



CATCH COMPOSITION AND SOME BIOLOGICAL ASPECTS OF SHARKS IN WESTERN SUMATERA WATERS OF INDONESIA

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ABSTRACT

This study was conducted in western Sumatera and since October 2013 to June 2014. The sampling locations in Banda Aceh and Sibolga-North Sumatera which were the largest base of fisheries in western Sumatera region. Shark landing recorded by enumerators was used as sampling data daily. This research aim to describ sex ratio, size composition, catch composition of sharks, and length at first maturity. In Banda Aceh, the sharks as target fish collected by sorting the bycatch from tuna longlines and tuna handlines. In Sibolga, sharks is bycatch from fish net, bottom gillnet and purse seine. Overall, there were 20 species of shark caught in west Indian Ocean and landed at those fish landing sites, dominated by Spot tail shark (23%) and Silky shark (13%), whereas Hammerhead shark contributed about 10% and Oceanic whitetip shark was only less than 1%. Almost of Spot tail shark, Silky shark, and Scalloped hammerhead that caught in that area were immature, while for the almost part of Tiger shark and Pelagic thresher were matured. The sex ratios for Spot tail shark, Silky shark, Tiger shark, Pelagic thresher, and Scalloped hammerhead caught and landed at Lampulo and Sibolga fish landing sites were not balance. The length at first maturity for Spot tail shark was $L_m=87,1$ cm and $L_m = 213,2$ cm total length for Tiger shark.

Keywords : Sharks; biology; fisheries; Western Sumatera

INTRODUCTION

Indonesia is the largest country in Southeast Asia, where shark and ray commodities have an important role. Especially, for shark fin trade. FAO data indicate that Indonesia is the largest shark producer in the world (Lack & Sant, 2009), contributing around 12.3% of total world production. However, shark production in Indonesia only contributes about 2% of the total marine fishery production. The Indonesian production of shark has shown a significant decrease in last two decades. It was recorded at 46.125 tonnes in 1991 and 42.036 tonnes (2012), but shark production increased to be 52.268 tonnes in 2013 (DGCF, 2014) and then decreased to be 49.020 tonnes (DGCF, 2015). Eventually, intensive shark fishing is likely to lead to depletion of Indonesia's shark populations, a pattern that is becoming apparent with the decreasing abundance and size of the sharks in the landings (Fahmi & Dharmadi, 2013). Despite many years of international concern about the depletion of shark populations globally (including in Indonesia), with

growing evidence that several species are endangered, populations continue to decline, which is due largely to ineffective fisheries management, lack of enforcement and/or poor implementation of existing regulations (Bonfil, 2002; Lack & Sant, 2006; Fahmi & Dharmadi, 2013). Shark fishing activities in Indonesia were mostly occurred as a bycatch (72%) and only 28% were done as a targeted fishery (Zainuddin, 2011). In Indonesia, the most potential of shark fisheries region is Indian Ocean.

The shark fisheries region in western Sumatera contributed about 12.3% for national shark production (DGCF, 2013). Large contribution of captured shark was mostly from Banda Aceh and Sibolga, North Sumatera. Sharks landed in Lampulo-Banda Aceh are the catch of shark longline and as by catch from tuna long line and tuna hand line. Whilst in Sibolga, sharks as by catch were obtained by fish net, bottom gillnet and purse seine. There is a little information about biology and shark fisheries that landed at West Sumatera. The main aim of this paper is to provide

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on species, size compositions, length frequency, sex ratio, and length at first maturity for both of Spot tail shark and Tiger shark from West Sumatera waters.

MATERIALS AND METHODS

This study were conducted since October 2013 to June 2014 at two fish landing sites, there were Lampulo-Banda Aceh and Sibolga-North Sumatera. The map of study areas has been shown in Figure 1. The shark landing recorded by enumerators was used sampling data daily. To avoid identification errors of this study, the enumerators also attached shark species photos which they are measured for cross checked in daily data collection form. The number of individuals of each species landed, their sex and their total length (TL) were recorded. In the case of males, the outer length of the clasper (LC), taken from lateral junction with pelvic-fin inner margin and apex of clasper, and its level of calcification, i.e. non-calcified, partially calcified or fully calcified, were recorded (where possible). The Length at first maturity (Lm) of males was calculated by *Carcharhinus sorrah* and *Galeocerdo cuvier*, the only species with adequate number of males with claspers measured. Individuals with either non-calcified or partially calcified claspers were considered immature (juvenile-young), while those with fully calcified claspers were considered mature (adult). (Fig. 2).

