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An ecosystem approach to manage Pelagic Thresher Shark (*Alopias pelagicus*) based in the Fishing Port of Kutaraja, Aceh

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ABSTRACT

Sharks are dominant bycatch of purse seine and drifting longline vessels that landed at the fishing port of Kutaraja, particularly for pelagic thresher shark species (*Alopias pelagicus*). The management of shark fisheries in Aceh waters has not been implemented yet. According to the IUCN red list, the pelagic thresher shark has been classified as an endangered species. The capture and trade of pelagic thresher sharks are regulated by CITES (Appendix II). The procedures have been adopted through the Decree of Minister of Marine Affairs and Fisheries of the Republic of Indonesia Number 61/PERMEN-KP/2018. However, the exploitation and trades of *A. pelagicus* continue without proper management. The impact will threaten the extinction of the pelagic thresher shark population and in terms of a negative image of fisheries management in Indonesia, in particular. Thus, integrated management such as the ecosystem approach to fisheries management (EAFM) is needed to solve this problem. This study aims to evaluate the fisheries management status of the pelagic thresher shark based on the EAFM indicator of fish resources domain at the fishing port of Kutaraja. This research was conducted by field measurement and interviews with key stakeholders. Data were analyzed using a multi-criteria analysis (MCA) approach through the development of a composite index. The results showed that the trend of catch per unit effort (CPUE) tends to fluctuate in the last five years. The total length of the sharks was relatively constant. The proportion of immature *A. pelagicus* was 16% (male), and 28% (female) of the total catch of *A. pelagicus* landed at fishing port of Kutaraja. The shark was bycatch 1% of the total purse seine and handline biomass catch. The fishing ground was getting further away. Based on this assessment, the shark fishery resources were in the 'good' category. However, some indicators need improvement through better fisheries management actions.

Introduction

Indonesia has been endowed with a high abundance of fish resources, production and economic value. Fish resource utilization is generally done by using multi-fishing gears. Fishers typically tend to fish intensively to get a maximum catch. The fishers catch not only target but also non-target fish. Fishers do non-target fishing with thresher shark catches (e.g. Salmarika *et al.*, 2018).

The impact of sharks and rays fishing in fisheries have become a global issue. Sharks are cartilaginous fish (Elasmobranchii) that have high economic value so that fishers continue to catch these animal (Fahmi and Dharmadi, 2013). All parts of the body of a shark have a high selling value, one of which is the fin (White *et al.,* 2006; Saraswati, 2016). Fishing activities on sharks and rays in Indonesian water have been done since 1970 (Rahardjo, 2009). Annual catch of the sharks and rays in Indonesia in 1976 was relatively high, about 100,000 tons, compared to other Southeast Asian countries (Stevens *et al.,* 2000). From 2000-2010, the annual average catch of the shark in Indonesia of 106,288 tons (Arrum *et al.,* 2016). Malaysia, for example, the average shark catch was about 21,459 tons/year according to The Wildlife Trade Monitoring Network (TRAFFIC) (Adawiyah, 2019).

The capture and trade of sharks have received significant global attention. Some shark species, e.g., whale shark (*Rhincodon typus*) have since 2016 been

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classified as endangered species (Pierce and Norman, 2016). In addition, the hammerhead shark (*Sphyrna lewini*) and pelagic thresher shark (*Alopias pelagicus*) have since 2018 been classified as critically endangered and endangered species by the IUCN (The International Union for the Conservation of Nature and Natural Resources) (Rigby *et al.*, 2019; Rigby *et al.*, 2019). Since 1978, fishing and trading of sharks must also apply the procedures outlined by CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora). In Indonesia, the capture and trading of sharks have been regulated by Decree of Minister of Marine Affairs and Fisheries Number 61/PERMEN-KP/2018 concerning the Utilization of Protected Fish Species and Listed Fish Species in the CITES Appendix. However, the capture of sharks, particularly the pelagic thresher shark (*Alopias pelagicus*) is still happened in Indonesia, particularly in the fishing ground of Aceh waters.

