

# Growth, mortality, and exploitation rate of spadenose shark (*Scoliodon laticaudus*) landed at PPI Dumai, Riau Province

Rina D Sibagariang<sup>1\*</sup>, Ummi M Batubara<sup>1</sup>, M Arief Wibowo<sup>1</sup>, Rindi Metalisa<sup>1</sup>

<sup>1</sup>Faculty of Fisheries and Marine Science, Universitas Riau, Pekanbaru, Indonesia 28293

**Abstract.** The IUCN Red List most recently evaluated the spadenose shark (*Scoliodon laticaudus*) in 2005 and classed it as near threatened. The research was done at fish landing locations at PPI Dumai between May and July 2023. The goal of this study is estimating spadenose shark growth, mortality, and exploitation rates. Total length and total weight were the kind of information that were collected. The frequency distribution formula was used to assess the frequency of fish length. The FISAT II program's ELEFAN 1 was used to examine fish growth parameters. The result showed that there were 1103 fishes (590 females and 513 males) captured. The total length (TL) of spadenose sharks in May, June, and July respectively obtained the range between 251-470; 218-500, and 279-485 mmTL with a maximum length of 500 mmTL. With an assumed coefficient of determination ( $R^2$ ) of 0,68, the relationship between total weight (in g) and total length (in mm) for the combined sexes is estimated as  $W = 0,0001TL^{2,4582}$ . The growth pattern of spadenose shark is negative allometric. Asymptotic length ( $L_\infty$ ) = 578,2 TL, growth rate ( $K$ ) = 0,51  $y^{-1}$ , and theoretical age at length 0 ( $t_0$ ) = -0,86 y were found as estimates of the growth parameters. Total mortality ( $Z$ ) was 2,24  $y^{-1}$ , with natural mortality ( $M$ ) at 0,52  $y^{-1}$  and fishing mortality ( $F$ ) at 1,72  $y^{-1}$ . The exploitation rate ( $E$ ) for this fish was 0,77 $y^{-1}$ , which indicates high levels of exploitation.

## 1 Introduction

Sharks (class Chondrichthyes) are the top predators, and their life history makes them especially vulnerable to overfishing [2]. Shark exploitation in Indonesia is still going on currently [3]. Sharks are a species that is currently a global capture fishery issue. Sharks are by-catch, considered to have high economic value because they have a higher price than the main target. The high price of sharks is due to the presence of shark fins. Catching sharks will have implications for high and low trophic [4].

Indonesian waters have abundant natural resources including marine fishery resources. Shark species diversity is fairly high in Indonesian waters. In Indonesian seas, there are at least 116 shark species from 25 families. Sharks are thought to play a crucial part in maintaining and controlling the ecosystem's balance. Based on the range of percentages caught by sharks as bycatch, gill nets and longlines are gears with a high risk of catching sharks [5]. Longline are usually used to catch rays and sharks [6]. Sharks are the target fish

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\*Corresponding author: [rinasibagariang@lecturer.unri.ac.id](mailto:rinasibagariang@lecturer.unri.ac.id)

in longline fishing gear and by-catch in gillnets [4].

Dumai City is one of the cities in Riau Province which has a large role in the sector sea fisheries [7]. The activities occur across numerous districts of Dumai City. The catches that were landed came from sondong fishermen, gill nets, longlines and splint fishing gear [8]. The fishing fleet used by the fishermen consists of boats with engines measuring 3-5 GT. The size of the ship to be used is 10-11 m, with a 2,5 m width and a height of 2 m, and made of wood [9].

The Spadenose shark (*Scoliodon laticaudus*) belongs to the Carcharhinidae family. [10], viviparous [11], marine neritic [12]. near threatened [12]. *S.laticaudus* is mainly a coastal species which is found in warm temperature water [13]. Species is not a quick swimmer and found near seashore waters in shallow waters between 10 to 33 meter [13]. *S. laticaudus* is high in the marine foodweb, far from the primary producers, which contributes to the low productivity of its fishery, as compared with Coilia, sardines, or mackerel [14]. *S. laticaudus* caught by bottom set gillnet [13]; by trawls and gillnets [14].

The goal of this study is to determine the growth, mortality and exploitation rate of *S. laticaudus* to serve as an important information basis for the sustainable management of *S. laticaudus* populations in the Rupert and Malacca Strait waters.

## 2 Materials and methods of research

**Study site.** This study was carried out at PPI Dumai, Dumai City Riau Province Indonesia (Fig. 1) in May - July 2023. The research was carried out using a survey method.



**Fig. 1.** Research site  
(Google earth)

(Google earth)

**Data collection.** Species were identified in-situ using a combination of local and scientific names, according to the [15]–[17] identification keys.

