



PRELIMINARY STUDY ON BIOLOGICAL ASPECTS OF PAPUAN SEERFISH (*Scomberomorus multiradiatus* MUNRO, 1964) IN MERAUKE WATERS, PAPUA, INDONESIA

Duranta Diandria Kembaren*¹, Adi Surahman¹ and Tegoeh Noegroho¹

¹Researcher of Research Institute for Marine Fisheries, Cibinong, Jl. Raya Bogor KM. 47, Cibinong, Bogor Jawa Barat, Indonesia

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ABSTRACT

Papuan seerfish (*Scomberomorus multiradiatus*; local: tenggiri papua) is an endemic species to the Papuan waters and distributed from the waters of Papua New Guinea to Merauke in Indonesia. The biological information of this species is little known. This study aimed to determine the biological aspects of Papuan seerfish to fill the research gap of this species. The data collection were conducted from February to November 2016. Biological parameters observation of the fish sample included of fork length (FL), sex, and maturity stages. All the data were analyzed using standard methods. The maximum length and weight of Papuan seerfish from Merauke waters were 49 cm and 908 g and this size became the largest published size ever. The sex ratio was in an equal condition and the growth pattern was isometric. Spawning occurs all year arounds and reach its peak on August. The relative condition factor of Papuan seerfish tend to be low in the reproductive periods. Papuan seerfish from Merauke waters were caught before reaching their size at maturity ($L_c < L_m$). For the sustainability of this resources and precautionary approach of fisheries management, it is suggested to apply the minimum catch size in 33 cm.

Keywords: Biological; condition factor; size; maturity; Papuan seerfish

INTRODUCTION

Papuan seerfish (*Scomberomorus multiradiatus* Munro, 1964) also called Papuan Spanish mackerel (locally called *tenggiri papua* or *tenggiri polos*) is one of species in the Scrombridae family and the smallest species in the genus of *Scomberomorus*. Papuan seerfish is an endemic species to the Gulf of Papua off the mouth of Fly River, Papua New Guinea (Collette, 2001) but maybe more widespread as there are records from the Timor Sea (Buckworth & Clarke, 2001 in Collette *et al.*, 2011). Papuan seerfish is an epipelagic, neritic species found in turbid water and nothing is known about its biology (Collette, 2001). Morphologically, Papuan seerfish showed a different characteristic than other Scrombridae members, especially on its body color, where its body color is silvery without spots, blotches, or bars (Collette, 2001). Color patterns are dark bluish black dorsally, silvery white ventrally, with no spots, blotches, or bars. First dorsal fin black anteriorly and along distal edge posteriorly with some white at base of fin posteriorly (Collette & Russo, 1984).

Papuan seerfish in Indonesia has never been reported. Collette (2001) reported that the spread of this species only endemic in the Gulf of Papua waters off the mouth of Fly River (part of Papua New Guinea waters), while this fish is also found in the waters of Merauke, Indonesia. This could be happen because species in the genus *Scomberomorus* migrate along the coastline (Randall, 1995) and commonly found on the edge of the continental shelf to shallow coastal waters, gentle reefs and lagoons with depths between 10-70 meters (McPherson 1985, Myers 1991). In North Queensland Australia, it was found to be up to 10 cm in tributaries, estuaries and mangrove waters in protected areas during the rainy season (McPherson, 1981) and some species were known migrate along the coast, but some do not migrate. Some fish will migrate up to 1,000 miles after spawning on coral reefs (McPherson, 1989). In Merauke waters, Papuan seerfish was caught using gillnet with 3 inch in mesh size by small-scale fisherman. Gillnets are commonly operated at 15 – 20 m water depth. Fishing activities were conducted from dusk until dawn and consumed by local people.

correspondence author:
e-mail: dd.kembaren@gmail.com

The biological information of Papuan seerfish was little known (Collette, 2001) and according to the IUCN list, this species belongs to the Least Concern criteria (Collette *et al.*, 2011). A least concern species is a species which has been categorized as evaluated but not qualified for any other category because the information not adequate. This study aimed to determine the biological aspects of Papuan seerfish that includes morphometric characteristic (length distribution, length-weight relationship), sex ratio, maturity, and relative condition factor based on the monthly catches landed in Merauke Regency of Papua Province. The results from this study will be valuable in term of fill the research gap and contribute as an auxiliary information to assess the status of *S. multiradiatus* in the waters of Merauke.