The fishing port of Kutaraja is the largest class A fishing port in Banda Aceh, Aceh Province. The major fishing gears used by local fishers are purse seine, handline, and tuna longline. The main catches landed in this fishing port were yellowfin tuna (*Thunnus albacares*), skip jack (*Katsuwonus pelamis*), mackerel tuna (*Euthynnus affinis, Auxis rochei,* and *Auxis thazard*) and scads (*Decapterus* spp.) (PPS Kutaraja, 2020). The non-target (bycatch) sharks landed in the fishing port of Kutaraja are dominated by the pelagic thresher shark (*Alopias pelagicus*) (PPS Kutaraja, 2020). Pelagic thresher sharks are caught with purse seines and handline gear due to inadvertent fishing. The main target species of these gears are schooling pelagic fishes. The dominant pelagic thresher shark is caught using handlines fishing gear. Before or after operating the main fishing gear, the fishers normaly using additional fishing gear e.g. handline to fish in around of Fish Aggregating Device (FADs). The crew uses the handline fishing gear to fill their spare time and increase their income. The handline is usually targeted yellowfin tuna (*Thunnus albacares*), while the sharks is a bycatch of the tuna fisheries. As pelagic fish sharks could be found in shallow and deep ocean waters (Suryagalih and Darmawan, 2012).

Based on capture fisheries statistics of the UPTD PPS Kutaraja (2021) the production of pelagic thresher sharks landed at fishing port of Kutaraja in 2016-2020 fluctuated from 10 to 15 tons/year. Although the production of *A. pelagicus* is very small, it contributes to the fisher's income. Fahmi and Dharmadi (2013) mentioned that shark production contributes to fishers income as a target spesies or by-catch Pelagic thresher sharks have been listed in the CITES Appendix II (Fahmi, 2018). According to the IUCN red list, the thresher shark is an 'endangered' animal status. Such status is due to its relatively low population and very vulnerable to fishing (Fahmi and Dharmadi, 2013; Hoenig and Gruber, 1990).

Preliminary information reveals that pelagic thresher sharks are common bycatch of the handline and also additional gear in the purse seine and drifting longline fisheries. The bycatch is an additional income for crews, but sometimes the fishers sell their catches to local traders who mostly buy sharks at the Kutaraja fishing port. Traders then sell the shark meat to local consumers, and send the fins to Medan. The fins sent to Medan will be exported to China, Singapore, and Malaysia.

The fishing practices and trading of the sharks indicates that some relevant regulations to promote sustainable management and conservation of shark fisheries are not effectively implemented. As consequence, the threat to the shark species may have been uncontrolled which leads to the local extinction of the shark. Decreasing shark population will impact the stability of the marine ecosystem, particularly imbalance in the marine trophic level (Pauly *et al.*, 1998; Hardiningsih *et al.*, 2017). In an economic perspective, the impact of declining shark populations will be felt by fishers and businesses who depend on the shark supply chain.

This study provides some basic information required to develop local shark management, such as species identification, biological aspects and its utilization through fishing. This study aims to aim at management status and formulate management actions for thresher shark resources based at the fishing port of Kutaraja, Aceh. The provided information and the status of the fisheries management are important to the CITES management authority (Ministry of Marine Affairs and Fisheries, i.e. DG of Marine Spatial Management, DG of Capture Fisheries), CITES scientific authority (LIPI), Aceh Provincial Government and other stakeholders.

## Materials and Methods
Location and time of research
This research was conducted from June to September 2021 at the fishing port of Kutaraja, Banda Aceh City, Aceh Province (Figure 1).
Data collection
Data were collected by conducting 4 monthly - field surveys (fish length measurement and documentation). Fish samples were measured using

accidental sampling technique. Accidental Sampling technique was a sampling technique without determining the preferred sample first, but the sample was selected directly from the sampling unit encountered (Sugiyono, 2012). Furthermore, interviews with respondents who are fisher's representatives are selected from the fishing vessel in question. They were shipowners, captains, and crews who are assumed to have sufficient information related to pelagic thresher sharks fishing, particularly using purse seine and handline fishing gears. The sample of fishing vessels was selected randomly in each group size from the total number of fishing vessels. According to FAO (2017), 25% of the population of the fishing vessels were taken for 50 – 500 vessel units. In this study, 61 respondents as representative of about 244 fishing vessels (purse seine and drifting longline), were interviewed for the characteristics of fishing vessels, fishing gear, fishing methods, fishing grounds, fishing time, shark utilization, and shark fishing benefits.

