



An overview of reef fish catching seasonal patterns in the coastal waters of Spelman Strait, in Central Buton Regency, Indonesia

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Abstract. The coral reefs in the coastal waters of the Spelman Strait are experiencing continuous environmental degradation due to exploitation by fishermen. This study, therefore, aims to identify the target fish catch based on the fishing season using local, domestic, and international reef marketing systems. This research was conducted from January to April (west monsoon season) and May to November 2019 (east monsoon season). The results showed that Lutjanidae (6 species), Serranidae (8 species), Prettodidae (1 species), Haemulidae (1 species), Caesionidae (1 species), Ostraciidae (1 species), Mullidae (6 species), Labridae (2 species), Siganidae (3 species), Holocentridae (1 species), Lethrinidae (7 species), Symphysanodontidae (1 species), Chaetodontidae (1 species), Platycephalidae (1 species) and Nemipteridae (3 species) are the identified genera of fishes found in coastal waters of the Spelman Strait. During the west monsoon season, fishermen use the hook sizes numbered 5 and 8 to catch a large size fishes of the Serranidae and Lutjanidae families, and in the east monsoon season, hook sizes of 15, 16, 17 are utilized for catching small fish species. These reef fishes are internationally marketed in other Asian countries such as Singapore, Taiwan, and China.

Key Words: fish resources, local wisdom, fishermen, middlemen, coral reefs, monsoon.

Introduction. The Spelman Strait is directly facing the Flores Sea and the Gulf of Bone. Due to its strategic position, high biodiversity fisheries are present, that are owned and utilized by fishermen communities. The coral reefs are experiencing environmental degradation due to the continuous exploitation by fishermen. The anthropogenic influence capable of pressurizing and disrupting these coastal waters include the use non-environmentally friendly materials, indiscriminate disposal of household waste and sand mining on the straits coast (Muis et al 2019). However, without information on catch composition, catching effort, and number of catches, it is still unclear which fishermen are most affected by the depletion of fish populations and which management strategies can achieve sustainability in fisheries while minimizing costs for the fishing community. Robinson et al (2020) revealed that management strategies must maximize catch diversity and help protect fishermen livelihoods. One of the key incentives of fisheries diversification is that it enables fishermen to exploit the skills, knowledge and social networks gained from fishing, without leaving the industry (Morgan et al 2012; Urquhart et al 2014).

Local wisdom has considerations in contributing significantly to regional development. The existence of local wisdom has long caused people to be able to withstand various environmental problems that occur. Local wisdom is also present in fisheries management, such as local expertise in community empowerment regarding sustainable fisheries resource management and development (Ibad 2017). Local wisdom is used to control fisheries activity in Sabangau Area, Central Kalimantan (Elbaar & Limantara 2019).

It regulates fisheries efforts in sustainable marine resource management in Bengkulu (Ambarini et al 2018). The Kamoro Tribe uses local wisdom in fisheries resource utilization in the Far East Mimica District of Papua (Tebaiy & Manuputty 2017). Local wisdom is also present in other fisheries resource management (Widarmanto 2018), like policies in the northern waters of Aceh (Rizqi et al 2017), relationship of community perceptions and participation in the management of fisheries resources (Bekti et al 2019), strengthening local wisdom as a foundation for public water fisheries management in Sumatra (Oktaviani et al 2016; Zamzami & Effendi 2018), and traditional knowledge in fisheries management of Panglima Laot (Sea Commander) in the Aceh (Utomo 2010).

Over the past decades, local fishermen utilized the west and east monsoon season to carry out their fishing business, with the west and east seasons being marked by strong waves and cool winds, respectively. According to Case et al (2007), climate change due to season is the average weather conditions of a place at a certain time. Riyadi & Yunisa (2007) stated that seasonal patterns that occur in water are influenced by current and changes in wind direction. Holbrook & Johnson (2014) reported that strong climate change is a challenge for the current and future existence of the fishing industry. The fishermen in this habitat hunt for large and small fishes during the west and east seasons, respectively. Based on the description, it is important to conduct a research on the sustainable management of coral fisheries to identify the target fish catch (reef fish) based on seasons, using local wisdom and the fisheries system in the coastal waters of the Spelman Strait. This research aimed to identify the fish catch target based on the fishing season using local, domestic and international reef marketing systems.

