Saintek Perikanan: Indonesian Journal of Fisheries Science and Technology
Available at http://ejournal.undip.ac.id/index.php/saintek
Vol. 20 No.4 : 197 - 206, December 2024

SHARK SPECIES COMPOSITION AND DISTRIBUTION OF FISHING GROUND BASED ON FISHING GEAR IN CILACAP OCEAN FISHERY PORT

Dian Novianto[1], Santoso Budi Widiarto[2], Anhar Muslim[2], Miftah Wahyu Purnomo Aji[2], Kukuh Prakoso*[3]
[1]National Research and Innovation Agency
[2]Coastal and Sea Resource Management Loka Serang
[3]Aquatic Resources Department, Faculty of Fisheries Management, Universitas Diponegoro
Jl. Pasir Putih I, Ancol Timur, Jakarta, Indonesia 14430
Email*:* kuhprakoso7@gmail.com

Received: 2 october 2024, Accepted: 4 December 2024

ABSTRACT

This study focuses on shark species composition, fishing techniques, and geographical distribution in the South Java Waters of Cilacap Ocean Fishing Port (COFP) during 2023. From the data collected, 18 shark species from 8 families were landed, with *Alopias superciliosus* as the dominant species (29%), followed by *Carcharhinus falciformis* (25%), and *Alopias pelagicus* (18%). Shark fishing was conducted with various gears such as tuna longline, drift longline, longline, drift gillnet, and bottom gillnet, with drift longline being the most effective gear with the largest contribution to the catch. Most of the sharks caught were categorized as endangered (EN) and vulnerable (VU) based on the IUCN conservation list, and listed in Appendix II of CITES. The results show that the geographic distribution of shark fishing grounds covers a wide area from the coast to the Indian Ocean, with high concentrations in the waters around Kebumen to the south of Yogyakarta. Fishing activities often overlap between fishing gears, increasing the risk of overfishing. Length distributions and maturity rates of sharks also indicate that many mating-ready adults are being caught, threatening slow population regeneration. To ensure the sustainability of shark populations and maintain the balance of marine ecosystems, a holistic and data-driven management strategy is needed. This includes strengthening regulations, raising public awareness through conservation education, and developing collaborative approaches involving fishers, government, and conservation organizations. Consistent law enforcement is also key in minimizing violations and ensuring the sustainability of shark fisheries in Indonesia.

Keywords: Shark species; fishing gear; fishing grounds

INTRODUCTION

Indonesia is one of the countries with a high diversity of shark species (Sentosa, 2017). In Indonesia, there are about 218 species (114 sharks, 101 rays, and 3 chimeras) from 44 tribes (Allen & Erdmann, 2012), only about 88 shark species have been utilized in Indonesia (White et al., 2006). Most of the utilization of shark fishery products in Indonesia is bycatch (72%), and only 28% is the main target catch (Wahyuni, 2023). Sharks as a target species are common, especially in the southern coastal area of Java triggered by the high demand for products from sharks, especially fins and other body parts that have high selling value such as meat, cartilage, skin, teeth, jaws, and liver (Ferdiansyah and Hidayat, 2016; Zuhri et al., 2022), so that sharks were originally a by-catch, but in recent years hunting of sharks has been rampant (Arum et al., 2017). In 2017 Indonesia still exported 3.800 tons of shark meat and 1.350 tons of shark fins per year (Syahfriliani and Sunarsi, 2020).

The Cilacap Ocean Fishing Port (COFP) is a major landing site for large pelagic species including sharks, which are caught with fishing rods and nets. The sharks are the main catch and bycatch in the South Java Sea, especially pelagic sharks, such as the Carcharhinidae, Sphyrnidae, and Alopiidae families (Darmadi and Kasim, 2010). Shark production in Cilacap Ocean Fishing Port statistics recorded from 2016 to 2020 overall reached 2.667,49 tons, and shark catches from Cilacap contributed 4,7% of Indonesia's shark production (Bhagawati et al., 2017).

Market demand and high prices have an impact on its high exploitation rate (Basri et al., 2014; Yusrina et al., 2019), which can lead to overfishing (Hehanussa et al., 2023). This will have a negative impact on the sustainability of shark species and marine ecosystems if shark exploitation activities are not properly addressed (Wahyuni, 2023). Recent analyses have concluded that the global abundance of sharks and rays has declined by 71% from 1970 to 2018, at a steady rate, averaging 18,2% per decade (Fowler et al., 2021).

Indonesia has ratified CITES with the issuance of Presidential Decree Number 43 of 1978, as a concrete step to participate and support the protection of wildlife. As a member of CITES and FAO Indonesia has an obligation to manage and conserve shark resources (Sentosa, 2017) where 14 species of pelagic sharks, 11 pelagic stingrays, and 16 stingrays have been listed in Appendix II of CITES since 2002 and based on the decision of the Nineteenth meeting of the Conference of the Parties to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (COP19 CITES), fish species in the families Carcharhinidae, Sphyrnidae and Rhinobatidae are included in the CITES Appendix II list which encourages Indonesia to make efforts to manage and conserve them.

Sustainable research and research-based shark resource management strategies are needed to develop, manage, and conserve shark resources sustainably. However, management policies must be determined cautiously. This research aims to update the results of previous studies (Arum et al., 2017; Hanifa et al., 2018; Prihatiningsih et al., 2018; Muslim et al., 2019) and provide updated data and information related to shark fisheries in the waters of South Java in the eastern part of the Indian Ocean.

RESEARCH METHODS

Ocean Fisheries Port (COFP) from February to December 2023. The collection and recording of shark landing data was carried out by Coastal and Sea Resource Management Loka (CSRML), Serang enumerators who had previously attended training as shark and ray production recording officers in the CSRML Serang work area. Identification of sharks landed at COFP was carried out using the reference White *et al*., 2006.

Data collection was carried out by identifying the species, recording the weight and number of individual sharks, measuring the standard length of the sample fish landed, and interviewing the captain of the boat to obtain information on fishing operations such as fishing location points.

Individual weight measurements use analog scales operated by PPSC with an accuracy of± 0,5 kg, while length measurements use a 5-meter tape measurement with an accuracy of±0,5 cm.

Maturity measurement in sharks is done with a maturity level approach clasper and clasper length measurement. Classification of the maturity level of clasps was observed based on three maturity levels namely non-classified (NC), non-full classified (NFC), and fully classified (FC).

Sampling was done by purposive sampling. All data collected were analyzed by descriptive statistics to obtain an overview of catch composition, catch production, length size distribution of each species, and distribution of fishing points by gear type. Analyze and display images using R software (R core team, 2023) and several other supporting R packages.