MATERIALS AND METHODS

Biometric measurement and biological examination were conducted from February to November 2016. Fish sample (Figure 1) were collected from fishermen landed which is caught using gillnet in Merauke Regency, Papua, Indonesia (Figure 2). Biological parameters observation of the fish sample included of length, sex, and maturity. The measured length used in this analysis is fork length (FL). The length frequency distribution was created with 2 cm class interval. Size structure are observed to estimate the fishing gear selectivity, the size of dominant fish caught, size at maturity, and growth. Fish sampling was done by trained enumerator through semi-regular observation.



Figure 1. Papuan seerfish (*S. multiradiatus*) caught in the waters of Merauke, Papua.

Sex ratio was estimated as (Fowler *et al.*, 1998):

$$X^2 = \sum \frac{(o_i - e_i)^2}{e_i} \dots\dots\dots(1)$$

where o_i is frequency numbers of males and females, e_i is expected frequency number of males and females and Chi-square test was performed to test the homogeneity of males and females

distribution. Gonado-somatic index (GSI) was calculated using the formula (Effendi, 2002):

$$GSI = \frac{GW}{BW} \times 100 \dots\dots\dots(2)$$

where GW is the gonad weight and BW is body weight, both in g.

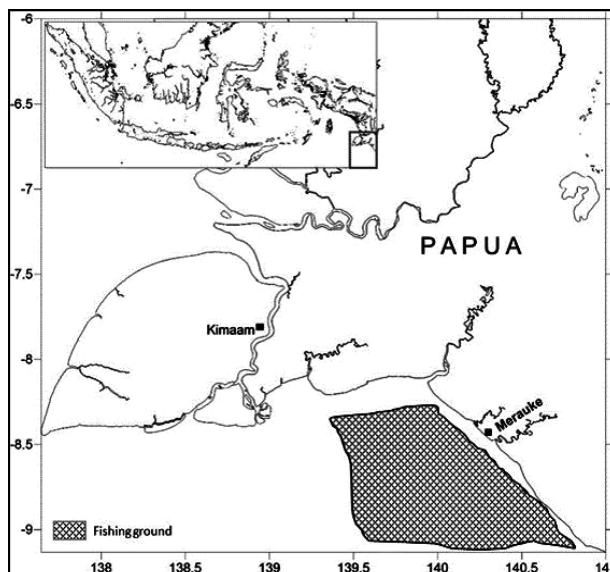


Figure 2. Fishing ground of gillnet fishery and sampling site of Papuan seerfish biological information.

Length-weight relationship was expressed as (Le Cren, 1951; Effendi, 2002):

$$W = aL^b \dots\dots\dots(3)$$

and calculated as:

$$\log W = \log a + b \log L \dots\dots\dots(4)$$

where W is the weight of fish in g, L is fork length (FL) in cm, log a is the regression intercept, and b is the slope. To assess the growth pattern, t-test was performed to test the significance different of b value toward 3.

When the value of b equal to 3 (b = 3) then the growth pattern is isometric but if b value significantly different from 3 then the growth pattern is allometric. The b value greater than 3 (b > 3) the growth pattern is positive allometric, while the b value smaller than 3 (b < 3) then the growth pattern is negative allometric.

Relative condition factor was estimated as (LeCren, 1951; Effendi, 2002; King, 2007):

$$K_n = \frac{w}{w'} \dots\dots\dots(5)$$

where K_n is relative condition factor, W is observed weight, and W' is predicted weight ($W=aL^b$).

Length at first capture (Lc) was estimated using logistic function (Sparre & Venema, 1998) as:

$$S_{Lc} = \frac{1}{1 + e^{(a-bL)}} \dots\dots\dots(6)$$

where S_{Lc} is gear selectivity of gillnet, a and b are a

constant, L is fork length (FL) and Lc is calculated from a/b. Length at maturity (Lm) was estimated using the logistic equation as outlined by King (2007) by fitting the fraction of mature fish (stages III and above) against the fork length (FL). The equation formula calculated as:

$$P = \frac{1}{1 + e^{[-r(L-L_m)]}} \dots\dots\dots(7)$$

This equation can be transformed to linier form as:

$$\ln \left[\frac{1-P}{P} \right] = rL_m - rL \dots\dots\dots(8)$$

Where P is a proportion of fork length at mature stages divided by fork length at immature and mature stages, rL_m is intercept, r is the slope, then length which corresponds to a proportion of 0.5 (50%) in reproductive condition (L_m) is equal to (intercept)/r.

