JURNAL LAUT PULAU: 3 (2): 10 - 20
E-ISSN: 2830-1676
https://ojs3.unpatti.ac.id/index.php/jlp

Dynamics of Coral Fish Biomass in The Coastal Waters of Spelman Strait, Central Buton Regency, Southeast Sulawesi

Dinamika Biomassa Ikan Karang di Perairan Pesisir Selat Spelman, Kabupaten Buton Tengah, Sulawesi Tenggara

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Article Info:
Received: 01 – 07 - 2024
in revised form: 17 – 07 - 2024
Accepted: 18 – 07 - 2024
Available Online: 24 – 07- 2024

Keywords:
Small scale fisheries, reef fish, coral fishing, condition of coral.

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DOI:
https://doi.org/10.30598/jlpvol3iss2pp10-20

Abstract: The study aims to analyze how coral fish biomass in two fishing seasons, namely the west and east seasons. The results of the study, reef fish biomass in the two seasons is relatively different. The difference between the two is due to different fishing patterns, wherein the wet season, the reef fish that are targeted by fishermen are the Serranismallnidae families, and the size of the fish is relatively large by using hooks number 5, 6, 7 and 8. In contrast, in the east season, the target fish fishers are all reef fishes and are relatively small in size using hooks 15, 16 and 17. The problem is that some fishermen still use explosives in catching reef fish. Muis et al. (2019) reported the condition of live coral cover in the coastal waters of the Spelman Strait in moderate condition (37.71) and dead coral (33.71). Community participation in the management of fisheries resources is significant to note because the community is the user of these resources. Community participation in the management of fisheries resources is crucial to do because of fishermen as users of resources. Muis et al. (2019) reported the condition of live coral cover in the coastal waters of the Spelman Strait in moderate condition (37.71) and dead coral (33.71).

Abstrak: *Penelitian ini bertujuan untuk menganalisis bagaimana biomassa ikan karang dalam dua musim penangkapan ikan, yaitu musim barat dan timur. Hasil penelitian, biomassa ikan karang pada dua musim relatif berbeda. Perbedaan keduanya adalah karena pola penangkapan ikan yang berbeda, dimana pada musim hujan, ikan karang yang menjadi sasaran nelayan adalah famili Serranismallnidae, dan ukuran ikannya relatif besar dengan menggunakan kail nomor 5, 6, 7 dan 8. Sebaliknya, pada musim timur, target nelayan ikan adalah semua ikan karang dan ukurannya relatif kecil menggunakan kail 15, 16 dan 17. Masalahnya, beberapa nelayan masih menggunakan bahan peledak dalam menangkap ikan karang. Muis et al. (2019) melaporkan kondisi tutupan karang hidup di perairan pesisir Selat Spelman dalam kondisi sedang (37,71) dan karang mati (33,71). Partisipasi masyarakat dalam pengelolaan sumber daya perikanan penting untuk diperhatikan karena masyarakat adalah pengguna sumber daya tersebut. Partisipasi masyarakat dalam pengelolaan sumber daya perikanan sangat penting dilakukan karena nelayan sebagai pengguna sumber daya. Muis et al. (2019) melaporkan kondisi tutupan karang hidup di perairan pesisir Selat Spelman dalam kondisi sedang (37,71) dan karang mati (33,71).*

INTRODUCTION

As the development of the human population in the world, it is very closely related to the availability of resources, one of which is reef fisheries resources. The challenges of fisheries management in the future are increasingly severe, particularly in poor and developing countries (Costello et al., 2012; Levin and Lubchenco, 2008). Often the objectives of fisheries management are not achieved, and outcomes are unclear due to lack of available data and information (Worm et al., 2009).

Spelman Strait coastal waters are one of the straits in Indonesia, precisely located in Central Buton Regency, Southeast Sulawesi Province. One potential is the coral reef ecosystem. Local fishers utilize potential coral reef ecosystem resources by using boats with a capacity of under 1 GT with hand line fishing equipment. According to WWF Indonesia (2011), hand line is a type of tool that uses fishing line using lead or iron ballast. Catching activities carried out alone, and the fishing ground has taken within 15 to 20 minutes from the landing base. According to Karubaba et al. (2001), the distance travelled in fishing is usually not far from the residence and around the coast, ranging from 350-400 m.

