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Ecosystem Approach to Fisheries Management in Palabuhanratu Nusantara Fishing Port: Evaluation and Development Strategy

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ABSTRACT

The Indonesian fisheries are fully utilized compared to the estimated total allowable catch, which indicates that fishing activity should be monitored and maintained carefully. This study aims to evaluate how deep the fishing practices of Palabuhanratu Nusantara Fishing Port have been managed sustainably based on indicators in the Ecosystem Approach to Fisheries Management (EAFM). The method used is a field survey using composite analysis and flag modelling visualization techniques. This method will assess the EAFM indicator as a multi-criteria system that ends in a composite index in a score of values related to the level of achievement or sustainability of fisheries management by EAFM principles. The findings demonstrate that Palabuhanratu Nusantara Fishing Port fisheries management effectively promotes sustainable fisheries management with a composite value of 67,68. Then the strategies for developing and strengthening the sustainability of fisheries management at Palabuhanratu Nusantara Fishing Port are: limiting fishing efforts and the minimum size of fish that can be caught; socializing and educating the principles of sustainable fisheries management; enforcing the law and providing strict sanctions indiscriminately; providing access to capital with easy guarantees and profitable process; increasing the quantity and quality of the fish processing industry; optimizing the usage of technology in fisheries management. It is hoped that similar research can be carried out, at least at the coastal fishing port to ocean fishing port, as one of the bases for determining the sustainability of fisheries management at a broader level.

Keywords: Development; EAFM; Evaluation; Palabuhanratu

INTRODUCTION

The Decree of the Minister of Marine Affairs and Fisheries of the Republic of Indonesia Number 50 of 2017 stated that most marine Fish resources in Indonesia are categorized at a highly exploited level. This level generally indicated that fishing efforts should be maintained with strict monitoring. The condition is also the same for FMA 573, an area where Palabuhanratu fishers where fishing activities and their management must be managed optimally to generate sustainable and beneficial values. The utilization of fishery resources in an optimal, continuous, and sustainable manner is an urgent demand for the prosperity of the people, especially to improve the welfare of fishers and coastal communities (Sutaman et al., 2017). However, the fisher community is one of the social groups of the population or community who have been marginalized socially, economically, and politically, identified as poor and having the lowest income apart from farmers (Anwar et al., 2019). Fishing communities might not be “economically” (in the income-poverty sense) worse off than other rural communities, but it is conceivable that they suffer from higher vulnerability (Bene, 2006). This situation indicates that the fisheries management process has not been carried out optimally by implementing the principles of sustainable fisheries management.

In addition, from an environmental aspect, the development of coastal areas to support the activities of the fishing, tourism, and trade industries still does not pay attention to environmental quality. In this context, FAO (1995) described several principles that must be considered in implementing fisheries management with an ecosystem approach (EAF). There are five components, i.e.: (1) fisheries must be managed at limits that have a minimal impact on the

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ecosystem; (2) maintaining ecological interactions between fish resources and their ecosystems must be maintained; (3 management tools should be appropriate and can be used for all distribution of fish resources; (4) precautionary principles in the fisheries management decision-making process; and (5) fisheries governance includes the interests of ecological systems and human systems. The ecosystems that become their habitats and the processes associated with them are the main studies in EAFM, so this approach differs from previously used, such as the Rappfish approach. However, the studies in EAFM do not stop there but also discuss the relationship between fishing activities and the ecosystem, including social impacts and the resulting economy (FAO, 1995).

The location of this research was chosen because capture fisheries in Sukabumi Regency have a strategic role as one of the capture fisheries management centers in West Java, with a fishing ground of 702 km2 and a coastline of 117 km or about 28% of the total length of the southern coast of West Java (Badan Pusat Statistik, 2018). Fishing activities are carried out around the Indian Ocean, part of FMA 573, with potential tuna resources, especially yellowfin and bigeye (Nurani et al., 2018). This research was conducted to analyze whether fisheries management practices at Palabuhanratu Nusantara Fishing Port have been managed sustainably based on the existing indicators in the EAFM. The scope of the assessment is also carried out at a fishing port, an integrated area between fishing activities, processing, and buying and selling fishery products. The fisheries management by a technical implementing unit represents the government regulating, implementing, and supervising fishery management activities in an area. Therefore, the assessment would also involve respondents from various related stakeholders, such as fishermen, port officials, and business people.