RESULT AND DISCUSSION

Shark catch Composition and Conservation Status

Shark species landed at COFP are generally bycatch from tuna longline, hand line, drift gillnet, and bottom gillnet, but sometimes become target fish in the drift longline fleet which catches all types of large pelagic fish (tuna and similar species). The results of sampling and recording the species composition of the catch during the study period 2023 contained 18 types of shark species grouped into 8 families. *Alopias superciliosus* was the most caught species (29%), followed by *Carcharhinus falciformis* (25%), then *Alopias pelagicus* (18%) and *Prionace glauca* (11%), while other shark species were caught in numbers below 5% (Table 1). The results of previous research showed the abundance of shark species consisting of 11 families and 30 species dominated by *Alopias pelagicus* followed by *Alopias superciliosus* (Hanifa *et al.*, 2018). Furthermore, Prihatiningsih *et al.*, 2018, reported that the types of sharks recorded at COFP consisted of 16 pelagic shark species and were dominated by *Alopias pelagicus* and *Alopias superciliosus*. Different results were obtained by Krisnafi *et al.*, 2024, who obtained results similar to this study, where the Alopias superciliosus species was the most caught species followed by the *Carcharhinus falciformis* species, this is thought to be related to the return of the abundant stock of FAL species in the eastern part of the Indian Ocean reported by Simeon *et al*., 2018.

Table 1. Shark Species Composition and Conservation and Trade Status

Species	FAO Code	N %	IUCN Status	CITES Status
Alopias superciliosus	BTH	28,6	EN	II
Carcharhinus falciformis	FAL	24,9	VU	II
Alopias pelagicus	PTH	17,5	EN	II
Prionace glauca	BSH	10,8	NT	II
Isurus oxyrinchus	SMA	4,02	EN	II
Isurus paucus	LMA	3,8	EN	II
Squalus crassispinus	DOP	2,9	LC	N
Carcharhinus sorrah	CCQ	1,4	NT	II
Carcharhinus brevipinna	CCB	1,3	VU	II
Galeocerdo cuvier	TIG	1,2	NT	N
Carcharhinus plumbeus	CCP	1,2	EN	II
Carcharhinus longimanus	OCS	0,71	CR	II
Sphyrna zygaena	SPZ	0,61	VU	II
Squatina pseudocellata	SUF	0,55	LC	N
Dalatias licha	SCK	0,06	VU	N
Carcharhinus leucas	CCE	0,03	VU	II
Hexanchus griseus	SBL	0,03	NT	N
Carcharhinus plumbeus	CCP	1,2	EN	II
Carcharhinus longimanus	OCS	0,71	CR	II
Sphyrna zygaena	SPZ	0,61	VU	II
Squatina pseudocellata	SUF	0,55	LC	N
Sphyrna lewini	SPL	0,03	CR	II

Based on the IUCN conservation status list, the shark catches landed are dominated by the endangered (EN) and vulnerable (VU) categories with a proportion of 28% each, and for those that are almost threatened as much as 22% (Figure 1). Meanwhile, the status of sharks according to CITES is dominated by the Appendix II category as much as 72% and only 28% of the category has not been evaluated (Figure 2).

Control and conservation efforts have been carried out by the Indonesian government through several regulations and ratification of international legal provisions related to shark fisheries. Among them: Regulation of the Minister of Marine Affairs and Fisheries Number 49/PERMEN-KP/2016 Amending Regulation of the Minister of Marine Affairs and Fisheries No. 35/PERMEN-KP/2013 concerning Procedures for Determining the Protection Status of Fish Species. Furthermore, the issuance of KP Regulation Number 48/PERMEN-KP/2016 regulates the prohibition of the release of hammerhead sharks (*Sphyrna* sp) and cowboy sharks (*Carharhinus Longimanus*) and is expanded as a national and global reference with the issuance of Minister of Marine Affairs and Fisheries Regulation Number 61/PERMEN-KP/2018. 61/PERMEN-KP/2018 concerning the utilization of protected fish species and/or fish species listed in the Appendices of the Convention on International Trade in Endangered Species of Wild Fauna and Flora, which is further regulated in Minister of Marine Affairs and Fisheries Regulation Number 12 of 2022 concerning the take quota for limited utilization of protected fish species based on national provisions and fish species in appendix II of the convention on international trade in endangered species of wild fauna and flora.

Exploitation of shark species with Appendix II status in Indonesian waters is still ongoing, indicating that regulations and policies have not been fully implemented in fishing communities. Socialization about fish conservation can also help increase public awareness about the importance of maintaining the survival of fish and marine ecosystems, so as to develop collaborative and effective conservation strategies without harming fishermen and shark resources remain sustainable, and certainty in the application of law enforcement is also needed to minimize violations.

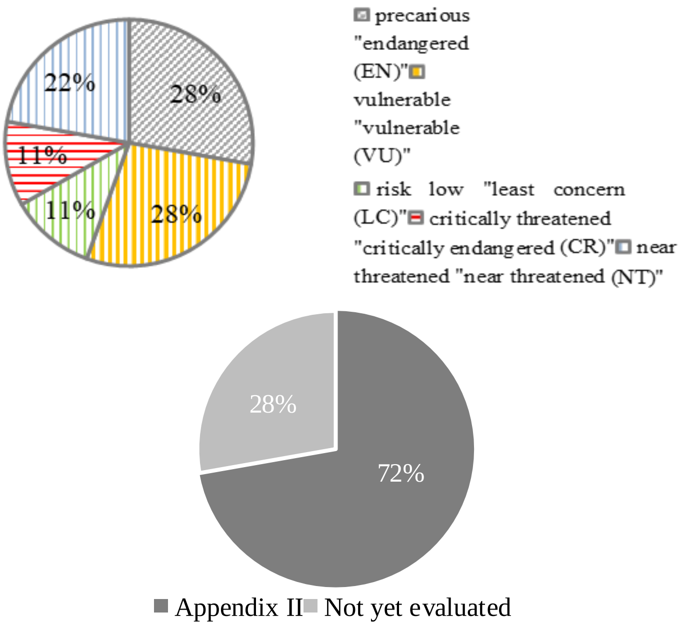

Figure 2. Trade Status Under CITES

Shark Catches by Gear

Five fishing gears land shark catches at COFP, namely tuna longline, drift longline, drift gillnet, bottom gillnet, and tuna longline. Generally, these fishing gears target large pelagic fish groups such as tuna and the like except for the bottom gillnet which targets demersal fish groups. The proportion of sharks (kg) landed was dominated by drift gillnet gear at 61%, hand line at 33%, tuna longline, and drift gillnet at 3% each, and the smallest proportion from bottom gillnet at 0,6% (Table 2).

Drift longlines other than tuna longlines tend to target sharks as the main catch and are effective in catching pelagic sharks. With the construction of fishing line placement by the shark swimming layer (67 - 82 meters (Haris *et al.*, 2023)) shark longlines are very effective in catching sharks compared to other fishing gear. The sampling results in this study show that the catch of drift gillnets both in number and weight has a greater value than other tools.

As for other fishing gear, shark catch is a bycatch that is kept for utilization. Interestingly, the longline fishery is known to be very selective in its operations but also lands a significant number of sharks. The large number of sharks caught in the Cilacap longline fishery is due to the activities of crew members who use additional fishing gear (float lines) to supplement their income.

Table 2. Shark Catches by Gear

Fishing Gear	Number of sharks	
	Tail	kg
Basic gillnet	120	857
Gillnet drift	83	3488
Line fishing	1281	41880
Tuna longline	98	3551
Shark longline	1512	78255

Length Distribution, Sex Ratio, and Clasper Condition

Measurements of 2.507 Appendix II sharks (12 species) during 2023 showed that the smallest size was recorded at 49 cmFL for silky sharks (FAL) and the longest at 49 cmFL for silky sharks (FAL).