Other 15 respondents from the local fisheries management as representatives of Aceh Provincial Marine Affairs and Fisheries Agency, Marine Police, Marine and Fishery Resources Surveillance (PSDKP), *Panglima Laot*, Non-Governmental Organizations (NGOs), and scientific groups (researchers) were also interviewed. They were interviewed for violations related to information on fishing operations, shark conservation areas, and shark fisheries management practices. They were purposively selected as respondents. The primary considerations for selecting samples were the presence and availability as a respondent, reputation, position, and credibility as an expert, experiences, and knowledge related to the problems of the study (Edwarsyah dan Gazali, 2015).
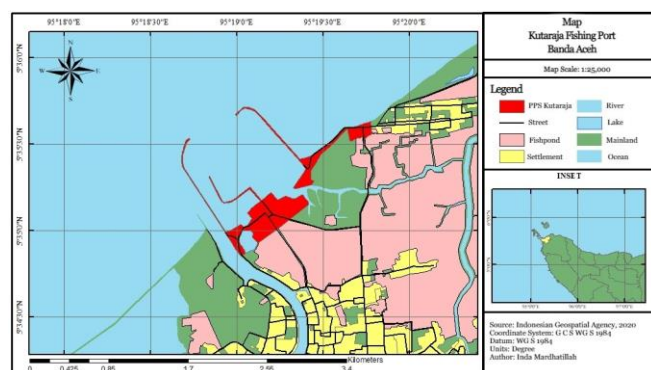
Figure 1. Research site in the fishing port of Kutaraja, Banda Aceh.

Data analysis

Data interviews of 61 fishers were processed to generate the quantitative description of indicators that can be used to evaluate the status of the fisheries management in terms of fish resources perspective (domain). Meanwhile, data from 15 stakeholder respondents support the assessment of fishery management status.

a. Indicator identification

Various fishing gears use, one of which is used as standard fishing gear (Gulland, 1993). The standard fishing gear has a fishing power index (FPI) value of one (Tampubolon dan Sutedjo, 1983). The value of the fishing power of each fishing gear in each year was obtained from the formula proposed by Sparre and Venema (1998) as follows:

$$CPUE_i = \frac{C_i}{F_i} \quad \text{.. (1)}$$

$$CPUE_{st} = \frac{C_s}{F_s} \quad \text{... (2)}$$

$$FPI_i = \frac{CPUE_i}{CPUE_s} \quad \text{... (3)}$$

For the rest of fishing gears use the following equation:

Effort standard = $\Sigma FPI_i \times \Sigma F_i$............................. (4)

where:

$CPUE_{st}$ = catch per unit effort standard
$CPUE_i$ = catch per unit effort i
C_s = total catch of standard fishing gear
C_i = total catch of i fishing gear
Fst = total effort of standard fishing gear
F_i = total effort of i fishing gear
FPI_i = fishing power index of i fishing gear

The Fishing Power Index (FPI) of each fishing gear in each year was then averaged.

The fish size trend was evaluated from the data of length class distribution of shark samples landed at the fishing port of Kutaraja. The shark's total length was compared with the length at first maturity (L_m) of this species after White *et al.* (2006) and Ichsan *et al.* (2020). According these studies, the average Lm value for the male shark was 236 cm and the female 252 cm. The proportion of immatures caught was measured by the number of fish that were lower than the L_m.

The calculation of the composition of the catch was carried out based on the fishing vessel. The number of vessel samples used was 35 vessels. Proportions of target catch and bycatch species compared based on biomass. The catch composition indicator was estimated by the following equation (Krebs, 1989):

$$P_i = n_i/N \times 100\% \quad \text{................... (5)}$$

Where:

P_i = proportion catch of i (%)
n_i = total catch of i (kg)
N = total catch (kg)

The number of Endangered, Threatened, and Protected (ETP) species indicators were obtained by

identifying the ETP species that landed at the fishing port of Kutaraja. Identification was carried out by direct observation and based on fishery statistics. The ETP species categories are turtles, dolphins, and some sharks and rays. The ETP species landed at the fishing port of Kutaraja in the period August - September 2018, namely *A. pelagicus* (Salmarika, 2019). According to Diah *et al.* (2018), the ETP species categories in the case of West Papua waters are turtles, bull sharks (*Carcharhinus leucas*), scalloped hammerhead (*Sphyrna lewini*), largetooth sawfish (*Pristis microdon*), and guitarfish (*Rhinobatos* spp.). To evaluate the range collapse indicator, the existing fishing grounds was compared to the distance of the fishing ground from the fishing base in about ten years ago. Fishing grounds data is collected from the interviews of fishers and compared with previous literature studies.

b. Indicator assessment

A multi-criteria analysis (MCA) approach was used to assess the six indicators of the pelagic thresher shark fisheries resource management status in terms of EAFM indicator. Adrianto *et al.* (2005) proposed to use stakeholder perceptions in multi-criteria analysis (MCA) in decision-making processes. The first step in this MCA approach is a simple scoring with a likers scale based on ordinal 1, 2, and 3 (Table 1).