**Analisis Data.** FiSAT II [18] computer software packages were utilized in this work.

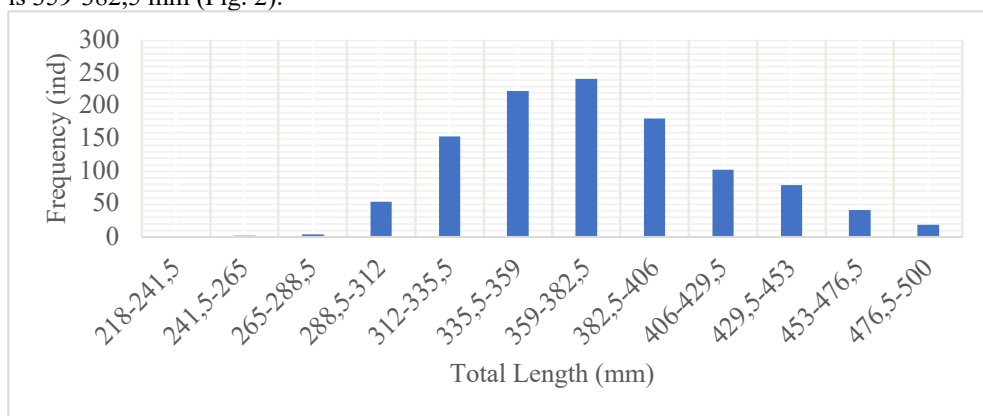
The growth of the study was made using the model of Von Bertalanffy (1957). This model shows the relationship between the growth parameters and expresses the total length ( $L_t$ ) of the fish as a function of its age  $t$ , according to the following expression:  $L_t = L_\infty(1 - \exp(-K(t - t_0)))$  where:  $L_t$  = total fish length;  $L_\infty$  = asymptotic length (average length that a fish would reach that could live and grow indefinitely);  $K$  = growth coefficient, indicating the speed at which the curve approaches the asymptote;  $t_0$  is the age for which  $L_t = 0$ . In the present work, The  $K$  and  $L_\infty$  parameters were computed in the current study using the ELEFAN I tool, which is part of the FISAT (FAO-ICLARM. Stock Assessment Tools) II software[18].

Growth parameters ( $L_\infty$ ,  $K$ ) obtained, were used to analyze catch curves converted to

length to obtain estimates of total mortality (Z). Natural mortality (M) was estimated using the empirical formula of [19]:  $\log M = 0.0066 \log K + 0.279 \log LT + 0.4634 \log T$  where T is the environmental temperature annual average (°C), it is about 30°C in Rupert and Malacca Strait. The fishing mortality rate, F, was calculated as  $Z-M: F=Z-M$ . The exploitation rate (E) is defined by the ratio of fishing mortality to total mortality:  $E = F/Z$ . It is between 0 and 1. When  $E < 0.5$ , the stock is underexploited. On the other hand, when  $E > 0.5$ ; the stock is overexploited. Yield is optimal when total mortality equals fishing mortality [20]

### 3 Results and Discussion

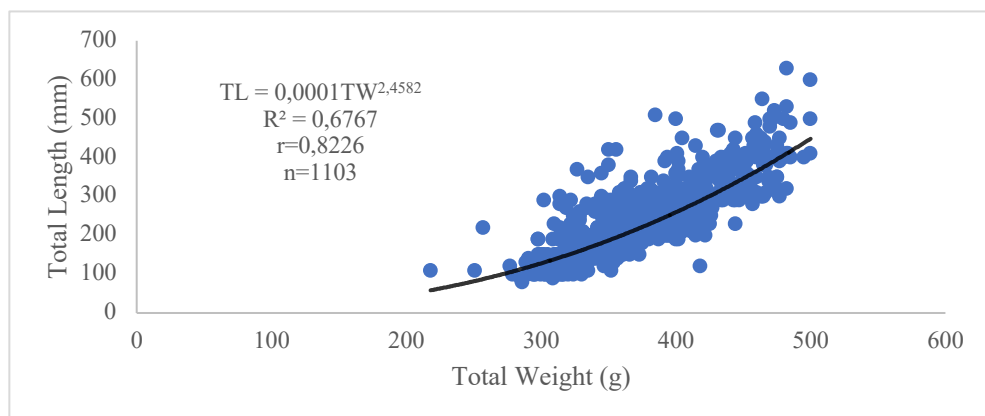
The results showed that the total length (TL) of spadenose sharks in May, June, and July ranged from 251-470 (347 ind), 218-500 (557 ind), and 279-485 (199 ind) mmTL with a maximum length of 500 mmTL for females and 442 mmTL for males. The dominant length is 359-382,5 mm (Fig. 2).



**Fig. 2.** Frequency distribution of Total Length (mm) for sexes combined of *S. laticaudus*

Maximum length of 500 mmTL for females and 442 mmTL for males in this study smaller than [11] 580 mm male and 690 mm female; 685 mm [14]; 630 [21]; 660 mm males and 600mm females [22]; 700 mm [10]. This research was carried out from May to June 2023 because according to information from local officials, many sharks and rays were landed and the research was carried out in the east monsoon. The east season is from May to October 2020, due to the east season fish landing activities at PPI Dumai increase. In the east monsoon there is a movement of wind from the Australian continent to the Asian continent through Indonesia [8].