The largest length was 296 cm FL for Shortfin mako (SMA) (Figure 3). Blue shark (BSH) length distribution was minimal at 101 cmFL and largest at 252 cmFL with a mean length of 186 cmFL (SD± 30,8), where the estimated length at sexual maturity for BSH males was 161,4 cm and 179,3 cm for females (Zhu *et al.*, 2023). Scalloped hammerhead (SPL) length distribution was recorded from 155 - 230 cmFL with a mean length of 183 cmFL (SD ± 26,9), with an estimated length to reach adulthood at 155 cm for females and 140 cm for males (Simeon *et al.*, 2020) This is by the statement of White *et al.* (2006) where the size of adult males is smaller than adult females.

Pelagic thresher (PTH) length distribution ranged from 83 - 177 cmFL with an average of 143 cmFL (SD ± 15,33), this average length distribution is smaller than the size of PTH found by Chodrijah *et al.* (2021) where the size structure ranged from 60-270 cmFL with the mode ranging from 140 cmFL. Furthermore, the length to reach adult size for this species is 232 cm for males and 244 cm for females (Drew *et al*, 2015). While the length distribution for Bigeye thresher (BTH) has a length of 77 - 256 cmFL with a mean length of 153 cmFL (SD ± 29,5), this size is on average larger when compared to the size of BTH along southern Indian waters which has a length distribution between 101 - 140 cmFL (Mohanraj *et al.*, 2024), then the first length of adulthood is 279 cm for males and 332 cm for females (Das *et al.*, 2016). For silky shark (FAL) length distribution is between 49 - 215 cmFL with an average length of 95 cmFL (SD ± 33), with the size reaching maturity is 2156 mm for females and 2076 mm for males (Hall *et al.*, 2012). Furthermore, the length distribution of Longfin mako (LMA) ranged from 102 - 261 cmFL with an average of 177 cmFL (SD± 27,7) and Shortfin mako (SMA) between 107 - 296 cmFL with an average length of 188 cmFL. According to White (2007), the first adult length of SMA males has a length of 185 cm TL and females 250 cm TL while the adult length of LMA males: is 229 cm TL females: >245 cm TL (Reardon *et al.*, 2019).

D'Alberto *et al.* (2017) found an OCS length distribution of 76 - 235 cmTL and estimated adult males to be 193 cm long, while adult females were 224 cmTL, while the recorded Whitetip shark (OCS) length distribution showed a distribution from 83 - 142 cmFL with a mean of 103 (SD±

19,97). Spinner shark (CCB) had a length distribution from 112 - 240 cmFL with a mean of 182 cmFL (SD ± 38,8), Palmrose (2021), estimated the size at maturity at 130 and 140 cm FL for males and females. Furthermore, the length distribution of the Sandbar shark (CCP) has a range from 153 - 276 cmFL with a mean of 225 cmFL (SD ± 27,5), and the size at maturity of males is 174 and 164 cm TL (Geraghty, 2015). Compagno *et al* (2005) have provided information on the general biological aspects of the Spot-tail shark (CCQ) and reported a maximum size greater than 160 cm, size at maturity of 106 cm for males and 110 - 118 cm for females, while the size of CCQ in this study ranged from 59 to 172 cm FL with a mean of 107 (SD± 23,5). Smooth hammerhead (SPZ) showed a range from 82 - 243 cmFL with a mean of 161 (SD± 53,7), with adult males measuring around 250-260 cm TL and females around 265 cm TL off the east coast of Australia (Stevens, 2000).

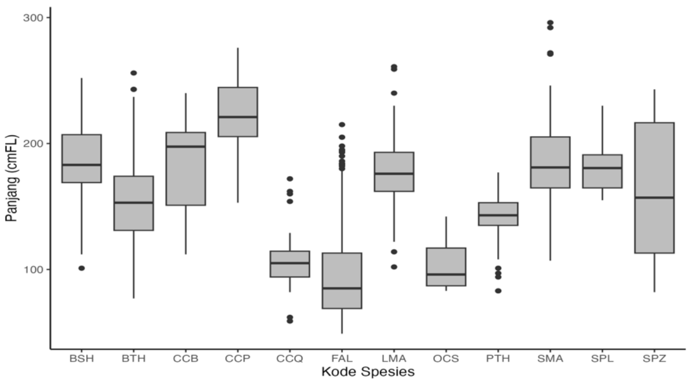

Figure 3. Length Distribution of Appendix II Sharks

For the recording of male and female sex, 3059 fish were recorded, consisting of 1852 females (60,5%) and 1.208 males (39,4%). The condition of the sex ratio generally shows an imbalance but there is also an equilibrium sex ratio such as in the types of BTH and SMA (Figure 4). An unequal sex ratio can be caused by differences in fish behavior according to sex, environmental conditions, reproductive processes, eating habits, migration, and fishing factors (Rahardjo, 2007). Differences in the sex composition of the catch can also illustrate differences in the natural distribution of sex and size, which may stem from sexual differences in reproductive behavior (Megalofonou, 2009).

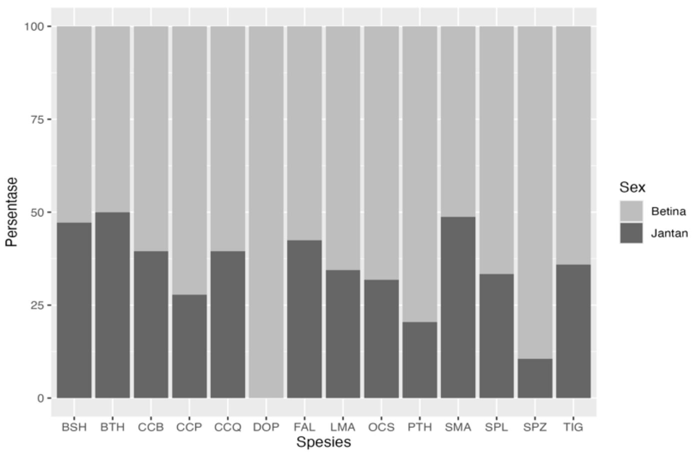

Figure 4. Sex Ratio of Each Shark Species

The results of observations of the maturity level of male sharks recorded 1.179 male sharks that were successfully identified (Figure 5). Where the composition of the clasper condition is dominated by level I as many as 680 fish (57,7%), level II as many as 171 fish (14,5%) and level I as many as 328 fish (27,8%). This condition is suspected that the fishing fleet based in PPSC is a mating ground for sharks with many adult male sharks caught. This condition also shows that the high threat of loss of adult sharks ready to mate will further degrade their pupation, where we know that it takes a long time for sharks to reach adult size, while the level of threat of being caught is at all age levels of sharks.

