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ANALYSIS OF SURFACE GILLNET FISHING GEAR AT BAGAN SIAPI-API WATERS, INDONESIA USING EAFM INDICATORS

Analisis Perikanan Gillnet Permukaan di Perairan Bagan Siapi-Api, Indonesia Menggunakan Indikator EAFM

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ABSTRACT

The fisheries management based on the Ecosystem Approach to Fisheries Management (EAFM) can be implemented to optimize the potential of fisheries resources. The purpose of this research is to apply EAFM indicators for analyzing surface gillnet fishing gear in Bagan Siapi-api waters, especially fish resources, fishing methods, habitats, and ecosystems. The evaluation of fishery management status was carried out using multi-criteria analysis (MCA) through the development of the composite index of each EAFM indicator. The results showed that the surface gillnet fishing gear was dominant with 1,645 tons of fish caught in 2019 by fishermen in Bagan Siapi-Api Waters. The composition of the catches was sukain fish (Eleutheronema tetradactylum), flounder fish (Pleuronectiformes), and tornfish (Bovichthyidae). Based on the analysis of the EAFM indicators, the value of the domain of fish resources, habitats, and ecosystems, as well as fishing methods has a value between 2 and 2.5. This indicated that the status of ecosystem-based area management in the waters of Bagan Siapi-api is in the medium-good category.

Keywords: *Bagan Siapi-api, EAFM, Fisheries Sustainability, Gill Net*

ABSTRAK

Pengelolaan perikanan berbasis *Ecosystem Approach to Fisheries Management* (EAFM) dapat dilakukan untuk mengoptimalkan potensi sumber daya perikanan. Tujuan penelitian ini adalah untuk menerapkan indikator EAFM dalam menganalisis alat tangkap jaring insang permukaan di perairan Bagan Siapi-api, terutama indikator sumber daya ikan, metode penangkapan, serta habitat dan ekosistemnya. Evaluasi status pengelolaan perikanan dilakukan dengan menggunakan analisis multi kriteria (MCA) melalui pengembangan indeks komposit masing-masing indikator Pendekatan Ekosistem Pengelolaan Perikanan (EAFM). Hasil penelitian menunjukkan bahwa alat tangkap jaring insang permukaan merupakan alat tangkap yang dominan (1.645 ton, 2019) yang digunakan oleh nelayan di Perairan Bagan Siapi-Api. Komposisi hasil tangkapan jaring insang permukaan yang dominan tertangkap pada saat penelitian adalah jenis ikan sukain (*Eleutheronema tetradactylum*), ikan flounder *(Pleuronectiformes*) dan ikan sobek (*Bovichthyidae*). Berdasarkan analisis indikator EAFM, nilai Domain Sumber Daya Ikan, Habitat dan Ekosistemnya, dan Cara Penangkapan Ikan di Perairan Bagan Siapi-api memiliki nilai antara 2 -2,5. Hal ini menunjukkan bahwa status pengelolaan kawasan berbasis ekosistem di perairan Bagan Siapi-api berada pada kategori sedang-baik.

Kata kunci: Bagan Siapi-api, EAFM, Perikanan Berkelanjutan, Jaring Insang.

INTRODUCTION

Several fishing methods are often used by fishermen globally which include the operation vary of fishing gear. Fishing gear is classified as selective and non-selective. The selective fishing gear includes gillnets, long lines, traps, and pots because they catch the target fish species (Lisna *et al*. 2018, Lucchetti *et al*. 2020, Devi *et al*. 2017), while trawls and purse seine are non-selective fishing gear. The impact of non-selective fishing gear on the marine environment is damaging the environment due to its construction and untargeted practices. In example, Purse seining is a non-selective gear regarding fish size, as the mesh size is chosen to be so small that there should be no risk of mass meshing of fish, even by the smallest size groups of the target species. These destructive practices create unbalanced situations such as coral reef destruction, seabed disturbance, reduction of fish species, and devastation of fishing grounds (Sutriyono *et al*. 2017, Reis-Filho and Loiola 2022).