Material and Method

Description of the study sites. This study was conducted in the coastal waters of the Spelman Strait (Figure 1) from January to June 2019. The location of this study consisted of 5 sampling points of coral reef ecosystems with 3 sampling replications. In addition, it was carried out in 2 (two) reef fishing seasons, namely from January to April (west monsoon season) and May to November (east monsoon season).

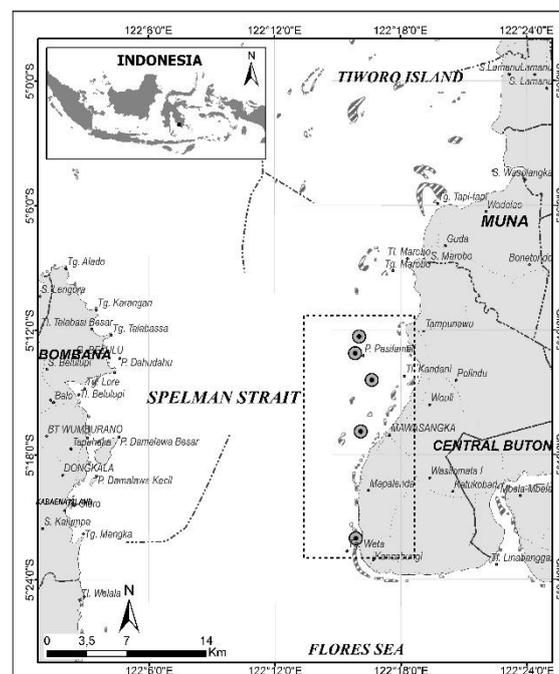


Figure 1. Location of research in the coastal waters of Spelman Strait, in Central Buton Regency, Indonesia.

Data collection. Data primer consisted of the number of catches, fish species, fish prices, water level, as well as the local, domestic and international trade routes of the Spelman Strait. Interviews and Focus Group Discussions (FGD) were conducted with a total of 53 fishermen.

Data analysis. Data collected was tabulated using Microsoft Excel tools and analyzed qualitatively. The determination of the study always from the focus of study (Bogdan et al 1992; Moleong 2010; Septianto et al 2015).

Results and Discussion

Identification of target fish based on fishing season. The identification of target fish species was conducted during 2 (two) fishing seasons in the coastal waters of the Spelman Strait (Table 1). The west monsoon season is synonymous with the changing pattern of winds that cause large waves around the coastal waters of the Spelman Strait. During this season, most fishermen stay away from the sea due to the high sea waves and storms. This condition is known as "famine," which influences the income of fishermen in fulfilling their needs (Imran 2012). The adaptation patterns, are an alternative in dealing with seasonal changes, and are present in many regions, such as in Bambu village, Mamuju Regency (Ansaar 2019), Posek, Kepulauan Posek Sub-district, Lingga Regency, Riau Island (Irak et al 2018), Ciawitali Hamlet, Pamotan Village, Ciamis Regency, West Java (Patriana 2013) and ecological changes (Helmi & Satria 2012). Fishermen have undertaken various strategies of physical, socio-economic, and human resources adaptations through proactive and reactive approaches. Physical adaptation strategy can be performed with a proactive approach such as planting trees that directly withstand sea level rise, large waves, tidal flooding, and a reactive approach such as managing catching seasons and improving coral reefs management. Mulyasari et al (2018) argued that the important adaptation strategies include diversification of household economic activities, augmenting of fishing gear, changing the fishing grounds, mobilization of family members to work, and fishing time adjustment.

The strategic location of the Spelman Strait enables it to deal directly with the Flores Sea and the Gulf of Bone. However, the strong winds and large waves from this sea during the west season, are diminished by Mount Sabampolulu on the Kabaena Island, therefore, fishermen tend to actively go fishing throughout the year.

The waters have an annual upwelling cycle, where wind speed causes waves. When the water mass flows towards the coast and meets a rough bottom topography, it leads to a mixture of water masses and this phenomenon occurs in the west season from January to April.

