THE EVALUATION OF REEF FISHERIES MANAGEMENT IN THE SPELMAN STRAIT COASTAL WATERS OF CENTRAL BUTON REGENCY, INDONESIA

Muis[1*], Rahmat Kurnia[2], Sulistiono[2], Taryono[2], Azhari[3], Risfandi[1*] and Dafit Ariyanto[4]

[1*]Fisheries Agribusiness Department, Faculty of Fisheries and Marine Sciences; Halu Oleo University, Kendari, 93132, Indonesia

[2]Departement of Aquatic Resources Management, Faculty of Fisheries and Marine Sciences, IPB University, Dramaga Bogor, West Java, 16680, Indonesia

[3]Nineteen November University, Kolaka, 93560, Indonesia

[4]Department of Aquaculture, Asahan University, Kisaran, North Sumatera, 21219, Indonesia.

Abstract

Coral reefs has an important function of reef fish. Several symptoms of reef overfishing have been observed in the Spelman Strait coastal waters and they include decreasing live coral cover and catch, deeper fishing ground and destructive fishing. This study was conducted to assess the reef fisheries management status and efforts in the Spelman Strait coastal waters. The research was conducted in Central Buton Regency on November 2018 - October 2019. Both EAFM and FGD Tools were applied for assessment using Microsoft Excel. The results show approximately 48.4 EAFM has been implemented in the area while Focus Group Discussion (FGD) with stakeholders reported the community jointly formed an institution to save reef fisheries and this involved the inclusion of religious leaders (*ustadz/ustadzah*) in management efforts. The formation of strong institutions involving all the components of society such as community, religious, traditional leaders and youth leaders, academics, government and other stakeholders is recommended to solve this problem.

Key words: Coral reefs, management status, religious leaders, Spelman Strait.

Introduction

Coral reefs are one of the typical ecosystems in tropical waters inhabited by economically important reef fish. It has been reported that adequate management of this natural habit in accordance with predetermined rules/ norms is expected to maintain the existence of stock of fish and consequently provide adequate welfare for fishermen (Hafsaridewi *et al.,* 2018). However, the increase in fishing activities over the past decade has led to several overfishing symptoms and to protect the ecosystem from damage (Pregiwati *et al.,* 2015); (USAID Sustainable Ecosystems Advanced (SEA) Project and the Ministry of Marine Affairs and Fisheries (MMAF), 2018; Yuliana *et al.,* 2019). EAF was introduced by FAO as a refinement of the previous

approach (Battersby and Bally, 2014; Hutubessy and Mosse, 2015).

Several symptoms of overfishing such as the decrease in the live coral cover and catch, fishing ground getting farther from the landing base and the use of destructive tools have been discovered in Spelman Strait coastal waters. Live coral cover from 5 stations observed in Spelman Strait was in a moderate condition with 37.71% (Muis *et al.,* 2019). Moreover, destructive fishing and rampant use of explosives or bombs as well as potassium cyanide have the ability to cause a decline in the quality of the reef ecosystem (Campbell *et al.,* 2013) and this further shows its growth and structure is influenced by some physical factors (Aldyza *et al.,* 2015).

The Ecosystem Approach to Fisheries Management (EAFM) is a very comprehensive approach implemented

Author for correspondence : E-mail: muisfpikuho@gmail.com

as one of the solutions to ensure sustainable reef fisheries management (FAO, 2019). It involves balancing the objectives of fish resources, habitat, fishing, social, economic and institutional factors by considering knowledge, information, human interaction in the ecosystem for an integrated, comprehensive and sustainable management (Kenny *et al.,* 2018). The implementation of this approach requires some assessment strategies and criteria in the overall ecosystem (Allain *et al.,* 2012) as well as the coordination between several interrelated institutions. However, the criteria should be easy to understand, measurable, transparent, participatory and has the ability to reflect the condition of resources for management purposes (Ye *et al.,* 2011).