In addition to stretching fishing, there is a small portion of local fishermen who still use fishing gear that tends to damage the ecosystem (destructive fishing). As a result, damage to the coral reef ecosystem in the coastal waters of the Spelman Strait (Muis et al., 2020). Muis et al. (2019) also reported that the condition of coral cover in the coastal waters of the Spelman Strait was in a situation of moderate damage (37.71%). Damage to the coral reef ecosystem in the coastal waters of the Spelman Strait means that in the future it will be threatened with degradation. Therefore, we need a solution for improvement.

The coastal waters of Spelman Strait have exploited after the independent Republic of Indonesia in 1946-1947, and until now (human knowledge). In 1997 until now, the fisheries resources had decreased the catch, so the fishing ground is getting further from the landing base, and the biomass of the score is getting smaller (human knowledge). Utilization of the coral reef ecosystem is closely related to the perception of fishers. Research on coral fish biomass and fishermen's opinions of the reef ecosystems in the coastal waters of the Spelman Strait is the first to be conducted. It is a hope for the need for baseline data in the management of coral reef fisheries. The purpose of this study was to analyze how coral fish biomass in two fishing seasons, namely the west and east seasons, and fishermen's perceptions of the use of coral reef ecosystems.

Research on coral fish biomass in other waters in Indonesia has been widely carried out, including Central Tapanuli (Suharti & Edrus, 2018), West Lombok (Edrus & Suharti, 2016), Weh Island, Aceh (Hastuty et al., 2014), Oransbari Village, South Manokwari Regency (Parenden et al. 2018), Manggis, Karangasem Regency (Putra et al., 2019), South Misool, Raja Ampat (Prasetya et al., 2014), North Minahasa (Setiawan et al., 2016), Manado Tua Island (Setiawan et al., 2013), Karimunjawa National Park (Yuliana et al., 2017), Lesser Sunda Banda (Setiawan et al., 2017), Batee Island, Aceh Besar District (Nasir et al. 2017), Gita Nada, West Lombok (Yulianto et al., 2018), Pulau Semak Daun (Sriati, 2015)

METHODE

Study Location

Research sites in the coastal waters of the Spelman Strait at five coral reef station stations consisting of station 1 type fringing reef depths of 3-15 meters, stations 2-5 types of reef burns (patch reef) where station two depths 3-8 meters, stations 3 and 4 depth 5-10 meters and station five depth 3-6 meters. Observations were made in two fishing seasons namely the west season and the

east season. The west season is identical with strong winds (big waves) and east season; the waters are relatively shady. The west season usually occurs in January to mid-April, while the eastern season is in early May to November (Figure 1). This research was conducted for one year, from November 2019 to October 2020.

