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Analysis Domain Fish Resources of Shark (*Carcharhinus melanopterus*) For Sustainable Management in Spermonde Islands

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Abstract- *Carcharhinus melanopterus* has been designated by the IUCN Red List as a near threatened species because the level of utilization is quite high. This study aims to analyze the condition of the *Carcharhinus melanopterus* shark resources through an ecosystem approach (EAFM) that focusing on the dimensions of fish resources (SDI). It can becomes part of the information in developing a shark fisheries management strategy in the Spermonde Islands. This study used a survey method of respondents at Paotere Fish Auction Makassar City. Retrieval of questionnaire data on fishermen is determined using purposive sampling method. Shark samples were obtained from Paotere Fish Auction in Makassar City during August - November 2019. The attributes measured were CPUE, Catch Size Trend, Juwana Proportion, Species Composition, Range Collapse, and ETP Species. The results of the leverage analysis show that the most sensitive attribute during the last 5 years is the proportion of juveniles of sharks caught. As much as 44.59% of the sharks caught were in the juvenile category. This is considered to greatly affect the population of sharks in the wild, because juvenile sharks are expected to grow up and reproduce before being caught in order to maintain their population in the wild..

Keywords: *Carcharhinus melanopterus*, SDI dimensions of the Ecosystem Approach, Leverage Analysis, and Spermonde Islands

I. INTRODUCTION

The population and diversity of sharks in Indonesia waters have recently become a concern among observers of the sustainability of fish resources. The high level of shark populations in Indonesia supports the interest of fishermen to take advantage of this high economic value fish resource. Currently, fisheries management prioritizes utilization for the social and economic welfare of the community rather than maintaining the health of the ecosystem. As a consequence, the approach taken is still partially integrated in an ecosystem boundary that becomes a container for fish resources as a management target.

The waters of the Spermonde Islands become a fishing area for sharks by fishermen and bring their catch to the Paotere fish auction in Makassar City. In the shark and ray enumerator report of BPSPL Makassar (2018), one of the species of shark with the highest number of catches at Paotere fish auction is *Carcharhinus melanopterus*. This shark is a species that traded in living conditions or processed into frozen meat and dried fins. The result of observations at Paotere fish auction, Makassar City, fisherman admitted that shark is a bycatch. Although sharks are not the main target for fishing, a new profession has emerged to collect shark products at Paotere and export shark product.

Carcharhinus melanopterus has been assigned as a near threatened species by IUCN Red List (Cavanagh, 2003) and the status of Vulnerable species in the wild (KKP, 2016). Analysis the domain of fish resources through an ecosystem approach, EAFM (Ecosystem Approach for Fisheries Management)

expected to provide information on shark fisheries management in formulating shark fisheries management strategies in the Spermonde Islands. Therefore, a comprehensive assessment is needed for the management of the shark species *Carcharhinus melanopterus* in the Spermonde Islands.

II. METHODS

This study used a survey method of respondents at Paotere Fish Auction Makassar City and Spermonde Islands. Retrieval of questionnaire data on fishermen is determined using purposive sampling method. Shark samples were obtained from Paotere Fish Auction in Makassar City during August - November 2019. Respondents at the Paotere Fish Landing Auction Site (TPI) in Makassar City and several islands in the Spermonde Islands such as Sarappo Caddi Island, Podang-Podang Island, Pajenekang Island, Bontosua Island, Balang Caddi Island, and Balang Lompo Island. Determination of respondents was done by purposive sampling (Lestaluhu and Wasahua, 2014), based on the consideration that the respondent fishermen are fishermen who have and still catch sharks. The identification of shark species landed refers to a shark and ray identification manual (KKP, 2015) The attributes measured were CPUE, Catch Size Trend, Juwana Proportion, Species Composition, Range Collapse, and ETP Species.