Several studies have been conducted using the EAFM approach to assess ecosystem management such as reef fisheries in protected areas (Yuliana *et al.,* 2019), grouper fish in Karimunjawa National Park (Yulianto *et al.,* 2015) and lobster fisheries in Palabuhanratu Bay (Rombe *et al.,* 2018). Moreover, it was also used in the EU for the current science-policy-society interface and emerging requirements (Ramírez-Monsalve *et al.,* 2016) as well as on climate information for fisheries

management (Heenan *et al.,* 2015; Cisneros-Mata *et al.,* 2019). However, no research has been published on its application on reef fisheries in the Spelman Strait. This study aimed to assess the status of reef fisheries management in the Spelman Strait coastal waters of Central Buton Regency, Southeast Sulawesi, Indonesia. The findings are expected to be useful as a basis for current and future management efforts.

Materials and Methods

Time and Location

This research was conducted in the coastal waters and all villages of the Spelman Strait, Central Buton Regency, Southeast Sulawesi (Fig. 1) between November 2018 and October 2019.

Data Collection

Primary data including ecological, social, economic and institutional information were collected using census techniques. The ecological data including live coral cover, water parameters and amount of reef fish catch were through direct observation in the field while social, economic and institutional data were conducted using
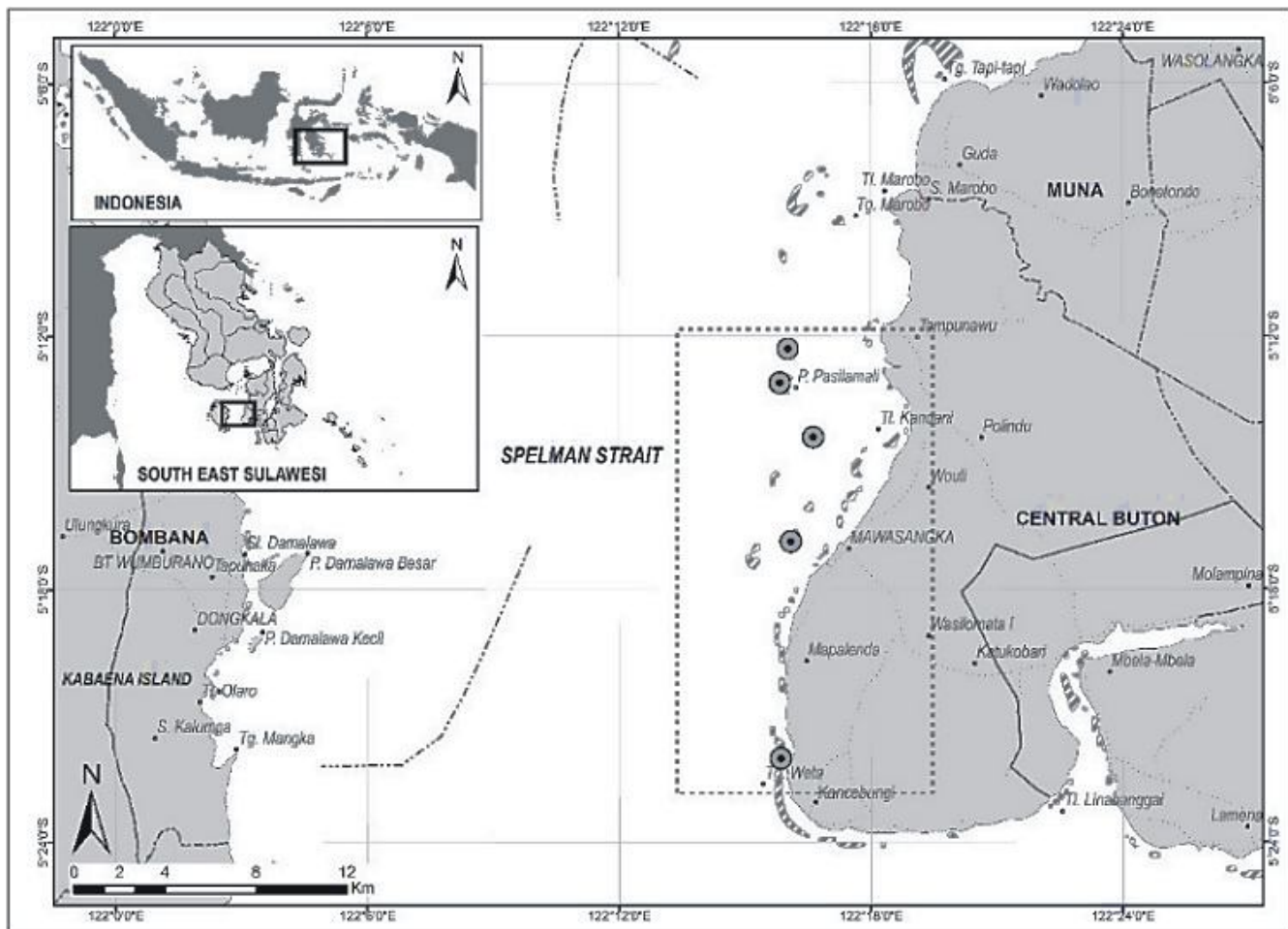