Estimation of the proportion of clasper mature were estimated using the following formula:

$$P_{mi} = \sum \frac{j_m}{j_m + j_i} \times 100\%$$

where :

P_{mi} = Proportion of mature fish at each length group;

J_m = Numbers of mature fish at each length group;

J_i = Numbers of immature fish at each length group

Proportion of clasper mature at each length group then plotted as Y-axis while length groups as X-axis using S-shape curve. *Generalized Linear Model (GLM)* was used to estimate length at 50% maturity. Slope value (*b*) from the model was recognize as the Length at first maturity (Lm), R statistical tool was using analysis (King, 2007).

RESULTS AND DISCUSSION

Results

Species Composition

Total of 2,986 individual sharks, comprising 20 species and belonging to 10 families, were recorded at two main landing sites, Banda Aceh and Sibolga–western Sumatera October 2013 to June 2014 (Table 1).

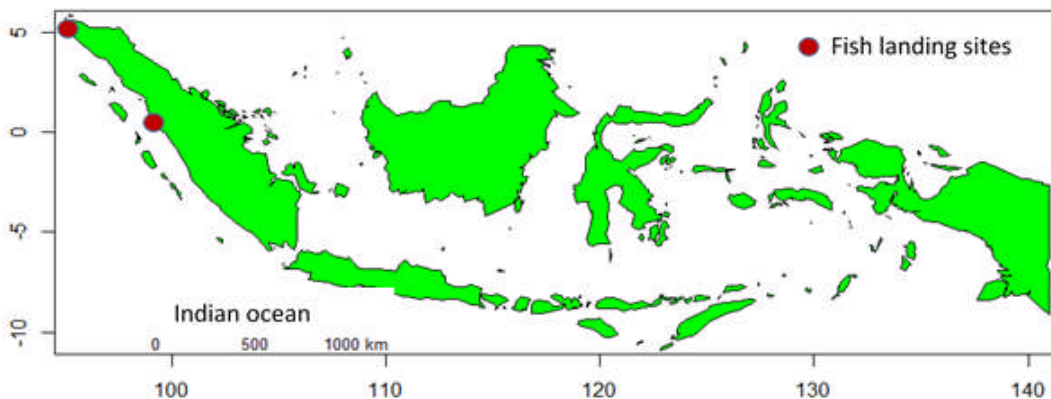


Figure 1. Map showing the study area in the western part of Sumatera

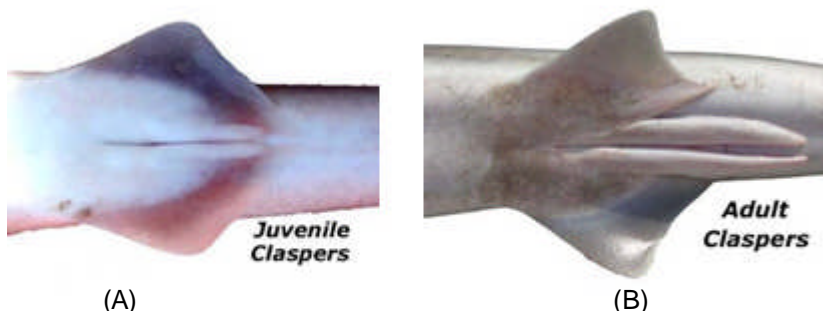


Figure 2. Clasper condition with non or partially calcified (A) and fully calcified (B)

Table 1. Species composition and size of shark caught from western Sumatera waters.