Data Analysis

1) Sustainability Analysis

SDI-EAFM shark fisheries sustainability analysis is carried out by providing a score (value) based on the measurement results of fish data, interview results, and secondary data. The score given ranges from 1-3 depending on the circumstances of each based on the modification of the EAFM (Ecological Approach to Fisheries Management) module. Each attribute is used to determine the value / score of each dimension so that it can be objectively assessed.

2) Composite Values

Composite values are obtained by the equation (NWG EAFM, 2014):

Composite Value

$$Nilai\ Komposit,\ NK = \frac{C_{at}}{C_{at-max}} \times 100 \dots \dots \dots (1)$$

3) Leverage Analysis

This analysis is used to identify the attributes that are a factor in the problem. Then the attributes that have an extreme point can be used as a reference in developing a management strategy for the shark species studied.

III. RESULTS AND DISCUSSION

1. Attribute Assessment

The weighted score of each indicator in the fish resource domain can be seen in Table 1.

Table 1. Assessment and attribute sensitivity

No.	Indicator	Criteria	Score	Weight	Index value	Maximum Score
1	CPUE	1 = decreased sharply > 25% / year 2 = Decreased slightly ≤ 25% / year 3 = stable or increasing > 25% / year	1	40	40	120
2	Catch Size Trends	1 = The size of the fish is getting smaller 2 = Fixed relative size 3 = Size is getting longer	3	20	60	60
3	Proportion of Juwana	1 = Number of Juveniles (> 60%) 2 = Number of Juveniles (30-60%) 3 = Number of Juveniles (< 30%)	2	15	30	45
4	Species Composition	1 = proportion of target fish is the same as target (16-30% of total volume) 2 = proportion of target fish (≥ 30% of volume)	3	10	30	30
5	Range Collapse	1 = Fishing Ground is very far (> 10 miles) 2 = Fishing Ground far (> 5 miles) 3 = Fishing Ground is relatively fixed (< 2 miles)	3	10	30	30
6	ETP species	1 = Number of ETP catches (> 5 Species) 2 = Slight ETP catch (1-5 Species) 3 = No ETP capture	1	5	5	15
Total					195	300
Composite Value					65	

Composite value of Shark resources *Carcharhinus melanopterus* at a good level in implementing EAFM (Table 1) with a value of 65. The presence of sharks can maintain the balance of marine ecosystems by acting as top-level predators. Decreasing shark populations can cause problems for marine animal populations. Sharks prey on weak and sick animals so that they can maintain the genetic quality of the types of animals that are in the food chain below them. (WWF, 2015). The amount of pressure experienced by sharks in their habitat due to

exploitation from catch fisheries activities even though it is the object of non-target catch by fishermen in the Spermonde Islands.

CPUE

CPUE for shark fishing rates in the Spermonde Islands measured from the catch of fishermen land at TPI Paotere Makassar City. The highest CPUE value in 2019 was 33,479 kg / trip and the lowest in 2016 was 19,460 kg / trip. Following the development of the CPUE trend is presented in Figure 1.

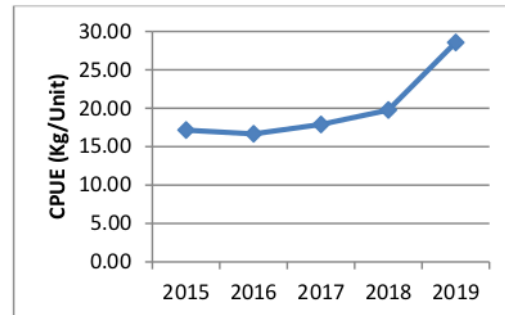


Figure 1. CPUE Trends for *Carcharhinus melanopterus* Sharks in 2015-2019

Based on the CPUE parameter assessment criteria in the SDI domain, the CPUE score for *C. melanopterus* species is 1 due to the sharp increase in catch. As a bycatch object, *C. melanopterus* is still experiencing an increase in the number of catches from 2017 to 2019. This occurs because almost all parts of the shark's body can be used, such as fins, meat, and liver. The selling price tends to be high considering the weight and body size of the sharks caught. In addition, this method of processing sharks is quite easy because most fishermen do not carry out special handling such as applying ice to these fish. This makes fishermen consider utilizing rather than releasing bycatch.