Fig. 1: Research location in the Spelman Strait, Central Buton Regency, Southeast Sulawesi.

Table 1: Limitation of dominant and aggregate scores in implementing EAFM.

Value range		Flag Model	Description
Low	High		
1.00	33.33		Bad
>33.33	66.66		Moderate
>66.66	100		Good
Source: Modification (Hutubessy and Mosse, 2015; Cury *et al.,* 2016).			

direct interviews, questionnaires and Focus Group Discussions (FGD) on all stakeholders such as Mawasangka Subdistrict Head, Mawasangka Police Chief and Military Rayon Commander, Fisheries Agency, coastal village heads and chairman of Village Consultative Body (VCB), community, religious and youth leaders, activists and academics. The sample population included all 50 reef fish fishermen and 31 other stakeholders in the community.

Data Analysis

The data were analyzed using EAFM. The EAFM used by modification Ministry of Marine Affair and Fisheries (MoMAF, 2014) consists of fish resources, habitat, fishing technology, economic, social and institutional domain and the limits of values and aggregates are shown in the following table.

Results and Discussions

Fish Resources Domain

The results of this study presented in fig. 2 are a one-year CPUE while the monthly catch. Fig. 2 show the standard CPUE for each indicator was in a moderate condition with a value of 14.65% and the size of the reef fish found was observed to be getting smaller. The data obtained from the Karimunjawa National Park indicated
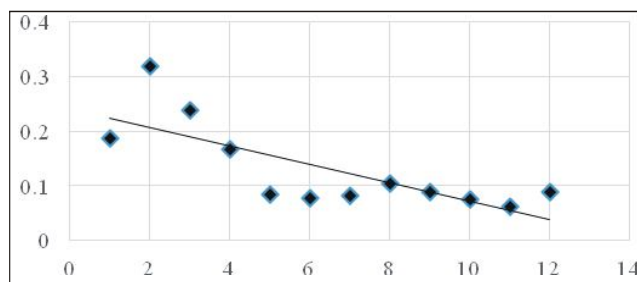
Fig. 2: CPUE of reef fisheries in 1 year at the Spelman Strait coastal waters.

the grouper CPUE drastically decreased in the 2009-2011 period and was between 0.06-0.15 kg in 1 trip using a fishing rod (Yulianto *et al.,* 2015). However, a contrasting result was recorded in a 2016 research with the CPUE of the reef fish found to be increasing every month throughout the year (Yuliana *et al.,* 2016).

The fishing ground was also discovered to be getting farther and more difficult due to the range collapse causing a reduction in the size and quantity of the fish each year and this is making the fishermen move deeper in the waters to catch fish. This is, however, associated with illegal fishing, overfishing and irresponsible management and preservation of coral reef ecosystems (Millennium Ecosystem Assessment, 2005). Allowing excessive fishing pressure and trips in Palabuhanratu (Rombe *et al.,* 2018). The use of explosives in catching reef fish also damages the coral reef ecosystem, affects live coral cover and consequently the abundance of reef fish. It has also been reported that a higher quality of the ecosystem as a habitat, foraging or feeding, nursery, shelter and spawning ground helps in the production of more fish.

Aquatic Habitat and Ecosystem Domain

In general, the conditions or parameters of the water

Table 2: The measurement results of fishery water parameters in January and may 2019.

