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DIVERSITY, DISTRIBUTION AND CONSERVATION STATUS OF SHARK SPECIES FROM THE WATERS OF LANGKAI ISLAND, SPERMONDE ARCHIPELAGO

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ABSTRACT

Sharks as top predators in marine waters have important role in balancing the ecosystem, however they were suffering from high overfishing fishery. The study was conducted to identify species composition and sex determination observed sharks as well as mapping their distribution, and to define interviewed by-catch sharks into their conservation status based on the IUCN Red List. This research was carried out in April 2021 in the adjacent waters of Langkai Island, Spermonde Archipelago. A survey method was carried out to gather fisheries data and biological aspects of catches in 11 trips, as well as conducting interviews as secondary data needs. There were 20 individuals of identified shark with a length range of 58-131 cm, and within composition of five species: Chiloscyllium punctatum (45%), Triaenodon obesus (25%), Carcharhinus melanopterus (20%), C. falciformis (5%), and C. sealei (5%). The female sharks composition was higher (65%) than male ones (35%). The observed sharks were fished in the adjacent water of Langkai Island within distances of 0.20-8.25 km to the southwest of the island. Meanwhile, there had been 12 species of by-catch sharks from the fishermen interviews, which were classified into conservation status of Near Threatened (58%), Vulnerable (17%), Endangered (17%), and Critically Endangered (8%).

Keywords: sharks, species composition, sex determination, distribution, conservation status, Langkai Island, Spermonde

INTRODUCTION

Indonesia has the highest level of endemism in the world, referring to the complex geological history in the Indonesian region. The diversity of marine biota species such as bony fish and cartilaginous fish (Elasmobranchii) in Indonesia is very huge (White *et al.*, 2006). As well, Indonesia has the largest waters among countries that produce sharks. Its territorial waters cover 3.1 million km², and if combined with the ZEE, the area becomes 5.5 million km². Meanwhile, India, as the second largest shark-producing country after Indonesia, has territorial waters that do not reach half the size of Indonesia's waters. The diversity of sharks in Indonesia is quite varied, where out of 200 shark species in the world, 118 species have been identified in Indonesia (Sadili, 2013).

In 1987, shark fisheries production in Indonesia amounted to 36,884 tons, which then increased to double, reaching 68,366 tons in 2000, resulting in a decrease in shark population (Mawan, 2019). In 2018, the FAO recorded more than 110,000 tons in recent years from Indonesia. Indonesia is not the only supplier of processed shark products in Asia, amongst 17 countries. For a decade (2000-2010), the Wildlife Trade Monitoring Network (TRAFFIC) reported that Indonesia became the highest levels of shark exploitation in the world, while Taiwan was recorded by the FAO as the largest importer of shark products. In the eastern part of Indonesia, from 2015 to 2018, BPSPL Makassar recorded 189,102 kg of non-appendix shark products from various species that had been licensed for export to consumer countries.

Sharks, as apex predators in marine waters, act as regulators of the ecosystem and are also as fish that are very vulnerable to the impacts of excessive fishing. Shark species groups have slow growth and take a long time, even decades, to reach adulthood and reproduce (Stevens *et al.*, 2000). In addition, the number of offspring produced each year is relatively low compared to other economically valuable fish groups. Furthermore, the decline in shark populations is mostly caused by human actions such as overexploitation. The International Union for Conservation of Nature (IUCN) had established the Shark Specialist Group (SSG) in 1991, as part of the Species Survival Commission and as a mediator for shark conservation activists. The preparation of reports on the status of cartilaginous fishes worldwide has been carried out by reviewing population status and shark fisheries status, as well as assigning conservation status both regionally and globally for selected shark species. In addition, this commission provides assessments based on the condition of species that are currently or may be threatened (Camhi *et al.*, 1998).

The presence of shark communities in a fishing area needs to be known to obtain information about the distribution of their populations. The abundance of shark species varies since some shark species occupy very wide habitats and can be found in almost all types of waters depending on depth, habitat, and geographic conditions (Last & Compagno, 2002). Information about the distribution of the diversity of several shark species is important for the management of shark resources in Indonesia, as it can be used to mapping water areas that are potentially suitable as fishing grounds, which will later be useful for their management, hence shark production remains sustainable and continuous.