Scientific name	Common name	Number (ind.)	% by number	Min.size (cm)	Max.size (cm)
Carcharhinidae					
<i>Carcharhinus sorrah</i>	Spot-tail shark	683	22.8	54	152
<i>C. falciformis</i>	Silky shark	404	13.5	56	234
<i>C. brevipinna</i>	Spinner shark	44	1.5	-	-
<i>C. melanopterus</i>	Blacktip reef shark	8	0.3	80	157
<i>C. longimanus</i>	Whitetip shark	6	0.2	129	197
<i>C. leucas</i>	Bull shark	230	7.7	102	330
<i>C. altimus</i>	Bignose shark	19	0.6	-	-
<i>Galeocerdo cuvier</i>	Tiger shark	173	5.8	95	350
<i>Triaenodon obesus</i>	Whitetip reef shark	1	0.03	-	-
<i>Scoliodon laticaudus</i>	Spadenose shark	325	10.8	30	65
Sphyrnidae					
<i>Sphyrna lewini</i>	Scalloped hammerhead	291	9.7	39	270
Triakidae					
<i>Hemistriakish sp.</i>	Indonesian houndshark	139	4.6	-	-
Lamnidae					
<i>Isurus paucus</i>	Longfin shark	46	1.5	80	210
Alopiidae					
<i>Alopias pelagicus</i>	Pelagic thresher	151	5.4	143	300
Stegostomatidae					
<i>Stegostoma fasciatum</i>	Zebra shark	52	1.7	193	231
Hemicyllidae					
<i>C. punctatum</i>	Brownbanded bambooshark	159	5.3	67	113
Squalidae					
<i>Squalus nasutus</i>	Western longnose spurdog	250	8.3	48	65
Orectolobidae					
<i>Orectolobus ornatus</i>	Indo wobbegong	6	0.2	71	101
Gynglymostomatidae					
<i>Nebrius ferrugineus</i>	Tawny nurse shark	12	0.4	80	305
Total		2986	100		

The first dominant family shark landed was carcharhinidae, which is about 63,1 % for total number of sharks recorded and the second dominant Sphyrnidae which is contribute about 10% (Fig.3). In this study, several species recorded were estimated in Appendix II of CITES, Hammerhead shark (*Sphyrna* spp) and Whitetip shark (*C.longimanus*). However C.

longimanus made up less than 1 % of the total catch landed at two main landings sites in western Sumatera.

There were three types of fishing gear operated in western Sumatera, which potentially captured sharks and rays as bycatch. Those were tuna longline, bottom gillnet and handline.

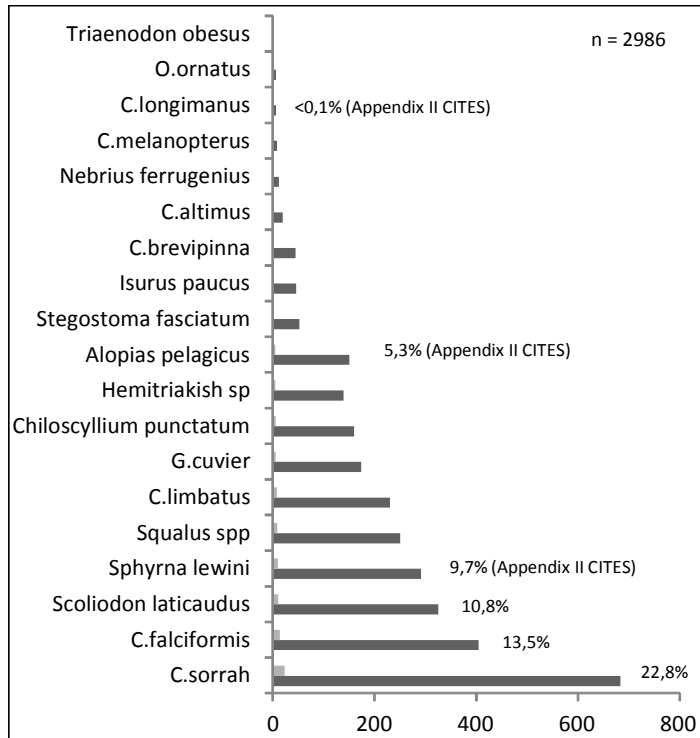


Figure 3. Species composition of shark landed at West Sumatera.