Gillnet, as one of selective fishing gear, is modified eco-friendly fishing gear and has the same mesh size throughout, and the width is shorter than the length (Hout *et al*. 2022). Although it is generally carried out passively, gillnet is also operated semi-actively and actively. The passive method is usually operated at night with or without light aids, the net is installed in the waters or area where fish are expected to pass, and left for some time to allow fish to enter. To facilitate its operation, the net is usually assisted by a hauler (pulling nets) and operated with an outboard motor for one day (Hassan and Sathiadhas 2009).

The State Fisheries Management Area of the Republic of Indonesia (WPP NRI) 571 is one of the potential fishing grounds in the country. The WPP NRI 571 is among the 11 management areas which cover the waters of the Andaman Sea, the Malacca Strait, and the eastern part of the province of Nangroe Aceh Darussalam, Riau, and North Sumatra. The status of fisheries in the area includes fish resources, their exploitation, and infrastructures. The status of fish resources is presented by observing the performance of its potential, while the exploitation is shown by human consumption, the fishing fleet and gear, as well as the amount of production due to fishing activities. Meanwhile, the fishery infrastructure is presented by identifying the availability of fishing ports and economic institutions in WPP 571. Based on data from the Ministry of Maritime Affairs and Fisheries in 2019, capture fisheries production reached 1,332,854 tons (MMFA 2019).

The capture fisheries activities in the waters of Bagan Saipi-api and the Melaka Strait in WPP NRI 571 are one of the economic driving sectors for the people of Rokan Hilir Regency. The abundance of fish resources has led to widespread fishing using various gears. Reza (2020) stated that the Bagan Siapi-api waters in the Malacca Strait are a red zone in the fishing map issued by the Ministry of Maritime and Fisheries Affairs (MMFA). This red zone indicates that overfishing has occurred, which causes a decrease in the number of fish catches.

The main cause of overfishing is the operation of non-environmentally friendly fishing gear such as sondong which is similar to trawling. This has an impact on the community who carry out fishing activities in the waters of Bagan Siapi-api. According to Dulvy *et al*. (2021), the exploitation of aquatic resources such as marine waters will be threatened with extinction due to poor management, especially fishing activities that are not environmentally friendly. One approach that can be used for fisheries sustainability is the Ecosystem Approach to Fisheries Management (EAFM). This approach has great potential to improve the ecosystem and human well-being in the future and contribute to the blue economy to attain a few SDG targets (Islam *et al*. 2022). Puansalaing *et al*. (2021) used the EAFM to assess the management of scad fish in the waters of the Sulawesi Sea. The results showed that the management status and the fish resource domain in the North Sulawesi Sea are in the 'good' and 'medium' categories. Management actions take precedence over domains that have a “poor” indicator value and are implemented in the economic sector, followed by the fish resources, social, institutional, and fishing technical domains.

The EAFM approach aims to balance the socio-economic objectives in fisheries management. These include welfare, fair use of fish resources by considering knowledge, information, and uncertainty about biotic, abiotic components and human interactions in aquatic ecosystems through an integrated, comprehensive fisheries management and sustainability.

Subehi *et al*. (2017) stated that surface gillnet fishing gear has a small possibility of damaging the coral and seagrass environment and can be used as an alternative sustainable fishing method. Further investigation is needed

to explain the level of environmental friendly of using gillnets. Therefore, this research aims to i) determine the status and feasibility of gillnet fishing gear with Environment Approach to Fisheries Management (EAFM) indicators and ii) provide alternative solutions in managing fish resources in Bagan Siapi-api waters. The results are expected to show the status of fisheries management in the waters of Bagan Siapi-api and formulate an improvement action plan for the benefit of the sustainability of fish resources.

METHODS

This research was conducted in Rokan Hilir Regency, located at coordinates 1º14` to 2º45' North Latitude & 100º17' to 101º21 East Longitude in November 2020 (Figure 1).

The survey method was used to obtain information directly on the object of research. The primary and secondary data were collected from the result of the analysis of water quality parameters, catch, and EAFM indicators in the field.

