Shark fisheries management as a sustainable development implementation in Indonesia fishery sector

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Abstract. The challenge of ensuring shark resource preservation is the main issue in fisheries management of Indonesia. Therefore, appropriate fisheries management needs to be developed. This paper aims to explain the shark fisheries condition in Indonesia based on ecological, social, and economic aspects following the sustainable development approach. The research was conducted through academic literature study and fisheries statistic reports. Data were analysed through the graphical approach and tabulation data trends based on the availability of time-series data that have been publish. The result shows that there are about 116 species of sharks in Indonesia ocean waters. One shark species was categorized as critically endangered, 5 species are endangered, 23 species are vulnerable, and 35 species are near-threatened category. Legislation in Indonesia has given enough serious attention to shark protection. To achieve the goal of sustainable shark fisheries management, several strategies can be implemented, namely: (i) preparation of regulations and their implementation to support the management of shark fisheries; (ii) strengthening of scientific database and review of shark fishery in Indonesia as well as at international level; (iii) institutional strengthening, and; (iv) increasing the HR capacity of fisherman and fishery personnel.

1. Introduction
Sustainable Development Goals (SDGs) stated that no poverty is the top priority to be solved. This means that all countries agree to eliminate poverty in any form throughout the world \cite{1}. Concerning poverty, the coastal regions of Indonesia are areas that usually have high poverty levels, whereas the coastal area has high economic potential from the fisheries sector.

As many as 3,215 fish species live in Indonesia’s marine waters \cite{2}, with a total of fish resources reach 6.5 million tons in 2011 \cite{3} and increasing to 9.6 million tons in 2016 \cite{4}. The abundance of fish resources needs to be managed properly and also wisely so its biodiversity will have maintained and its economic potential can be utilized for the prosperity of the fishermen community in the present and the future.

Today’s, about 29% of the commercial fish resource have been over-fishing and 61% have been fully-exploited \cite{5}. Therefore, following the objective of the 14th SDGs, the good marine ecosystem management is needed to ensure the achievement of sustainable fisheries resource utilization. Fisheries management should balance the priorities between growth and conservation that ensure equal benefits for fishing communities.

One of the fish resources that are widely captured by fishermen in Indonesia is the shark. These fish are usually caught as by-catch (fish caught unintentionally/non-target fish). Shark fish has a high economic value, especially for the fin and liver. Shark fins are usually for consumption and cosmetics
ingredients, while the liver is extracted for oil. Currently, a high number of shark fish are caught from Indonesia's marine waters. As many as 1,000 tons of various species sharks have been captured in 1950 and continue to increase about 120,670 tons in 2003 [6]. There are seven species of sharks widely caught by fishermen [7]. Those species are blue shark (*Prionace glauca*), leaf scale gulper shark (*Centrophorus squamosus*), shortfin mako shark (*Isurus oxyrinchus*), tiger shark (*Galeocerdo cuvier*), great hammerhead (*Sphyrna mokarran*), silky shark (*Carcharhinus falciformis*), dan pelagic thresher (*Alopias pelagicus*). The seven most dominant shark species caught in the Indian Ocean are the blue shark, oceanic whitetip shark (*Carcharhinus longimanus*), scalloped hammerhead (*Sphyrna lewini*), shortfin mako shark, silky shark, pelagic thresher, and bigeye thresher shark (*Alopias superciliosus*) [8]. The stock status of shark resources is unknown. Therefore, to ensure its utilization does not exceed the carrying capacity, precautionary approach management needs to be applied. Arrangement setting for fishing effort can be used to reduce the biomass reduction rate of fish resources [8].

The challenge of ensuring the preservation of shark resources is a key issue in the shark resources management of Indonesia. Therefore, an appropriate fisheries management model needs to be developed based on accurate and up-to-date scientific data and information. This paper aims to explain the shark fisheries condition in Indonesia based on ecological, social, and economic aspects following the sustainable development approach.