RESULT AND DISCUSSION

Result

Size Structure

The length distribution of males *S. multiradiatus* in the commercial landings ranged between 22 - 45 cm with a mean length of 31.6 cm (±3.2, s.d), while the females ranged between 25 - 49 cm with a mean length 32.6 cm (±3.9, s.d). The length frequency distribution showed that there were two modus (peaks) which is representing the age group of this species. There was no difference found in the modus of males and females. The first modus was found at the length class of 30 cm, while the second modus was found at the length class of 34 cm (Figure 3).

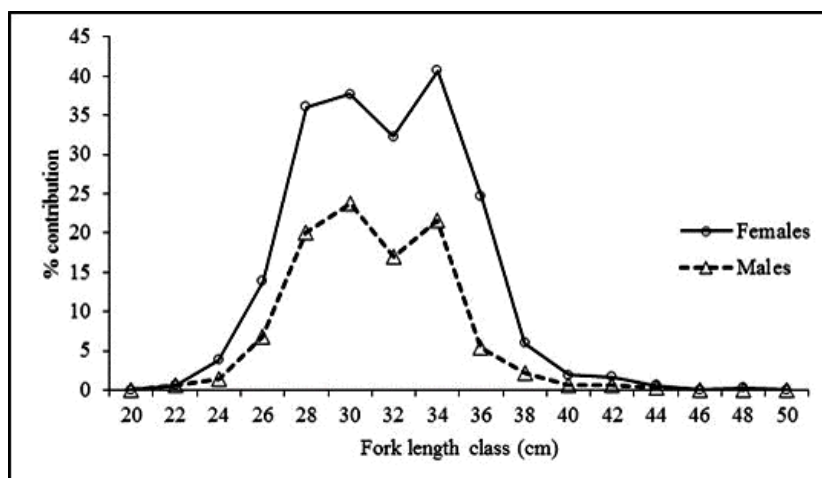


Figure 3. Length frequency distribution of Papuan seerfish (*S. multiradiatus*) caught in the Merauke waters, 2016.

Size structure on length and weight of *S. multiradiatus* without differentiating sexes (pooled data) was presented in the Figure 4. The average length of *S. multiradiatus* caught monthly ranged from 22 cm to 49 cm with the mean of 31.8 ± 3.4 cm, while its individual body weight ranged from 120.1 g to 908 g with the mean of 261.7 ± 133.6 g. The highest length and body weight of this species was found on September as well as its average size. The lowest length was found on March and August while the lowest weight was found on February. The lowest average of length and body weight was found on February (Figure 4).

Sex Ratio and Reproductive Biology

A total of 736 individual of *S. multiradiatus* were collected for biological studies, comprising of 369 males and 267 females. The overall sex ratio of males to females was 1:0.9 and the chi-square test showed that the proportion of the sexes was not different significantly ($p > 0.05$). It is mean that population of males and females in the equal condition. Monthly-wise analysis of pooled data shows a dynamic on the sex predominance. Chi-square test showed significant dominance ($p < 0.05$) of males during August and females during February-March ($p < 0.05$) (Figure 5).

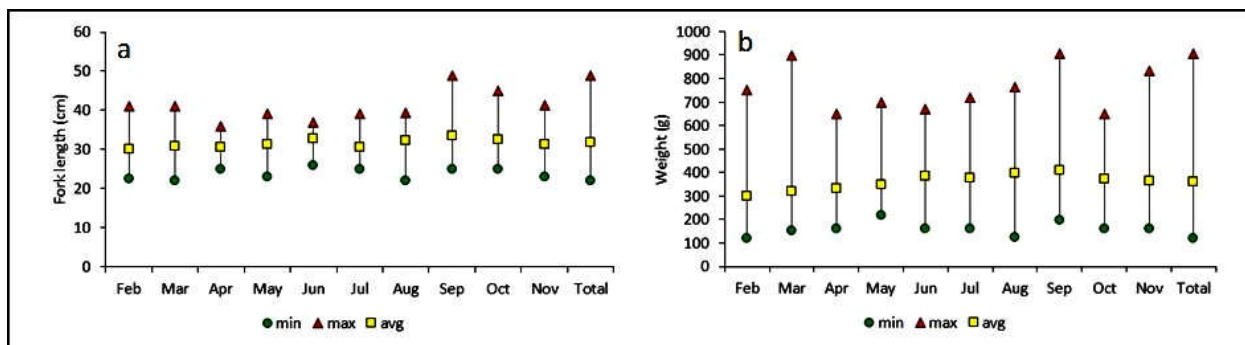


Figure 4. Monthly fork length (a) and body weight (b) structure of Papuan seerfish (*S. multiradiatus*) in Merauke waters, 2016.