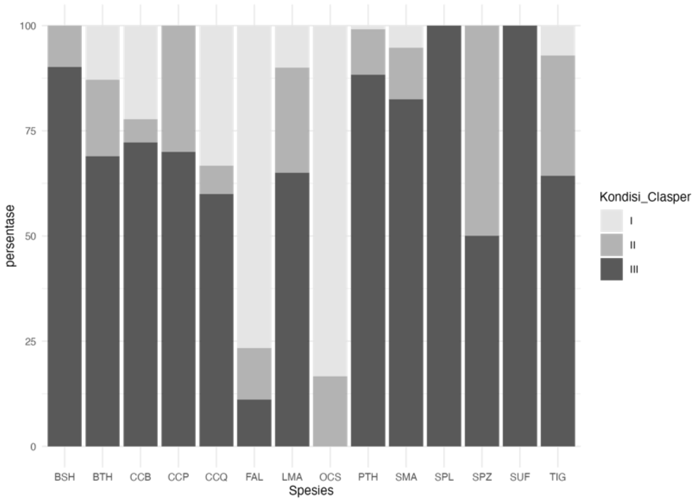

Figure 5. Clasper Condition of Each Shark Species

Distribution of Fishing Areas and Shark Density

Cilacap fishermen determine their fishing grounds from the Indian Ocean, which has been passed down from generation to generation. Fishing areas often overlap between fishing gear, where the bottom gillnet tends to be closer to the coast with muddy and sandy water types. Meanwhile, other fishing gear tend to move further to the south of the Indian Ocean.

The distribution of longline gear fishing grounds extends from coastal to far south of the Indian Ocean from 70º to 140º South latitude and 101º to 113º East longitude (Figure 6). Accidental capture of sharks in longline fisheries has been reported in previous research studies in the Indonesian region (Mardhatillah *et al.*, 2023; Yahya *et al.*, 2023). As bycatch, shark densities are quite high in this fishery. Interviews with the captain of the longline fleet, as well as supporting data from PPSC capture fisheries statistics, show that the largest shark density distribution is located between the waters of Kebumen to South Yogyakarta. Novianto *et al.*, 2023 revealed that sharks are rarely caught around FADs, but sharks are more often caught if the vessels used as FADs drift during the eastern season from July to September. They further stated that, despite the insignificance of shark catches, shark catches are still considered important to supplement fishermen's income, so the longline fleet still catches a large number of sharks.

The fishing grounds of the drift gillnet fleet were seen to intersect and overlap with the fishing grounds of other gears, with the drift gillnet operating not too far south of the Indian Ocean between 70º - 110º South latitude and 106º - 111º East longitude (Figure 7). Sharks caught were bycatch that were generally twisted and entangled in nets. There were 9 shark species caught in this fleet whereas, Novianto *et al*. 2016 found

13 shark species dominated by the Alopidae family (pelagic and bigeye thresher) whose conservation status has been regulated in the IOTC resolution.

Considered to pose a high level of threat to the survival of sharks and ecologically sensitive species, the use of gillnets operating in the Indian Ocean has been regulated through Resolution 12/12 of the Indian Ocean Tuna Commission which prohibits the use of large-scale gillnets as gillnets, or a combination of other nets, greater than 2,5 kilometers in length on the high seas in the IOTC Convention area. This resolution was based on UNGA resolution 46/215 which called for a global moratorium on large-scale driftnet fishing on the high seas (Martin, 2017).

There is very little information on the bottom gillnet fleet based at COFP. Interview results and COFP capture fisheries statistics show that the basic gillnet fishing grounds are located at 70º - 90º South latitude and 107º - 112º East longitude with the highest shark density at 80º South latitude 110º East longitude (Figure 8). There were 9 species of both pelagic and demersal sharks caught in this fleet. One of the characteristics of the catch that indicates it comes from this fleet is the Isabela shark (*Squatina pseudocellata*) and Patilan shark (*Squalus crassispinus).*

In addition to catching sharks, this fleet also has great potential to catch several types of ray sharks from the Rhinidae family. Alaudin *et al.*, 2021 stated that the basic gillnet at Ujong Baroh Meulaboh fish landing station often lands hammerhead sharks (*Sphyrna lewini*) every day. Meanwhile, the bottom gillnet in Sungai Liat also catches stingray sharks of the Rhinidae family (*Rhynchobatus australiae* and *Rhina ancylostomus*) as the main catch (Feniola *et al.*, 2024).

During 2023 the drift gillnet fleet's fishing grounds were recorded at 80º south latitude and 102º to 111º east longitude with the highest concentration of shark biomass at 80º south latitude and 109º - 111º east longitude (Figure 9). During 2023 drift gillnets are very effective in shark fishing operations, where a small amount of effort can land a significant number of sharks. As for tuna longlines, the fishing area is wider in the Indian Ocean between 80º - 150º south latitude and 100º - 112º east longitude (Figure 10). The fishing operations of both gears utilize the water column to place the fishing line according to the swimming depth (swimming layer) to catch the target fish. Significant differences lie in the number of fishing lines between floats, branch line length, bait type, and fishing line immersion time (soak time). Drift lines targeting sharks are generally positioned closer to the surface using shorter branch lines and fewer lines between floats (4 - 7 lines) than tuna lines (11 - 18 lines). The long-line immersion strategy requires a type of bait that is durable and has a strong odor (attractant) so that it can attract sharks to eat it, this type of bait is usually pieces of uneconomical fish meat from previous catches.