It is hoped that by considering the matters, the results will provide a more comprehensive EAFM assessment to describe the sustainability of fisheries management in an integrated area determined by the government, especially fishing ports. This finding will certainly be instrumental and support the government in measuring fisheries management sustainability throughout Indonesia, consisting of 592 fishing ports throughout Indonesia. Furthermore, this result follows the previous research of Pomeroy et al. (2013), which states that increasing the scale of the area or area for the EAFM assessment can support international, regional, and sub-regional fisheries management plans.

MATERIAL AND METHODS

Period and Location

The research was conducted from March 2019 to January 2020. The research location was in the Palabuhanratu Nusantara Fishing Port area, which

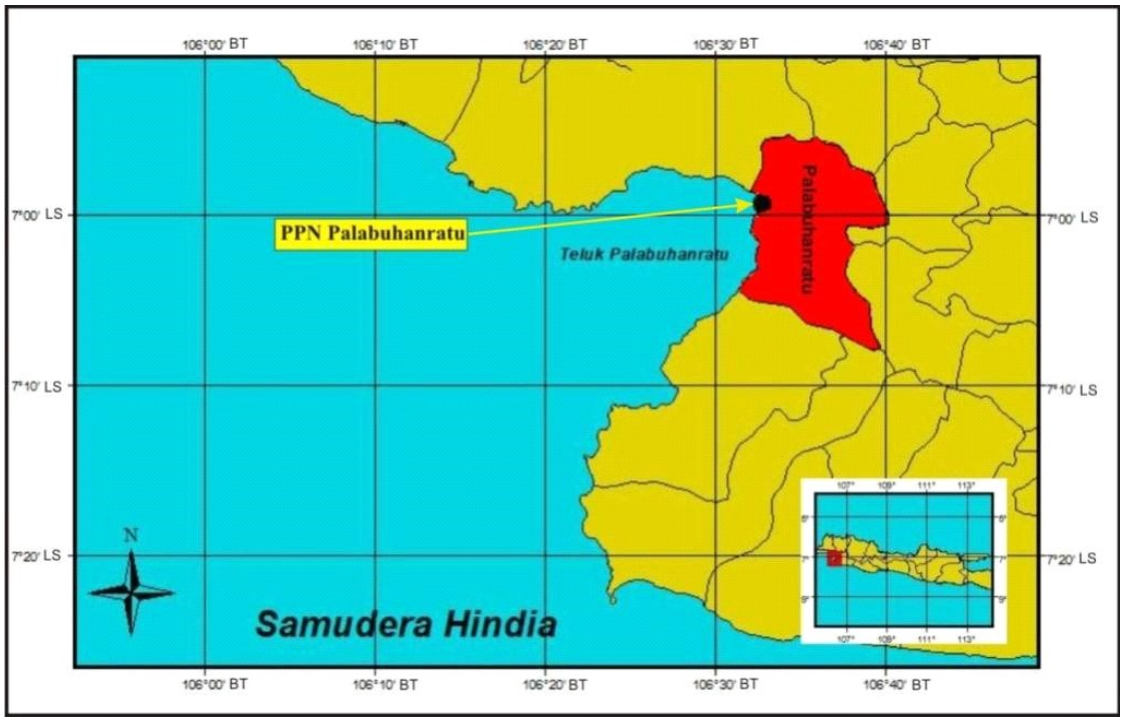


Figure 1. Research site (Source: Lubis et.al, 2012)

includes management activities by a government officer, fishing activity, and processing of fish products, including the trading process.

Type and Source of the Data

The sampling technique used in this study was purposive sampling and proportional sampling. Primary data were obtained from field observations, questionnaires, and interviews with respondents from various stakeholders of the fishing port, such as fishermen, port managers, and entrepreneurs who run their businesses. Fishers were grouped by vessel size and traders clustered according to number of employees. In addition, secondary data is obtained from annual statistical reports, fishery logbooks, and other relevant data and information.