2. Material and methods

The research was conducted through academic literature study and fisheries statistic reports. Data and information collected are those related to shark fisheries in Indonesia. The data were analysed descriptively through graphical approach and tabulation also data trends based on the availability of time-series data that have been published.

3. Result and discussion

3.1. Shark Fishery Status

Indonesia's marine waters have a high abundance of shark fish resources. No less than 116 species of sharks from 25 families are found in Indonesian waters [9]. Shark fishing activities in these waters have been going on for a long time. Initially, shark fishing was only by-catch of tuna fisheries, purse seine, drifting gill net, and longline, but due to the high price of shark fins around the late 1980s, these fish began to be targeted by fishermen [10]. The existence of economic utilization opportunities and lack of adequate regulation resulted in the development of shark landing centres of fisherman catches, especially on the west coast of Sumatra Island and the southern coast of Java Island to Nusa Tenggara. More clearly, the location of the sharks landing of fisherman catches can be seen in Figure 1.

![Figure 1. Map of shark fisheries landing site in Indonesia.](image-url)
Shark fishing activities both as a target and non-target fish are still ongoing. It can be seen from Figure 2 that this activity has been going on since the mid-1970s. The number of shark fishing production in Indonesia has been on an upward trend, reaching its peak in 2000 to almost 70,000 tons, but has begun to decline in the following years about 40,000 tons in 2012. The decrease in shark catch production can be caused by various factors, but it is reasonable to suspect that the production decline is due to overfishing. Based on data released by the Food and Agriculture Organization (FAO), the total catch of Elasmobranches fish in the world in 2008 reached 700,000 tons [11]. Indonesia, India, Spain, Taiwan, and Mexico are the five largest shark producing countries in the world [12].

![Shark Data Catch in Indonesia Year 1975-2012. Source: [11]](image)

The dominant catch of some shark species in Indonesian waters is present in Table 1. The silky shark becomes the shark species most caught by fishermen. This may be because this shark is oceanic and pelagic, but generally more prevalent in offshore waters close to the mainland and layers near the surface [13] so this species easily caught by fishermen.

| No. | Species           | 2005  | 2006  | 2007  | 2008  | 2009  | 2010  | 2011  |
|-----|-------------------|-------|-------|-------|-------|-------|-------|-------|
| 1   | Silky shark       | 12,971| 25,530| 29,687| 26,000| 28,738| 26,454| 23,934|
| 2   | Pelagic thresher  | 13,274| 14,474| 13,767| 9,385 | 8,210 | 12,890| 18,240|
| 3   | Crocodile shark   | 16,536| 14,474| 12,066| 5,413 | 5,302 | 2,585 | 4,014 |
| 4   | Hammerhead        | 253   | 99    | 1,423 | 2,366 | 3,112 | 3,438 | 3,394 |
| 5   | Short fin mako    | 272   | 1,363 | 497   | 461   | 830   | 733   | 632   |

Source: [14]

3.2. Shark Protection Status and it's Regulation

Shark is one species of fish that has a high level of threat. In Indonesia there is one species of shark that has been categorized as critically endangered, 5 species that are endangered, 23 vulnerable species, and 35 species of shark is in the near-threatened category. In detail, the status of IUCN seven sharks that are often caught in Indian Ocean waters and need to get serious attention can be seen in Table 2.
Table 2. Vulnerability categories of some sharks species according to IUCN list.

| No | Common Name         | Scientific Name          | IUCN Status   |
|----|---------------------|--------------------------|---------------|
| 1. | Scalloped hammerhead| *Sphyrna lewini*         | Endangered    |
| 2. | Oceanic whitetip    | *Carcharhinus longimanus*| Vulnerable    |
| 3. | Short fin mako      | *Isurus oxyrinchus*      | Vulnerable    |
| 4. | Pelagic thresher    | *Alopias pelagicus*      | Vulnerable    |
| 5. | Big eye thresher    | *Alopias superciliosus*  | Vulnerable    |
| 6. | Blue shark          | *Prionace glauca*        | Threatened    |
| 7. | Silky shark         | *Carcharhinus falciformis*| Threatened    |

Source: [8]