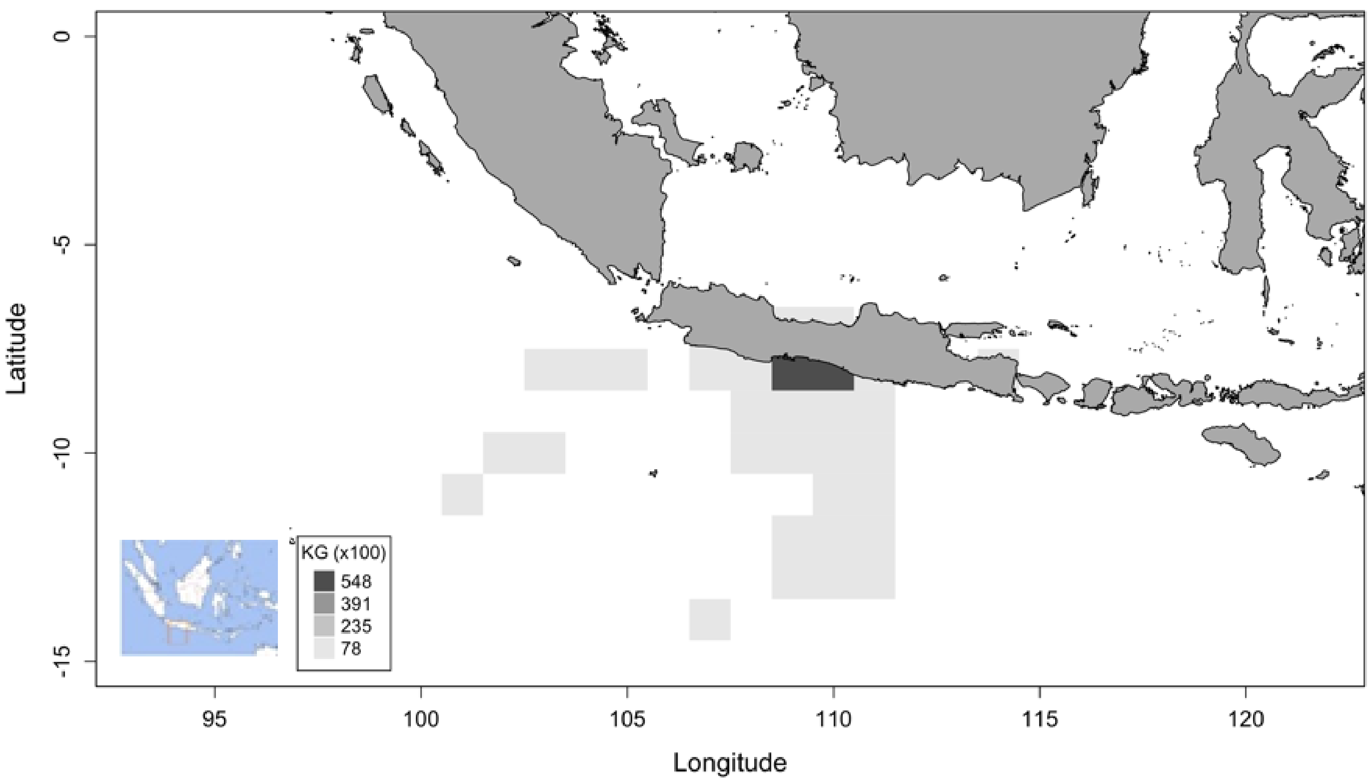

Figure 6. Handline Catch Area Distribution (1º x1º) and Shark Density Caught in 2023

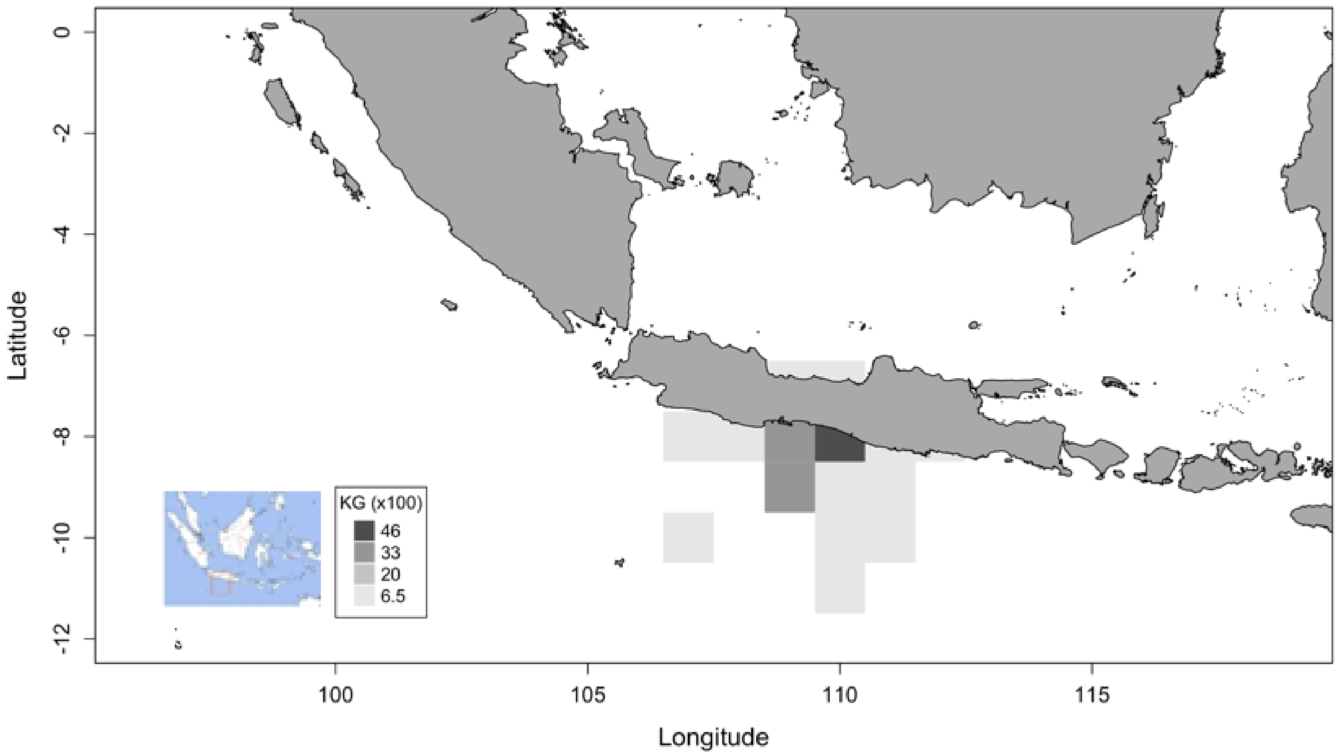

Figure 7. Distribution of Drift Gillnet Fishing Grounds (1º x1º) and Shark Density Caught in 2023

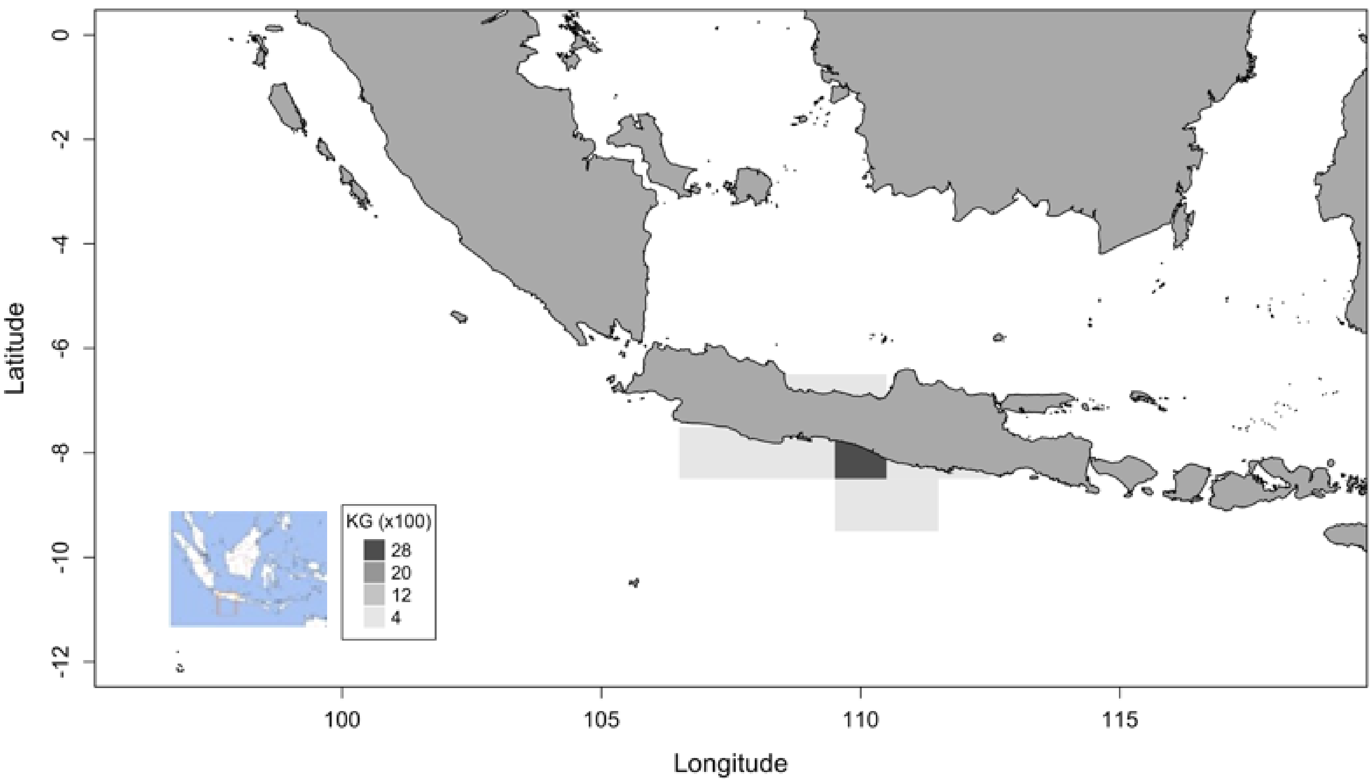

Figure 8. Distribution of Bottom Gillnet Fishing Grounds (1º x1º) and Shark Density Caught in 2023.