In the fish resource domain, the time series data for at least the last three years, which contains the volume of catches and fishing trips, is needed to calculate CpUE. Then to determine the trend of fish size, the proportion of juvenile fish, catch composition, range collapse, and ETP species, data on the size or weight of each type of fish caught during the last four months at least and the coordinates of the fishing location are needed. All these data can be obtained from logbooks or annual reports of fishing ports. In the domain of habitats and aquatic ecosystems, the data used are primary data from measurements for water quality indicators; relevant research data for the quality of mangrove, seagrass, and coral reef ecosystems; and questionnaire data for specific habitat indicators and climate change on water conditions. Then for assessing other domains, most of the data used are the results of interviews and questionnaires.

Data Analysis

The methods used in this research are the survey method using composite analysis with flag modelling visualization techniques and the gap analysis method. This method will assess the EAFM indicator as a multi-criteria system that ends in a composite index related to the sustainability of fisheries management by EAFM principles. The composite value and the flag model have respective descriptions that indicate the level of EAFM application in fisheries management activities. Other terms indicate the status of the sustainability of fisheries management in the region or area. The measurement score for each indicator then scaled and multiplied by the weight and density according to the EAFM assessment guidelines from the government. The result then divided by the maximum score that can be obtained (when the scale reaches 3) and multiplied by a value of 100. In simple terms, the formula for calculating the composite value of each indicator is explained as follows.

$$CI\text{-}i = \frac{Si \times Wi \times Di}{Cat\text{-}i\ max} \times 100$$

Note:

CI-*i*	= composite value of the *i* indicator
Si	= score/ rating scale of the *i* indicator
Wi	= weight of the *i* indicator
Di	= density of the *i* indicator
Cat-i max	= maximum score of the *i* indicator

Table 1. Visualization of the flag model for EAFM indicators

Composite Value	Flag Model	Description
1 – 20		Poor
21 – 40		Less
41 – 60		Moderate
61 – 80		Good
81 - 100		Excellent

Then the gap analysis method is used to determine strategies for developing and strengthening the sustainability of fisheries management by comparing the current conditions obtained from the assessment results using EAFM with the expected ideal conditions.

RESULT AND DISCUSSION

In general, from 2015 to 2019, the volume of fish landed at Palabuhanratu Nusantara Fishing Port decreased significantly. This decreasing volume is probably due to a government policy that fishing vessels must unload their catch according to the main port where the ship is located. Before this policy, many fishing vessels from other regions, such as Central Java, Yogyakarta, and East Java, unloaded their catches at Palabuhanratu PPN to reduce their operational costs for shipping to Jakarta and other cities. However, after the enactment of the policy, ships from outside regions could not land fish at the Palabuhanratu Nusantara Fishing Port, so the number of fish landed decreased drastically. The increase began to occur in 2018 and 2019, along with fishing efforts (Table 2).

Sustainability Evaluation

Based on the assessment results of the overall EAFM indicators and domains at Palabuhanratu Nusantara Fishing Port, the average composite value was 66.72, with a suitable category in implementing EAFM. This average composite value means that it can be concluded that it is good to support sustainable fisheries management principles in the process of

Table 2. Total production, the value of landed fish, and catch frequency at Palabuhanratu Nusantara Fishing Port from 2015 to 2019

No.	Year	Number and Value of Landed Fish Catch		Catch Frequency
		Production (kg)	Value (IDR)	
1	2015	9.122.320	225.823.087.000	24.924
2	2016	3.839.057	106.224.971.000	17.407
3	2017	3.471.290	79.824.295.000	24.622
4	2018	3.968.197	75.083.594.000	26.770
5	2019	5.414.240	111.363.857.750	39.136

(Source: PPN Palabuhanratu, 2020)

implementing fisheries management. The sustainability conditions of each EAFM domain in Palabuhanratu Nusantara Fishing Port are described in Table 3.