The index value was the result of scoring and the weight value of each indicator. The weight value was obtained from the magnitude of the role or level of importance. The equation used to calculate the index value of the indicator based on the NWG EAFM (2014) is as follows:

$$\text{Index value} = \text{score} \times 100 \times \text{weight} \quad \text{............................ (6)}$$

The results of the composite values are then displayed in the form of a flag model in Table 2 with five criteria based on the obtained value limits.

Results

The status of pelagic thresher shark resource management has been evaluated based on six indicators, i.e. CPUE trends, fish size, the proportion of immatures, catch composition, range collapse, and ETP species. The catch of pelagic thresher sharks tends to fluctuate due to secondary fishing gear, namely hand lines. The CPUE value from 2016 to 2019 tends to experience an insignificant increase. However, in 2020, the CPUE value of thresher sharks experienced a significant addition to reaching 1.50 individual/trip (Table 3). This condition was accompanied by a substantial decrease in fishing efforts from 2016 to 2020.

Based on field measurements of landed pelagic thresher sharks at fishing port of Kutaraja, total of 140 individuals with the minimum total length was 179 cm, while the maximum was 291 cm. The dominant catch size of *A. pelagicus* was 244 to 282 cm (Figure 2).

The catch of male and female sharks were mostly above Lm size or maturity size to spawn (Fig. 2). About 16% males and 28% females of the pelagic thresher sharks were caught lower than Lm size. In addition, the percentage of female pelagic thresher sharks caught was 73%, and males 23%.

Table 1. Criteria for each indicator of fish resource management based on fishing port of Kutaraja.

Indicator	Scores and their criteria	Weight
Trend CPUE	1= CPUE drops sharply (>25%) 2= CPUE decreased slightly (<25%) 3= CPUE stable or increasing	40%
Fish size	1 = the size of the fish is getting smaller 2= relatively fixed fish size 3= fish size increases	20%
Proportion of immature	1= very much (>60%) 2= a lot (30-60%) 3= little (<30%)	15%
Catch composition	1= less target proportion (<15% of total volume) 2= proportion of target equal to non-target (16-30% of total volume) 3= more target proportions (>31% of total volume)	10%
Range collapse	1= fishing ground further away 2= fishing ground is getting further away 3= relatively fixed fishing ground	10%
ETP species	1= number of ETP species caught (< 1) 2= few ETP species caught (= 1) 3= no ETP species caught	5%

Source: (NWG EAFM, 2014)

Table 2. Domain and aggregate value score limits.

| Composite score	Flag model	Category
1 – 20		Bad
21 – 40		Poor
41 – 60		Moderate
61 – 80		Good
81 – 100		Excellent

Source: NWG EAFM 2014

Table 3. The CPUE trend of thresher shark fisheries at fishing port of Kutaraja.

No	Year	Number of catch (ind)	Effort Standar (trip)	CPUE (ind/trip)
1	2016	261	1400	0.19
2	2017	438	2150	0.20
3	2018	473	1877	0.25
4	2019	461	1444	0.32
5	2020	387	259	1.50

Table 4. Composition of catches landed at the fishing port of Kutaraja for the period June-September 2021.