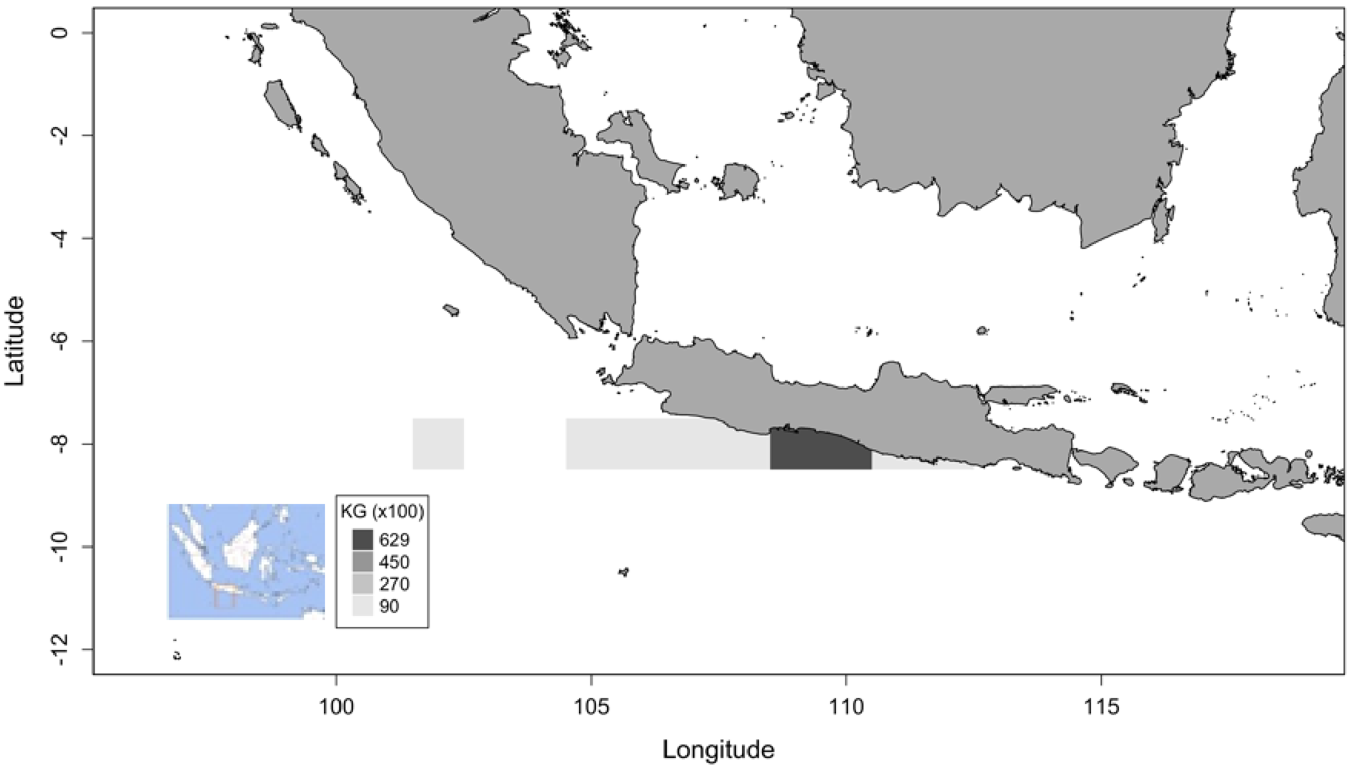

Figure 9. Distribution of Drift Gillnet Fishing Grounds (1° x1°) and Shark Density Caught in 2023.

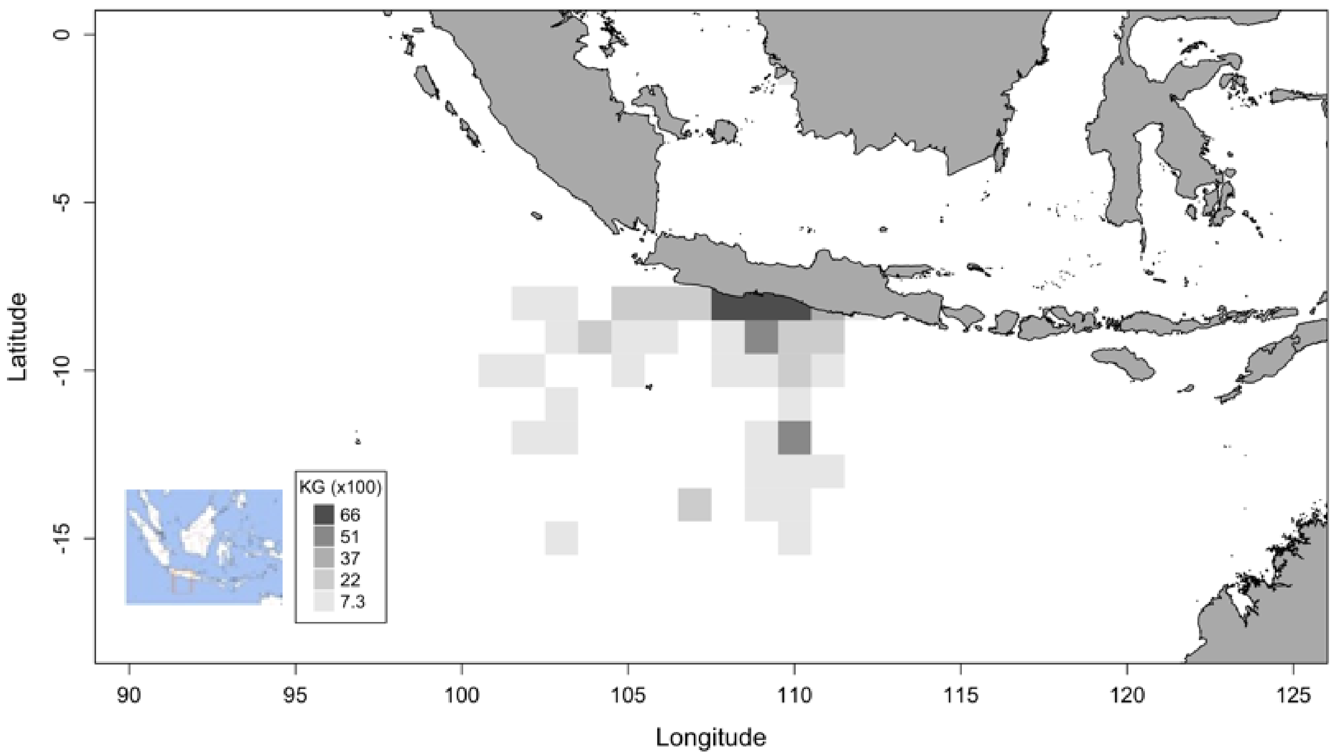

Figure 10. Distribution of Tuna Longline Fishing Grounds (1° x1°) and Shark Density Caught in 2023