Fish Resources & Habitat and Aquatic Ecosystem

Based on Table 3, two indicators must be improved from the fish resources domain: CpUE and juvenile fish proportion (33,33). The data were obtained from the composition of 5 dominant fish species with complete data, namely Yellowfin Tuna *(Thunnus albacares),* Bigeye Tuna *(Thunnus obesus),* Skipjack *(Katsuwonus pelamis),* Striped Marlin *(Kajikia audax*), and Mackerel Tuna (*Euthynnus affinis*). A low CpUE value indicates a negative impact on fish stocks due to pressure on the ecosystem, increased fishing activities, or overfishing. Goby et al. (2012) argue that over-exploitation of coastal and marine resources is extremely dangerous in the sustainable use of resources while accelerating the loss of biodiversity and ecosystem stability. Then the low value for juvenile fish proportion indicates a threat to sustainable fisheries management because juvenile fish stocks that should be allowed to continue developing into adults and productive spawners continue to decrease. This juvenile proportion threatens sustainability and reduces the value of fisherman catches because the selling price of fish is not optimal. Therefore, fishing efforts must be controlled to allow fish to reproduce, grow, and reach optimal.

Furthermore, three indicators must be improved in the habitat and aquatic ecosystem domains, i.e. mangrove ecosystems, seagrass, and coral reefs (33,33). These three indicators, especially for mangroves, play an essential role in the development of coastal fisheries (Heriyanto & Subiandono, 2012) as a spawning ground and breeding ground for several species of fish, shellfish, crabs, and shrimp (Djohan, 2007; Kariada et al., 2014). Besides that, seagrass ecosystems play an important role in the survival of fish as a shelter to hide from predators as well as a feeding ground for prey species, particularly small juvenile fish (Shervette et al., 2007; Irawan et al., 2018). The good quality of these three ecosystems will ensure the sustainability of the food chain and food web in these water areas and those traversed by fish or other marine biota. Especially for seagrass has the potential to be a very productive fishery resource that provides local people with a sustainable fisheries stock (Tebaiy et al., 2021).

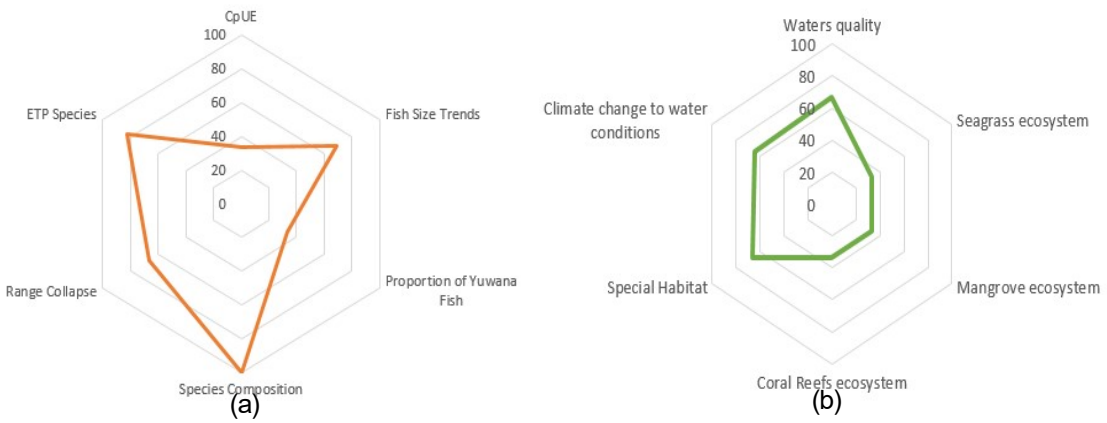
Fishing Technology and Economy

Focus on low-scoring indicators of the fishing technology domain, and two indicators must be improved, modification of fishing gear and fishing capacity (33,33). Fishing gear modification is related to the proportion of fish caught by fishers. The value of this indicator is small when the fish caught are dominated by small fish that have not yet reached their adult size and age, so it is estimated that there is a modification of fishing gear. The research data shows that approximately 83% of the fish caught are still immature. Therefore, relevant stakeholders must immediately curb the use of fishing gear that does not follow responsible fisheries management principles. Another action that is also important to take is to limit the size of both the length and weight of fish that can be caught because it can make fish populations more productive (Fujita, 2013). Then, the low value of fishing capacity shows an increase in the intensity of fishing that is not proportional to the catch, impacting the sustainability of fishery resources in these waters. Therefore, like the fish resource domain, fishing efforts must be controlled and enforce the rules regarding the use of appropriate fishing gear.