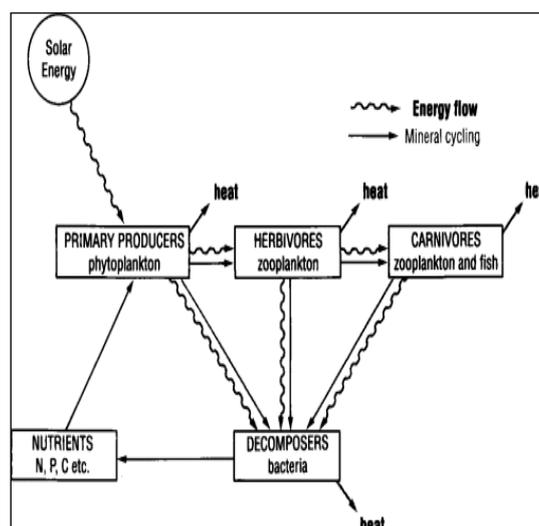


Figure 2. Energy flow in the water (Mann & Lazier 1996).

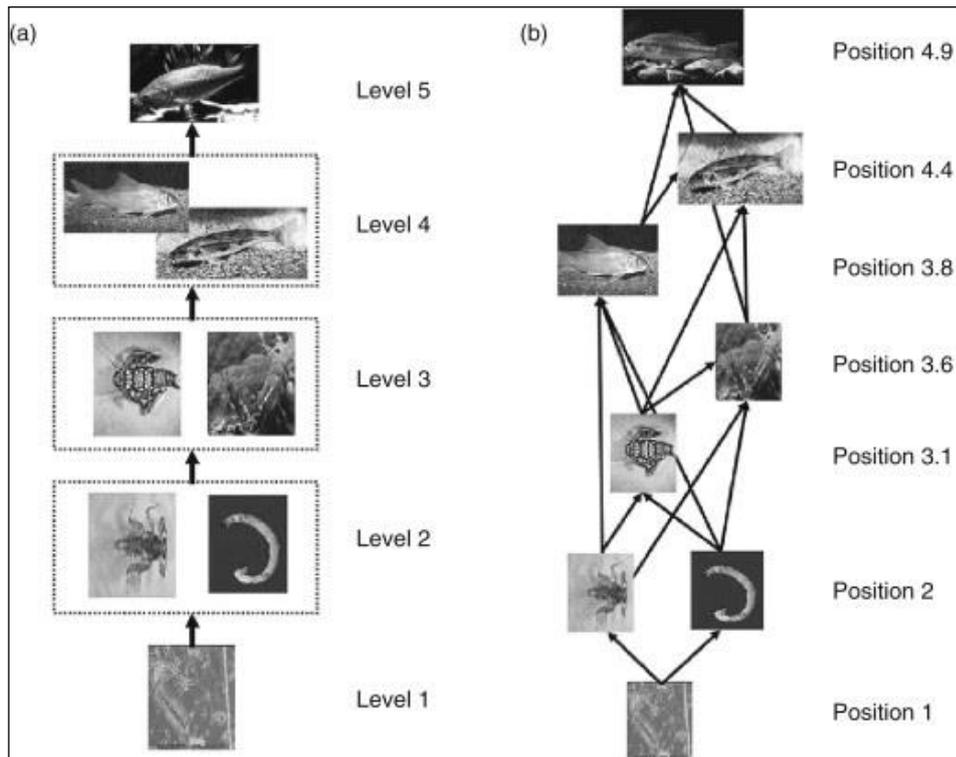


Figure 3. Food chain examples in marine habitats (Laili & Parsons 1997; Thorp et al 2008).

The upwelling process is the rise of water, in the form of waves, from a deeper column to the surface due to winds blowing in certain periods. According to Wu et al (2019), coasts with high topography have a great chance of upwelling. Waas et al (2014) stated that the upwelling phenomenon occurred in the northern coastal waters of the Papua Island due to the west wind (WWB) from December to March and is marked by low sea surface temperature (SST) (25 - 28°C).

Ecologically, upwelling has two important impacts namely, (1) it brings cold and nutrient-rich water to the surface and supports phytoplankton growth, (2) the main energy base for bigger animals upper in the food chain, including fish, marine mammals, and seabirds is formed by phytoplankton as shown in Figure 2 (Mann & Lazier 1996). The energy flow has an effect over the food chains in those waters (Laili & Parsons 1997; Thorp et al 2008) (Figure 3).