No.	Species		Biomass (kg)	Catch Composition (P_i) $n = 140$
	Common Name	Scientific Name		
1	Skipjack tuna	*Katsuwonus pelamis*	177,140	0.420
2	Scad	*Decapterus* spp.	126,100	0.299
3	Little tuna	*Auxis thazard*	37,890	0.090
4	Yellowfin tuna	*Thunnus albacares*	74,900	0.177
5	Spotted oceanic triggerfish	*Abalistes stellaris*	1,000	0.002
6	Pelagic thresher shark	*Alopias pelagicus*	4,046	0.010
7	Bottlenose wedgefish	*Rhynchobatus australiae*	673	0.002
8	Scalloped hammerhead	*Sphyrna lewini*	484	0.001
	Total		422,233	
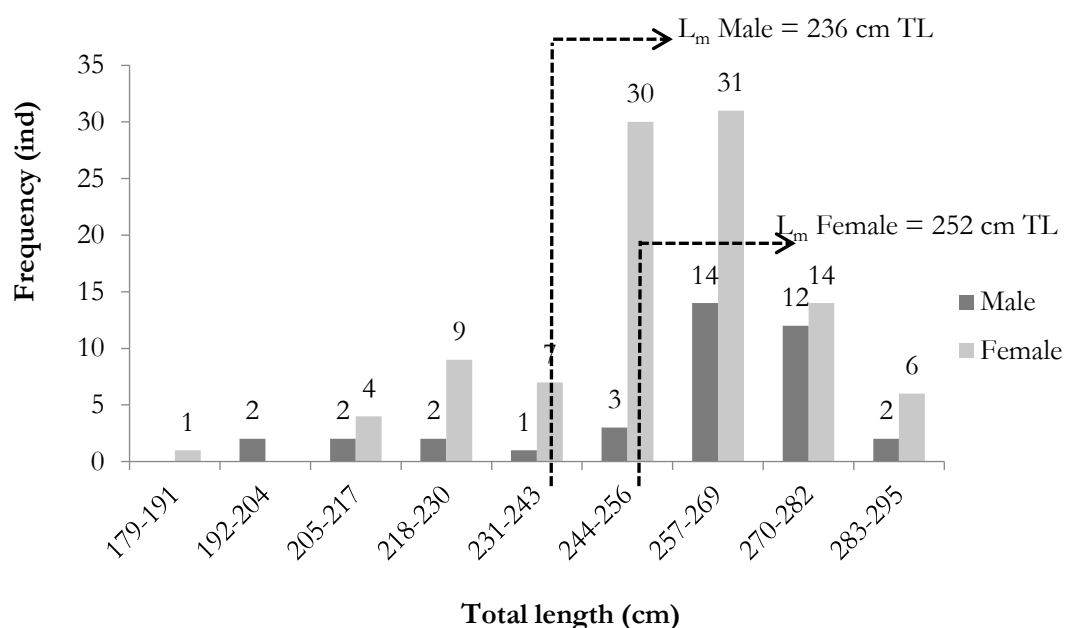
Figure 2. Size distribution of the thresher sharks landed at fishing port of Kutaraja
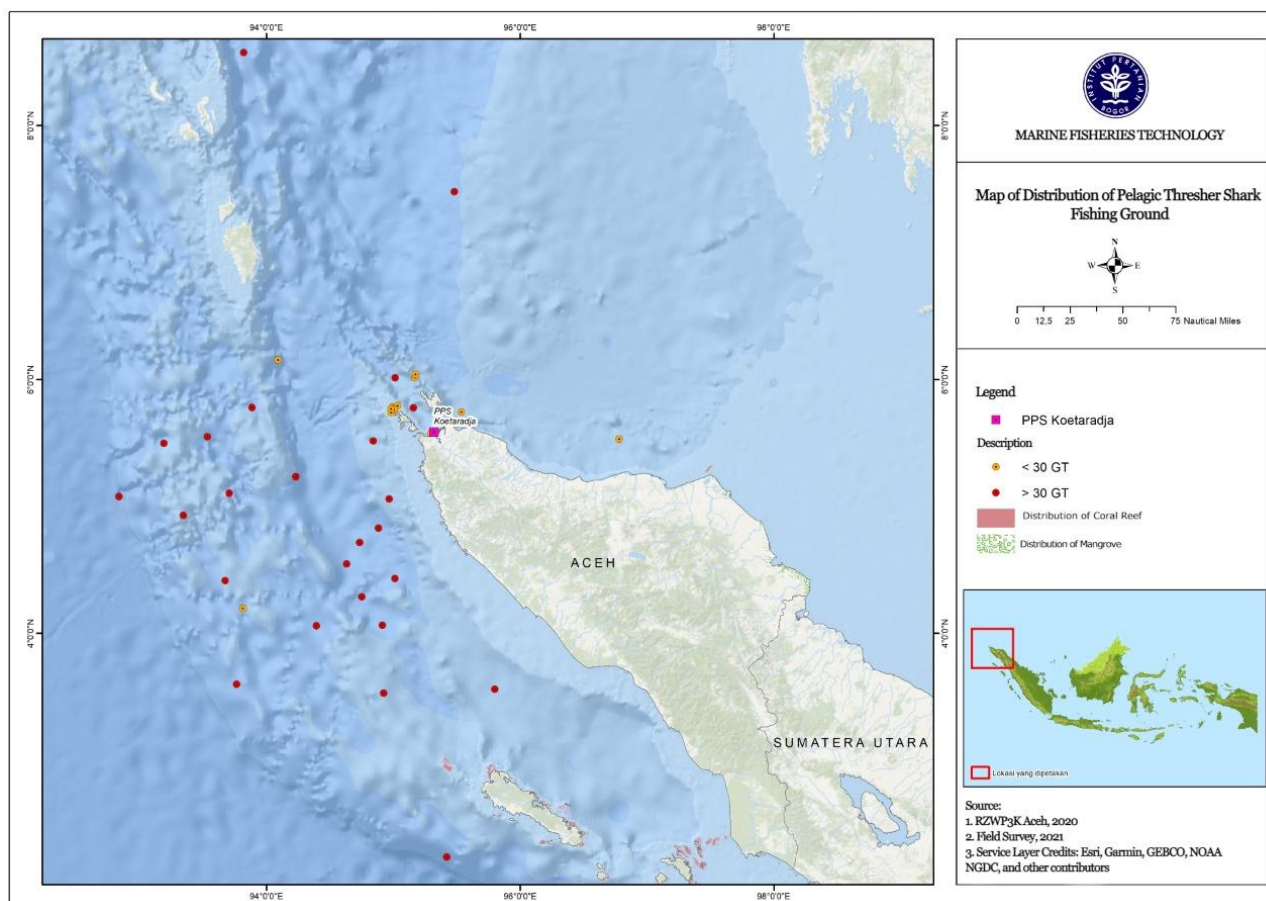
Figure 3. Map of fishing ground for fishermen based at the fishing port of Kutaraja.