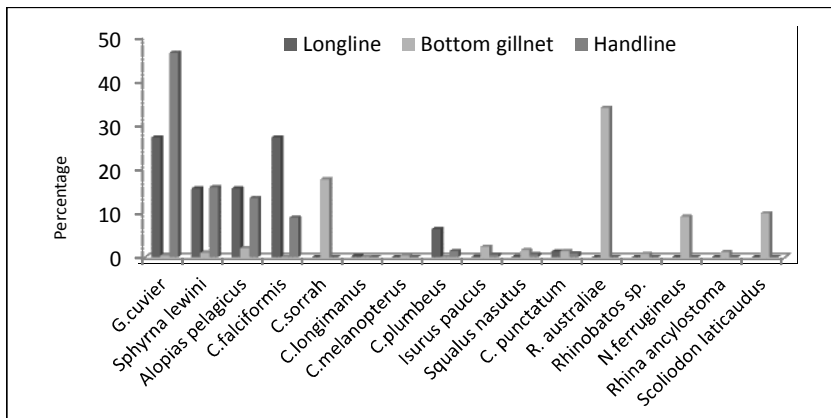


Figure 4. Catch composition of shark and ray based on fishing gear.

The species composition of shark that was caught by tuna longline and handline have similarities domination. They were dominated by tiger shark (*Galeocerdo cuvier*), Scollape hammerhead (*Sphyrna lewini*), thresher sharks (*Alopias spp*) and Silky shark (*Carcharhinus falciformis*) (Fig.4). The percentage of each species caught by tuna longline were 27.2%, 15.6%, 15.6% and 27.2%, and for the handline were 46.4%, 15.9%, 13.4% and 9%, respectively. However, the catches of bottom gillnet were dominated by whitesspotted guitarfish, *Rhynchobatus australiae* (33.9), Spot-tail shark, *Carcharhinus sorrah* (17.7%), and Tawny nurse shark, *Nebrius ferrugineus* (9, 2%) respectively.

Size Composition

The dominant size composition of sharks landed at the two fish landings sites (Sibolga and Lampulo) is presented in Fig. 5. The size compositions of each species were:

Family Carcharhinidae : Total of 193 *C. sorrah* was recorded, which 87 were females and 106 males. Females and males length ranged from 57 to 115 cm and 54 to 119 cm, respectively [Fig. 5(a)]. Based on the figure, there were at least three age groups both of males and females and they have the same size pattern. The males and females in the age group of

50-70 cm, 71-90 cm and the total length including the young group, and in the cohort between 91-120 cm total length is a adult group. White *et al.* (2006) mentioned that length size of spot- tail shark (*C.sorrah*) can attains at least 160 cm; males mature at 103–115 cm and females at 110–118 cm.

Total recorded of *Galeocerdo cuvier* were 102 which 57 were females that have length ranged 103–350 cm and 45 were males that have length ranged 145 -344 cm[Fig. 5(b). The males and females in the age group of 145-344 cm cm, and 103-350 cm total length, respectively [(Fig.5(b)). Total of 87 Silky shark (*C.falciformis*) were recorded, of which 37 were female and 25 males. The males and females in the age group of 43-44 cm and 65-165 cm total length, respectively [(Fig.5(c)).

Family Sphyrnidae : Total of 208 *Sphyrna lewini* was recorded, which 123 were females and 85 males. Females and males measured from 83 to 270 cm and 38 to 218 cm total length, respectively [Fig. 5(d)]. The males and females between the age group of 40-140 cm total length including the young group, and in the age group of 141- 280 cm total length is a adult group.

Family Alopiidae: Total of 62 *A. pelagicus* were recorded, which 37 were females and 25 were males. Females and males measured from 182 to 295 cm and 245 to 300 cm total length, respectively [Fig. 5(e)]. A study of this species from Indian ocean on the length frequency of male *Alopias pelagicus* showed that the lowest size range of 150-170 cm total length (*immature*) and the highest frequency was at range between 251-270 cm total length with 260 cm mode (*mature, non reproductive*).

