Size distribution and sex ratio of scalloped hammerhead shark (*Sphyrna lewini*) in Banda Aceh fisheries

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Abstract. Scalloped hammerhead sharks (*Sphyrna lewini*) are top predators in the marine ecosystem. This species also began to be listed in Appendix II CITES in 2013 and received Indonesia government regulation through banning export. Kutaraja is one of fishing port Banda Aceh, and hammerhead sharks often caught as by-catch from coastal and pelagic fisheries that operate in Indian ocean western part of Aceh. This research aims to determine the size distribution and sex ratio of scalloped hammerhead sharks that landed in Kutaraja fishing port. Data were collected including length distribution and sex composition of captured scalloped hammerhead shark during January-December 2017. Results show that the size distribution of hammerhead sharks are between 62 and 272 cm in Total Length (TL) with an average of 131 cm TL for males and between 58 and 281 cm TL with an average of 128 cm TL for females. There was a positive relationship between the total length and clasper length. The Sex ratio of male and female is 1:1.7. The result of this study hopefully will help management effort for this endangered species, especially in how to reduce the by-catch of female and immature hammerhead sharks that dominate the catch in Banda Aceh fisheries.

Keywords: size distribution, Aceh, shark

1. Introduction

Sharks and Rays are the top predators that play an important role in the food chain, where it balances the ecosystem on the ocean. Shark only feeds on weak and sick preys within a group, and this helps fish regeneration. Shark is one of the important visual indicator species for coral ecosystem health [1, 2]. Shark and ray fisheries in Indonesia has been going on for decades and contributes 13% of the total global production with >100,000 tonnes/year. In 2002 the shark and ray production in Indonesia reached 106,398 tonnes, and this kept increasing until its peak of 117,559 tonnes in 2003 [3]. Shark and rays production was derived from by-catch of tuna longlines and varied gillnets fisheries. Since the increasing price of shark fin in the international market in 1970, the shark fisheries business was also developing rapidly; it even became the main catch commodity. Both target and bycatch fisheries bring some concern for sharks and rays sustainability.

One of the main catch in Indonesia shark fisheries is scalloped hammerhead sharks (*Sphyrna lewini*). This species is top predators that maintain balance the marine ecosystem. This species also began to be listed in Appendix II CITES in 2013 and received Indonesia government regulation through banning export. One of the regions where hammerhead sharks were landed as both target and bycatch is in Kutaraja fishing port (PPS Kutaraja), Banda Aceh, Aceh Province. Kutaraja is one of a fishing port where hammerhead sharks often caught as by-catch from coastal and pelagic fisheries that operate in
Indian ocean western part of Aceh. This research aims to determine the size distribution and sex ratio of scalloped hammerhead sharks that landed in Kutaraja fishing port.

2. Methods

2.1. Data Collection
The methods to identify hammerhead sharks biological indicator is the landing survey that conducted daily in PPS Kutaraja in 2017. We collected fisheries characteristic and catch information. Fisheries characteristic information includes the name of the boat, fishing gear, duration of the trip, number of setting(s), soaking time, fishing ground, main catches, and operational cost. Catch information includes species, count of individual, sex, stage of maturity, and price [4]. Stage of maturity for male shark classified based on clasper condition. Criteria are: 1=non-calcification, 2=non-full calcification 3=full calcification [5, 6].

3. Results and Discussion

3.1. Size distribution and sex ratio
The total length (TL) measurement of hammerhead sharks is distinguished between males and females. The measurement results show that male hammerhead sharks were distributed in sizes between 62-272 cm TL with an average length of 131 cm TL and for female hammerhead sharks the size length distribution was between 58-281 cm TL with an average length of 128 cm TL (figure 1). Both male and female sharks mostly caught before reaching maturity. The sex ratio between male and female are 1:1.7.

![Figure 1. Size distribution total length (TL) of hammerhead shark in the Indian Ocean at Western Part of Aceh. Length of first maturity (Lm=198 cm TL male; Lm=210 cm TL female) [7], = female, = male.](image)

3.2 The correlation between the total length and clasper length
In this study, the size of the clasper was ranged between 2-21 cm. In figure 2 it can be seen that the relationship between the clasper length and body length.
3.3. Monthly production

According to our result, the peak season for hammerhead sharks catch is between August to October and between February to April (figure 3). This results due to the number of trips that increase in these particular seasons regardless of the type of fishing gear used (average catch per trip was 1.01).

3.4 Fisheries characteristic

The targeted fishing boat used in a boat survey is wooden boats, with 4-6 GT capacity, using longline that fish in the coast of Aceh not far from the mainland. The trip duration is within one day with a submersion period between 1-6 hours. The boats that caught hammerhead shark unintentionally were recorded in fish landing trips are varied from small to large fishing boats. Small boats, with 4-5 GT capacity are using gillnets targeting reef fish in the coastal waters of Aceh while the large fishing boats, with 33-110 GT capacity using purse seine targeting mackerel, trevally, and tuna usually caught sharks

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y = 0.0942x - 4.5646 \\
R^2 = 0.8749
\]
with their secondary fishing gear (handline) in Indian Ocean, Malacca Strait and Andaman Sea (figure 4).

![Figure 4. The fishing ground of shark in Aceh.](image)

Based on the results obtained, the length average range of male sharks is longer than female sharks. In a population, the sex ratio of sharks is a tool comparison between male and female. The results comparison shows that the male and female ratio is 1:1.7. This means that in this study male and female sharks are caught in unbalanced amounts. Based on this, it can be concluded that the sex ratio in this study is not ideal for the continuation of the reproduction process of a species in the waters while the probability of reproduction is greater if the ratio between male and female individuals is balanced. Thus, the imbalance of the sex ratio will increase the vulnerability of hammerhead sharks in their natural habitat if they are overexploited. Furthermore, the variation in sex ratio occurs due to several factors, namely the differences in sexual behaviour, environmental and catch conditions which can be caused by the difference in fishing ground or time of the year.

4. Conclusion

The result of this study hopefully will help management effort for this endangered species, especially in how to reduce the by-catch of female and immature hammerhead sharks that dominate the catch in Banda Aceh fisheries.

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