The waters of Langkai Island cover an area of more than 27 ha and are surrounded by a coral reef area of 142 ha (Subhan, 2019). The selection of this research area was based on several information regarding sharks that are often encountered and even become bycatch for fishermen, specifically in adjacent waters of Langkai Island, which is part of the Spermonde Islands group. Information from interviews with fishermen in Makassar City indicated that on average, the sharks landed at PPI Paotere come from the outer island waters of Makassar City, especially the waters around Langkai Island, which is about 36 km from the coast of Makassar City. All sharks considered as bycatch. Subhan (2019) monitored during April and May 2019, in which a total of 459 sharks of various species were recorded, e.g. *Carcharhinus albimarginatus*, *C. amblyrhynchos*, *C. brevipinna*, *C. falciformis*, *C. limbatus*, *C. melanopterus*, *C. sealei*, *C. sorrah*, *Chyloscyllium punctatum*, *Galeocerdo cuvier*, *Prionace glauca*, *Sphyrna zygaena*, and *Triaenodon obesus*. This research was taken to obtain species composition, sex determination, and their distribution area from adjacent Langkai Island waters, as well as their conservation status.

MATERIALS AND METHODS

This research was conducted in April 2021 in adjacent waters of Langkai Island, Spermonde Archipelago, South Sulawesi. The equipment used included were writing instruments, identification books, de-hooker, GPS, towels/wet cloths -to cover shark's eyes to keep it calm during data collection, camera, protective gloves, laptop/PC, measuring tape, boat, and longline or net/trawl.

Observations were conducted through direct surveys of vessels engaged in shark fishing (both bycatch and targeted). Data collection was carried out by reviewing three aspects: (1) The fishery data collection aspect, which involves determining or taking the catch's coordinate points either directly or indirectly (depending on field conditions), (2) The biological aspect of the catch, which includes species identification, visual determination of sex, and morphometric measurements, and (3) The aspect of specific data needs through interviews in the form of open questionnaires, to obtain general information regarding the types of sharks that have been caught by fishermen from Langkai Island.

Determination of the conservation status of recorded sharks was adjusted based on the Red List categories established by the IUCN through its official website. The shark catch distribution map was created using ArcGIS software through the digitization stage, which was a process of converting analog data into digital format, and the layouting stage, which was the process of creating thematic maps. The data analysis stage in the form of data tabulation from identification resulted in Microsoft Excel. The calculation to obtain the percentage of species and sex of sharks was based on a modification of Odum's (1971) formula:

$$Pi = \frac{ni}{N}$$

Note:
Pi = proportion of the i-th species, proportion of sex determination;
ni = number of individuals of the i-th species, number of individuals based on sex determination;
N = total number of individuals.

RESULTS AND DISCUSSION

General Overview of the Site

The observation sites in adjacent waters of Langkai Island were determined from the general fishing areas of the island's fishermen. There were 11 identified trips where shark objects were found, where the fishing points located in the neritic zone. This zone has higher abundance and diversity of biota compared to the oceanic zone, due to the more dynamic conditions, abundant nutrients making it more fertile, and sunlight penetrating the water column allowing photosynthesis doing well, thereby producing food for other biota (Yulianda, 2009).

Composition of Species and Sex Determination

The total number of individual sharks caught by fishermen of Langkai Island was 20, as identified into 5 species (4 species from the family Carcharhinidae, 1 species from the family Hemiscylliidae) (Table 1). The total length of the catch ranged from 58-131 cm, with 13 females and 7 males, with clasper lengths ranging from 3-14 cm (Table 2).

Table 1. Taxonomy of sharks identified from the waters of Langkai Island.

Order	Family	Genus	Species
Carcharhiniformes	Carcharhinidae	*Carcharhinus*	*Carcharhinus falciformis*
			Carcharhinus melanopterus
			Carcharhinus sealei
		Triaenodon	*Triaenodon obesus*
Orectolobiformes	Hemiscylliidae	*Chyloscillium*	*Chiloscyllium punctatum*

Table 2. Sex determination and morphometric data of sharks identified from the waters of Langkai Island.