The laws and regulations in Indonesia have paid considerable attention to the protection of protected and endangered species, including the shark fish resources (Table 3). Through this legislation, the government seeks to encourage shark fishermen to take conservation measures by releasing it back to the sea (for protected shark species) and collecting data on all species of sharks caught and report them to fisheries officers when the ship is docked. Not only that, the Indonesia Ocean Tuna Commission (IOTC) as one of the organizations engaged in fisheries management in the Indian Ocean region, in Resolution 10/12 also has massively banned the fishing activities of pelagic thresher sharks known as the Thresher Shark (*Alopias pelagicus, Alopias superciliosus* dan *Alopias vulpinus*). The prohibition is not legally binding and is only limited to socialization because of no legal provision regarding this matter from the Indonesian government [15].

Table 3. National regulation related to shark management in Indonesia.

| No. | Regulation                                           | Year | Description                                                                 |
|-----|------------------------------------------------------|------|----------------------------------------------------------------------------|
| 1.  | Law of The Republic Of Indonesia No. 31              | 2004 | Concerning fisheries                                                      |
| 2.  | Government Regulations No. 7                         | 1999 | Concerning the preservation of flora and fauna                           |
| 3.  | Regulation of the Minister of Marine Affairs and Fisheries No. 12 | 2012 | Concerning the terms of fishing business on the high seas                |
| 4.  | Regulation of the Minister of Marine Affairs and Fisheries No. 57 | 2014 | Concerning the fishing capture business in fisheries management area of the Republic of Indonesia |
| 5.  | Regulation of the Minister of Marine Affairs and Fisheries No. 18 | 2010 | Concerning the log book of fishing                                        |
| 6.  | Regulation of the Minister of Marine Affairs and Fisheries No. 1 | 2013 | Concerning the monitoring of fishing vessel and fish carrier vessel       |
| 7.  | Regulation of the Minister of Marine Affairs and Fisheries No. 18 | 2013 | Concerning the determination of Whale Shark (*Rhincodon typus*) Protection Status |
| 8.  | Regulation of the Minister of Marine Affairs and Fisheries No. 59 | 2014 | Concerning the prohibition of oceanic whitetip shark (*Carcharhinus longimanus*) and silky shark (*Sphyrna spp.*) from the territory of the Republic of Indonesia to the outside of the Republic of Indonesia |

3.3. Social Economics of Shark Fisheries

In general, shark fishermen can be categorized as poor people. This is because most of them are workers who earn revenue based on profit sharing and have a tendency to debt-laden with the owners
of capital. The income of these working fishermen is also low, so they can be classified as poor and or vulnerable poor. Limited capital, skills, pressure from the owners of capital (unfair fishery sharing system), non-transparent fish trading system or auction (no proper regulation and weak authority or government), and traditional or conventional work culture is the most commonly found problems in Indonesia's fishery sub-sector. The poverty experienced by Indonesian fishermen makes them socially weak, as well as politically [16]. The factors that influence the poverty of traditional fishermen are the quality of human, economic, and institutional resources [17].

Today, Indonesia is the largest exporter of shark fins in the world [18]. Although shark fisheries production in Indonesia is less than 0.1% of national fishery production, shark fisheries contribute substantially to fisherman income, both as a major catch and by-catch [19]. Processed products of shark products from Indonesia are generally intended for export purposes. Based on Figure 3, can be seen as the main country destination shark fin export products originating from Indonesia in 2005-2006.

![Figure 3](image_url). Indonesian Shark Fin Exports in 2005-2006. Source: [11]

Based on Figure 3 it can be seen that the main countries of export destination of shark fin are Japan and Hong Kong. According to Anonymous (2013), shark fins in Japan have been known as high-value fishery commodities and exported to China since the Edo period (1603-1868). In Hong Kong and China, shark fins are widely processed into soups and are the most widely consumed prestigious foods during special day celebrations such as during the Chinese New Year celebration [20].

Figure 4 shown the economic value of shark export in Indonesia during the period 1976-2008. Besides, shark fin prices are also displayed per kg from year to year. Until 1992, the total export capital of shark fins and the price per kilogram of shark fin reached the highest point.