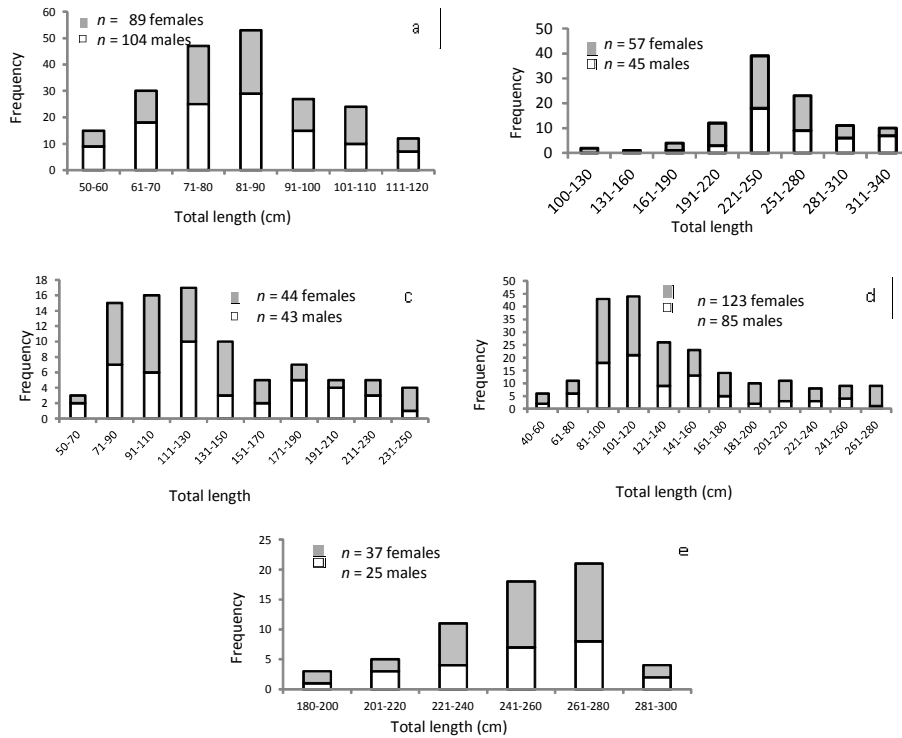


Figure 5. Frequency length of *Carcharhinus sorrah* (a), *Galeocerdo cuvier* (b), *Carcharhinus falciformis* (c), *Sphyrna lewini* (d), and *Alopias pelagicus* (e).

Sex Ratio

One of the success factors of fish reproduction in maintaining the population is by determining sex comparison or sex ratio. In this study, sex ratios of *Carcharhinus falciformis*, *C. sorrah*, *Galeocerdo*

cuvier, *Alopias pelagicus*, and *Sphyrna lewini*, were 1: 1,7; 1,3:1; 1:1,6; 1:1,9, and 1:1,6, respectively (Fig.6). In general the sex ratios for those shark species landed at Lampulo and Sibolga landings sites in October 2013 to June 2014 were not in balance.

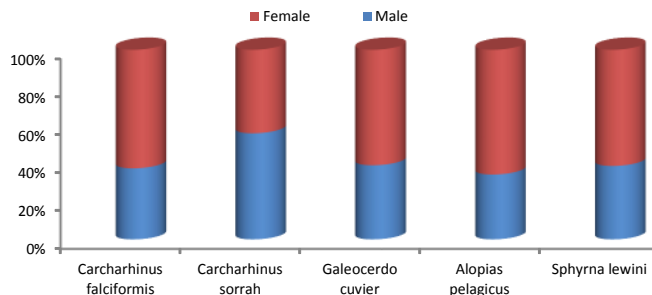


Figure 6. Sex ratio of *C. falciformis*, *C.sorrah*, *Galeocerdo cuvier*, *Alopias pelagicus*, and *Sphyrna lewini*.

Carcharhinus sorrah : This species is a commonly caught in west Indian ocean landed at West Sumatera. In this study the length at first maturity (Lm) of Spot-tail shark were found in size 87,1 cm (Fig. 7a).

Galeocerdo cuvier : In west Sumatera, this species was caught by longline and contribute about less than 10 % from the total landings in 2013-2014. The proportion of maturity and length at 50% maturity for male of tiger shark shows in Figure 7.