Furthermore, the catches of purse seine and tuna longline vessels landed at the fishing port of Kutaraja consisted of small pelagic fish and large pelagic fish. The catch composition was dominated by 99% target species and 1% bycatch from total landings (Table 4). The main catches of purse seine vessels were yellowfin tuna (*Thunnus albacores*), skipjack (*Katsuwonus pelamis*), little tuna (*Euthynnus affinis*), and scad (*Decapterus* spp.). The non-target species were spotted oceanic triggerfish (*Abalistes stellaris*), pelagic thresher shark (*A. pelagicus*), scalloped hammerhead (*S. lewini*), bottlenose wedgefish (*Rhynchobatus australiae*). While the main catches of tuna longline were tuna (*Thunnus albacares*), skipjack (*K. pelamis*) and the non-target species were pelagic thresher sharks (*A. pelagicus*), scalloped hammerhead (*S. lewini*), bottlenose wedgefish (*R. australiae*).

Several ETP species were bycatch, such as pelagic thresher sharks (*A. pelagicus*), scalloped hammerhead (*S. lewini*), and bottlenose wedgefish *(R. australiae)*. The third species is on the IUCN red list (www.iucnredlist.org, 2022). The status of the shark and ray population are endangered.

Based on the EAFM indicator from the aspect of fish resources, the assessment results presented in Table 5. The scores given for each indicator are based on interviews and data identification. So that it is obtained, the assessment results from the aspect of fish resources with value of 70.00 or in the 'good' category.

The CPUE trend indicator and fish size get a score of 2 or based on the analysis of the yellow flag, which is 'medium' status. Furthermore, the indicator of the proportion of immatures caught and the composition of the catch with a score of 3 in the green flag, which is 'good' status. The indicators that must be considered in their management are the range collapse indicators and ETP species. This is because the indicator is red, which is a 'bad' status with a value of 1.

The fishing vessels ranged from small boats to more than 30 GT. The fishing ground was around the Indian Ocean as presented in Figure 4. According to fishers, fishing grounds have a longer distance from the fishing base (20-200 nautical miles) (Figure 4).

Discussion

Based on the analysis, the highest CPUE value was achieved in 2020 (Table 3) because of the fishing ground's abundance of fish resource stocks. From 2016 to 2019, very few sharks were used, as seen

from the catch per unit of effort (CPUE) that year was also small. The very high effort influenced the low CPUE value in 2016-2019 by reducing the CPUE. The number of fishing efforts lead to increase competition among fishers to reduce catches (Simbolon *et al.*, 2011).