No.	Species	Sex Determination	Total Length (cm)	*Clasper*	
				Length (cm)	Condition
1.	*Carcharhinus falciformis*	Female	119	-	-
2.	*Carcharhinus melanopterus*	Female	92	-	-
3.	*Carcharhinus melanopterus*	Male	65	3	I
4.	*Carcharhinus melanopterus*	Female	90	-	-
5.	*Carcharhinus melanopterus*	Male	131	14	III
6.	*Carcharhinus sealei*	Female	80	-	-
7.	*Chyloscillium punctatum*	Male	63	4	I
8.	*Chyloscillium punctatum*	Female	73	-	-
9.	*Chyloscillium punctatum*	Female	69	-	-
10.	*Chyloscillium punctatum*	Female	75	-	-
11.	*Chyloscillium punctatum*	Male	79	3	I
12.	*Chyloscillium punctatum*	Male	68	4	I
13.	*Chyloscillium punctatum*	Female	68	-	-
14.	*Chyloscillium punctatum*	Female	58	-	-
15.	*Chyloscillium punctatum*	Female	83	-	-
16.	*Triaenodon obesus*	Female	113	-	-
17.	*Triaenodon obesus*	Male	110	9	II
18.	*Triaenodon obesus*	Female	102	-	-
19.	*Triaenodon obesus*	Male	72	6	I
20.	*Triaenodon obesus*	Female	96	-	-
	Length range	=	58-131 cm		

Of the total identified shark individuals, the most dominant species was *Chiloscyllium punctatum* from the family Hemiscylliidae at 45%, while the remaining 55% came from the family Carcharhinidae with the largest percentage was *Triaenodon obesus* (25%), followed by *Carcharhinus melanopterus* (20%), whereas *C. falciformis* and *C. sealei* were the least caught species (5%) (Fig. 1).

Sexually, sharks are dimorphic (male sharks are different from female ones). Of the total sharks whose sex was determined, 65% were female and 35% were male (Fig. 2). In general, the female was determined in all species, while the male was not determined in *Carcharhinus falciformis* and *C. sealei*. The most females found were *Chiloscyllium punctatum* (6 individuals), as well as the most males in the same species (3 individuals) (Fig. 3).

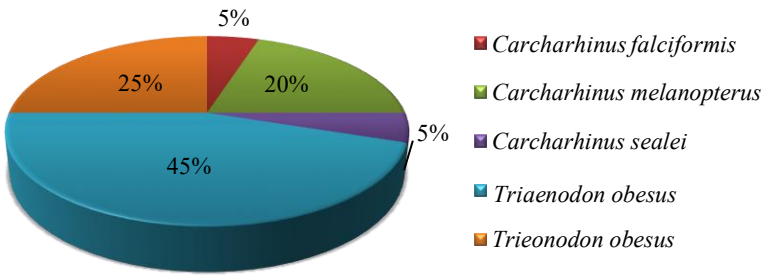

Figure 1. The composition of shark species identified from the waters of Langkai Island.

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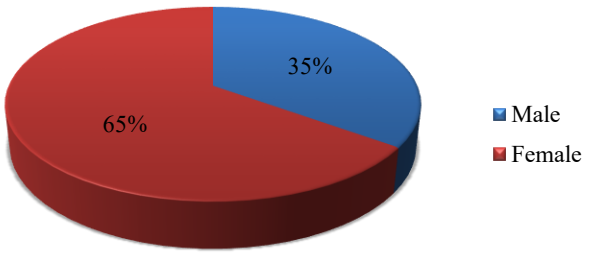

Figure 2. The composition of male and female sharks caught in the waters of Langkai Island.

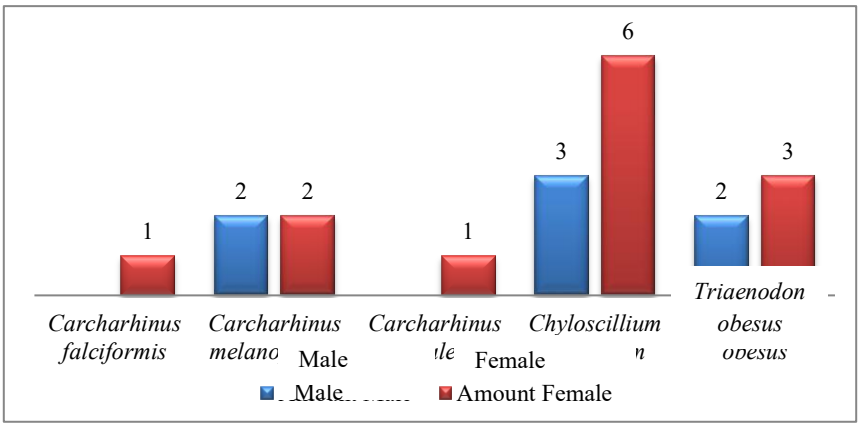

Figure 3. Composition of sex determination based on species.