The Spermonde Islands have a variety of coral fish species that vary in each group of islands with the dominance of different forms of growth and physical condition of coral reefs on each island, this condition causes the distribution of reef fish in the Spermonde Islands to also vary (Nurjirannah and Burhanuddin, 2017). It is not uncommon for fishermen who target grouper, catombo, and siberian fish to catch sharks that live in coral reef ecosystems by mistake. This happens because sharks as bycatch are generally obtained from the use of longline fishing gears and gill nets (Rahardjo, 2009).

Shark Size Trends

Measurement of the sample length of the Blackfin Coral Shark (*Carcharhinus melanopterus*) as many as 74 samples caught using fishing rods (longline drift) and landed at TPI Paotere Makassar City. The size of the first mature gonads (Lm) of *Carcharhinus melanopterus* was at a length of 95 cm males and 97 cm females (Lyle, 1987). Class intervals and percentage of total shark length are shown in Figure 2.

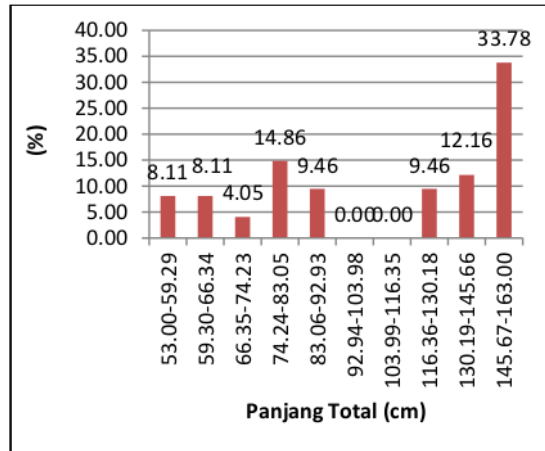


Figure 2. Class Intervals and Percentage of Total Length Measurement Results for Sharks (*Carcharhinus melanopterus*) August-November 2019 at TPI Paotere Makassar City

Figure 2 shows the highest percentage of the total length of the *Carcharhinus melanopterus* shark caught in the class interval 145.67 cm to 163.00 cm with a percentage of 33.78%. Based on the body length standard for sharks that first matured gonad, the percentage of shark fishing size trends for this species was mostly above the standard (> Lm) of 55.41%. The results of interviews with fishermen who collect sharks at TPI Paotere admit that landed sharks are often still in the juvenile category, while adults only appear 1-2 times a month. Based on field observations, this type of shark is often caught along with sharks from other Carcharhinidae families such as *Carcharhinus limbatus* and *Triaenodon obesus*. Although the catch size of the *Carcharhinus melanopterus* shark is considered variable, however current research shows the highest percentage of the graph of the trend of catch size is getting bigger. Therefore, based on the EAFM module this indicator gets a score of 3.

Proportion of Juwana

Carcharhinus melanopterus which is included in the juvenile category, namely sharks that have a body size of less than 95 cm (<95 cm) for males while females with a body size below 97 cm (<97 cm) (Lyle, 1987). The results of measuring fish samples during August-November 2019 from 74 samples of *Carcharhinus melanopterus* were found to be 44.59% with a length that was included in the juvenile category and 55.41% in the adult category. Therefore, based on the juvenile proportion indicator, a score of 2 was given, namely the number of juveniles (30-60%) of the total sample (Figure 3).