After going through the standardization method of fishing gear, fishing effort from 2016-2020 has decreased. The decrease in efforts was caused by the number of ships not operating. The CPUE value and catch productivity can be influenced by the number of trips and the availability of fish resource stocks (Nurdin *et al.*, 2015). This happened in the pelagic thresher shark fishery based at fishing port of Kutaraja, where fishing effort significantly affected the CPUE values but did not significantly affect the annual production of thresher sharks. Simeon *et al.* (2020) reported that the capture of sharks at fishing port of Kutaraja in 2018 decreased and fishing efforts increased, thus CPUE tends to decrease as well. The fluctuating CPUE value is normally led by the addition or reduction number of fishing efforts (Listiani *et al.*, 2017). CPUE trends are also of the highest weight compared to other indicators in this analysis (Table 1). CPUE is also an important indicator of fish abundance and fishing ground quality (Harley *et al.*, 2001).

There were wide variations of the thresher shark's size landed in the fishing port of Kutaraja. Fish size can be influenced by aquatic environmental conditions, food availability, and other factors. Arisandi *et al.* (2020) stated that aquatic environmental conditions influence differences in the body size of sharks. Variations in length size can be caused by water conditions (availability of food, temperature, water physicochemical factors) and biological factors (physiological factors, genetics, age, sex) of the biota itself (Fry and Milton, 2009; Fitriya, 2017).

There are more female sharks caught by fishers than males. Female fish are more active in foraging for food to nourish the body and gonads develop properly and spawn well (Nikolsky, 1963; Arisandi *et al.*, 2020). Differences in the sex of sharks caught might be caused by fish behavior, environmental conditions, and fishing factors (Tampubolon *et al.*, 2016).

Furthermore, 16% of the male and 28% female of the caught sharks were immature with lower than Lm size. The adult shark was dominant landed in the fishing port. Simeon *et al.* (2020) reported that the male and female pelagic thresher sharks caught and landed in Aceh were mostly adult-sized. Although the captured thresher sharks are dominantly adults, the

conservation of the thresher sharks needs to be considered. This is supported by Stevens *et al.* (2000) statement that the biological characteristics of sharks take a long time to reach adult stage, and the recruitment rate is very low. Pelagic thresher sharks caught in the Indian Ocean can reach a maximum total length of 365 cm, the male maturity size of 240 cm, and females of 260 cm (White *et al.*, 2006).

The composition of the catch landed at fishing port of Kutaraja was more dominantly target pelagic fish, as much as 99% and non-target (shark and ray) species as much as 1% (Table 4). The catches of pelagic thresher sharks landed at fishing port of Kutaraja generally use a small fishing vessel. Simeon *et al.* (2020) explained that sharks landed at the fishing port of Kutaraja were as bycatch from longlines, handlines, and purse seines. Pelagic thresher sharks are usually caught by tuna hand line (Dharmadi *et al.*, 2012). The *A. pelagicus* is a bycatch from the tuna fishery. This species is actually an oceanic shark that lives from coastal waters to the high seas, from the surface layer to 600 m depth (White *et al.*, 2006; Ichsan *et al.*, 2020). The specific habitat associated with the thresher shark is unknown yet. Limited data and information on spawning and nursery ground of the shark are essential to maintain the sustainability of shark resources in a sustainable manner (Fahmi and Dharmadi, 2013).

Generally, pelagic thresher sharks are caught in the same fishing grounds as yellowfin tuna. Dharmadi *et al.* (2012) explained that pelagic thresher sharks are caught in nets, with the main catch targets being tuna and skipjack tuna operating in the waters of the Indian Ocean. Thus, fishing gear is an important factor that needs to be considered in managing thresher shark fisheries.

In addition, the pelagic thresher shark was the dominant ETP species landed at the fishing port of Kutaraja (Table 4). Based on the IUCN red list, the shark has already be an endangered status (Rigby *et al.*, 2019). Dharmadi *et al.* (2012) explained one indication of a decline in the pelagic thresher shark population due to fishing activities in the Indian Ocean. Based on the interviews, pelagic thresher sharks or other species of sharks and rays were not species targets. They were accidentally caught during the fishing operation.