Diversity of reef fish species. The pattern of reef fishing species catches in the coastal waters of the Spelman Strait using motorboats and fishing lines (Figure 4) is divided into two seasons, namely east and west seasons (Tables 1 and 2).



Figure 4. Reef fishing line with weighted hook (left) and outboard vessel (right) and used by fishermen in the coastal waters of the Spelman Strait.

Table 1

Families and species of reef fish caught in the east monsoon season in the coastal waters of Spelman Strait, in Central Buton Regency, Indonesia

No.	Family	Species
1	Lutjanidae	<i>Lutjanus</i> sp., <i>L. madras</i> , <i>L. kasmira</i> , <i>L. gibbus</i> , <i>L. campechanus</i> , <i>L. bitaeniatus</i>
2	Prettodidae	<i>Psettodes erumei</i>
3	Haemullidae	<i>Diagramma picatum</i>
4	Caesionidae	<i>Caesio cuning</i>
5	Serranidae	<i>Epinephelus fuscoguttatus</i> , <i>E. quoyanus</i> , <i>E. polyhekadion</i> <i>Plectropomus marculatus</i> , <i>P. leopardus</i> , <i>Viriola louti</i> , <i>Cromiletes altivelis</i> , <i>Cephalopholis boenak</i>
6	Ostraciidae	<i>Lactoria pentacantha</i>
7	Mullidae	<i>Upeneus tragula</i> , <i>U. vittatus</i> , <i>Parupeneus barberionides</i> , <i>P. indicus</i> , <i>P. macronema</i> , <i>Mulloidichthys flavolineatus</i>
8	Labridae	<i>Choerodon</i> sp., <i>Halichoeres scapularis</i>
9	Siganidae	<i>Siganus javus</i> , <i>S. guttatus</i> , <i>S. canaliculatus</i>
10	Holocentridae	<i>Sargocentron rubrum</i>
11	Lethrinidae	<i>Lethrinus atkinsoni</i> , <i>L. letjan</i> , <i>L. genivittatus</i> , <i>Lethrinus</i> spp., <i>L. microdon</i> , <i>L. obsoletus</i> , <i>Gymnocranius elongates</i>
12	Symphysanodontidae	<i>Symphysanodon katayamai</i>
13	Chatodontidae	<i>Parachaetodon ocellatus</i>
14	Platycephalidae	<i>Sunagocia otaitensis</i>
15	Nemipteridae	<i>Scolopsis</i> sp., <i>Nemipterus furcosus</i> , <i>N. nematophorus</i>

Table 2

Families and species of reef fish caught in the west monsoon season

No.	Family	Species
1	Lutjanidae	<i>Lutjanus</i> sp., <i>L. bitaeniatus</i>
2	Serranidae	<i>Epinephelus fuscoguttatus</i> , <i>E. polyhekadion</i> , <i>E. quoyanus</i> , <i>Viriola louti</i> , <i>Plectropomus marculatus</i> , <i>P. leopardus</i> , <i>Cromiletes altivelis</i> , <i>Cephalopholis boenak</i>