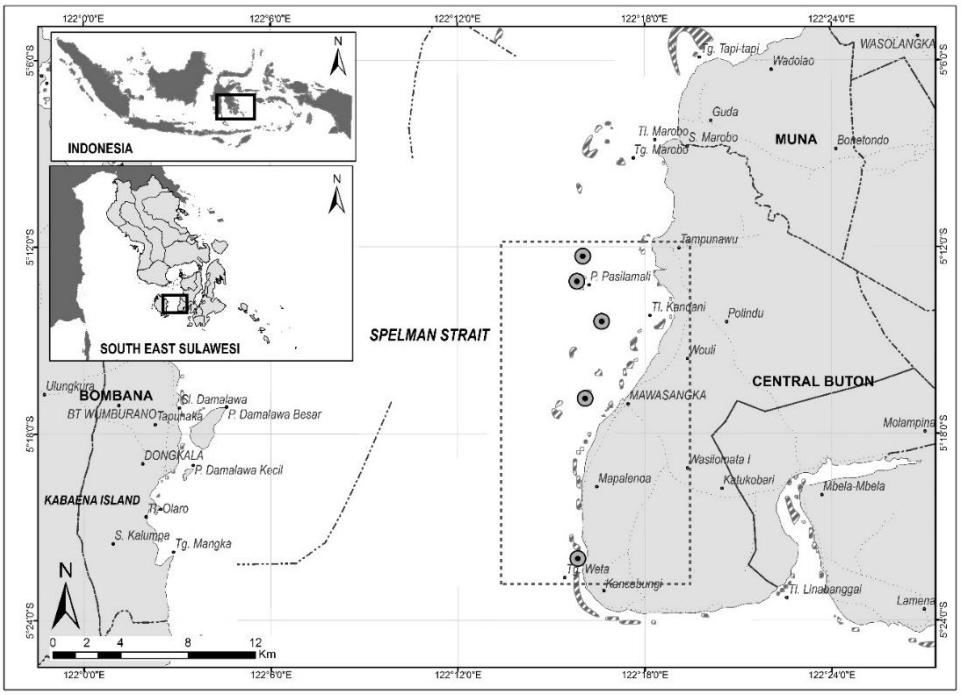

Figure 1. Map of the study site.

Material

Retrieval of data in this study uses primary data, namely, direct measurements in the field. The method used is the Underwater Visual Census (UVC). Transect size 75 x 5 x 5 m (length, width and height). Observation and measurement of fish species using an underwater slate system, each diver observes on the left (2.5 m) and other divers on the right (2.5 m). Fish measurements use an estimation system, not exceeding 20% of the actual fish size (Luthfi et al., 2017).

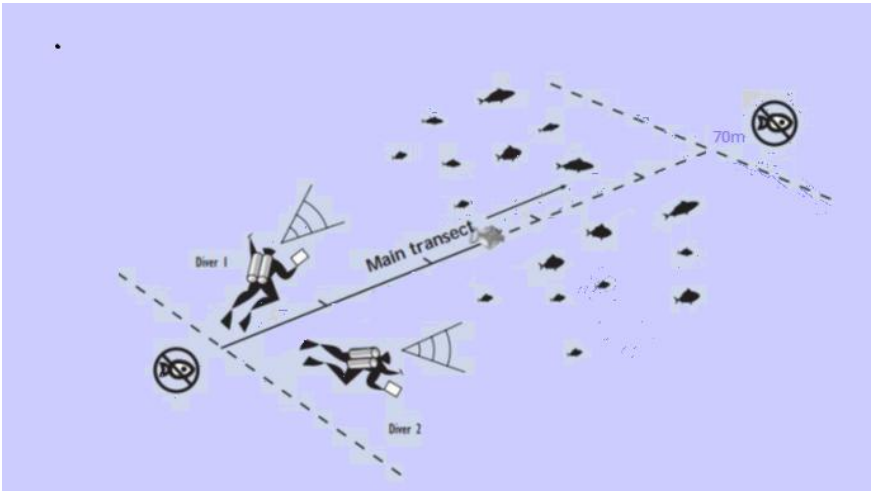

Figure 2. Methods of observation and measurement of reef fish species by UVC (Crosby and Reese 1996; Hill and Wilkinson 2004; Giyanto et al. 2014; Giyanto et al. 2017; Lutfi et al. 2017; Muis et al. 2020).

Data Analysis

Fish biomass through length (L) and weight (W): W = a x Lb, where values a and b are constants obtained from Fishbase (Froese & Pauly 2014). Fish in biomass (B) is the weight of individual target fish (W) expand the observation area, can be calculated using the formula:

$$B = \frac{\boldsymbol{W\ total\ setiap\ famili\ (g)}}{\boldsymbol{transek\ (350\ m2)}}$$

In assessing reef fish biomass in the coastal waters of the Spelman Strait, the select or low category uses the approach used by McClanahan (2017) (Table 1).

Table 1. Definitions, criteria and abbreviations of category clusters identified in marine coral reef communities

No.	Biomass cluster abbreviation	Biomass cluster definition	Cluster
1.	LB	Low biomass (< 300 kg ha^{-1})	1
2.	MB	Medium biomass (300-600 kg ha^{-1})	2
3.	HB	High biomass (600-1400 kg ha^{-1})	3
4.	vHB	Very high biomass (> 1400 kg ha^{-1})	4

Sumber: McClanahan 2017

RESULTS AND DISCUSSION

Composition and Biomass of Coral Fish

The composition of coral fish is closely related to the existence of coral reef ecosystems—healthy coral reef ecosystems, affecting the diversity and abundance of reef fish. UVC results, the composition of reef fish in the coastal waters of the Spelman Strait, still found a variety of families and species that inhabit coral reef ecosystems both in the west and east seasons (Tables 2 and 3).