Distribution of Caught Sharks

Sharks caught as by-catch by fishermen on Langkai Island have a distribution in the neritic zone with a expendable radius. Sharks have a wide area distribution; some shark species live on the continental shelf, ranging from tidal areas to depths of 200 m; the continental slope areas ranging from 200 meters to more than 2000 meters; some also live freely in the open ocean (oceanic) or inhabit various types of habitats, depending on the adaptation patterns and behavior of specific shark species (Last & Compagno, 2002).

The observed of 20 individual sharks of 5 species were within a range of 0.20-8.25 km from the coast of Langkai Island, heading southwest of the island. One Carcharhinus falciformis shark was caught at a distance of about 1.47 km from the shore of Langkai Island (Fig. 4). This type of shark is oceanic and pelagic, but generally it is more commonly found in offshore waters near land and in layers close to the surface, although it has been found at depths of up to 500 meters. The maximum length of this species of shark can reach up to 350 cm. Male sharks reach adulthood at a total length of 183-204 cm, while females reach at 216-223 cm (White et al., 2006).

Four Carcharhinus melanopterus sharks were found at distance range 0.27-1.85 km from the shore of Langkai Island (Fig. 4). In general, this species usually inhabits shallow waters, including tropical coral reef areas. Their body length can reach up to 140 cm and is even estimated to reach 180 cm. At birth, the shark has a size of 48-50 cm. Adult male sharks have a length range of 98-113 cm, and adult female sharks have a length range of 96-120 cm (White et al., 2006). There was one Carcharhinus sealei at a distance of 0.80 km from the coastline of Langkai Island (Fig. 4). Generally, this species lives on the seabed of coastal waters and is distributed in tropical waters ranging from areas near the shore to depths of 40 meters. The body length can reach 95 cm, and the size at birth ranges from 33-36 cm. Adult male fish measure more than 80 cm, while adult female sharks range from 68-75 cm (White et al., 2006).

There were nine Chyloscillium punctatum sharks with radius range of 0.20-5.55 km (Fig. 4). In general, this species is usually found at the bottom of the waters, including coral reefs and seagrass beds, and is distributed in tidal areas up to a depth of 85 m. The body length can reach 121 cm, with adult male sizes ranging from 67-70 cm.