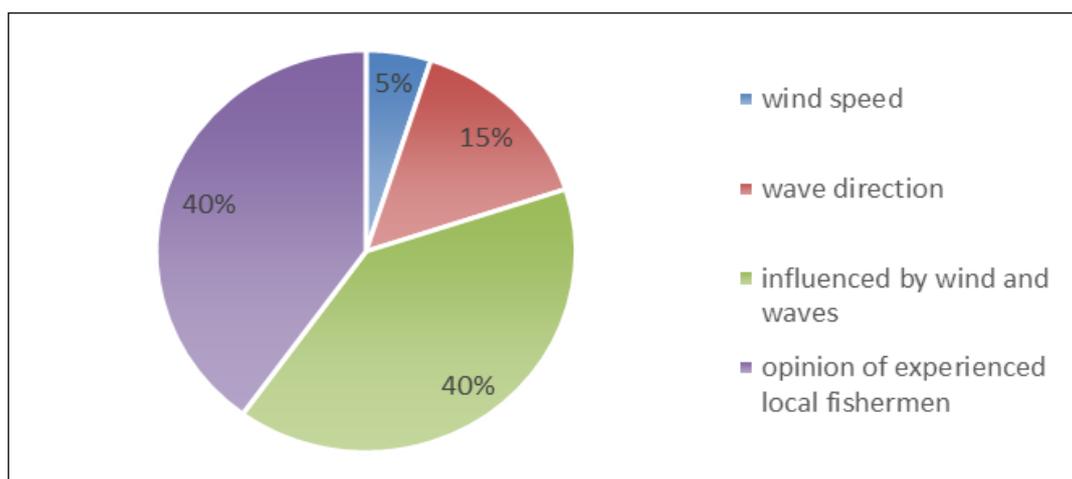


Figure 5. The proportion of different types of local knowledge about reef fishing in the coastal waters of Spelman Strait, in Central Buton Regency, Indonesia.

Based on Figure 5, the pattern of knowledge on reef fishing in the west and east seasons are 40% based on the opinion of experienced local fishermen, 40% is influenced by wind and waves, 15% is influenced by wave direction and 5% by wind speed. According to Mulyasari et al (2018), fishermen perceive that climate change is only a change between east and west monsoon, and they do not understand climate change indicators including temperature change, rainfall and others.

The pattern used by fishermen in catching reef fishes has become local knowledge for the sustainability and utilization of the reef fishery resource. Over the years, this knowledge has been passed down to various generations.

Local knowledge shows the sustainability of reef fishing resources, this being exemplified by the fact that coral reefs offer fishing opportunities every season. "In the west season, fishermen target big fishes using rod sizes of 5 and 8, while in the east season, they aim at small fish using rods sizes of 15, 16 and 17" (Utomo 2010). Therefore, local knowledge is a form of management for coral reef ecosystems that are good and sustainable. When the knowledge is responsibly managed, it tends to provide a positive impact on its sustainability and the economic value of fishermen thereby, increasing their welfare.

According to Ambarini et al (2018), the initiative of fisheries management arises from the local community by using existing understanding and through institutionalized customary law system. The local knowledge possessed by reef fishermen in the coastal waters acts as a great opportunity for the proper management of rules agreed and institutionalized by the local government. As stated by Utomo (2010), in Aceh the Panglima Laot establishes customary laws for local fishing, Panglima Laot being a local leader.

According to (Ibad 2017), local knowledge needs to take sides on environmental sustainability, however, in terms of culture, a management concept is utilized which has an impact on the sustainability of coral reef ecosystem resources. According to Jorge (2014), an ecosystem needs sustainable fishery management, therefore, the recovery of fish resources are an added value to improved food security. Kathijotes (2013), stated that farmers and fishermen still pay attention to the sustainability of ecosystems to sustain business and livelihoods.

According to Indonesia Regulation No. 32 (Environmental Protection and Management 2009), these community values are used to sustain, protect and manage the environment. These serve as benchmarks for the sustainability of the conservation of coral reef ecosystem resources because the basic principle of sustainable fisheries is to integrate ecological, social, economic, and institutional goals. Furthermore, according to the Ministry of National Development Planning (2014), the initial concept of sustainable fisheries is the availability of fishing at a sustainable level.

Distribution of reef fish market. The reef fishing system in the coastal waters of the Spelman Strait is observed yearly. It also plays an important role in fulfilling and improving the welfare of fishermen, that use fishing lines and other fishing tools (Table 3). Table 3 shows that during the west season, each fisherman catches fishes weighing 9 to 50 kg, and during the east season, they weigh 10 to 18 kg with a total of 10,653 kg/day and 4,134 kg/day respectively. The 12th and 5th months are the transition seasons. However, the fishing fleet (vessels) determines the number of fishes caught and the income of fishermen. According to Triarso (2013), the availability of fisheries facilities and infrastructure influences the number of fishes caught and sold to the middlemen. They influence the dependence of fishermen, due to the large market network.

Based on Table 4, the highest price for reef fish is for red grouper with 250.000 Rp (Indonesian Rupiah), and the lowest price is for snapper with 28.000 Rp (Indonesian Rupiah), therefore, the middlemen play an important role in determining the price of reef fish. Their dependence is due to their inability to access the market. The following is the reef fish trade market network as shown in Figure 6.

