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Fisheries management status in the marine protected area of eastern coast of Weh Island, Sabang, Indonesia

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Abstract. This study aims to determine the status of fisheries management, formulate priority tactical steps for fisheries management in the marine protected area of eastern coast of Weh Island. The types of data sources used in this study are primary data obtained through direct measurements and interviews, and desk study data. Data is processed and analyzed using the Ecosystem Approach to Fisheries Management (EAFM) indicator, and Flag modeling. Determination of priority improvement indicators and priority tactical steps using the Analytical Hierarchy Process (AHP). The assessment of fisheries management status shows that fisheries management in the conservation area of the East Coast of Weh belongs to the good category. Determination of priority indicators on fisheries management and regional suitability is carried out to determine the priority of short-term indicators which are then needed to determine the priority of tactical steps in fisheries management and regional suitability for marine tourism.

1. Introduction

Marine Protected Area (MPA) is a protected water area managed by a zoning system to realize sustainable fishery resource management and its environment [1]. The marine protected area of eastern coast of Weh Island (MPA-ECWI) is a conservation area that has the potential for fish resources and ecosystems that can be used as opportunities for the utilization of fisheries and marine tourism activities for the surrounding community [2]. Population density in coastal areas is one of the factors causing degradation and excessive exploitation of fish resources [3] and is driven by market demand for fish resources which will worsen these conditions [4]. MPA was originally formed to reduce negative impacts caused by human activities [5], such as overfishing habits and marine tourism activities that are not environmentally friendly. More fishing habits are said to damage the environment because often caught are juvenile fish [6], if that activity is carried out continuously will certainly result in a decrease in the number and even loss of a species [7].

The increase in tourist visits, shows that Sabang City is a tourism area that is in great demand. Increasing the capacity of marine tourism such as adding diving and snorkeling locations with supporting structures can improve the economy of Sabang City [8]. However, tourism activities have a



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negative impact on the environment [9], because fisheries and marine tourism activities can damage the environment directly or indirectly [10]. Fisheries management and the establishment of conservation areas are important because there have been many studies that state marine natural resource reserves have tended to decrease over time [11]. Therefore, it is necessary to study fisheries management through an ecosystem approach to determine management strategies and actions that aim to balance conservation, sustainable use and socioeconomic conditions [12]. Fisheries management is called the Ecosystem Approach to Fisheries Management (EAFM), the use of EAFM internationally has been regulated by FAO-UN in the CCRF [13]. The purpose of this study is to assess the status of fisheries management and formulate priority tactical steps for fisheries management using EAFM in the MPA-ECWI.

2. Material and Methods

The study was conducted in January-April 2018 in the Anoi Itam and Sumur Tiga in the marine protected area of eastern coast of Weh Island, Sukajaya District, Sabang City. The types of data sources used in this study are primary data obtained through direct measurements and interviews, secondary data obtained from other parties and in this study is research data form [14]. Secondary data used in this study are data on coral reefs and reef fishes. Data is processed and analyzed qualitatively and quantitatively. The study of the status of fisheries management was carried out using an EAFM and making strategies and steps for fisheries management using flag modeling. EAFM analysis is carried out through an indicator approach, an indicator is defined as a tool to measure, indicate or refer to something with more or less the desired size [15]. The domains used in the management status study are fish resources, habitats and ecosystems, fishing, economic, social and institutional technologies. The stages of assessment of fisheries management can be seen in the following figure.