Parameter/unit	Quality standards[*)]	Average analysis results of each station[**)]				
		1	2	3	4	5
Temperature (^{o}C)	Coral 28-30	29.5	29.5	29	30	29
Salinity (ppt)	Coral 33-34	32	32	32	32	32
Transparency (m)	Coral >5	9.4	5.6	6.7	6.1	5.0
pH	7-8.5	8	8	8	8	8
Current speed (m.sec)	-	0.06	0.1	0.1	0.14	0.15
DO (mg/l)	>5	7.0	7.4	7.8	7.4	7.0
BOD$_5$ (mg/l)	20	3.7	5.3	6.2	4.5	3.7
Nitrate (mg/l)	0.008	0.09	0.09	0.09	0.10	0.09
Phosphate (mg/l)	0.015	0.03	0.05	0.04	0.02	0.03
Ammonia (mg/l)	0.3	0.03	0.03	0.02	0.04	0.03
([*]Ministry of Environment, 2004)						

Table 3: Criteria for mangrove density level.

Criteria	Density	Density (tree/ha)[*]	Density in the study area (tree/ha)[**]
Good	Very dense	≥ 1500	-
	Moderate	$\geq 1000 - <1500$	-
Damaged	Rarely	<1000	750
Remark: (*Ministry of Environment, 2004)			

in all the observed stations were found to be in good condition according to the standard criteria MENLH (Minister of Environment Decree) Number 51 in 2004 as shown in table 3.

The mangrove density data in the Spelman Strait coast was 750 trees/ha (Table 4) according to the criteria (Ministry of Environment, 2004) and this means the forest is damaged. Moreover, the seagrass ecosystem was discovered to be in good condition because it has not been utilized to date as observed from the 54,172% recorded. The damage to the coral reef ecosystem was caused by anthropogenic influences (Prada *et al.,* 2019), generally, through irresponsible fishermen catching fish using explosives, cyanide poisons and those using coral as building materials (Thangaraj, 2019). Mangrove has high productivity (Ariyanto *et al.,* 2018a, b; Ariyanto *et al.,* 2019), food source (Ariyanto, 2019) and element content (Ningsih *et al.,* 2020) and many functions for fish and benthic (Ariyanto *et al.,* 2018c). Furthermore, the decreased density of the mangrove ecosystems was caused by the use of trees as firewood, house poles and step chart poles as well as through inadequate coordination of pond land between the community and related agencies.

Seagrass and mangrove are inseparable from coral reef ecosystems due to the support they provide for each and this relationship has been suspected by ecologists for so many years but it has not been biologically proven (Camp *et al.,* 2016; Guannel *et al.,* 2016). This relationship has been observed in Curacao Island, the Caribbean where several fish species were found to be using seagrass and mangrove areas as a nursery ground to raise juveniles (Nagelkerken *et al.,* 2000).

There are no reports on the effects of climate change on waters and habitats from both the universities and local governments. However, the waters conservation

Fig. 3: The fishing technique in the Spelman Strait coastal waters.

area in the Anambas Islands Regency was affected even though the impact is minimal for coastal communities depending on fisheries. The Spelman Strait coastal waters have a unique habitat known as the upwelling cycle and this involves raising of water from the deeper column to the surface mainly by winds blowing in certain periods. Moreover, coastal with high topography has a great chance of upwelling (Wu *et al.,* 2019) and this is the reason it mostly occurs on the north coast of the Papua continent as a response to the west winds during December to March and characterized by low sea surface temperatures (SST) (25-28°C) (Waas *et al.,* 2014).

Fishing Technique Domain

The major technique used for fishing is the rampant use of bombs as shown in fig. 3. Destructive fishing techniques were found to be over 30 cases/year, thereby presenting a great challenge for the sustainability of the coral reef ecosystem and to the fishing capacity of fishermen using hand lines.

Moreover, direct interviews with fishermen and the FGDs with stakeholders showed the rampant use of explosives affects fish production. Coastal ecosystems are depressed because they are affected by sedimentation, pollutants, extractive activities, habitat destruction and global environmental changes (Brown *et al.,* 2014; Gilby *et al.,* 2016). However, the use of fishing rods was found to be environmentally friendly and highly selective. Fishing scenarios, that coral reef ecosystems remain sustainable, using fishing rods and a restriction on overfishing of herbivorous fishes, including restrictions on underwater tourism (Weijerman *et al.,* 2018).