Table 2. Number of reef fish species in the coastal waters of the Spelman Strait in the east monsoon.

Famili	Genus	Fish species	Average	
			Total	Length (cm)
Chaetodontidae	*Chaetodon*	*Chaetodon xanthocephalus*	3.00	18.00
		Chaetodon semeion	2.00	20.00
		Chaetodon lunulatus	2.60	12.40
		Chaetodon vagabundus	2.75	20.00
		Chaetodon bennetti	3.00	12.00
	Henichus	*Henichus singularis*	2.00	25.00
		Henichus varius	2.00	20.00
		Henichus chrysostomus	2.00	15.00
Acanthuridae	*Acanthurus*	*Acanthurus nigricans*	2.00	10.00
		Acanthurus nigrofuscus	5.40	15.00
		Acanthurus thompsoni	7.80	14.20
		Acanthurus auranticavus	4.25	15.00
		Acanthurus blochii	10.00	30.00
		Acanthurus pyroferus	4.60	17.80
	Ctenochaetus	*Ctenochaetus binotatus*	4.20	12.00
		Ctenochaetus striatus	4.60	15.00
	Naso	*Naso unicornis*	2.00	35.00
		Naso lituratus	4.00	35.00
	Zebrasoma	*Zebrasoma veliferum*	4.00	20.00
		Zebrasoma scopas	5.25	13.25
Scaridae	*Chlorurus*	*Chlorurus bleekeri*	5.33	30.00
		Chlorurus sordidus	3.00	20.00

		Scarus ghobban	5.00	60.00
		Scarus tricolor	4.00	35.00
	Scarus	*Scarus dimidiatus*	6.75	23.75
		Scarus scaber	6.67	30.00
		Scarus rivulatus	9.20	20.00
		Siganus puellus	2.00	25.00
Siganidae	*Siganus*	*Siganus puelloides*	2.00	30.00
		Siganus vulpinus	3.50	15.00
		Plectorhinchus gibbosus	2.00	35.00
		Plectorhinchus chaetodonoides	1.67	50.00
		Lutjanus rivulatus	*10.50*	*20.00*
		Lutjanus Kasmira	*5.00*	*20.00*
		Lutjanus fulvus	*6.00*	*25.00*
		Lutjanus carponotatus	*3.00*	*35.00*
		Lutjanus fulviflamma	*5.00*	*20.00*
Haemulidae	*Plectorhinchus*	*Lutjanus semicinctus*	*2.33*	*30.00*
		macolor niger	*3.00*	*30.00*
		Gnathodentex aureolineatus	*4.00*	*30.00*
		Lethrinus olivaceus	*6.00*	*35.00*
		Cephalopholis boenak	*2.00*	*30.00*
		Cephalopholis urodeta	*2.00*	*25.00*
		Epinephelus merra	*2.50*	*33.75*

Table 3. Number of species of reef fish in the coastal waters of the Spelman Strait in the west season

Family	Genus	Fish species	Average	
			Total	Length(cm)*
		Chaetodon xanthocephalus	4.00	19.00
		Chaetodon semeion	2.00	20.00
		Chaetodon lunulatus	2.80	14.40
Chaetodontidae	*Chaetodon*	*Chaetodon vagabundus*	3.80	19.40
		Chaetodon bennetti	3.20	14.40
		Chaetodon kleini	7.00	14.00
		Chaetodon falcula	2.00	15.00
		Chaetodon octofasciatus	4.67	14.67
		Heniochus chrysostomus	2.00	16.67
	Heniochus	*Heniochus varius*	2.33	18.00
		Heniochus singularis	2.00	20.00
	Forcipiger	*Forcipiger flavissimus*	3.00	17.50
		Acanthurus nigricans	4.00	25.00
		Acanthurus blochii	8.00	33.33
	Acanthurus	*Acanthurus nigrofuscus*	4.33	23.67
		Acanthurus thompsoni	7.60	21.20
Acanthuridae		*Acanthurus auranticavus*	4.40	24.00
		Acanthurus pyroferus	5.40	20.60
	Ctenochaetus	*Ctenochaetus binotatus*	5.80	16.00
		Ctenochaetus striatus	5.00	16.20
	Naso	*Naso unicornis*	2.00	35.00
	Zebrasoma	*Zebrasoma scopas*	6.75	14.50
	Chlorurus	*Chlorurus bleekeri*	5.75	32.50
		Chlorurus sordidus	4.00	28.00
Scaridae		*Scarus tricolor*	5.00	34.00
	Scarus	*Scarus dimidiatus*	5.75	27.50
		Scarus scaber	7.25	30.00
		Scarus rivulatus	11.00	21.80
		Siganus puellus	2.67	25.00
Siganidae	*Siganus*	*Siganus guttatus*	5.40	34.00
		Siganus canaliculatus	11.00	25.00