The primary data were obtained through direct observation and questionnaire-based interviews with a total of 12 stakeholders, which consist of 10 fishermen and 2 employees of the Department of Marine Affairs and Fisheries of Rokan Hiir Regency. The respondents were selected based on the assumption that they have key information related to gillnet fishing activities in the Bagan Siapi-api waters. Meanwhile, the secondary data were obtained through literature review related to journals, books, and articles

The indicator was used to assess the level of fisheries management in line with EAFM principles. The EAFM indicators cover 3 domains, namely fish resources, habitats and ecosystems, as well as fishing methods (Table 1).

The Flag Modeling method was used to convert partial indicators into composite ones. This was carried out using a multi-criteria analysis (MCA) approach, where a set of criteria is built as a basis for the analysis of the performance of fisheries management areas from the EAFM through the development of a composite index with the stages stated below (Adrianto *et al*. 2005).

- Defining criteria for each EAFM indicator domain
- Reviewing the performance of each tested indicator/attribute based on the best data acquisition using predetermined criteria and reference points
- Giving a score for indicator performance in each WPP (Ordinal-based Likert scores 1,2,3). This scoring process shows the good or bad of an indicator, where the value of 1 is the lowest which indicates a bad condition, 2 means moderate, and the value of 3 shows that the condition is good.
- Analyzing the value of each domain using a simple arithmetic-based composite analysis. This composite index is the total conversion value of each EAFM domain.
- Determining the value of the regional conversion scale by averaging all domains.
- The results of the scale conversion value are displayed in form of a flag model. The scale of each domain describes the management status of an area, while the regional scale represents the entire area as shown in Table 1.

The indicator index is calculated using the equation stated below (NWG EAFM 2014):

Index value = score x 100 x weight ..... (1)

Composite values for each domain were defined by the model flags and determined using the equation below (NWG EAFM 2014):

$$NKi = \frac{C\ at-i}{C\ at-max} \times 100 \quad \text{..... (2)}$$

Description*:*
NKi : Composite value in the i-th domain
C_{at-i} : Total index value of all indicators on the – i domain
C_{at-max}: Maximum value in the i- domain

Data collection that refers to the EAFM indicator is also carried out and scored based on the results obtained from each attribute by comparing it with reference points as shown in Table 3.

The value of each indicator in the Domain of Fish Resources, Ecosystem Habitat, and Fishing Method was analyzed using a simple composite analysis based on the arithmetic mean as shown in form of a flag model in Table 2.

Table 1 Indicators for Each EAFM Domain

No.	Domain	Indicator	Definition	Criteria
1	Fish Resources	CPUE Trend	CPUE is the catch per unit of fishing effort. Fishing effort should be standardized so that it can capture the changing trend of fishing effort. Standard CPUE is used when there is a pattern of multiple fishing gears to catch one species in the fishery unit under study.	1 = decreased sharply (average decreased >25% per year); 2 = decreased slightly (mean decreased < 25% per year); 3 = stable or increasing
		Fish Size Trend	- Total length - Standard length - Carapace/fin length	1 = trend of the average size of fish caught getting smaller; 2 = relatively constant size trend; 3 = trend size is getting bigger
		Proportion of Juvenile Fish Caught	Percentage of fish caught before reaching maturity	1 = a lot (> 60%); 2 = a lot (30-60%); 3 little (<30%)
		Catch Species Composition	target species used, non-target species used and not utilized	1 = less target proportion (<15% of total volume); 2 = proportion of targets equal to non-targets (16-30% of total volume); 3 = more target proportion (>31% of total volume)
		"Range Collapse" fish resources	fishing ground that is getting farther away	1 = to be very far, depending on the target species; 2 = become distant, depending on the target species; 3 = relatively fixed distance, depending on target species
		ETP Species	Populations of ETP species (endangered species, threatened species, and protected species) according to CITES criteria	1= there are ETP species caught but not released; 2 = caught but released; 3 = no ETP species caught
2	Habitat and Ecosystem	Water quality	Identified waste using the parameters of the Minister of Environment Decree 51/2004 concerning Seawater Quality Standards	1=polluted; 2=medium polluted; 3=not polluted
		Seagrass Ecosystem	Seagrass species cover and diversity	1=low cover 30%; 2=medium cover >30% - <60%; 3=high cover, >60%
		Mangrove Ecosystem	Mangrove status is evaluated based on percentage of cover and density	1=low cover <50%; 2=medium cover >50-<75%; 3=high cover >75%
		Coral Reef Ecosystem	Percentage of live hard coral cover and live coral diversity based on live form	1=low cover <25%; 2=medium cover >25 - <50%; 3=high cover >50%
		Unique/Special Habitat	Area, time, cycle, distribution, and water fertility, spawning ground, nursery ground, feeding ground, upwelling, nesting beach	1=no known unique/special habitat; 2=known unique/special habitat but not managed properly; 3=the existence of unique/special habitats is known and well managed
		Climate change on water and habitat conditions	To find out the impact of climate change on water and habitat conditions	1=there is no study on the impact of climate change; 2=the impact of climate change is known but not