Furthermore, for the economic domain, almost all the indicators have relatively low composite values, namely asset ownership (58.33), fishery household income (49), and savings ratio (58.62). At the same time, the economic aspect is one of the main pillars of sustainable development, along with environmental and social aspects. Assessment in the economic domain relates to the value of benefits fishery entrepreneurs can directly involve, especially fishers and traders who depend on fishery commodities. The research results show that the average price of fresh

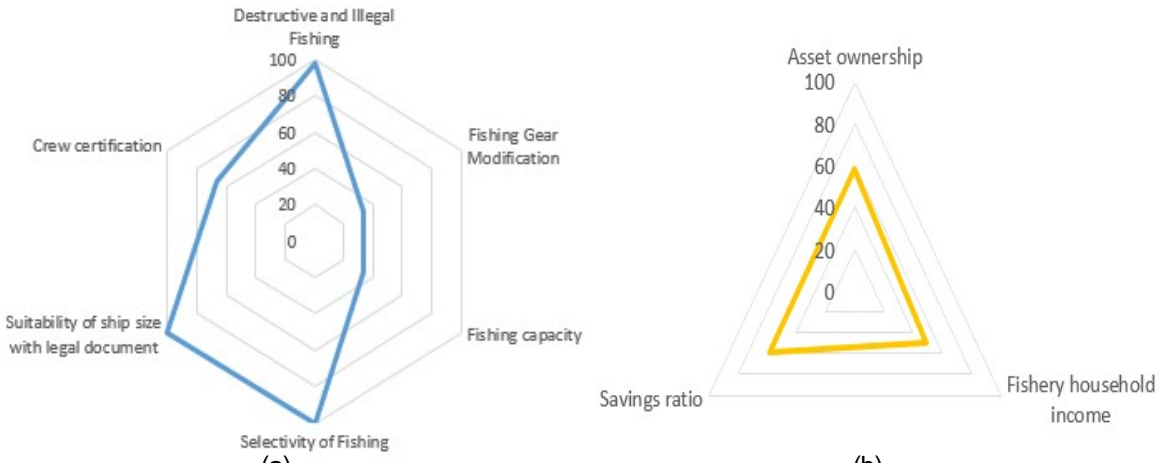
Table 3. Result of indicator assessment for each EAFM domain at Palabuhanratu Nusantara Fishing Port

No.	Domain	Score	Density	Weight	Composite Value	Flag Model	Category
1	**Fish resources**				**63,28**		
	CpUE	1,00	9	40	33,33		
	Fish size trends	2,00	7	20	66,67		
	Proportion of juvenile fish	1,00	3	15	33,33		Good
	Species composition	3,00	6	10	100		
	Range collapse	2,00	3	10	66,67		
	ETP species	2,39	6	5	79,67		
2	**Habitats and aquatic ecosystem**				**49,72**		
	Waters quality	2	2	25	66,67		
	Seagrass ecosystem	1	3	15	33,33		
	Mangrove ecosystem	1	3	15	33,33		Moderate
	Coral reefs ecosystem	1	2	15	33,33		
	Special habitat	2	3	20	66,67		
	Climate change to water condition	1,95	7	10	65,00		
3	**Fishing technology**				**72,22**		
	Destructive and illegal fishing	3,00	10	30	100		
	Fishing gear modification	1,00	7	25	33,33		
	Fishing capacity	1,00	3	15	33,33		
	Fishing selectivity	3,00	3	15	100		Good
	Suitability of vessel with legal document	3,00	2	10	100		
	Crew certification	2,00	2	5	66,67		
4	**Economy**				**55,32**		
	Asset ownership	1,75	2	45	58,33		
	Fishery household income	1,47	9	30	49		Moderate
	Saving ratio	1,76	1	25	58,62		
5	**Social**				**79,69**		
	Stakeholder participation	1,70	4	40	56,70		
	Fishery conflict	2,92	8	35	97,32		Good
	Utilization of local knowledge	2,55	6	25	85,06		
6	**Institutional**				**80,28**		
	Obedience to fishery management principle	2,00	9	25	66,67		
	Completeness of the rule	2,22	2	22	74,00		
	Decision-making mechanism	2,61	2	18	86,97		Good
	Fishery management plan	2,00	1	15	66,67		
	Policy synergy	2,93	1	11	97,70		
	Stakeholder capacity	2,69	2	9	89,66		
	Average				**67,68**		**Good**



