Biological aspects of sharks landed in the Fishing Port of Kutaraja, Banda Aceh, Indonesia

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Abstract. Shark fisheries in Aceh are not supported by the availability of research-based data and information that needed to support the preservation and development of this resource. The purposes of the study were to assess the biological aspects including shark species identify and their status in IUCN, length distribution, sex ratio, and maturity stage of male shark. This study was conducted from August to October 2017 in the Fishing Port of Kutaraja, Banda Aceh. The observation survey of fish landing sites was conducted to collect the catch species composition, total length of each individual, sex, and maturity stage of male genital of shark (clasper). The results showed there are 17 species of sharks caught by some fishing gears (n = 318). Mean total length, fork length, and standard length are 122.90 cm, 110.77 cm, and 86.50 cm, respectively. The sex ratio of dominated species (\textit{Carcharhinus sorrah}, \textit{Sphyrna lewini}, and \textit{Alopias pelagicus}) showed not significantly difference between males and females, based on Chi-square test. The percentage of male shark maturity for each category (NC, NFC, FC) is 52%, 13%, and 35%, respectively. The percentage of the IUCN status (threatened rare, threatened with extinction, and almost threatened) of collected species are 12%, 29%, and 41%, respectively.

1. Introduction
Pelabuhan Perikanan Samudera (PPS) Kutaraja, Banda Aceh is one of the largest ports in Aceh which is developing in recent years. The sharks caught which are cartilaginous fish were found in these ports. In previous research conducted by Munawir [10], there were 21 types of sharks landed at the PPS, consisting of 11 types of oceanic pelagic sharks, 4 types of bottom sharks, 2 types of deep-sea sharks (bottle shark), and 4 types of reef sharks. However, the information on further studies on sharks, especially in Aceh, is still very minimal and limited, so an in-depth study of sharks is urgently needed so that this data can be used for shark control and management to be sustainable. This study aims to look at the biological aspects of sharks including identification of their species, distribution of length, sex ratio, maturity level of male sharks, and assessing the conservation status of sharks caught based on the IUCN.
This research is expected to produce a conclusion that can be used as an effort to manage conservation and fishing responsibly and sustainably, to create sustainable fisheries resources, especially in Indonesia.

2. Materials and Methods

2.1. Time and site
This research was conducted for 3 months, starting from August to October 2017. The research location is at the Pelabuhan Perikanan Samudera (PPS) Kutaraja, Banda Aceh, Aceh Province.

2.2. Materials
The tools and materials used in this study were (1) stationery; (2) digital cameras; (3) measuring instruments; (4) research data form and (5) the identification book.

2.3. Data collection
This study used a direct observation survey by looking at the types of sharks caught, measuring the fish bodies, and looking at sex. The data taken include (1) Types of sharks caught; (2) Body length of each species; (3) Male and female sex of each species and (4) Maturity level of male sharks.

2.4. Data analysis
Data obtained is stored in excel form then tabulated in the form of pictures, tables, and graphs. Data are recorded in a daily logbook, the results of measurements of fish bodies include total length (TL), fork length (FL), and standard length (SL). Clasper measurement, namely the male genitalia which is a modification of the pelvic fins, is measured from the outermost indentation to the tip of the Clasper. The way to know the morphological characteristics of the observed fish is by placing the shark on a flat surface and then measuring the length using a meter in cm with an accuracy level of 1 cm. The measured fish length is the total length, fork length, standard length, and clasper length.

2.5. Sex ratio
Calculation of the sex ratio through the ratio of the number of male and female shark can be calculated using the following formula [9]:

\[
\text{Sex ratio} = \frac{M}{F}
\]

Remarks:
M = Number of male
F = Number of female

Furthermore, to test the balance of sex ratio for several shark species, the following formula is used [16]:

\[
\chi^2 = \sum_{i=1}^{b} \sum_{j=1}^{k} \left[ \frac{(O_{ij} - E_{ij})^2}{E_{ij}} \right]
\]

Remarks:
\( \chi^2 \) = Chi Square
\( O_{ij} \) = Observation frequency on i row j column
\( E_{ij} \) = Expected frequency on i row j column

2.6. Male shark maturity level (Clasper)
The Clasper category that indicating the maturity level of the male shark are (1) Non-calcification (NC) is male claspers have not been calcified so they are not ready to fertilize; (2) Non full Calcification (NFC), namely males in adolescence is almost ready to fertilize female shark; (3) Full Calcification
(FC), namely male shark that are mature. Measuring the Clasper length starts from the base of the outer curve to the tip [13].