No.	Domain	Indicator	Definition	Criteria
				followed by adaptation and mitigation strategies; 3=the impact of climate change is known and followed by adaptation and mitigation strategies
3	Fishing Methods	Destructive fishing	Destructive fishing is seen from the use of destructive fishing tools and methods and/or not in accordance with applicable regulations	1=frequency of violations>10 cases per year; 2=frequency of violations 5-10 cases per year; 3=frequency of violations <5 cases per year
		Modification of Fishing Gear	Use of fishing gear and tools that have a negative impact on fish resources	1 = more than 50% of the target species size < Lm; 2 = 25-50% target species size < Lm; 3 = < 25% target species size < Lm
		Fishing Capacity and Effort	The amount of fishing capacity divided by fishing activity	1 = fishing capacity ratio < 1; 2 = fishing capacity ratio = 1; 3 = fishing capacity ratio >1
		Fishing Selectivity	Fishing activities associated with the extent, timing and diversity of catches	1=low (> 75%); 2=medium (50-75%);3=high (<50%)
		Conformity of the function and size of fishing vessels with legal documents	Whether or not the function and size of the ship are in accordance with legal documents	1=low fit (>50%) 2=medium fit (30-50%) 3=high fit(<30%)
		Certification of fishing boat crew in accordance with regulations	Qualification of fishing vessel crew skills	1=certificate ownership <50% 2=certificate ownership 50-75% 3=certificate ownership >75%

Table 2 Composite Index Classification and Flag Model Visualization

Range (%)		Flag Model	Description Application of EAFM
Low	High		
1	20	Red	Very Bad
21	40	White	Bad
41	60	Yellow	Medium
61	80	Light green	Good
81	100	Dark green	Very Good

Table 3 Indicators of Comparison of Reference Points

Lower limit	Upper limit	Description	Color
1.00	1.5	Low/Poor	
1.51	2.5	Medium	
2.51	3.0	High/Good	

RESULT

Characteristics of Bagan Siapi-api Waters

Observation of water quality in the marine environment of Bagan Siapi-api showed that the temperature was normal. Water quality monitoring is one of important activity, especially in coastal water, which susceptive with pollution. The results of the measurement of water quality parameters obtained at the research site are presented in Table 4.

Although the temperature difference in the fishing operation in the morning is lower than in the afternoon, it is still in normal conditions for the physiological adaptation of small pelagic fish. Moreover, it was also discovered that water rightness varies during fishing operations. In ST1 waters, the brightness in the morning is 2.0 m/s, ST2 is 2.6 m/s, and ST3 is about 3.2 m/s. In the afternoon, ST1, ST2, and ST3 is 2.0 m/s, 2.6 m/s and 3.2 m/s, respectively. The depth of the waters at each station ranges from 10 to 16 m, where the deepest area is at station 3 and the shallowest is at location 1. The value of the degree of acidity (pH) also ranges from 7 to 9, which indicates that there is no significant difference in the pH value between stations and operating hours in the morning and evening. The salinity of the measurement results in the morning varied from 22 to 28.