(a) (b)

Figure 2. Chart of composite value for Fish Resources (a) & Habitat and Aquatic Ecosystem (b)



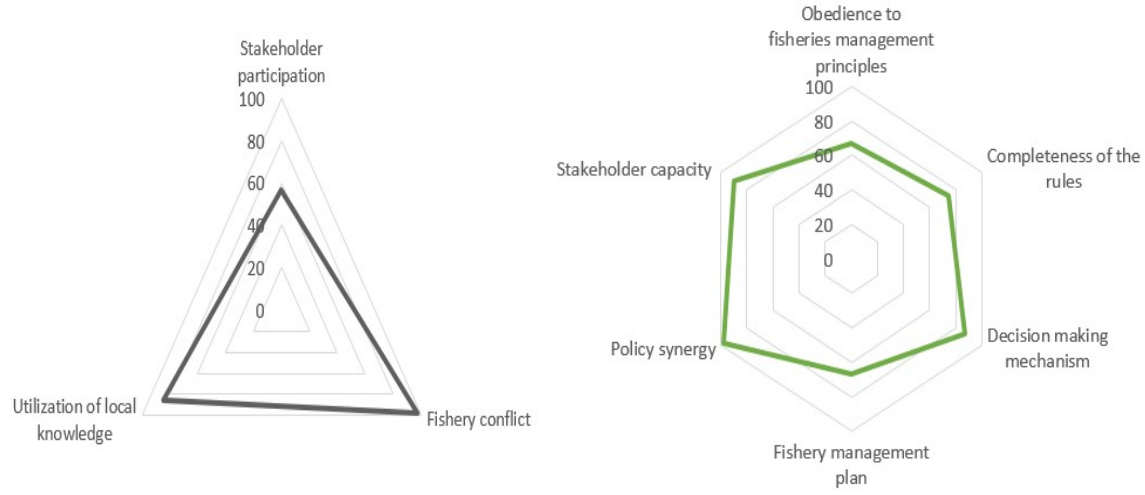
(a) (b)

Figure 3. Chart of composite value for Fishing Technology (a) and Economy (b)

fish caught by fishers tends to be low in the market. Then, the limitations of the refrigeration equipment owned by fishers and traders also cause the quality of fish to deteriorate quickly so that the selling price decreases. The lack of a fish processing industry (approximately only 20% of fish are processed into processed fish products) is also one of the factors for the low economic value obtained. Whereas fish quality can be maintained through the processing industry, various derivative products are created, yield losses can be suppressed, and benefits far greater than the current production value (Triyono et al., 2019). Therefore, increasing the economic value of fishery products will impact improving the overall economic condition of the community. Even the household income indicator is the indicator that has the most correlation with other indicators in the EAFM, so it is expected to have a positive effect on other indicators.

Social and Institutional

There are three indicators used to assess social conditions based on EAFM, namely stakeholder participation (56.70), fisheries conflict (97.32), and utilization of local knowledge (85.06). From the assessment results, only the indicator of stakeholder participation has the lowest score, so it becomes the focus of improvement to improve the sustainability status of this aspect. Based on the study results, the low indicator is related to the lack of role of local governments and law enforcers to regulate market mechanisms that are running unhealthy. Many middlemen and fish baskets are indebted to fishers without transparent selling prices and payment terms. In addition, pressure from capital owners and an unfair profit-sharing system (Retnowati, 2011) also make the economic conditions of fishers and small traders



(a) (b)

Figure 4. Chart of composite value for Social (a) and Institutional (b)

increasingly tricky.