Length at first maturity

Data available for the length at first maturity of shark during the study we recorded only two species were Spot-tail shark, *Carcharhinus sorrah* and Tiger

shark, *Galeocerdo cuvier* (Fig. 6). Length at first maturity we found during the study of *Carcharhinus sorrah* and *Galeocerdo cuvier* were 87,1 cm and 213,2 cm, respectively. Biology of those species in Indian Ocean is still not well documented, especially in the western Indian Ocean. Spanswick (2006) mentioned in Australian waters the *Carcharhinus sorrah* can reach sexual maturity at 90–95 cm after two or three years can exceed 160 cm in length but is more frequently 90–100 cm. For the species of *Galeocerdo cuvier*, males reach sexual maturity at 285-310 cm total length (TL), while females mature at 287-345 cm TL (Clark & van Schmidt 1965, Simpfendorfer 1992, Whitney & Crow 2007) and the length at first maturity range 210 - 350 cm.

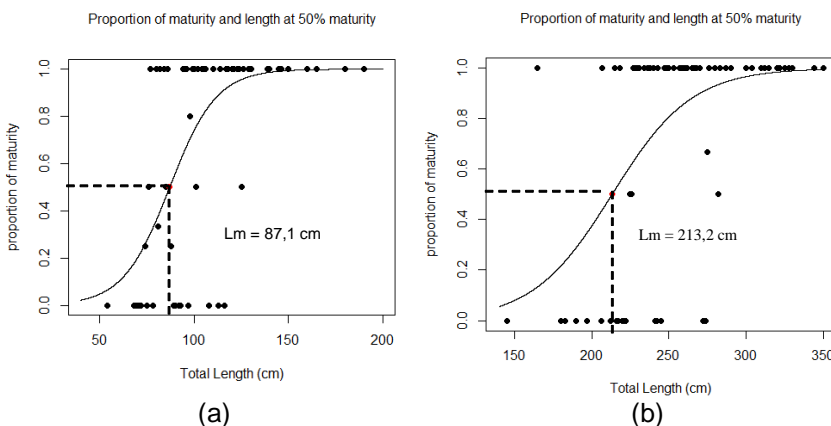


Figure 7. Length at first maturity of Spot-tail shark, *Carcharhinus sorrah*(a) and Tiger shark, *Galeocerdo cuvier* (b)

Shark Fisheries

The largest contribution of shark catches were from Banda Aceh and Sibolga. Sharks landed at Banda Aceh are from targeted shark longlines and bycatch from tuna longlines and tuna handlines. Sharks landed at Sibolga are bycatch from bottom gillnets and purse seines. The sharks landed at Lampulo-Banda Aceh fish landings sites are from surface longlines and hand lines operated from small boats 5 GT. Shark surface

longlines are used by fishing vessels with specifications of 11 m length, 2,6-m width, 0,8 m depth and having a pair of 30 horse power (HP) machines. This fishing gear has a main line with 8 mm diameter PE (polyethelene) rope, and 2 m branch lines with 4 mm diameter PA (polyamide) rope. Commonly J hook type number 1/0 or 2/0 used for shark longline. Each branch has a hook at the end of the rope. The main line length is 500 m and consists of 70 hooks with 4 m distance between the hooks. It takes a few hours

for getting to fishing area from the landings site. They begin to set hooks at 15.00 to 18.00 p.m. and hauled at 04.00 to 07.00 a.m., depending on the catch. The fishermen usually use baits with small pelagic fishes (mackerel, sardines, squids). In order to catch baits, a hand line is usually set in the morning and hauled in the afternoon. The surface longlines operated by 4-5 crews in Lampulo spends 7-15 days at sea. There is no specific target species, but sharks are dominate

catches. Shark species from the family of Carcharhinidae such as Spot-tail shark (*Carcharhinus sorrah*), Silky sharks (*Carcharhinus falciformis*), and Spadenose shark (*Scoliodon laticaudus*) are often caught by this gear.

Fishing areas for shark surface longlines and shark handlines are presented in Fig.8. It seems there are similar fishing areas for those fishing gears.