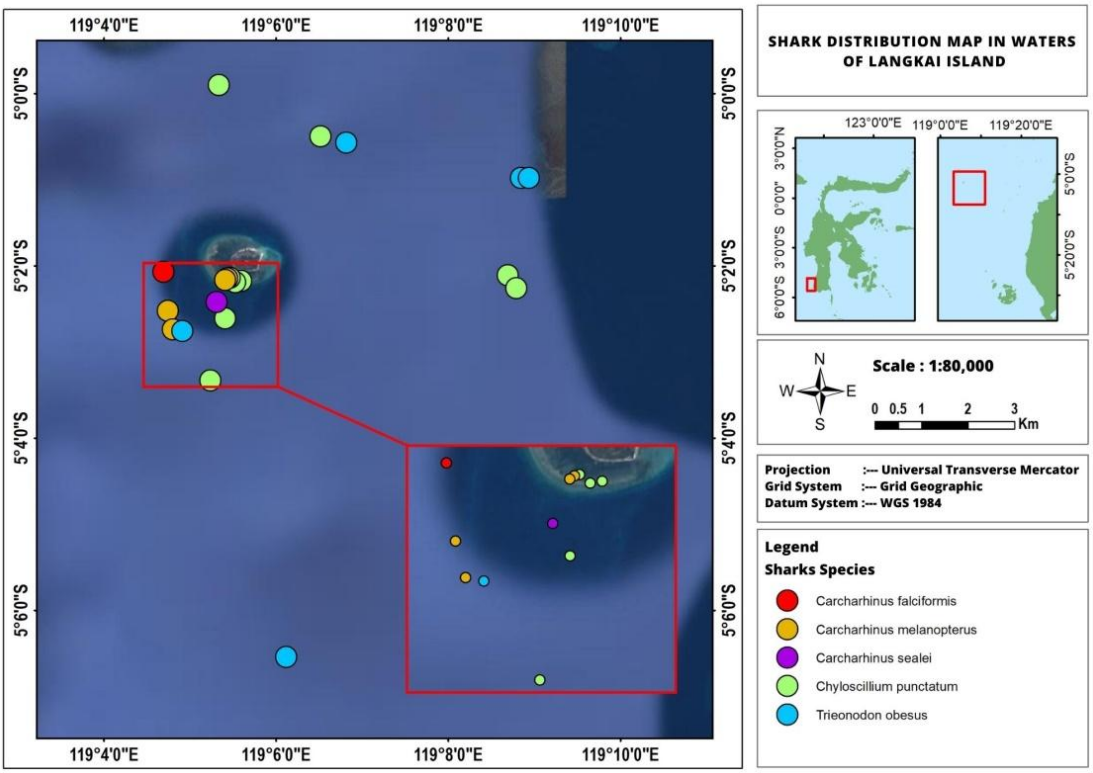

Figure 4. Map of the distribution of sharks caught in adjacent waters of Langkai Island, Spermonde Archipelago.

There were nine *Chyloscillium punctatum* sharks with radius range of 0.20-5.55 km (Fig. 4). In general, this species is usually found at the bottom of the waters, including coral reefs and seagrass beds, and is distributed in tidal areas up to a depth of 85 m. The body length can reach 121 cm, with adult male sizes ranging from 67-70 cm.

There were 5 individuals of the species Triaenodon *obesus*, with a distribution radius range of 2.94-8.25 km from the coastline of Langkai Island (Fig. 4). Generally, this species lives in areas near the seabed, such as crevices or holes in coral reef areas with clear water at depths ranging from 1 to 40 meters, although they have been found at depths of 330 meters. Their body length can reach up to 200 cm. At birth, this species measures between 52-60 cm, and as adults, male and female sharks have a size range of 105-120 cm (White *et al.*, 2006).

Species Assumptions and Conservation Status

Based on interviews with fishermen who catch sharks as by-catch, there were at least 13 shark species that had appeared or been caught in adjacent waters of Langkai Island, e.g. *Alopias superciliosus*, *Carcharhinus amblyrhynchos*, *C. falciformis*, *C. limbatus*, *C. melanopterus*, *C. sealei*, *C. sorrah*, *Chiloscyllium punctatum*, *Galeocerdo cuvier*, *Rhincodon typus*, *Sphyrna* sp, and *Triaenodon obesus*. They belong to five families, consisting of 1 species from the Alopidae, 8 species from the Carcharhinidae, 1 species from the Hemiscylliidae, 1 species from the Rhincodontidae, and 2 species from the Sphyrnidae (Table 3). The Carcharhinidae is the group of sharks that most commonly found and has the greatest diversity of species (White *et al.*, 2006), contributing about 14% of the total number of shark and ray species found in Indonesia or about 27% of the total number of shark species existed in Indonesia.

The Shark Specialist Group (SSG), established by the International Union for Conservation of Nature (IUCN), continuously assesses the population and fishery status of sharks, as well as assigns conservation status. From the information on shark species that are commonly seen or caught as by-catch on Langkai Island, they can be grouped into four of the nine Red List categories published by the IUCN, with most of the species caught (58%) already categorized as Near Threatened (Fig. 5).

Table 3. The shark species stated from fishermen interviews in Langkai Island, and their conservation status.

No.	Species	Family	Conservation Status (IUCN)	Year
1.	*Alopias superciliosus*	Alopiidae	*Vulnerable – VU*	2018
2.	*Carcharhinus amblyrhynchos*	Carcharhinidae	*Endangered – EN*	2020
3.	*Carcharhinus falciformis*	Carcharhinidae	*Endangered – EN*	2017
4.	*Carcharhinus limbatus*	Carcharhinidae	*Near Threatened – NT*	2005
5.	*Carcharhinus melanopterus*	Carcharhinidae	*Vulnerable – VU*	2020
6.	*Carcharhinus sealei*	Carcharhinidae	*Near Threatened – NT*	2003
7.	*Carcharhinus sorrah*	Carcharhinidae	*Near Threatened – NT*	2007
8.	*Chiloscyllium punctatum*	Hemiscylliidae	*Near Threatened – NT*	2015
9.	*Galeocerdo cuvier*	Carcharhinidae	*Near Threatened – NT*	2018
10.	*Rhincodon typus*	Rhincodontidae	*Endangered – EN*	2016
11.	*Sphyrna lewini*	Sphyrnidae	*Critically Endangered – CR*	2018
12.	*Sphyrna mokarran*	Sphyrnidae	*Critically Endangered – CR*	2018
13.	*Triaenodon obesus*	Carcharhinidae	*Vulnerable – VU*	2020