The following domain is institutional, which consists of six indicators, namely obedience to fisheries management principles (66.67), completeness of the rules (74), decision-making mechanism (86.97), fishery management plan (66.67), policy synergy (97.70), and stakeholder capacity (89.66). In general, the level of sustainability from this institutional aspect is good. Still, two indicators have the lowest value: obedience to fisheries management principles and fishery management plan. Based on the assessment, the lack of value from the observation of fisheries management principles indicator is related to the low assessment of fishing gear modification. This indicator shows the lack of awareness of the fishers in implementing the practice of using natural resources sustainably. Then the fishery management plan indicator related to the fishing port development plan provides more significant and broader benefits for the community. However, the preliminary assessment of this indicator is due to the many technical obstacles in implementing the agreed development plan, particularly in land acquisition for the construction of harbour ponds for fishing vessels >30GT. Therefore, improving coordination and cooperation with all stakeholders is required to minimize technical obstacles in the field.

Development Strategy

The strategy for strengthening the sustainability of fisheries management is determined using the gap analysis method, namely by comparing the current conditions obtained from the assessment results using the EAFM with the expected ideal conditions. Therefore, the strategy formulation will be conveyed to bridge the gap. The following are some of the strategies resulting from the gap analysis.

Limiting Fishing Efforts and The Minimum Size of Fish That Can Be Caught

Appropriate restriction on fishing effort in Palabuhanratu Nusantara Fishing Port is the limitation of fishing intensity and the number of ships operating in the port, especially for ships <10GT. Fishing efforts limitation is very important to minimize the pressure on marine ecosystems so that fish populations are sustainably maintained. Then another strategy to improve sustainability in fisheries management is to limit the size of fish that are allowed caught by fishermen. Based on the 1982 Law of the Sea Convention, article 62, paragraph 4, coastal countries such as Indonesia are given the authority to regulate the size or minimum weight of fish caught in the exclusive economic zone waters. In determining the minimum size limit of fish that can be caught, the government must consider various related aspects. In addition to maintaining the sustainability of the environmental aspect, this limitation of fish size must also consider the sustainability of the economic and social aspects. Therefore, in determining the regulation, the government must involve various stakeholders and experts in the related fields of science to minimize the negative impact of the regulation.

Socializing and Educating the Principles of Sustainable Fisheries Management

Stakeholder understanding of sustainable fisheries management principles is an integral part of supporting sustainable fisheries management. Several indicators with poor categories are based on the results of the assessment using EAFM due to insufficient understanding and knowledge of stakeholders on the principles of sustainable fisheries management. These stakeholders are not limited to community groups or parties with direct activities in ports (such as port officers, fishermen, entrepreneurs, or traders) but other parties who do not directly engage in activities at ports. Other parties related to the region's fishery management condition should also be considered. It is expected that the increasing stakeholders' understanding would increase their participation in supporting sustainable fisheries management.

Enforcing The Law and Providing Strict Sanctions Indiscriminately

This strategy includes strengthening all stakeholders' perceptions and knowledge of fisheries regulations/governance. A good perception of fisheries management greatly influences community attitudes and participation (Pramitasari et al., 2015). This perception and knowledge can encourage the level of awareness of stakeholders to maintain sustainability in fisheries management jointly. For example, suppose there are differences in perceptions and knowledge about the importance of regulating the size of fish that can be caught. In that case, sustainable fisheries management's goal is challenging. The absence of clear and firm rules regarding the size limits of fish that may and may not be caught, especially for fishers in Palabuhanratu Nusantara Fishing Port, is an indicator of the lack of mutual understanding to maintain the sustainability of fish resources as one of the main factors for sustainability in fisheries management.

Furthermore, related to law enforcement, it must be carried out consistently and apply the principles of justice. The law enforcement process is the primary key to solving fisheries crime problems that focus on legal substance and human resources so that fisheries development can run sustainably (Sasvia, 2019). For example, fishers still do not have a maritime certificate because there are no sanctions for these violations. Even though ownership of this certificate is significant in minimizing work accidents, it also ensures that the fishing process follows responsible fishing rules.