On the other hand, fishermen find sharks on their fishing rods, of course they will still take their catch to collectors to cover the operational costs of catching them. Even though sharks have a fairly high economic value in TPI, shark fishermen who are on Spermonde islands such as Sarappo Caddi Island, Podang-podang Island, Pajenekang Island, Bontosua Island, Balang Caddi Island, and Balang Lompo Island say that they do not need bring the catch of the sharks directly to the TPI because of the

availability of collector services on the island. Therefore, based on the EAFM module, this indicator is given a score of 2 where the proportion of juveniles is 30-60% of the total catch.

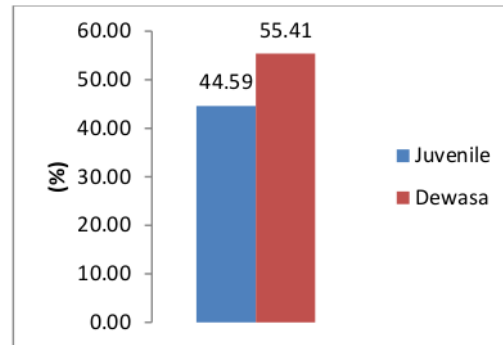


Figure 3. Proportion of Juwana Sharks *Carcharhinus melanopterus* in August-November 2019

Species Composition

The composition of the catch of fishermen using fishing rods is quite diverse. Based on the research results, it is known that the catch of fishermen's fishing rods in the research location is dominated by reef fish targeting the Katamba and Sibula fish. The percentage of total catch can be seen in Figure 4.

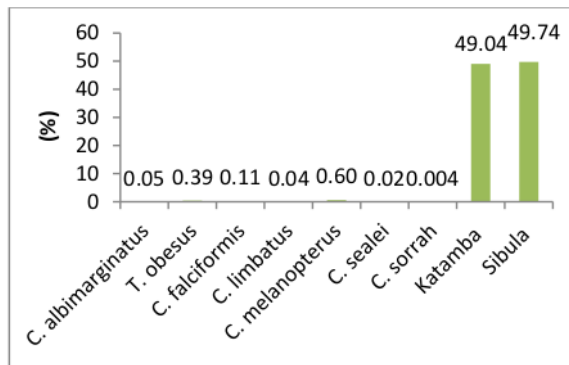


Figure 4. Target and non-target catches at TPI Paotere Makassar City for the period August-November 2019. Source: BPSPL Makassar Enumerator Report and PPI Paotere Production Report Makassar City

The composition of species caught by fishing rod fishermen shows the proportion of target fish is greater than non-target. The proportion of shark catch on respondent's fishing line is generally 1-2 of the 50 hooks installed. The emergence of sharks as a non-target species is still landed at TPI even though it is in the Eastern season. This season, the wind and wave speed is high enough in Spermonde waters so that fishermen will adapt to the climate by changing fishing targets such as squid or even reducing the amount of fishing activity. Therefore, based on the EAFM module, this indicator is given a score of 3 where the target proportion is > 30% of the total catch.

Range Collapse

The average distance from the point of departure to the fishing location is less than 2-3 miles to the West (> 2 nautical miles) with a travel time of ± 45-60 minutes. Fishermen whose fishing ground is in the waters of Spermonde explained that there is no special area for shark fishing, the general target is small pelagic fish that inhabit coral reef ecosystems such as katamba, grouper and sibula. On the other hand, fishermen are more worried about the unpredictable fishing season in the last few months. Of course, fishermen will take advantage of all the catch as long as the type of fish caught has economic value and is not in a protected category. Based on the EAFM module, the Range Collapse indicator is given a score of 3 because the fishing ground area of the fishermen is relatively fixed, which is > 2 nautical miles to the west of Sarapong Caddi Island.