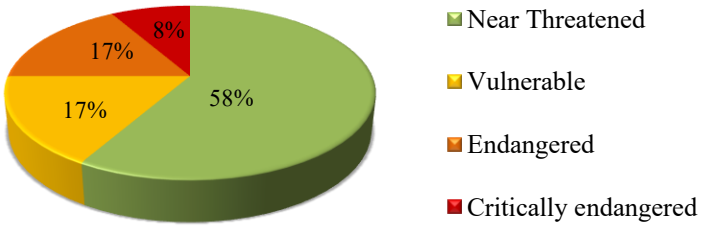

Figure 5. The conservation status of 12 shark species encountered in the adjacent waters of Langkai Island.

Subjected to the species *Alopias superciliosus*, the SSG-IUCN had conducted assessments twice, first in 2009 with a status of Vulnerable, and nine years later in 2018 the second was conducted with the remaining same status (Rigby *et al.*, 2019a).

The species Carcharhinus amblyrhynchos had been assessed three times, first in 2000 with a conservation status of Near Threatened, second in 2009 with the category still remaining at Near Threatened, but third in 2020 reported an increased status category of Endangered (Simpfendorfer et al., 2020a). The species C. falciformis had been assessed four times, first in 2000 with a conservation status of Least Concern, second in 2009 with the category increasing status to Near Threatened, third in 2016 with the status remaining at Near Threatened, and fourth in 2017 increasing status to Endangered (Rigby et al., 2017).

The species Carcharhinus limbatus had been assessed three times, first in 1996 with a conservation status of Vulnerable, second in 2000 when the status category dropped to Near Threatened, and third in 2005 remaining in the status of Near Threatened (Burges & Branstetter, 2009). The species C. melanopterus had been assessed three times, first in 2000 with a conservation status of Near Threatened, second in 2009 with still remaining status, but third in 2020 had increasing category to the status of Vulnerable (Simpfendorfer et al., 2020c).

The species Carcharhinus sealei had been assessed only once, which was in 2003 with a conservation status of Near Threatened (White, 2003). Similarly, the species C. sorrah had been assessed once, which was in 2007 with the same conservation status of Near Threatened (Pillans et al., 2009).

The species Chiloscyllium punctatum had been assessed twice, first in 2003 with the status of Near Threatened, and over a span of twelve years (2015) was reassessed with the status category remaining at Near Threatened (Dudgeon et al., 2016). The species Galeocerdo cuvier species has been assessed three times, first in 2000 with a conservation status of Near Threatened, whilst the second in 2009 and the third in 2018, the category remaining at status of Near Threatened (Ferreira & Simpfendorfer, 2019).

The species Rhincodon typus had been assessed six times, the first time in 1990 with a conservation status of Indeterminate, the second in 1994 remaining in the Indeterminate status, the third time in 1996 with a status category of Data Deficient, the fourth in 2000 rising to status of Vulnerable, the

fifth time in 2005 still remaining Vulnerable, and the sixth in 2016 increasing status to Endangered (Pierce & Norman, 2016).

The species Sphyrna lewini had been assessed three times, the first in 2000 with a conservation status of Near Threatened, the second in 2009 with an increased category to Endangered, and the third in 2018 increased again to Critically Endangered (Rigby et al., 2019c). The species S. mokarran had also been assessed three times, first in 2000 with a conservation status of Data Deficient, second in 2007 when it was raised to status of Endangered, and third in 2018 when it was further raised to the status of Critically Endangered (Rigby et al., 2019b). And the last listed species was Triaenodon obesus which had been assessed three times, the first in 2000 with a conservation status of Near Threatened, the second in 2009 with the category still remaining at Near Threatened, and the third in 2020 increasing to the status of Vulnerable (Simpfendorfer et al., 2020b).

CONCLUSION

There were 20 individuals of identified shark with a length range of 58-131 cm, and within composition of five species: *Chiloscyllium punctatum* (45%), *Triaenodon obesus* (25%), *Carcharhinus melanopterus* (20%), *C. falciformis* (5%), and *C. sealei* (5%). The female sharks composition was higher (65%) than male ones (35%). The observed sharks were fished in the adjacent water of Langkai Island within distances of 0.20-8.25 km to the southwest of the island.

There had been 12 species of by-catch sharks from the fishermen interviews, which were classified into conservation status of Near Threatened (58%), Vulnerable (17%), Endangered (17%), and Critically Endangered (8%).

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