Providing Access to Capital with Easy Guarantees and a Profitable Process

Nearly 85 % of actors in marine fisheries business in Indonesia are micro and small in scale, so the fishers mainly depend on external or other informal financial (Ministry of Marine Affairs and Fisheries, 2018). Therefore, strengthening the capital system in the fisheries business is one of the critical efforts to improve the welfare of fishers and other fishery entrepreneurs. This situation indicates that most fishers rely on debt to intermediaries as initial capital for their daily fishing operations (Adhi, 2019), so they cannot refuse the price determined by intermediaries.

In Palabuhanratu, many fishers still use capital borrowing through intermediaries because the process is more straightforward and without collateral. Still, they must sell their catch without going through an auction process (Lubis et al., 2012). Such a mechanism is unhealthy because price determination is not based on fair and transparent principles, which is detrimental to fishers. Therefore, it is necessary to encourage efforts to strengthen the capital system for fishers to enjoy the results of their hard work commensurately. One of them is through the empowerment of professionally managed fishers cooperatives.

Similar research can be duplicated in other fishing ports in Indonesia, at least 50 ports, from coastal fishing ports to ocean fishing ports (Badan Pusat Statistik, 2019). This finding is useful for determining the sustainability of fisheries management at a broader level. In addition, this development strategy is adaptable to the needs and characteristics of the area so that it will be more appropriate.

Increasing The Quantity and Quality of The Fish Processing Industry

This strategy appears related to the economic condition of most fishers and traders in Palabuhanratu, which is still unstable. This situation is indicated by the score of the economic aspect assessment, which only reached 55.32 in the moderate category. Then of the total catches entered in the fish market of Palabuhanratu Nusantara Fishing Port, only about 20% is processed into processed fish products in the form of fish balls, fish crackers, shredded fish, boiled fish, and salted fish. The low percentage means that about 80% of fish are sold without processing, so the product's competitiveness is low. This low product competitiveness causes fishery business activities to be at low effectiveness and efficiency. It generates fishery business actors who do not get rewards or benefits commensurate with the hard work that has been expended. This situation is one of the leading causes of the difficulty in improving the economic conditions of fishermen, in addition to "the pressure from the owners of capital and an unfair profit-sharing system (Retnowati, 2011). On the other hand, selling processed fish products has many advantages, such as higher prices, more extended storage periods, and reduced potential for damaged fish waste due to the lack of preservation facilities.

Optimizing The Usage of Technology in Fisheries Management

According to Ngafifi (2014), technology has provided many conveniences and new ways of carrying out various human activities. Technology can be used in almost all aspects of life, including fisheries management. This tool is considered adequate and efficient in helping fishing activities (Ministry of Marine Affairs and Fisheries, 2018; Idris, 2019). This tool is in line with FAO (2021), which states that fisheries management tools should be appropriate and used for all distributions of fish resources.

In this case, appropriate management tools include using effective and efficient tools to optimize the value of catches and low impact on the ecosystem. Fishers in Palabuhanratu have used several additional tools, such as fish finder, global positioning system, but they are still limited due to several implementation obstacles. For example, not all fishers understand applying the technology and less supportive facilities (Kurniawan & Erlina, 2016). Therefore, in addition to providing these technological facilities, increasing the capacity of fishers in mastering technology is also an essential part of its implementation.

CONCLUSION

The mean composite value for all EAFM domains is 67.68 with a suitable category, meaning fisheries management in the Palabuhanratu Nusantara Fishing Port is sustainable based on the EAFM indicator. The strategies for developing and strengthening the sustainability of fisheries management at Palabuhanratu Nusantara Fishing Port are through technical measures, i.e., limiting fishing efforts and the minimum size of fish that can be caught. In addition, increasing stakeholder awareness through socializing and educating on the principles of sustainable fisheries management and enforcing the law and providing strict sanctions indiscriminately; providing access to capital with easy guarantees and profitable processes; increasing the quantity and quality of the fish processing industry; and optimizing the usage of technology in fisheries management.

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