Indicators of Ecosystem Approach to Fisheries Management

The ecosystem approach to fisheries management (EAFM) is based on how to balance socio-economic goals in fisheries management by considering knowledge, information, uncertainty about biotic and abiotic, as well as human interactions in aquatic ecosystems through an integrated, comprehensive, and sustainable management. It was carried out in this research using three indicators, namely fish resource, habitat and ecosystem, and fishing method domain.

Catch per unit effort (CPUE) is defined as the catch rate per fishery years obtained using time series data, for a minimum of five (5) years (Adrianto *et al*. 2015). CPUE calculation result data for target fish from the tool catch surface gill nets in the waters of Bagan Ready-api can be seen in Table 5 below.

Based on the analysis that has been carried out, the composite value of the Fish Resources domain can be arranged as in Table 6. Based on the analysis that has been carried out, the composite value of the habitat domain and ecosystem can be arranged as in Table 7 below.

Table 7 shows that the average score for the habitat and ecosystem domains in the waters of Bagan Siapi-api has a value of 2. This implies that the domains are still in moderate condition, hence, there is a need to periodically monitor the status of the existing ecosystem simultaneously and continuously. The habitat and ecosystem domain consists of six indicators, namely water quality, seagrass, mangrove, coral reef status, unique/special habitats, as well as climate change on water and habitat conditions. Based on the analysis, the water quality of the research area is classified as good because it is not polluted at all fishing stations. The status of seagrass beds is still classified as moderate with an average cover per station of 29-49% and moderate diversity with 3-5 species of seagrass, including paddle grass (*Halophila decipiens*), star grass (*Halophila engelmoonii*), and shoal grass (*Halodude wrightii*).

Based on the analysis that has been carried out, the composite value of the fishing methods Domain can be arranged as in Table 8.

Table 4 Water quality parameters

Water Quality Parameters	Morning Station			Evening Station		
	ST1	ST2	ST3	ST1	ST2	ST3
Temperature (°C)	27	28	27	29	32	30
Current (m/sec)	0,18	0,20	0,26	0,20	0,24	0,30
Brightness (m)	2,0	2,6	3,2	2,0	2,6	3,2
Depth (m)	10	12	16	10	12	16
pH	7	7	8	7	8	9
Salinity (‰)	22	26	28	24	27	29

Source: Research Results, 2020

Table 5 CPUE Data of Target Fish (Senangin Fish) Caught Using Surface Gillnets in The Waters of Bagan Siapi-api from 2015 – 2019

No.	Year	Catch	Effort	CPUE
1.	2015	25,006	330	75,775
2.	2016	25,006	330	75,775
3.	2017	15,735	330	47,681
4.	2018	4,726	330	14,321
5.	2019	4,458	330	13,509

Source: Research Results, 2020

Table 6 Analysis of the Flag Model of Six Indicators of the Fish Resource Domain.

No	Indicator	Mark
1	Raw CPU	2
2	Fish size trend	2
3	Proportion of juvenile fish caught	3
4	Catch species composition	3
5	"Range Collapse" fish resources	3
6	ETP species	2
	Average	2.5

Source: Research Results, 2020

Table 7 Analysis of the Flag Model Six Indicators of Habitat and Ecosystem Domains

No	Indicator	Mark
1	Water quality	2
2	Seagrass ecosystem status	2
3	Mangrove ecosystem status	2
4	Coral reef ecosystem status	2
5	Unique/special habitat	1
6	Climate change on water and habitat conditions	3
	Average	2

Source: Research Result, 2020

Table 8 Analysis of Flag Model of Six Fishing Methods Domain Indicators

No	Indicator	Mark
1	Destructive fishing	2
2	Modification of fishing gear and fishing aids	2
3	Fishing Capacity and Effort	2
4	Fishing Selectivity	2
5	Conformity of the function and size of fishing vessels with legal documents	1
6	Certification of fishing boat crew in accordance with regulations	3
	Average	2

Source: Research,2020

Corrective Action Plan

Fish Resource Domain

A corrective action plan for each indicator of the Fish Resource Domain is presented in Table 9. In Table 10, the standard CPUE indicator, the trend of fish size, and ETP species in recent years are in the moderate category with a value of 2 and it is expected be improving from year 1 to 5. The steps needed can be in form of a TAC assessment (Total Allowable Catch) and optimal fishing effort for each of these indicators to achieve a good status between 4 and 5 years. This is followed by the regulation of the number of gear, vessels, and maximum fishing gear capacity, as well as conducting monitoring and supervision every year.

