming crab in the pati water (Nugraheni, 2016), and groupers fisheries in Karimun Java National Park (Sulistyowatia et al., 2018). In a fisheries management plan document (RPP), there are main elements regarding resource status and management action plans that are formulated based on main issues and problems. In the framework of EAFM, fisheries resources, socio-economic, and governance aspects (the MMAF Decree No 22/MMAF/2021) are included. The primary problem of lobster fisheries is the degradation of lobster stock resources, indicated by the decreasing catch size. Based on interviews with local fishers in 2017, the average catch size of lobster reached 600 to 900 grams/individual, and even the pronghorn spiny lobster caught was over 1000 grams/individual. However, the captured lobsters are now getting smaller, less than 500 grams/individual, ranging from 300 to 500 grams/individual.

**Recommendation of management measures**

1) **Economic aspect**

The indicators with the lowest economic value are low asset ownership and the saving ratio. To address these problems, this study recommends several management options, namely: (1) conducting extension and training on financial management in managing assets, particularly saving management; (2) reactivating joint business groups; (3) training on fish product processing for the wives of fisher; (4) conducting training on fish product marketing using offline and online technology, and (5) increasing the market value of lobsters through improving the catch handling skills (e.g. releasing lobsters from traps). Lobster deformities result in decreasing it's market value. As a follow-up financial management training, fishers would establish a community group to monitor the implementation of the training module. The monitoring should be regularly conducted until the fishers have the capacity and independently implement the financial management.

2) **Social aspect**
The utilization of local knowledge in lobster resource management and fisheries conflicts are the lowest indicator in social aspect. Thus, this study recommends several management options to improve the sustainability of lobster fisheries in Prigi Bay. First, conducting extension programs to increase fishers' understanding and awareness of the importance of not catching undersized lobsters is essential. Second, enhancing the synergy between POKMASWAS (Community Surveillance Group) and other stakeholders will help reduce the frequency of conflicts. Finally, incorporating local knowledge into fisheries management practices, particularly for lobster fisheries, should be initiated to ensure more effective and sustainable practices.

3) Institutional aspect

The availability of lobster fisheries management plan and the completeness of regulation for lobster fisheries management are the lowest indicator for institutional aspect of EAFM. Thus, several management options is recommended: (1) proper regulation implementation and law enforcement through increasing surveillance action; (2) conducting socialization and extension program particularly on sustainable lobster fisheries regulation, focusing also on illegal fishing gears and consequences; (3) conducting lobster data collection and study to support the lobster Fisheries Management Plan (RPP) regulation; and (4) strengthening collaboration between district and provincial government authority in sustainable management lobster fisheries in Prigi.

CONCLUSION

In terms of the human dimension aspect, the lobster fisheries management based in Prigi was generally in a “good” status. The existing management measures for the lobster fishery in this area should be maintained and improved particularly for the low score indicators. There are two indicators that have a lowest score in the EAFM assessment, namely: the utilization of local knowledge in fisheries management (social aspect) and the availability of the lobster fisheries management plans (institutional aspect). Thus, this study recommends initiating local knowledge for lobster fisheries management, and supporting the formulation of the lobster fisheries management plan, e.g. improving catch data collection.

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