Family	Genus	Fish species	Average	
			Total	Length(cm)*
Haemulidae	*Plectorhinchus*	*Siganus vulpinus*	4.50	15.00
		Siganus puelloides	2.00	30.00
		Plectorhinchus gibbosus	2.00	35.00
		Plectorhinchus chaetodonoides	1.25	35.50
Lutjanidae	*Lutjanus*	*Lutjanus rivulatus*	10.60	23.00
		Lutjanus Kasmira	6.20	24.00
		Lutjanus fulvus	5.50	22.50
		Lutjanus semicinctus	3.00	31.25
		Lutjanus biguttatus	9.25	23.33
		Lutjanus fulviflama	5.00	20.00
		Lutjanus carponotatus	4.00	35.00
	Macolor	*Macolor niger*	3.00	32.50
Lethrinidae	*Gnathodentex*	*Gnathodentex aureolineatus*	3.50	24.00
	Letrinus	*Letrinus ornatus*	3.50	24.50
		Letrinus letjan	3.00	30.00
		Lethrinus olivaceus	5.50	28.50

The diversity of families and species of reef fish found at all observation stations indicates that coral reef ecosystems still have a positive impact on the availability of food and water parameters suitable for the sustainability of reef fish resources. Muis et al. (2019), the water parameters in the coastal waters of the Spelman Strait are very suitable for the life of coral reef ecosystems.

Fish biomass is a driving force for fishers in exploiting or catching reef fish, especially reef fish that have significant economic value and are export commodities that are targeted by fishermen. Based on observations at all stations, reef fish biomass still contributes to fishers in its use, although some families have low biomass, overall fish biomass is very high (Tables 4 and 5).

Table 4. Coral fish biomass (target) in the west season in the coastal waters of the Spelman Strait

Biomass Observation	Target fish (kg/ha)						
	1	2	3	4	5	6	7
Station 1	18,090	4,675	10,542	12,742	4,086	1,696	3,059
Station 2	14,043	3,450	12,224	-	0,324	0,722	1,770
Station 3	40,800	27,049	10,286	-	-	1,336	8,769
Station 4	57,941	13,944	15,777	-	10.338	5,980	7,713
Station 5	26,834	5,365	8,775	-	-	0,360	5,808
Total	901,19	311,33	329,17	72,81	84,27	57,68	154,97

Table 5. Coral fish biomass (target) in the coastal waters of the Spelman Strait in the east monsoon

Biomass Observation	Target fish (kg/ha)						
	1	2	3	4	5	6	7
Station 1	40,352	8,529	28,719	19,848	2,043	16,716	15,804
Station 2	26,403	20,310	29,510	-	1,240	14,120	12,931
Station 3	23,308	30,126	22,644	-	-	2,043	10,414
Station 4	44,258	39,482	18,595	-	13,199	17,915	11,054
Station 5	49,204	33,109	51,335	-	-	21,533	18,365
Biomass	1048,71	751,75	861,73	113,42	94,18	413,30	391,82

West season coral fish biomass in the Scaridae family is in the high criteria, the Acanthuridae and Lutjanidae families are in the reasonable standards, and the Lethrinidae,

Haemulidae, Siganidae and Serranidae families are in the low rules (Table 4). The east season fish biomass in the Scaridae, Acanthuridae and Lutjanidae families is in the high criteria, the Siganidae and Serranidae family are in the common standards, and the Lethrinidae family and Haemulidae are in the low rules (Table 5).