3. Results and Discussion

3.1. Type and shark composition

Total shark caught is 318, consisting of 17 species, the highest percentage caught was *C. sorrah* at 31% (n = 100) and the least were *O. leptolineatus* and *S. fasciatum* each of 1% (n = 1). The highest number of sharks landed at PPS was in October (n = 129) and the least was August (n = 26) with almost even species composition every month.

![Figure 1](image1.png)

**Figure 1.** The percentage of shark composition that landed in the Fishing Port of Kutaraja.

**Table 1.** Shark composition in the Fishing Port of Kutaraja.

| No | Shark Species                  | Sample (species) |          |          |          |          |
|----|--------------------------------|------------------|----------|----------|----------|----------|
|    |                                | August | September | October | Total    |          |
| 1  | *Alopias pelagicus*             | 11     | 11        | 13       | 35       |          |
| 2  | *Carcharhinus falciformis*      | 4      | 0         | 1        | 5        |          |
| 3  | *Carcharhinus leucas*           | 13     | 1         | 8        | 22       |          |
| 4  | *Carcharhinus melanopterus*     | 0      | 4         | 19       | 23       |          |
| 5  | *Carcharhinus obscurus*         | 3      | 0         | 0        | 3        |          |
| 6  | *Carcharhinus sorrah*           | 11     | 46        | 43       | 100      |          |
| 7  | *Carcharhinus longimanus*       | 0      | 0         | 2        | 2        |          |
| 8  | *Chiloscyllium punctatum*       | 1      | 0         | 12       | 13       |          |
| 9  | *Galeocerdo cuvier*             | 0      | 7         | 1        | 8        |          |
| 10 | *Loxodon macrorhinus*           | 4      | 0         | 15       | 19       |          |
| 11 | *Orectolobus leptolineatus*     | 0      | 1         | 0        | 1        |          |
| 12 | *Prionace glouca*               | 1      | 7         | 1        | 9        |          |
| 13 | *Rhynchobatus australiae*       | 1      | 4         | 3        | 8        |          |
| 14 | *Sphyrna lewini*                | 2      | 31        | 10       | 43       |          |
| 15 | *Squalus edmundsi*              | 7      | 12        | 0        | 19       |          |
| 16 | *Stegostoma fasciatum*          | 0      | 0         | 1        | 1        |          |
| 17 | *Triaenodon obesus*             | 5      | 2         | 0        | 7        |          |
|    | **Total**                       | 63     | 126       | 129      | 318      |          |
At least 114 species of sharks were found in Indonesian waters up to 2010 based on various literature and studies [1, 5, 6]. The research in the southern waters of Java reported that 28 species of sharks landed at the Cilacap Fishing Port during the period February-April 2015 [14]. This number is more than what was found in this study, however, research at Tempat Pelelangan Ikan Bom Kalianda, Lampung found 10 species of sharks during the August-November 2015 period [12]. This difference is influenced at least by fishing gear type used, fishing area, and data collection period.

3.2. Measurement of body length
Based on data measurement, the average shark has a total length, fork length, standard length size of 122.90 cm, 110.77 cm and 86.50 cm, respectively. *G. cuvier* has the longest size of 255.33 cm and the smallest is *S. edmundsi* 67.7 cm (Table 2).

The most common species found in this study were *C. sorrah*, *S. lewini* and *A. pelagicus*. *C. sorrah* whose conservation status is near threatened with a total of 100 individuals with an average size (TL) of 92.60 cm; (FL) 74.60 cm; (SL) 66.55 cm. *S. lewini* are endangered and have entered CITES Appendix II as many as 43 individuals with an average size (TL) 107.27 cm; (FL) 85.25 cm; (SL) 75.59 cm. *A. pelagicus* is vulnerable with 35 individuals, an average size (TL) of 221.49 cm; (FL) 132.08 cm; (SL) 120.24 cm, the fishing pressure among shark species is high. The longest average size was *G. cuvier* with an average size (TL) of 255.33 cm; (FL) 209.02 cm and (SL) 189.03 cm. In a previous study [10], the captured *G. cuvier* also have a long size, which is 350 cm on average (TL), and *A. pelagicus* average length (TL) 340 cm.