ETP species

Respondent fishermen who come from dominant islands choose to utilize all their catch as long as the fish caught are not from the prohibited fishing category and have economic value. Meanwhile, respondent fishermen with vessels <30 GT choose to release their catch of sharks if they are caught by their fishing rods to avoid the risk of inspection by officers. Most of the identification results of shark catches obtained by fishermen and landed at TPI Paotere, Makassar City are Near Threatened (NT) such as (KKP, 2016): *Carcharhinus melanopterus*, *Carcharhinus albimarginatus*, *Carcharhinus limbatus*, *Carcharhinus sealei*, *Carcharhinus sorrah*, and *Triaenodon obesus*. While one type is included in the CITES Appendix II, namely the type *Carcharhinus falciformis*. Therefore, A score of 1 is given for the ETP species indicator because there were ETP individuals who were caught but not released. This continues to be socialized at TPI because there are still species of appendix sharks that were caught accidentally by fishermen.

2. Leverage analysis

The results of the leverage analysis on the dimensions of fish resources (Figure 5) show the most sensitive attribute, namely the proportion of juveniles caught in the last 5 years. The shark *Carcharhinus melanopterus*, which was found at 44.59% with length included in the juvenile category. This is considered greatly affect the population in nature, because based on the biological characteristics of sharks, generally have a slow growth rate, have a long life, are slow to reach sexual maturity and have a small number of tillers. Juvenile sharks are expected to remain in nature and experience growth until they reach adult size.

During the breeding season, female *Carcharhinus melanopterus* sharks will undergo phylopathy so they tend to give birth in their original waters. Some offspring show inbreeding which results in reduced population size, movement and limited distribution. This makes male sharks act as transmitters of genes between populations (Mouries and Planes, 2013). Female sharks can only give birth to 3-4 juvenile sharks in one season (Chin et al, 2013). If the spreader of this gene is caught in juvenile size, the population of *Carcharhinus melanopterus* can certainly will decrease.

Export commodities of sharks from Makassar and Takalar come from the catch of fishermen in the Spermonde Islands. Shark fishing activities in Indonesia take place throughout the year without being limited by certain seasons (Arisandi et al, 2020). On the other hand, the uncertain season makes fishermen continue to utilize all the catch that has economic value to cover the operational costs of fishing and other living needs. Interviews with fishing rods on several Spermonde Islands with more than 10 years of experience stated that the sharks caught were not the target catch due to the low prices offered by collectors on the Island. Even fishermen and collectors on the island only set prices based on the body weight of the sharks, not based on the species caught

The high international market demand for blackfin reef sharks (*Carcharhinus melanopterus*) is one of the reasons the shark trade continues to this day (Arisandi et al, 2020). CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) does not categorize blackfin reef sharks (*Carcharhinus melanopterus*) in the Appendix II list so that foreign trade is still allowed (Fahmi and Dharmadi, 2013). If this condition continue, then shark fishing activities will increase.

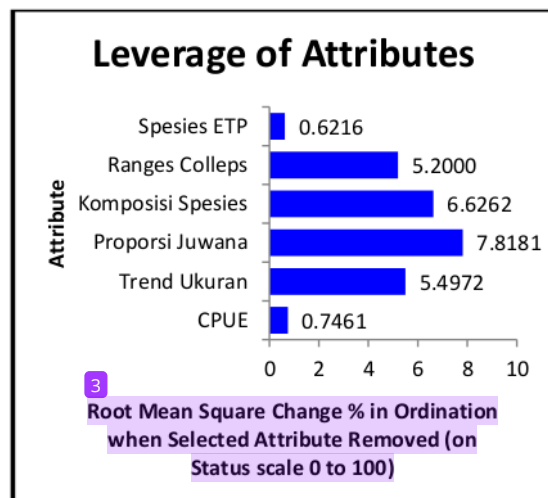


Figure 5. The results of the analysis of the leverage domain of fish resources

IV. CONCLUSION

The most sensitive attribute in the management of *Carcharhinus melanopterus* shark fisheries is the proportion of juveniles caught by fishermen. The strategy suggested for the sustainable management of this type of shark is to establish marine conservation areas in several points of coral reef areas that become shark spawning, nursery and foraging areas. This can reduce the chances of catching sharks by catch, especially those that fall into the juvenile / juwana category.

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