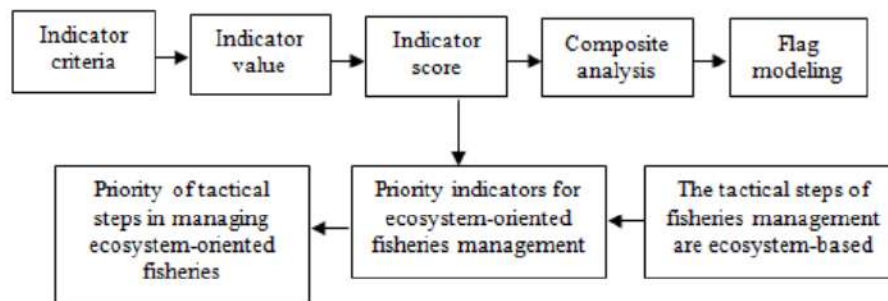


Figure 1. Stages of Fisheries Management Assessment

3. Research Analysis

3.1. Ecosystem approach fisheries management

Visualizing the results of the EAFM indicator assessment can use the modeling flag technique. The Flag Modeling technique is carried out by a multi-criteria analysis (MCA) approach, where a group of criteria is built as a basis for analysis of ecosystem approach fisheries management in fisheries management through the development of composite values [16]. The domains assessed are then analyzed using composite value analysis, then displayed in the form of a modeling flag.

Table 1. Flag Modelling

Composite Score	Color Indicator	Description
100-125	Red	Poor
126-150	Orange	Low
151-200	Yellow	Moderate
201-250	Light Green	Good
251-300	Dark Green	Very Good

3.2. Analytical hierarchy process

Determination of the priority of tactical steps in this research is to use the AHP Method. Process Hierarchy Analysis (AHP) is a model for building ideas and defining problems by making assumptions and obtaining desired solutions and allows testing the sensitivity of the results [17]. There are several important principles in AHP namely making hierarchies, evaluating alternative criteria, using pairwise-comparison methods, comparison scales [18], determining priorities of the criteria elements, and logical consistency.

The steps for determining priority indicators and tactical steps in this study are as follows:

1. The value of each EAFM domain indicator is known.
2. Sorted by the value starting from the lowest.
3. The class range method (Pairwise comparison) is used to determine the short, medium and long-term priorities of EAFM.
4. Pairwise comparison matrices are made and their importance.
5. Normalization is carried out.
6. The average value of each tactical step is obtained.
7. Multiplied by the weight of the pairwise comparison matrix, the highest value is the most important tactical step (priority).
8. Set priorities for tactical management measures.

Based on Table 2, determining the scale of the comparison to tactical steps must go through an interview method with experts who understand the problem of ecosystem approach fisheries management (expert judgment). The scale of intensity of interest can be seen in Table 3.

Table 2. EAFM Indicator Class Range

EAFM Class Range	Priority Scale
70,7 – 100	Long-term
41,4 – 70,6	Medium-term
12 – 41,3	Short-term

Table 3. The scale of Intensity of Interest

Scale	Intensity of Importance
1	Equal
3	Slightly
5	Strongly
7	Very strong
9	Extreme

4. Result and Discussions

4.1. Status of fisheries management in the marine protected area of eastern coast of weh island

Assessment of fisheries management status in the MPA-ECWI has six domains, sub-domains in each domain are scored with the Likert scale method 1; 2; 3. Each value has a different color, green for a score of 3 (good indicator conditions); yellow for score 2 (medium indicator condition); and red for score 1 (poor indicator condition). The results of the EAFM indicator scoring were then analyzed using the modeling flag model. The results show that fisheries management at MPA-ECWI falls into the "good" category with an average value of 222.66. The assessment of fisheries management status can be seen in Table 4.

Table 4. Fisheries Management Status Assessment in the MPA-ECWI

DOMAIN	SUB-DOMAIN	CRITERIA	SCORE	VALUE	COMPOSITE VALUE	EXPLANATION
Fish resources	Size of fish	relatively fixed size	2	40	80	
	Proportion of yuwana fish	0%	3	30	90	
	Range collapse	more difficult	1	16	16	
	ETP Species	no ETP species were caught	3	10	30	
	Coral fish density	4,772 ind/m ²	1	4	4	
TOTAL				100	220	GOOD
Habitat and ecosystem	Water quality	100% brightness	3	39	117	
	Status of coral reefs	48% coral reef cover	2	34	68	
	Climate change on the condition of the waters and habitat	There are no studies yet	1	27	27	
	TOTAL			100	212	MODERATE
Fish capture technology	Destructive and illegal fishing methods	0 cases / year	3	42	126	
	Modification of fishing gear and fishing aids	63.5% of target fish <LM	1	35	35	
	Catch selectivity	0%	3	23	69	
	TOTAL			100	230	GOOD
Economy	Asset ownership	Fixed assets	2	50	100	
	Household income	±IDR.1.557.575	1	29	29	
	Saving rate	0,12	2	21	42	
TOTAL				100	171	MODERATE
Social	Stakeholder participation	44,4%	1	40	40	
	Fisheries conflict	0 conflict	3	35	105	
	Utilization of local knowledge in SDI management	Effective application	3	25	75	
	TOTAL			100	220	GOOD
Institutional	Compliance with the principles of responsible fisheries	0 case/year	3	26	78	
	Complete rules of the game in fisheries management	Exist, the numbers are fixed	2	11	22	
	Elaboration of point 2 (comparing the current situation with before)	There is, and there is a prosecution	3	11	33	
	Institutional mechanism	There are decisions and are fully implemented	3	19	57	
	TOTAL			100	283	VERY GOOD
Institutional	Level of synergy of policies and institutional management of fisheries	Synergy goes well	3	11	33	
	Stakeholder capacity	There was an attempt but it didn't work properly	2	6	12	
TOTAL				100	283	VERY GOOD
AVERAGE COMPOSIT VALUE					222,66	GOOD