3.3. Composition of sex types
The shark catch was dominated by *C. sorrah* with 44 males (35.2%) and 56 females (29%), *A. pelagicus* as 26 females (13.5%), and 9 males (7.2%). *S. lewini* with 23 females (11.9%) males as many as 20 individuals (16.6%). Among 17 species, only 1 species does not have male sex, namely *O. leptolineatus*, and 1 species that was not found female, namely *S. fasciatum*.

| No | Species                | Total Length | Average (cm) | Standard Length |
|----|------------------------|--------------|--------------|-----------------|
| 1  | Alopias pelagicus       | 221.49       | 132.08       | 120.24          | 35              |
| 2  | Carcharhinus melanopterus | 124.19      | 99.91        | 88.01           | 23              |
| 3  | Carcharhinus obscures    | 173.33       | 133.56       | 123.43          | 3               |
| 4  | Carcharhinus sorrah      | 92.6         | 74.6         | 66.55           | 100             |
| 5  | Carharinus falciformis   | 104.44       | 84.62        | 74.2            | 5               |
| 6  | Carharinus leucas       | 122.55       | 101.52       | 85.35           | 22              |
| 7  | Carcharhinus longimanus  | 80.3         | 50.3         | 40.7            | 2               |
| 8  | Chiloscylium punctatum   | 86.41        | 304.9        | 61.99           | 13              |
| 9  | Galeoerco cuvier        | 255.33       | 209.02       | 189.03          | 8               |
| 10 | Loxodon macrorhinus     | 71.44        | 56.82        | 50.97           | 19              |
| 11 | Orectolobus leptolineatus| 80.7         | 70           | 60              | 1               |
| 12 | Prionace glouca         | 111.8        | 85.87        | 77.1            | 9               |
| 13 | Rhynchobatus australiae  | 136.49       | 127.35       | 115.125         | 8               |
| 14 | Sphyra lewini           | 107.27       | 85.25        | 75.59           | 43              |
| 15 | Squalus edmundsi        | 67.7         | 57.76        | 51.96           | 19              |
| 16 | Stegostoma fasciatum    | 160          | 130.5        | 120             | 1               |
| 17 | Triagenodon obesus      | 93.2         | 79.04        | 70.2            | 7               |
Based on the Chi-square test, it can be concluded that *C. sorrah* with a ratio of 1: 1.27; *S. lewini* (1: 1.15); and *A. pelagicus* (1: 2.88). If referring to the opinion [3] the catch is not ideal, the ratio between males and females should be 1: 1, but statistical difference is not very significant. *C. sorrah* and *S. lewini* which are still classified as ideal, while *A. pelagicus* is not ideal. Sex ratio knowledge is related to efforts to maintain the sustainability of the studied fish population, so it is expected that the ratio of male and female fish is balanced. The balance ratio between the number of male and female individuals allows the fertilization of eggs by spermatozoa so that new individuals are getting bigger [2].

### 3.4. Male shark maturity level (Clasper)

The data recorded only 11 adult species out of 17 species caught. The most caught species according to their maturity level, namely *A. pelagicus* 7 individuals and *L. macrorhinus* 6 individuals. Five individuals for each *C. punctatum* and *C. leucas*. *C. sorrah*, *S. lewini* and *C. melanopectus* each for 4 individuals (n = 125) (Figure 3). The maturity level of male sharks based on clasper consists of 52% non-calcification (NC), non-full calcification (NFC) of 52%. 13% and full calcification (FC) of 35%.

An imbalance in the ratio between male and female shark which is dominated by male shark causes the resulting sperm cells not to be used to fertilize eggs so that spawning will not occur. Spawning is an initial process in recruiting new individuals so that if the spawning does not occur, new individuals will not be produced in the waters. Generally, in aquatic biota, there are more females than males, so that one male individual marries several females. This is done so that these organisms can maintain their sustainability. Sex comparisons can be used to predict the success of spawning by looking at the balance of numbers between males and females in the waters, which can then affect the production, recruitment, and conservation of these resources.

### 3.5. Conservation status of shark catch

Based on the IUCN status among 17 suspected shark species, 2 species are endangered (*S. lewini* and *T. obesus*), 5 species are vulnerable to extinction (*S. fasciatum*, *C. longimanus*, *C. obsares*, *R. australiae* and *A. pelagicus*) and 7 endangered species (*C. leucas*, *P. glouca*, *S. Edmundsi*, *G. cuvier*, *C. sorrah*, *C. falciformis*, *C. melanopectus*). The rest *O. leptolineatus*, *C. punctatum* and *L. macrorhinus* have not been evaluated and are not yet a cause for concern.

![Figure 2. Composition of shark maturity level.](image-url)
Republic of Indonesia to Outside the Territory of the Republic of Indonesia and clause 3 and it is processed products as referred to in clause 2 is valid until 31 December 2017.

4. Conclusion
The results showed 17 species of sharks caught (n = 318), with an average length of TL, FL, and SL of 122.90 cm; 110.77 cm; and 86.50 cm. The Chi-square test conducted on the dominant catch showed no significant difference between male and female catches. The maturity level consists of non-calcification, non-full calcification, and full calcification of 52%, 13%, and 35%, respectively. The IUCN status is 12% endangered, 29% endangered and 41% almost threatened.

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