The relationship between weight (in g) and total length (in cm) for the combined sexes (Fig. 3) is estimated as  $TW = 0,0001TL^{2,4582}$  with a coefficient of determination ( $R^2$ ) of 0,68. The growth pattern of spadenose shark is negative allometric growth pattern ( $b=2,4582$ ) according to [18] when The value of b will be 3, indicating that the fish will maintain the same proportion of its shape throughout its existence. When the value is greater or less than 3, it implies that the growth rate is allometrically positive or negative.



**Fig. 3.** Relationship between Total Weight and Total Length for *S. laticaudus* (sexed combined)

[23] Karim et al 2013 reported the value of *b* for combined of the species Spadenose Shark (*S. laticaudus*) was 2,710 from Bay of Bengal, Bangladesh and in 2017, [10] Karim et al 2017 reported *b* for combined 2,1137 negative allometric growth and [21] Thomas et al 2020 also reported *b* for combined 2,6840 as mentioned at Table 1.

**Table 1.** Comparison of the estimated LWR parameters of Spadenose Shark (*S. laticaudus*) with the other studies

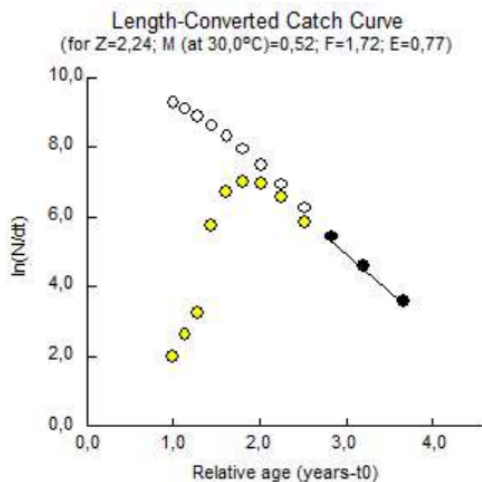
Species Name	Location	Slope “b”	Source
<i>(S. laticaudus)</i>	Bay of Bengal, Bangladesh	Combined 2,710	[23] Karim et al 2013
	Bay of Bengal, Bangladesh	Combined 2,1137	[10] Karim et al 2017
	The south eastern Arabian Sea along Karnataka, India	Combined 2,6840	[21] Thomas et al 2020
	Rupat and Malacca strait	Combined 2,4582	This study

The  $L_{\infty}$  and *K* were estimated using the ELEFAN-I method utilizing the *K*-scan procedure, and the results were  $L_{\infty}$ = 578,2 mm, *K*= 0,51 yr<sup>-1</sup> with *R*<sub>n</sub>= 0,802, and *t*<sub>0</sub>= -0,86 years (Table 2). The estimated  $L_{\infty}$ = 578,2 mm of the *S. laticaudus* was found at the acceptable range comparing to the maximum length 500 mm. According to [24] Moreau et al. 1986 The VBGF calculated  $L_{\infty}$  parameter should be closed to the maximal length while *t*<sub>0</sub> should be less than zero so that the fish might be positive in length at birth.

**Table 2.** Summary of estimated growth

Species Name	Location	$L_{\infty}$	<i>K</i>	<i>t</i> <sub>0</sub>	Source
<i>S. laticaudus</i>	India (Calicut)	F 71,5	0,358	0,590	[25] Devadoss (1998)
		M 57,6	0,4046	0,590	
	Maharastra State, India	74,023	0,6812	-0,01	[22] Mathew et al., (1997)
	Bay of Bengal, Bangladesh	73,5	0,30	-0,4335	[10] Karim et al, 2017
	Rupat and Malacca strait	578,2	0,51	-0,86	This study

The  $t_0$  value measures the growth rate of adults; negative values imply a higher percentage of juveniles than is predicted by the adult growth curve, whereas positive values show slower growth [26].



**Fig. 4.** Length convert catch curve for *S. laticaudus*

Total mortality ( $Z$ ) was 2,24 per year with natural mortality ( $M$ ) and fishing mortality ( $F$ ) respectively 0,52/year and 1,72/year. Fishing mortality higher because this species was landed almost daily during the study. The exploitation rate ( $E$ ) of this fish was 0,77/year (Fig. 4) indicating high levels of exploitation. indicating its vulnerability to overfishing [27] and listed as near threatened [12].

## 4 Conclusions

The growth pattern of spadenose shark (*S. laticaudus*) is negative allometric. Estimation of growth parameters obtained  $L_{\infty} = 578,2$  TL,  $K = 0,51\text{y}^{-1}$  and  $t_0 = -0,86$  years. Total mortality ( $Z$ ) was  $2,24\text{y}^{-1}$  with natural mortality ( $M$ ) was  $\text{y}^{-1}$  and fishing mortality ( $F$ )  $1,72\text{y}^{-1}$ . The exploitation rate ( $E$ ) of this fish was  $0,77\text{y}^{-1}$  indicating high levels of exploitation.

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