Generally, the habitat of the pelagic thresher shark seems similar to the fishing ground of tuna as the target species. The increase distance of fishing grounds is an indicator that makes it more difficult for fishers to catch the targeted fish. Aprilla *et al.* (2013) stated that the fishing ground of the purse seine vessels based in the fishing port of Kutaraja was

25-150 nautical miles. Simeon *et al.* (2020) explained that pelagic thresher sharks were caught in offshore areas, and *A. pelagicus* is a pelagic sharks migration species. The pelagic thresher shark is epipelagic and often migrates from the surface to 152 m water depth (Compagno, 2001). Differences in distance from fishing base to fishing grounds may indicate that fishing pressure increases, causing range collapse. Range collapse is a shift in fishing grounds in a particular ecosystem (Salmarika *et al.*, 2018).

The composite value of the fish resource aspect was 70.00 or in the 'good' category (Table 3). In general, the management of fish resources has been running optimally, but some indicators from this aspect still need to be managed. Several indicators of the fish resource aspects have scores in the 'low' and 'medium' categories.

The recommended management action on the CPUE trend indicator is by controlling the fishing effort of both purse seine and hand line. Banon *et al.* (2011) explained that fisheries management could be carried out with a controlled access system that is carried out by limiting input (fishing units) and output (catch quotas). Catch quotas can be set to avoid overfishing of *A. pelagicus*. It is essential to regulate and control fishing efforts to maintain the balance of the marine ecosystem and prevent the economic decline of fishers (Suwarni *et al.*, 2020).

The next recommended actions are also closing the fishing season for fishers. This action is to reduce the number of pelagic thresher sharks caught. If there is no closure of the fishing season, it will negatively impact on the sustainability of the pelagic thresher sharks in the waters. Simeon *et al.* (2020) describe the pattern of the shark season almost throughout the year except for the east monsoon season, and most are caught from July to December. The open-closed system during the fishing season is carried out to regulate the time of fishing, so that the intensity of fishing can be controlled (Salmarika *et al.*, 2018). Jamal *et al.* (2014) also stated that other actions could be conducted namely temporarily close fishing areas, especially in both spawning and nursery grounds. This reduces the catch of immature pelagic thresher sharks and gives the pelagic thresher shark time to regenerate properly. The following is also explained by Riyanto *et al.* (2015) to establish a protection zone for sharks to mate and release cubs. Although the assessment results on the proportion indicator of immatures caught are 'good', this needs to be implemented to reduce the catch of immature pelagic thresher shark.

The following management action is to reduce the use of bycatch, especially ETP species such as pelagic thresher sharks. Actions can be taken by way encourage fishers to release the ETP bycatch. This action can be done by providing dissemination to fishers. It is inline with the Minister of Marine Affairs and Fisheries Decree Number 12 year 2012 concerning Capture Fisheries on the High Seas. According to article 39 of the MMAF Decree, the bycatch that is ecologically related to tuna fisheries, like thresher sharks must be released alive. Diah *et al.* (2018) suggested that reducing the capture of ETP species is by dissemination to fishers regarding the species of protected biota and their regulations.

These actions must also be supported by effective catch reporting of the main actors so that the government can carry out optimal monitoring of fishing activities. Ichsan *et al.* (2020) also stated that monitoring and management are essential because pelagic thresher sharks are susceptible to overfishing and slow growth. The next step is to control the distance between Fish aggregating devices (FADs) to make it easier for fish to regenerate, reduce immature fish catches, and restore the shrinkage of fishing grounds (Salmarika *et al.*, 2018). The mesh size of the purse seine and hand line should be adjusted to the Decree of the Minister of Marine Affairs and Fisheries of the Republic of Indonesia (MMAF) Number 18 the year 2021 concerning the placement of fishing gear and FAD in the fisheries management area of the Republic of Indonesia and the high seas and regulation of the 'andon' fishing andon (migration fishers).

Conclusion

Resource status of the pelagic thresher shark based at fishing port of Kutaraja in the frame of EAFM assessment was in 'good' category. However, some indicators of this domain (range collapse, ETP species, trend CPUE and fish size) need to be considered to improve. Thus, to achieve sustainability for the shark, this study recommends some management actions: (1) to control fishing effort, (2) to regulate fishing quotas, (3) spatial management to open – closed areas and seasons, particularly in spawning and nursery grounds, (4) to control size limit by improving the selectivity of the fishing gears. Furthermore, dissemination program is needed to increase the understanding and awareness of the fishers and other stakeholders on the ecological role of sharks in sustainable fish resources. These management actions can be realized with accurate information data and supporting research.

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