Size distribution and population parameter of white-spotted wedgefish (*Rhynchobatus Australiae* Whitley, 1939) from the Eastern Indian Ocean, Indonesia

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**Abstract.** White Spotted Wedgefish (*Rhynchobatus australiae*, Whitley, 1939) is one of member Elasmobranchii family and it has economic value because of its fins valuable food source. The objective of the research is to determine population parameter and size distribution of White Spotted Wedgefish (*Rhynchobatus australiae*) from the Eastern Indian Ocean Fishing Region in Indonesia (WPP 573). A total of 407 samples were recorded from bottom longline fisheries at Tanjung Luar, Lombok from March 2014 to December 2016 by a trained enumerator. The size of sharks White Spotted Wedgefish varied from 95 mm to 323 m total length (TL), with average size was 222 mm. Size distributions and sex ratio between females and males were significantly different. Analysis on its population status showed that this species was very susceptible to overfishing. This condition should be responded by the government through management actions for its fishery.

1. **Introduction**

The white-spotted wedgefish (*Rhynchobatus australiae*) or pari kekeh in Indonesia name is one of Elasmobranch member that has important economic value in Indonesia. This species caught by bottom longline in Tanjung Luar, part of Eastern Indian Ocean Fishing region (WPP573) which is one of the most important fishing grounds in Indonesia and the center of shark fisheries in Indonesia because of many sharks is landing there. The white-spotted wedgefish is migratory and found in coastal inshore habitats in Southeast Asia and Australia. They are large benthopelagic shark-like batoids that are differentiated from other wedgefish species by their bottle-shaped snout. Like other species in the guitarfish family, the wedgefish is a bottom dweller and feeds on benthic invertebrates, crustaceans and small bottom-dwelling fish.

The white-spotted wedgefish spreads in Southeast Asia and Australia, ranging from Thailand, Taiwan, the Philippines, and Indonesia to the Australian sub-tropics [1]. It is the only widespread Rhynchobatus species throughout the central Indo-West Pacific and occurs more widely than was previously recorded, with samples located as far east as Fiji and as far west as India.
The status of this species in the IUCN red list for threatened species is classified as Vulnerable due to population depletions driven by overfishing in artisanal and commercial fisheries [2]; [1]; [3]; [4]. *Rhynchobatus australiae* was listed on Appendix II of the Convention on the Conservation of Migratory Species (CMS) in 2017; CMS Parties have thereby committed to cooperate toward conserving the species. In 2018, *R. australiae*, was added to Annex I of the CMS Memorandum of Understanding on the Conservation of Migratory Sharks, which aims to facilitate conservation efforts. *R. Australia* is caught as target species and as bycatch primarily for their fins, which are extremely valuable in international trade. Nevertheless, biological information of *Rhynchobatus australiae* is still limited. This study aims to provide updated information on parameter population of this species.

2. Material and methods

2.1. Data collection

The study of population of the white-spotted wedgefish was conducted during March 2014 to December 2016 in Tanjung Luar, part of Eastern Indian Ocean Fishing region (WPP573). A total of 407 samples were recorded from bottom longline fisheries by a trained enumerator. The parameters consisted of total length and sex, was collected as a baseline of this study. The total length was measured to the closest cm. Females and males were differentiated by the presence of claspers organ on males.

![Map of study site in Tanjung Luar](image)

**Figure 1.** Study site in Tanjung Luar

2.2. Data analysis

Analyses of growth Length-at-age data were fitted to the von Bertalanffy growth function (VBGF), the most commonly used growth model in fisheries science [5]. The VBGF is described as:

\[ L_t = L_\infty (1 - e^{-k(t-t_0)}) \] (1)

The parameters for the growth functions are as follows: \( L_t \) is the length at age \( t \) (in years); \( L_\infty \) is the species maximum (in mm); \( t_0 \) is the mean theoretical age when length is equal to zero (years); and \( k \) is the growth coefficient.

The theoretical age at birth (\( t_0 \)) was calculated using the empirical formula [6]

\[ \log (t_0) = -0.392 - 0.275 \log L_\infty - 1.038 \log K \] (2)

The total mortality coefficient (\( Z \)) was estimated by linearizing length-converted catch curve analysis [7]. \( Z \) was calculated by:

\[ Z = M + F \] (3)

Natural mortality of the stock was estimated using (Pauly, 1980):

\[ \log M = -0.0066 - 0.279 \log L_\infty + 0.6543 \log K + 0.4634 \log T \] (4)
Where, \( M \) = natural mortality and \( T (°C) \) = annual mean water temperature. The fishing mortality (\( F \)), describing the rate of mortality due to fishing activities, was estimated from the relationship [7]

Exploitation rate (\( E \)) was measured by the formula:

\[
E = \frac{F}{Z} \quad \ldots \quad 5)
\]

Sex ratio between females and males was also analyzed using Chi-Square test to determine the significant difference from the expected ratio 1:1 [8]

3. Results and discussion
3.1. Size distribution
Size distribution of white-spotted wedgefish showed that the total length 2014-2016 distributed from 95 to 325 cm with average is 222 cm. 2014, the white-spotted wedgefish was dominated by the size of 235 cm, 2015 it was dominated by size 255 cm and 2016 the size was dominate by 275 cm, respectively (Figure 2). The maximum size in this study is larger than size was found by [2] it was 300 cm.