Habitat and Ecosystem Domain

The corrective action plan for each Fish Resources Domain indicator is shown in Table 10. Table 10 shows that the condition of coral reefs in the waters of Bagan Siapi-api has an indicator value of 2, which indicates a moderate status. This is because there is still fishing by destructive means through bombs or poison. Therefore, an action plan to increase the value of the indicator needs to be carried out through existing monitoring methods.

Fishing Method Domain

The corrective action plan for each indicator of the Fishing Methods Domain is shown in Table 11.

Table 9 Action Plan for Fish Resource Domain Improvement

No	Indicator	Mark Recent	Maintenance plan (Year) The				
			1	2	3	4	5
1	CPU Trend	**2**	2	2	2	3	3
2	Fish Size Trends	**2**	2	2	2	3	3
3	The proportion of Juvenil fish caught	**3**	3	3	3	3	3
4	Catch species composition	**3**	3	3	3	3	3
5	"Range Collapse" fish resources	**3**	3	3	3	3	3
6	ETP species	**2**	2	2	2	3	3

Source: Research Result, 2020

Table 10 Action Plan for Habitat and Ecosystem Domain Improvement

No	Indicator	Mark	Improvement Plan (Year)				
			1	2	3	4	5
1	Water quality	**2**	2	2	2	3	3
2	Seagrass ecosystem status	**2**	2	2	2	3	3
3	Mangrove ecosystem status	**2**	2	2	2	3	3
4	Coral reef ecosystem status	**2**	2	2	2	3	3
5	Unique/special habitat	**1**	1	2	2	3	3
6	Climate change on water and habitat conditions	**3**	3	3	3	3	3

Source: Research Result, 2020

Table 11 Action Plan for Domain Improvement Fishing Methods

No	Indicator	Mark	Maintenance plan (Year) The				
			1	2	3	4	5
1	Destructive fishing	2	2	2	2	3	3
2	Modification of fishing gear and fishing aids	2	2	2	2	3	3
3	Fishing Capacity and Effort	2	2	2	2	3	3
4	Fishing Selectivity	2	2	2	2	3	3
5	Conformity of the function and size of fishing vessels with legal documents	1	1	2	2	3	3
6	Certification of fishing boat crew in accordance with regulations	3	3	3	3	3	3

Source: Research Result, 2020

DISCUSSION

Based on the results of interviews with respondents, the size of large pelagic fish caught by fishermen in Bagan Siapi-api has not changed over the last 5-10 years. This indicated that the fish had sufficient time to mature before being caught and pose little threat to their sustainability (Abdullah *et al*. 2011). The proportion of juvenile and large pelagic fish catches is included in the small or little category, which is below 30%. This is because the size of large pelagic fish catches is included in the catchable, however, the proportion of target fish caught was higher than 31%.

Based on the results of interviews with local stakeholders, especially at station 1, mangrove species, namely Rhizophora Stylosa and mucronate were discovered. The results showed that the status of mangroves and biodiversity is in moderate condition, while the unique habitat is unknown. Therefore, the condition of unique/special habitats gets the lowest score (poor) because the information needed is not yet owned by the Rokan Hilir district through data collection or certain investigations. The detailed information was also not obtained through interviews due to the respondent's ignorance. Although there are no reports on the effect of climate change on habitat and water conditions, the impact is still <5%.

The analysis of the diversity index gave a value of 2.13, which ranges from 1.0 to 3.32. This indicated that the condition of mangrove forests is of moderate diversity, productivity is sufficient, ecosystem conditions are balanced, and ecological pressure is moderate. Puansalaing *et al*. (2021) stated that the dominance index value shows the richness of community types and the balance of the number of each species.