Reef fish biomass in the two seasons is relatively different, such as the Acanthuridae and Lethrinidae families wherein the west season is low. The east season is high, so are the Siganidae and Serranidae families, in the west season the biomass is small, and in the eastern season, the biomass is medium. The Lutjanidae family is in the west season moderate and east season-high biomass. The difference in biomass is related to the fishing patterns adopted by the coastal fishermen of the Spelman Strait waters, wherein the western season catching economically important fish (export quality) namely red snapper (Lutjanidae family) and grouper fish (family Serranidae), this is based on wisdom local. Fishing hooks in the west season use large fishing hooks (5, 6, 7 and 8) and in the eastern season are small (15, 16 and 17).

Different from the west and east season biomass at stations 2, 3, 4 and 5, the Lethrinidae family and Haemulidae family at stations 3 and 5 were not found. This is caused by arrests using bombs (Muis et al. (2020). Damage to coral reefs in the Spelman Strait coastal waters based on observations caused using bombs. Muis et al. (2019) reported the condition of live coral cover in the coastal waters of the Spelman Strait in moderate condition (37.71) and dead coral (33.71). According to McClanahan et al. (2011) and Karr et al. (2015) reported damage to coral reefs in the western Indian Ocean (WIO), the Caribbean, in general, was caused by excessive pressure, so that coral fish biomass also decreased. Coral cover significantly affects the biodiversity of reef fish resources, the better the coral reefs, the better biodiversity, because of the availability of food, the availability of protection and the availability of nursery ground.

The reef fish resources of the Spelman Strait coastal waters, several economically essential fish families began to be threatened by their existence such as the Lethrinidae and Haemulidae families. This is influenced by anthropogenic influences that use fishing gear that is not environmentally friendly. The effect of destructive fishing is not only damaged resources but coral reefs which pose a threat. According to Puspito (2010), coral reef ecosystems in Indonesia are predicted to be at a 75% damage level due to bombs. Pet-Soeda et al. (1999) the effect of a bomb explosion using a beer bottle is estimated to damage the coral reef ecosystem by 5 m2. In all observation stations, coral fragments were found (Figure 3). According to Sitorus and Tarigan (2009), damage to coral reefs due to bombing is marked by the number of coral fragments. This is different from the stretching fishing line, which is an environmentally friendly and highly selective fishing line because it is compatible with fish mouth openings (Figure 3). According to Irnawati et al. (2012), as a form of management effort which is responsible for maintaining coral fishery resources in the Karimunjawa National Park area is the use of fishing gear, so that the presence of groupers is not overfished.

Figure 3. As a result of arrest using explosives and fishing gear for catching reef fish

Anthropogenic influences also determine the sustainability of coral reef ecosystems in the coastal waters of the Spelman Strait. Research by Parenden et al. (2018), in the coastal waters of Kampong Oransbari, South Manokwari Regency, differences in utilization rates and the percentage of coral cover are different causes, the abundance value and reef fish biomass. According to Acosta and Robertson (2002), the abundance and diversity of reef fish is an indicator of the size of the coral cover.

Reef fish is a neatly arranged community and has a level of the food chain based on past, environmental, ecological and anthropogenic influences (Pellessier et al. 2014; MacNeil et al. 2015, McClanahan et al. 2015, Mellin et al. 2016b). According to Bellwood (1988), reef fish are classified based on ecological associations between reef fish and coral reefs. The role of coral reefs in reef fish provides food, protection and as a place to spawn (Nybakken, 1992). The higher species composition, biomass, and diversity of reef fish can increase the resilience of coral reefs that are threatened by excessive pressure in their use (McClanahan et al., 2011; Graham et al., 2015). Therefore, to maintain fish biomass, management needs to be wise and prudent in preserving the sustainability of ecosystems. Based on research by McClanahan and Jadot (2017) in the waters of Madagascar, the effects of overfishing and environmental influences cause disturbed fish biomass.

CONCLUSIONS

Coral reefs in the coastal waters of the Spelman Strait need scenarios to restore as their previous habitat, as well as reef fish biomass requires situations in its management.

ACKNOWLEDGEMENTS

Further research is needed on the identification of coral reefs, so that the rehabilitation scenario is reached, as a reference in returning the native species of reef fishes to the Spelman Strait waters.

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