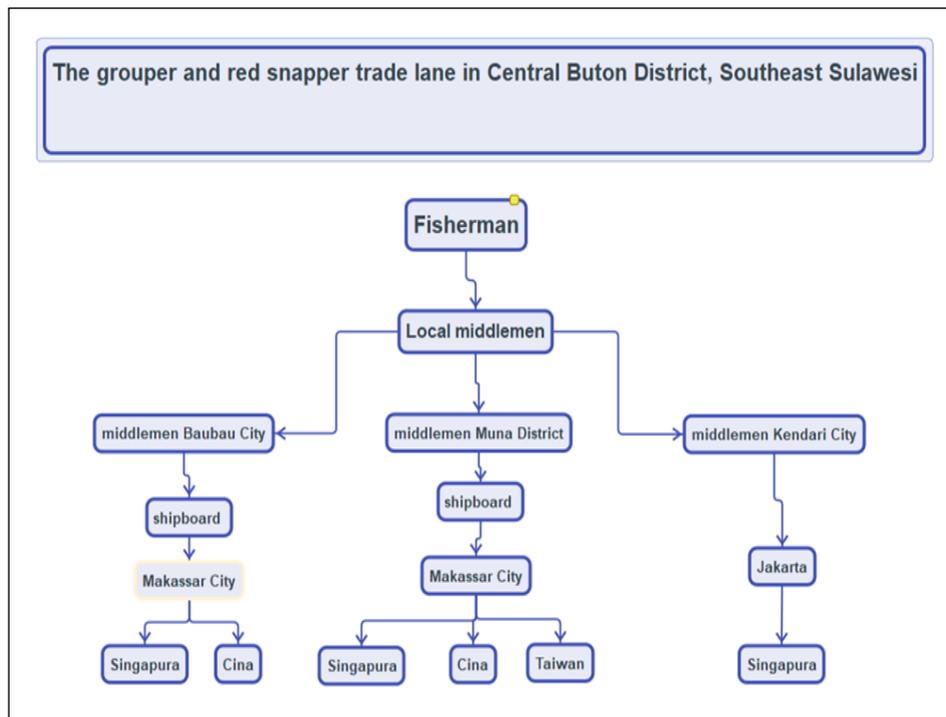


Figure 6. Reef fish trade routes in the coastal waters of Spelman Strait.

Table 3

Ships, fishing gear and reef fish production in the west and east monsoon seasons in the coastal waters of Spelman Strait

Month	West season Production (kg/day/person)	Month	East season production (kg/day/person)	Fishing rods	Fishermen	Ships	Collectors (person)
12	9	6	10				
1	30	7	15				
2	45	8	18				
3	47	9	15				
4	50	10	10				
5	20	11	10				
Total	10,653	Total	4,134	212	53	53	3

Table 4

Prices of reef fish practiced by middlemen in the coastal waters of Spelman Strait

Size (kg)	Fish Species (price Rp/kg)				
	Groupers	Red Groupers	Yellow Groupers	Snappers	Red Snappers
1 – 1.9	35,000	-	-	28,000	-
2 – 2.9	50,000	-	-	28,000	-
0,5 – 2.9	-	-	-	28,000	50,000
3 – more than 7	-	-	-	28,000	45,000
1.5 – 3.9	-	120,000	110,000	28,000	-
1 – 1.4	-	170,000	-	28,000	-
4 – more than 5	-	100,000	90,000	28,000	-
5 – 9	-	250,000	150,000	28,000	-

The Spelman Strait middlemen consist of a large domestic market network, between fishermen and middlemen. According to CEA (2018), middlemen control the market,

therefore, they monopolize trade routes, and create dependency in accordance with the needs of fishermen. This similar situation occurred in Palabuhanratu, where 90% of fishermen used middlemen to obtain capital due to easy processing techniques, while agreeing to sell most of their catches to them without going through auctions (Lubis et al 2012).

Conclusions. In conclusion, the east monsoon season in the coastal waters of Spelman Strait, in Central Buton Regency, Indonesia offers good fishing conditions for 15 fish families and the west monsoon season offers good fishing conditions for 2 fish families. The reef fish production was 10,653 (kg/day/person) in west season and 4,134 (kg/day/person) in east season. The local knowledge on reef fishing season can be influenced by middlemen. The pattern of coral reef fishing knowledge used by the Spelman Strait coastal fisheries can be used as local wisdom in reef fisheries management.

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