CONCLUSION

Eighteen shark species were identified, with *Alopias superciliosus* being the most dominant species, followed by *Carcharhinus falciformis* and *Alopias pelagicus*. Sharks were caught with a variety of gears such as drift gillnet, longline, tuna longline, drift gillnet, and bottom gillnet, with drift gillnet recording the largest catch. Most of the sharks caught are in the (EN) and vulnerable (VU) categories according to the IUCN, and the majority are listed in Appendix II of CITES, which restricts their international trade. Geographical distribution shows that shark fishing covers a wide area, from the coast to the Indian Ocean, with the largest concentration of catches in the waters between Kebumen and southern Yogyakarta. The length distribution and maturity rates of sharks indicate that many mature individuals ready to mate are caught, threatening the sustainability of shark populations that take a long time to regenerate.

High market demand has increased exploitation, much of which still occurs without adequate control. Regulations such as from Minister of Marine Affairs and Fisheries related to protection and fishing quotas, the implementation at the field level is still weak, as seen from the following continued high levels of shark fishing activity. There is a need for a holistic approach to shark resource management that includes increasing public awareness, strengthening regulations, implementing consistent law enforcement, and developing a data-driven conservation strategy that involves collaboration between the government, fishers, and conservation organizations. These efforts are important to maintain the balance of marine ecosystems and ensure the sustainability of shark fisheries in Indonesia.

REFERENCES

Alaudin, Jaliadi, Burhanis, Muhammad Rizal. 2021. Size distribution and growth of hammerhead sharks (by catch) landed at the Ujong Baroh Meulaboh fish landing base (PPI). Journal of Tropical Fisheries. Vol 8, Number 1. Page: 65-77

Allen, G. R. & M. V. Erdmann. 2012. Reef Fishes of the East Indies. (Volumes I, II, III).1292 pp.

Arrum, S.P., GhofarA., & Redjeki S. (2016). Composition of shark species and distribution of fishing points in coastal waters of Cilacap, Central Java. Diponegoro Journal of Maquares, 5(4), 242-248.

Basri, M. I., Sara, L., & Yusnaini, Y. (2014). Aspects of Reproductive Biology as a Basis for Resource Management of Crab (Portunus Pelagicus, Linn 1758) in Toronipa Waters, Konawe. Jsipi (Journal Of Fishery Science And Innovation), 1(2).

Bhagawati, D., Nurani, T., & Abulias, M. N. (2017). Species, performance and sex ratio of sharks landed at Cilacap Ocean Fishing Port. Indonesian Journal of Ichthyology, 17(2), 185-200.

Chodrijah. U, P. Lestari, Prihatiningsih, Tirtadanu. 2021. Growth estimates of pelagic thresher shark (Alopias pelagicus nakamura, 1935) in Indian Ocean southern Java waters.In IOP Conference Series: Earth and Environmental Science, 674 (1) (2021), Article 012009, 10.1088/1755-1315/674/1/012009

Compagno, L.J.V.; Dando, M.; Fowler, S. Sharks of the World: Collins Field Guide; Harper Collins Publishers: London, UK, 2005; p. 368.

D'Alberto BM, Andrew Chin, Jonathan J. Smart, Leontine Baje, William T. White and Colin A. Simpfendorfer. 2017. Age, growth and maturity of oceanic whitetip sharks (Carcharhinus longimanus) from Papua New Guinea. Marine and Freshwater Research, 68, 1118-1129. http://dx.doi.org/10.1071/MF16165

Das P, Sinha M K, Bhargava A K, Singh P, Sahu K C and Mali K S 2016 A report on recruitment of Alopias pelagicus and Alopias superciliosus in the Andaman Sea.J. Aquac.Mar. Biol. 4(6) 1-5

Dewi, S.P.S., Lasniroha, R., Pumpun Y.K., Abidin, Z., Wardono, S. 2018. Catch Composition and Fishing Area of Appendix Ii Cites Sharks Landed in Namosain -East Nusa Tenggara. Journal of Indonesian Fisheries Research (JPPI), 24(2): 149-156.

Dharmadi & Kasim, K. (2010). Shark and ray fisheries in the Java Sea. J. Lit. Fisheries.Ind, 16(3), 205-216

Dharmadi, Fahmi., & White, W. (2009). Biodiversity of sharks and rays in South-Eastern Indonesia. Ind.Fish Res.J, 15 (1), 17-28.

Dharmadi, Triharyuni, S., & Rianto, J. (2010). Catches of sharks caught with surface gillnets in Indian Ocean waters.J. Lit. Fisheries. Ind, 16(4), 285- 291.

Drew M, White W T, Dharmadi, Harry A V and Huveneer C .2015. Age, growth and maturity of the pelagic thresher Alopias pelagicus and the scalloped hammerhead Sphyrna lewini.Journal of Fish Biology 86 333-354

Fahmi, Dharmadi. 2013. Overview of shark fisheries status and conservation efforts in Indonesia. Directorate of Conservation of Fish Areas and Species, Directorate General of Marine, Coastal and Small Islands. Jakarta. 179 pp.

Feniola Livia, Fika Dewi Pratiwi, and M. Rizza Muftiadi. 2024. Diversity and Conservation Status of Fish Caught in Fixed Gillnet Gear at Sungailiat VAT. Aquatic Journal of Aquatic Resources. Volume 18 Number 1: 35-45.

Ferdiansyah, D., & Hidayat, M. T. (2016). Small-scale fisheries threats to sharks in Sumenep for effective and sustainable management needs. Journal of Agrosains: Creative and Innovative Works, 3(1), 224-233.

Geraghty, P., William, M., and Williamson, J. 2015. Aspects of the reproductive biology of dusky, spinner and sandbar sharks (Family Carcharhinidae) from the Tasman Sea. Marine and Freshwater Research. 10.1071/MF14228.

Hall NG, Bartron C, White WT, Dharmadi, Potter IC. Biology of the silky shark Carcharhinus falciformis (Carcharhinidae) in the eastern Indian Ocean, including an approach to estimating age when timing of parturition is not well defined. J Fish Biol. 2012;80: 1320-1341

Haris Dandi, Dian Sutono HS, M Jamaludin, Robet Perangin-angin, Mula Tumpu.2023. Effect of different depths of tuna handline fishing line on catches at km viona iii based at Cilacap oceanic fishing port, Central Java Province. Barakuda 45 5 (1), 58- 67.

Hehanussa, K. G., Haruna, B. G., Matrutty, D. D. P., & Paillin, J. B. (2023). Environmentally Friendly Capture Fisheries Management for Marine Resource Sustainability.

Hidayat, E. H., Alkadrie, S. I. T., Getreda, G., & Sabri, M. (2019). Diversity of shark and ray species in West Kalimantan waters. Proceedings of Fisheries Research Center, 1(1), 89-95.