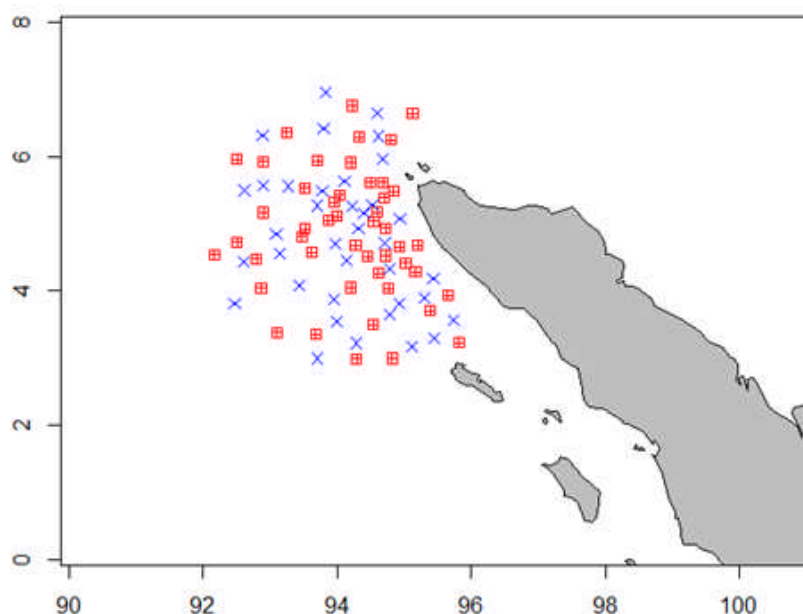


Figure 8. Map of the fishing area for shark surface longline (red) and handline (blue) in Lampulo, Banda Aceh.

Discussion

The shark fisheries in western Sumatera contributed about 12.3% of the national shark production (DGCF, 2013). There are 20 species of 10 families of sharks caught in the western Indian Ocean landed at west Sumatera (Lampulo, Banda Aceh and Sibolga North Sumatera). The dominated caught of sharks is *C. sorrah* (23%), *C. falciformis* (13,5%), *Scoliodon laticaudus* (10,8%), and *Sphyrna lewini* (9,7%). In this study, several species recorded listed in Appendix II of CITES are Hammerhead shark (*Sphyrna* spp) and Whitetip shark (*C.longimanus*). Species *S. lewini* ranged about 39-270 cm, but almost for this species were small size (*juvenile-immature*). The maximum size of *Sphyrna lewini* is 367 cm (Dudley & Simpfendorfer 2006). Hazin et al. (2001) described that the size of majority maturing female sampel was range about 213.5 to 255 cm TL found in the Northeastern Brazil waters. However, *C. longimanus* contributed less than 1 % of the total catch landed at two main landings sites. Other study reported that species of *S.lewini* commonly caught in

Java Sea by gillnet were juvenile-immature condition (Yuneni, 2014). Commonly, in Indonesia waters, *S.lewini* juvenile was founded in coastal waters, which are typically the fishing grounds for intensive utilization fisheries (Fahmi & Dharmadi 2013). Stricter policies are needed to regulate how to exploitation resources friendly, especially juvenile shark. In addition, fishing gear was used by fishers are not very selective, that make many juvenile sharks were caught as bycatch (Dharmadi et al., 2015).

Coastal waters are subjected to high fishing pressure from artisanal fishers using a variety of non selective gear types that take a high proportion of juveniles. In this area are spawning and nursery grounds for numerous of fish and shark (Heupel et al., 2007; Nagelkerken et al., 2008).

The percentage of each species caught by tuna longline were 27.2%, 15.6%, 15.6% and 27.2%, while for the handline it was 46.4%, 15.9%, 13.4% and 9%, respectively. However the catches of bottom gillnet were dominated by whitesspotted guitarfish,

Rhynchobatus australiae (33.9), Spot-tail shark, *Carcharhinus sorrah* (17.7%), and Tawny nurse shark, *Nebrius ferrugineus* (9, 2%) respectively. Size composition of the females and males length ranged of *C. sorrah* from 57 to 115 cm and 54 to 119 cm, respectively [Fig. 6(a)]. *Carcharhinus sorrah* is a coastal pelagic shark of the tropical and sub-tropical Indo-West Pacific reaching 1.6m, and a common catch component of line, net and trawl fisheries over tropical continental shelves from intertidal zone to a depth of at least 80 m (Last & Stevens, 2009), and it is found mainly in mid water or near the surface. Sexual maturity about 90-95 cm after two or three years, it can be up to exceed 160 cm but is more frequently 90-100 cm (Spanwick, 2006).