Social Domain

Social life affects the community's social system and the use of resources is closely related to survival. Therefore, the participation of stakeholders plays an important role in the fisheries' social system of Spelman Strait. The results of the coral social domain assessment are presented in the following fig. 4. The interview showed the participation of stakeholders is low and that frequent conflicts occur between traditional fishermen and those using bombs. Moreover, local wisdom has not been established in the reef fisheries management and institutions at the community level. The results also showed there are no rules to manage or limit fishermen in order to ensure the sustainability of the reef fisheries.

Conflict is unavoidable in resource
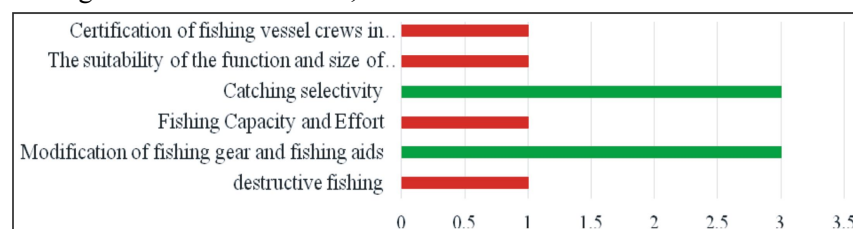
management mainly due to the differences in the needs and goals of stakeholders. It is a struggle between several parties to obtain rare things such as values, status, power, authority and other benefits using any means necessary and in this case, it is influenced by the seizure of fisheries resources (García-Lorenzo *et al.,* 2019). However, the results showed the absence of conflicts in Palabuhanratu due to the availability of several accesses to the resources (Rombe *et al.,* 2018). Local knowledge or wisdom in managing reef fisheries resources was found to be lacking in the studied area except for the recitation of prayers to have enough income every year. Therefore, it is important to note that stakeholders' participation is very important due to its important role in reducing conflict with rules and forming an institution to strengthen a shared ownership sense in the management of reef fisheries in Spelman Strait.

Economy Domain

Economic factors have a great influence on fisheries resources used by fishermen to improve their welfare. However, the economic criteria in evaluating reef fisheries management are shown in the following fig. 5.

The interviews and FGDs showed some of the boats were bought using village funds, especially 5 people from

Fig. 4: EAFM criteria for the social domain in the Spelman Strait coastal waters.

Fig. 5: EAFM criteria of the economic domain in the Spelman Strait coastal waters.

Fig. 6: The institutional domain in the Spelman Strait.

Fig. 7: The average score of each EAFM domain of reef fisheries in the Spelman strait coastal waters.

Kancebungi Village, while the others are privately owned. Moreover, the average capacity of the boat 3 GT while the household income earned from catching reef fish ranged between Rp. 150,000 and Rp. 200,000 per day with an additional income from cultivating seaweed. This means the monthly income is approximately Rp. 4,500,000 to Rp. 6,000,000.

Fishery assets ownership is a means for fishermen to achieve prosperity while production is the current household assets (RTP) with the previous year. It is also important to note that some of the income earned in a month is saved with the average expenditure in a month recorded to be between Rp. 1,500,000 and Rp. 3,000,000. However, the income of Lobster fishermen in Palabuhanratu was found to be below the monthly Regional Minimum Wage (UMR) approximated at Rp. 1,800,000 per person (Rombe *et al,* 2018). The expenses depend on the number of family members while the savings ratio determines the potential of the household to save excess income such that if the value is positive, there is enough to be saved and vice versa.

Institutional Domain

Institutional influence on fisheries management is required for the sustainable utilization of the Spelman Strait as shown in fig. 6. The figure shows the use of bombs in catching reef fish is frequent at 10 times/month without concrete action to put an end to it. Moreover, there is neither effective communication between institutions and stakeholders nor adequate implementation of the Fisheries Management Plan (FMP) and regulations. There are both formal and informal levels of compliance with the principles of fisheries management but none was found to have been properly implemented. The interviews and FGDs showed the fishermen only complied based on their knowledge since there are no effective rules from responsible stakeholders. Moreover, the only available regulation is at the ministerial level without any proper application in the region and this led to low and improper enforcement of the laws in Spelman Strait coastal waters.