4.2. Fisheries management tactical steps in the marine protected area of eastern coast of weh island

The tactical step is performed on indicators that are not by the value of the reference point or which have a score of 1 and 2 in the EAFM assessment. This tactical step was carried out to be able to improve the condition of the fisheries from the poor category to being moderate and from the category of being good. The priority of tactical steps that can be taken can be seen in Table 5.

Table 5. Priority Tactical Steps for Ecosystem-Based Fisheries Management

Indicator	Tactical Steps	Code	Value	Priority
Stakeholder capacity	Monitoring and mentoring capacity building for stakeholders	1	10,60	2
Range collapse	Stakeholders must conduct re-research for zoning determination, after which there must be binding regulations related to the prohibition of fishing in spawning areas	2	10,56	3
Complete rules of the game	Add rules for law enforcement for unregistered tourism activities	3	6,48	11
	Strong and consistent law enforcement	4	8	8
Coral fish density	Making bio rock and coral transplants	5	10,06	4
Climate change	An assessment of climate change must be carried out	6	9,23	7
	Adaptive management	7	11,63	1
Household income	Fishermen are given counseling on target, such as notifications where the fishing ground area, the right time to go to sea, and handling the catches on the ship, so that the catch increases and the quality of the fish gets better	8	7,85	9
	Alternative livelihood training, such as processing fishery products (fish nuggets, fish fillets and shredded fish)	9	9,35	6
Modification of fishing gear	Study of the size of fishing rods and determination of the size of fishing rods suitable for catching sunu and grouper groupers	10	6,63	10
	Study of areas suitable for fishing ground	11	9,63	5

Based on Table 5, the priority sequence of tactical steps in ecosystem approach fisheries management is as follows:

1. Adaptive management, by conducting a study of the results of previous planning, then making a new plan and the realization of repetitive corrective actions to achieve the expected goals.
2. Monitoring and mentoring capacity building for stakeholders.
3. Stakeholders must conduct re-research for zoning determination, after which there must be binding regulations related to the prohibition of fishing in spawning areas.
4. Making bio rock and coral transplants.
5. Study of areas suitable for fishing ground.
6. Alternative livelihood training, such as processing fishery products (fish nuggets, fish fillets and shredded fish).
7. An assessment of climate change must be carried out.
8. Strong and consistent law enforcement.
9. Fishermen are given counseling on target, such as notifications where the fishing ground area, the right time to go to sea, and handling the catches on the ship, so that the catch increases and the quality of the fish gets better.
10. Study of the size of fishing rods and determining the size of fishing rods suitable for catching groupers and mackerels.

Conclusions

The conclusions of this research are:

1. The domain habitat ecosystem and economy can be categorized as *moderate*. Fish resources, fish capture technology and social categorized as *good*. Institutional categorized *very good*. Assessment of fisheries status using EAFM and flag modeling analysis methods shows that fisheries management on the east coast of Weh Island is in a *good* category; and

2. Conducting a review of the results of previous planning, creating new plans, and realizing repeated corrective actions are *the most important priorities* based on EAFM in the marine protected area of eastern coast of Weh Island.

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