Based on the Figure 4, there are group at 3 age of both males and females that have the same size pattern. The males and females in the age group of 50-70 cm, 71-90 cm and the total length including the young group, and in the cohort between 91-120 cm total length is a adult group. According to Compagno (1984) this species can attains at least 160 cm; males mature at 103–115 cm and females at 110–118 cm. There were as substantial landings of *C. falciformis* and *S. laticaudus* (Fig.4), which are also common in the tropical Indo-West Pacific. Dharmadi *et al.* (2013) reported that majority of *C. falciformis* caught in eastern Indian Ocean are immature (75,9 %) and only 24.1% are mature. The length frequency of the Silky sharks fluctuates between 50-250 cm, dominated by 100 cm individuals corresponding to immature individuals (Oshitani *et al.*, 2003). The estimated mean LT as birth of females (811 mm, range: 79,9–82,3 cm) and males (81,2 cm, range: 79,4–83,0 cm), derived from the back calculations correspond to the birth zones in the centra, were not significantly different ($P > 0.05$). The LT ranges in the catches of post-natal females (57,0–259,2 cm) and males (55,3–228,9 cm) taken by gillnetting were wider of the females (117,7–262,3 cm) and males (118,4–240,9 cm) were taken by longlining (Hall *et al.*, 2012). The catches of other species, such as *Prionace glauca*, were represented almost entirely by mature fish, indicating that the fishing gear does not capture their juveniles or that the juveniles of these species occur in habitats where fishing pressure was limited. *P. glauca* juvenile are known to occur in separate areas from the adults in other regions (Stevens, *in* White, 2003).

The lowest frequency of female *Alopias pelagicus* was at size of 291-310 cm total length (mature), and the highest length frequency of female *A. pelagicus* was between 231-250 cm (Dharmadi *et al.*, 2013). The length frequency both of sexes of *A. pelagicus*

shows that females generally are larger than males. Liu *et al.* in Camhi *et al.* (2008) mentioned that the growth of females of the Alopiidae is faster than males. *A. pelagicus* from the Indian Ocean can reach the maximum length up to 365 cm. Males reach adult at size about 240-250 cm and females at 260-285 cm (White *et al.*, 2006; White, 2007). Liu *et al.* (1999) reported that the total length at maturity was 282-292 cm for females and 267- 276 cm for males. Based on the results of this study, it can be concluded that the majority *A.-pelagicus* caught from the Indian Ocean on 2002-2007 are commonly as adult stage (mature non reproductive or mature sexually).

In this study, the length at first maturity of *Galeocerdo cuvier* was $L_m=213,3$ cm (Fig. 6b). Last & Steven (2009) mentioned this species born at 50-80 cm and attains approximately 600 cm. While White *et al.* (2006) reported that this species can be up to 740 cm, males mature about 300-305 cm and females about 250-350 cm. Males mature at about 300 cm and females at about 330 cm. The tiger shark commonly reaches a length about 325-425 cm and weight over 385-635 kg. Length at birth varies from 51-76 cm. Males reach sexual maturity about 226-290 cm, while females become mature about 250-325 cm.

CONCLUSION

The sharks are targeting from shark longlines and bycatch from tuna longlines and tuna handlines in Lampulo, Banda Aceh. Whilst in Sibolga, sharks are caught as bycatch from fish net, bottom gillnet and purse seine. The shark fishing activities by using longlines and handlines were done in the same fishing area in the west of Sumatera waters. There were at least 20 species of shark caught in Indian Ocean and landed at those fish landings sites, dominated by Spot tail shark (23%) and Silky shark (13%), whereas Hammerhead shark contributed about 10% and Oceanic whitetip shark was only less than 1 %. Part of Spot tail shark, Silky shark, and Scalloped hammerhead caught in those area are immature, while for part of Tiger shark and Pelagic thresher are matured. The sex ratios for Spot tail shark, Silky shark, Tiger shark, Pelagic thresher, and Scalloped hammerhead caught and landed at Lampulo and Sibolga fish landings sites were not balance.

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