Hanifa Irfan, Mulyono S. Baskoro, Sulaeman Martasuganda, Domu Simbolon. 2018. Utilization Level and Conservation Status of Shark Fisheries in Cilacap Ocean Fishing Port (PPS). Journal of Fisheries and Marine Technology Vol. 9 No. 1 Pp: 25- 34

Mardhatillah I, Taurusman A A and Sondita M F A. 2023. Social, economic, and institutional assessments of thresher shark (Alopias pelagicus) fisheries management at Kutaraja Ocean Fishing Port, Banda Aceh: an ecosystem approach IOP Conference Series: Earth and Environmental Science 1137 012060

Martín Aranda. 2017. Description of tuna gillnet capacity and bycatch in the IOTC Convention Area. IOTC-2017-WPEB13-18. available at: https://www.bmis-bycatch.org/system/files/zotero_attachments/library_1/QCFKB893%20.%20Aranda%20%20Description%20of%20tuna%20gillnet%20capacity%20and%20bycatch%20i.pdf Megalofonou P D damalas and G de metrio 2009 Biological characteristics of blue shark Prionace glauca in the Mediterranean Sea Journal of Marine Biological Associationof the United Kingdom, 2009 89(6),1233–1242. https://doi:10.1017/S0025315409000216.

Mohanraj, T. Jebarani Rajathy, S.R.T. Sherly Cross. 2024. Length-weight relationship, condition factor, and diet analysis of thresher sharks (Family: Alopiidae) along the southern coast of India. Fisheries Research.Vol. 277. https://doi.org/10.1016/j.fishres.2024.107067.

Muslim, A., Fitri, A.D., 2019. Sustainability Analysis of Shark Fisheries in Cilacap Regency, Central Java. Journal of Fisheries and Marine, 9(1): 1 - 14.

Novianto Dian, Bram Setyadji, Lilis sadiyah, Fayakun Satriya, Umi Chodrijah, AgustinusA. Widodo, Wudianto, Agung F. Nugroho. 2023. Developing an Abundance Index of Blue Shark From a Handline Fishery in Southern Java Waters Part of Eastern Indian Ocean. IOTC-2023 WPEB19-21. Available at website: https://iotc.org/sites/default/files/documents/2023/08/IOTC- 2023-WPEB19-21_-_abundance_BSH_IDN.pdf

Novianto Dian, Agung F. Nugroho, Raymon R. Zedta.2017. Composition and Abundance of Pelagic Shark Caught by Drift Gillnet in Cilacap Oceanic Fishing Port, Indonesia. IOTC-2016-WPEB12-17. Available at page: https://iotc.org/sites/default/files/documents/2016/08/IOTC 2016-WPEB12-17- Gillnet_Indonesia.pdf.

Palmrose, Kristin K., "Reproductive Biology of the Spinner Shark Carcharhinus Brevipinna, Off Southeast U.S. Coast" (2021). UNF Graduate Theses and Dissertations. 1115. https://digitalcommons.unf.edu/etd/1115

Prihatiningsih, Erfind Nurdin & UmiChodriyah. (2018). Species composition, catch per effort, season and area of shark fishing in the South Indian Ocean waters of Java. J.Lit.Perikan.Ind. Vol.24 No.4 pp: 283-297.

R Core Team. (2023). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL http://www.R-project.org/

Rahardjo P 2007 Utilization and Management of Cucut and Pari (Elasmobranchii) Fisheries in the Java Sea Postgraduate School Bogor Agricultural University Bogor

Reardon, M.B., Gerber, L. & Cavanagh, R.D. 2019. Longfin Mako, Isurus paucus. CMS.Int. https://www.fish.gov.au/docs/SharkReport/FRDC_Isurus_paucus.pdf

Sarah Fowler, Amie, Nicola Okes, Glenn Sant (2021). Conservation, Fisheries, Trade and Management Status of CITES Listed Sharks

Sentosa, A. A. (2017). Biological Characteristics of CITES Appendix II Sharks and Rays Landed in Tanjung Luar, East Lombok. In National Seminar XIV Year of Fisheries and Marine Research Results (Vol. 22).

Sentosa, A. A., Widarmanto, N., Wiadnyana, N. N., & Satria, F. (2016). Differences in shark catches from drift and bottom longlines based in Tanjung Luar, Lombok. J. Lit. Fisheries. Indonesia. 22(2), 105 - 114.

Simeon BM, Baskoro MS, Taurusman AA, Gautama DA. 2015. Feeding Habits of Kejen Shark (Carcharinus falciformis): Case Study of Shark Landing at PPP Muncar, East Java. Marine Fisheries 6: 202-209.

Simeon, B.M, Efin Muttaqin, Ulfah Mardhiah, Muhammad Ichsan, Dharmadi, Andhika Prima Prasetyo, Fahmi, and Irfan Yulianto. 2018. "Increasing Abundance of Silky

Sharks in the Eastern Indian Ocean: Good News or a Reason to be Cautious?" Fishes 3, no. 3: 29. https://doi.org/10.3390/fishes3030029

Simeon, B.M., Ula, S., Supadminingsih, F.N., Muhsin, Muttaqin, E., 2020. Technical Report: data collection on shark and ray landings in Tanjung Luar 2017-2019. Wildlife Conservation Society - Indonesia Program, Bogor, Indonesia.

Stevens JD.2000. Biological observations on sharks caught by sports fishermen off New South Wales. Australian Journal of Marine and Freshwater Research 35, 573-590.

Syahfriliani, L. R., & Sunarsi, D. (2020). Legal protection of shark wildlife trade in Indonesia. SUPREMASI: Journal of Law, 3(1), 76-85.

Wahyuni, A. P. (2023). Conservation Status of Sharks Traded Outside Makassar City (Case Study: Sharks Based on Identification at the Makassar Coastal and Marine Resources Management Center). Tarjih Fisheries and Aquatic Studies, 3(2), 62-73.

White, W.T., P.R. Last, J.D. Stevens, G.K. Yearsley, Fahmi & Dharmadi. (2006). Economically important sharks and rays of Indonesia. ACIAR Monograph Series; no. 124. (Australian Center for International Agricultural Research, Canberra. 329 Yahyah, Ismawan T, Paulus C A, Aludin A A, Hadjrah A and Muhammad S A 2023.

Fishing Technology of the "Bando" Handline and the Composition of Catches in the South Waters of Ende Regency of East Nusa Tenggara Province, Indonesia Russian Journal of Agricultural and Socio-Economic Sciences 134 208-18.

Yusrina, F., Atkhiyah, V. M., & Afkarina, I. (2019). Impact of Processing and Consumption of Shark Fin Soup. Journal of Food Technology and Agroindustry, 1(2), 31-36.)

Zuhri, A. B., Maulana, D. I., & Maheswara, E. S. (2022). Optimization of Image Classification on Shark Fish with Convolutional Neural Network Method and Data Augmentation. Tika Journal, 7(1), 1-11.

Zhu, J.; Geng, Z.; Zhu, J.; Richard, K. Reproductive Biology and Distribution of the Blue Shark (Prionace glauca) in the Western Indian Ocean. 2023. Biology, 12, 1128. https://doi.org/10.3390/ biology12081128