FMP as contained in the Decree of the Minister of Maritime Affairs and Fisheries No. 45, 2015 is absolutely necessary as an operational standard,
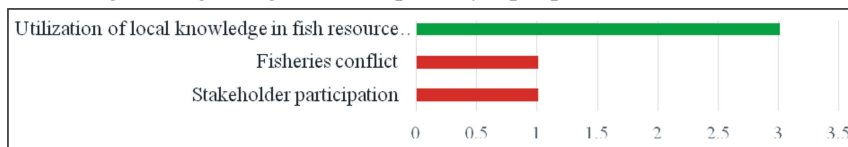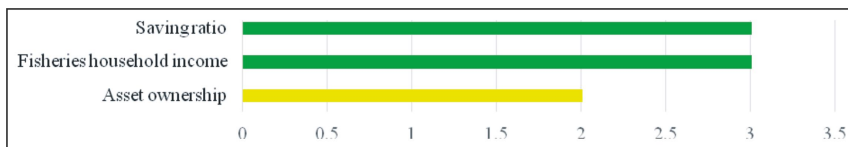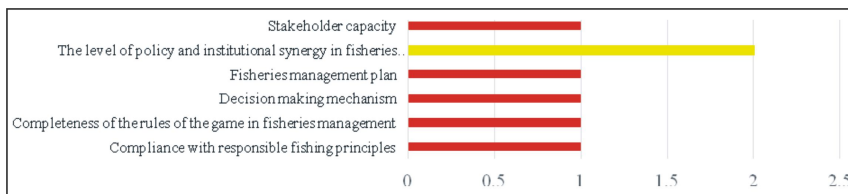
Table 4: Criteria of coverage/density assessment in seagrass ecosystems

Coverage (%)	Criteria	Coverage in the study area[**)] (%)
C < 5%	Very rarely	-
5% ≤ C < 25%	Rarely	-
25% ≤ C < 50%	Moderate	-
50% ≤ C < 75%	Dense	54,172
C ≥ 75%	Very Dense	-

however, it has not been implemented in the local government. Moreover, the synergy level of inter-policies and inter-institutions in fisheries management involves creating movements and steps to avoid conflicts. However, the interviews and FGDs conducted with stakeholders were ego sectoral or partial and was found to be inhibiting coordination and cooperation in the sustainable management of fish resources and management in Karimunjawa National Park (Yuliana *et al.,* 2016). The low participation of stakeholders causes weak supervision and consequential damages to the coral reef ecosystems. This is in line with the report that the activeness of stakeholders influences the success of fisheries management (FAO, 2019). Therefore, it is very important they participate starting from the initial determination of a policy or regulation to the supervision and evaluation stage.

EAFM Indicator Assessment for each Domain

The indicator of each EAFM domain was assessed and the results are presented in the following fig. 7. The results showed the actual conditions were in the moderate category based on the value of 48.4 recorded.

The fig. 7 shows the domains with the lowest actual scores were social and institutional and this is attached to anthropogenic influence in catching reef fish such as very weak supervision, very low government involvement, a limited knowledge of fishermen, weak law enforcement and lack of strong synergy between competent institutions. Moreover, the formal institutionalization in Polman Regency, West Sulawesi, showed a non-optimal role and function in integrating traditional practices to support the effort towards preserving the flying fish (Yusuf *et al.,* 2018). Therefore, the formation of strong institutions involving all the components of society such as community, religious, traditional leaders and youth leaders, academics, government and other stakeholders is recommended to solve this problem.

Conclusion

Domain of fish resources, habitat and ecosystem, fishing techniques and social domain in the coastal waters of the Spelman Strait under the conditions of not applying EAFM. This condition was triggered by the low awareness of fishermen, especially fishing patterns that are not environmentally friendly. The institutional domain, not yet implementing EAFM. This condition is caused by weak supervision and law enforcement with a lack of counseling for fishermen

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