The fishing method domain consists of six indicators, namely destructive fishing, modification of tools and equipment, fishery capacity and effort, capture selectivity, suitability of the function and size of fishing vessels with legal documents, as well as certification of vessel crews in line with regulations. The number of destructive fishing in 2019 was relatively low, which is less than 5% with cases of violations in form of using potash and bombs.

Surface gillnet boats have conformity with the function and size of fishing vessels with legal documents. Meanwhile, the fishing vessels in Bagan Siapi-api are mostly under 5GT, which is 3 GT. The modification of the net is approximately 25% because it includes selective fishing gear.

Furthermore, in years 1 to 5, an improvement plan will be implemented in form of making regulations to prohibit the catching and releasing of fish that do not meet size standards, socialization, and FGD among stakeholders. The regulations are made based on the size of fish that are allowed to be caught, monitoring, and supervision of the implementation of activities to achieve a good status in the 5th year

Good status was obtained for the indicator of the proportion of juveniles caught, the species composition of the catch, and the "Range Collapse" of fish resources because it has a value of 3. For the proportion of juveniles, the plan is to maintain this status by making appropriate mesh size regulations, socialization, FGD, and monitoring the implementation of regulations by POKMASWAS. Furthermore, the management of the catchment area and the control of fishing efforts need to be maintained until the 5th year.

The condition of unique/special habitats gets a score of 1 or bad status. This is because the information on knowledge about the unique/special habitats needed is not yet owned by Rokan Hilir Regency through data collection or certain studies. The information is also not obtained in detail through interviews because of the respondent's ignorance. Furthermore, climate change on water and habitat conditions has a value of 3, which shows that the status is good. Although there has been no study on the effect of climate change on habitat and aquatic conditions, the impact is still <5%.

The table 8 shows that the condition of coral reefs in the waters of Bagan Siapi-api has an indicator value of 2, which indicates a moderate status. This is because there are still fishing activities by destructive means through bombing or poisoning. Therefore, an action plan needs to be implemented to increase the indicator by monitoring and enforcing legal sanctions on individuals that violate existing rules. Furthermore, the condition of unique/special habitats gets a score of 1 or bad status because the information needed is not yet owned by Rokan Hilir Regency through data collection or investigation. The information is also not obtained in detail through interviews because of the respondent's ignorance.

According to Puspasari *et al*. (2018), the operational objectives of management to

overcome this challenge are to reduce water pollution and prevent high concentrations of contamination. This can be achieved by recommending some management steps, namely (1) controlling waste management in companies, (2) conducting routine monitoring of water and coastal quality, (3) enforcing regulations, and (4) awarding actors who comply with regulations and sanctions for those who break the rules. Climate change on water and habitat conditions has a value of 3, which indicates a good status. Although there are no studies on the effect of climate change on habitat and water conditions, the impact is still <5%.

The indicators in the Fishing Method domain such as destructive approach, modification of fishing gear and aids, as well as the status of the mangrove ecosystems and coral reefs in the waters of Bagan Siapi-api have a value of 2. This indicates that the status is moderate because fishing activities are carried out through destructive means, such as bombing or poisoning. Therefore, an action plan needs to be implemented to increase the indicator value by monitoring and enforcing legal sanctions that violate existing rules. Furthermore, the condition of unique/special habitats gets a score of 1 or bad status. This is because the information needed is not yet owned by Rokan Hilir Regency through data collection or certain investigations. Based on the interview, detailed information was not obtained due to the respondent's ignorance. Climate change on water and habitat conditions has a value of 3, which implies the status is good. Although there are no studies on the effect of climate change on habitat and water conditions, the impact is still <5%.

CONCLUSION

Based on the EAFM Analysis it is found that the gill nets operation at Bagan Siapi-Api Waters is categorized as moderate condition for domain of fish resources, habitat and ecosystem, and fishing methods. This indicated that the status of ecosystem-based area management in the waters of Bagan Siapi-api is in the medium-good category.

SUGGESTION

Follow-up and implement the corrective action plan fisheries management through the EAFM approach in the waters of Bagan Ready-api on the domain of Fish Resources and Habitats and Exosystems are recommended.

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