![Figure 4](image_url). Export capitalization trend of Indonesian shark products in 1976-2008. Source: [21]
Shark fishing in Indonesia has been carried out for generations, especially in coastal areas. This activity forms a complex trading chain ranging from fishermen, merchants, exporters, importers, restaurants to final consumers. For more details, the shark fin trade chain can be seen in the flow chart of Figure 5. The length of the distribution chain, the limited commodity, and the high demand resulted in the increasing price of shark fin. However, this needs to be watched out by the fishery stakeholders in Indonesia. The increasing demand for shark fins has the potential to increase the welfare of fishermen, on the other hand, it can lead to the increased hunting of sharks in nature.

![Flow chart of shark fin trade](source)

**Figure 5.** The flow chart of shark fin trade. Source: [22]

### 3.4. Sustainable Shark Fisheries Management

Development of marine and fisheries has been able to increase Gross Domestic Product (GDP) of the fishery by 6.48% with a nominal value of 57.69 trillion rupiahs and increase exports with a surplus of US $ 3.52 billion. Indonesia also needs fishery management that is oriented to long-term interests (sustainable), not only for the present generation but for future generations as well. Therefore, responsible fishery management becomes the key to achieving sustainable fisheries development [23].

In principle, fisheries management aims to regulate the intensity of capture in order to obtain optimal catch from various aspects [24]. In the context of shark fisheries, management also aims to determine the level of long term sustainable catch [25]. As part of efforts to achieve sustainable shark fisheries management, fishermen community involvement is an essential and necessary factor. Sustainable fisheries management requires synergy between ecology, social and economic elements (Figure 6).

![Sustainable fisheries management concept](source)

**Figure 6.** Sustainable fisheries management concept.
One of the management concepts that adopt the synergy of ecology, social, and economic elements is community-based fisheries management. This management is one of the approaches to managing coastal area resources that can increase the active participation of the community in supporting environmentally sustainable development. This management model is expected to overcome the damage and loss of resources by changing the mindset of the fishermen community about the utilization of fish resources from open access to public ownership by involving the community. This pattern is known in the form of Community-based Coastal Resources Management (CB-CRM) or community-based resource management (CBM) [26].

To realize the achievement of sustainable management objectives, through community engagement, the main strategies implemented are: (1) Preparation of regulations and their implementation to support the management of shark resources. The objective of this strategy is to enact the legal umbrella of shark resource management in Indonesia effectively. (2) Strengthening of scientific database and review of shark fishery in Indonesia as well as at the international level. The goal is to have good scientific information available so that every policy can be taken appropriately. (3) Institutional Strengthening. Shark resource management involves various sectors both central and regional and can be multi-sectorial. Therefore, a joint working group is needed that can facilitate communication among these stakeholders. It is expected that this working group can assist the government in determining the policy direction and evaluating management effectiveness. (4) Increasing HR Capacity. This strategy focuses on educating and enhancing knowledge of fishermen and fisheries officers so that policy implementation becomes more easily implemented in the field.

4. Conclusion
Indonesia's marine waters have a high abundance of shark species. There are about 116 species of sharks from 25 families. Carcharhinus shark becomes the genus of shark most caught by fishermen. Currently, Indonesia is the largest exporter of shark fin in the world, with the main export destination Japan and Hongkong. In Indonesia there is one type of shark that has been categorized as critically endangered, 5 species that are endangered, 23 vulnerable species, and 35 species of shark is in the near-threatened category. Legislation in Indonesia has given enough serious attention to the protection of shark resources. To achieve the goal of sustainable shark fisheries management, several strategies can be implemented, namely: (i) Preparation of regulations and their implementation to support the management of shark resources; (ii) Strengthening of scientific database and review of shark fishery in Indonesia as well as at international level; (iii) Institutional Strengthening, and; (iv) Increasing the HR capacity of fisherman and fishery personnel.

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6. Acknowledgement
This research was supported independently.