Figure 2. Size distribution of white spotted wedgefish (\textit{Rhynchobatus australiae})

Size distribution was distinguished by sex. Size distribution of White Spotted Wedgefish showed that the total length of females distributed from 95 to 325 cm with size was dominated by 185 cm and males from 105 to 295 cm with size was dominated by 275 cm (Figure 3).
Figure 3. Size distribution of white spotted wedgefish (*Rhynchobatus australiae*) (a) Female (b) Male

3.2. Estimation of growth parameter ($L_\infty$, $K$, $t_0$)

Von Bertalanffy growth parameters for white-spotted wedgefish were estimated as follows: asymptotic length was 330 mm TL, the growth coefficient was 0.46/year, and the theoretical age at zero length was −1.18 years. Therefore, the growth equation was $L_t = 330 (1 - e^{-0.46(t+0.1839)})$ (Figure 3). The growth coefficient is similar with *Rhynchobatus* spp in Queensland with $k = 0.41$ year$^{-1}$ but $L_\infty$ is smaller than this study with value was 204.5 cm. Maximum observed age 228 was 12 years (female of 183 cm TL) [9] which would be well below longevity given that *R. palpebratus* reaches 262 cm TL and *R. australiae* reaches ~300 cm TL.

Figure 4. Growth of white spotted wedgefish (*Rhynchobatus australiae*)

3.3. The length at first captured ($L_c$)

Figure 4 shows the probability length of first at capture for white-spotted wedgefish. The probability of capture for *Rhynchobatus australiae* was estimated as: $L_c = 219, 78$ cm
Figure 5. The length of first capture of white spotted wedgefish (*Rhynchobatus australiae*)

3.4. Mortality and exploitation rate
The value of total mortality (Z) represented by the value of slope (b) between Ln N/dt and relative age was 1.15/year. The value of natural mortality (M) and fishing mortality (F) was 0.55/year and 0.60/year, respectively. Using exploitation rate equation (E) = F/Z, the value of E was calculated about 0.52/year (Figure 6)

Figure 6. Catch curve of white spotted wedgefish (*Rhynchobatus australiae*)

The value of fishing mortality (F) of white spotted wedgefish little bit more than the natural mortality (M). That means the exploitations for this species are not optimum. [10] Stated that the optimum fish stock is when fishing mortality value equal to its natural mortality. If the exploitation ratio was above 0.5, then the fish stocks are considered full-exploited. In this study, the exploitation rate of white spotted wedgefish (E) was 0.52 per year. It means that white spotted wedgefish stocks in Indian oceans waters has already full exploited
3.5. Recruitment
Figure 5 shows the recruitment pattern of white-spotted wedgefish. The recruitment pattern for this species was continuous throughout the period of study with two recruitment peaks - minor and major. Using macro inspection, the months for the minor and major recruitment peaks were March and August (Figure 5).

![Recruitment Pattern](image)

**Figure 7.** Recruitment pattern of white spotted wedgefish (*Rhynchobatus australiae*)

3.6. Sex ratio
Sex ratio is a number that indicates the ratio between males and females in a population and by natural, the ratio of males and females was 1:1 [11]. The overall sex ratio between males and females of the white spotted wedgefish (*Rhynchobatus australiae*) on this study was 1:5.44 (Figure 8) and it showed a significant difference from the expected ratio 1:1 ($\chi^2 = 3.814, P<0.05$), therefore it could be said the sex ratio for this species was not balance. By monthly, sex ratio in September 2014, 2015 and 2016, sex ratio between female and male was the similar (1:0, 100% female). That was indicated that the number of white spotted wedgefish caught in the Indian Ocean was dominated by females. It is could be also said that females were caught more frequent than males (Figure 9).

![Sex Ratio](image)

**Figure 8.** Sex ratio of white spotted wedgefish (*Rhynchobatus australiae*)
Figure 9. Monthly sex ratio of white spotted wedgefish (*Rhynchobatus australiae*)

[12] Argued that an adult females may occur at shallower waters to give birth. The other opinion expressed by [13] that there is an idea of segregation between females and males that occurred in different areas. [14] Added that the sex ratio was related to the amount of fish produced in the next generation and as a population control measure. That was predicted that unbalancing sex ratio will be increasing the susceptibility of white spotted wedgefish to be overexploited.

4. Conclusions

The size distribution of white-spotted wedge fish are between 95 and 325 mm in total length (TL) with average size was 222 cm, the length at first capture Lc = 219.78 cm, the asymptotic length was 330 cm TL, the growth coefficient was 0.46/year, and the theoretical age at zero length was –1.18 years, the value of total mortality (Z) represented by the value of slope (b) between Ln N/dt and relative age was 1.15/year, the value of natural mortality (M) and fishing mortality (F) was 0.55/year and 0.60/year, respectively, the sex ratio white-spotted wedgefish between 2014-2016 almost was dominated by female, and exploitation rate (E) of the white-spotted wedgefish in the waters is found quite high with a value of 0.52/year. From this research, it suggests that fishing effort should be reduced.

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