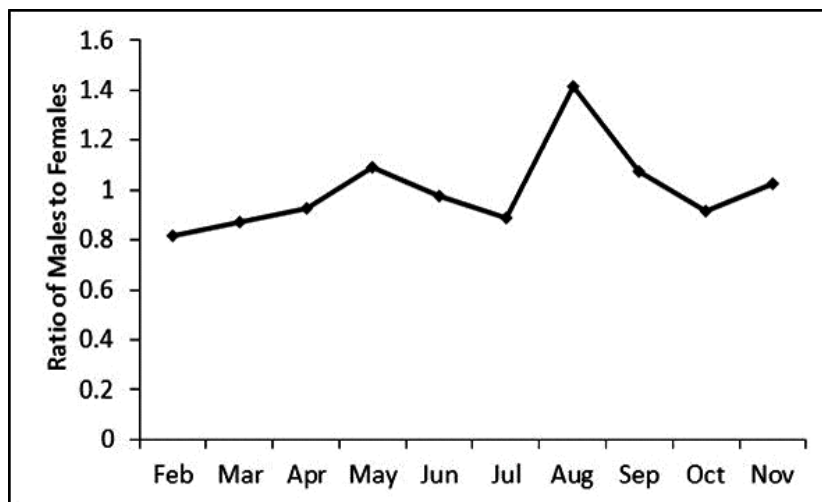


Figure 5. Monthly percentage contribution of males and females of *S. multiradiatus* in the waters of Merauke, Papua.

The average of gonado-somatic index (GSI) for females *S. multiradiatus* ranged from 0.5 to 4.3% (1.5 ± 1.05) while for males ranged from 0.1 to 0.3% (0.2 ± 0.05) and it was indicating that spawning occurred all year around. Moreover, GSI analysis

showed one distinctive spawning peak in a year which was observed on August, approximately 4.3% (Figure 6). This result revealed that the spawning peak season occurred on August (late of east monsoon).

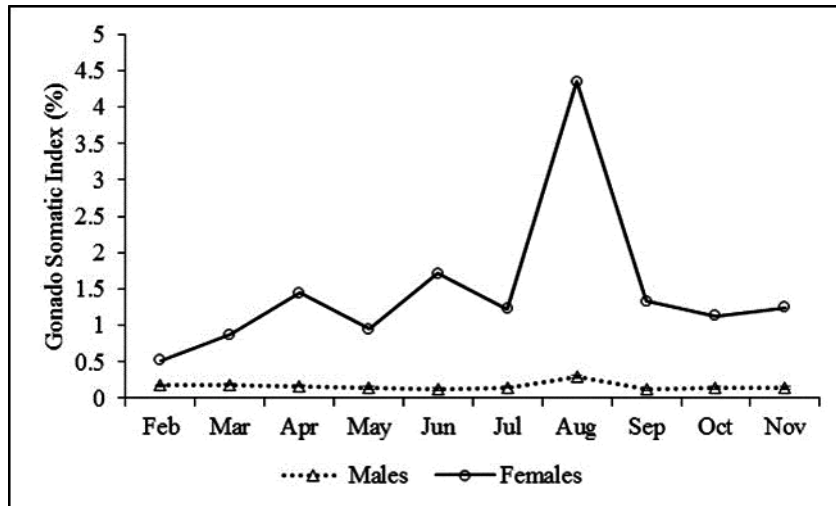


Figure 6. Gonado somatic index for females *S. multiradiatus* from Merauke waters.

Length-Weight Relationship

A total of 793 individuals were consisted of 370 males and 367 females were used to generate length-weight relationship for this species. The relationship between fork length and weight for males, females and pooled sexes were estimated as follows:

Length-weight relationship (males): $\log W = -1.2044 + 2.4868 \log L, R^2 = 0.71$
 Length-weight relationship (females): $\log W = -2.1267 + 3.1129 \log L, R^2 = 0.83$
 Length-weight relationship (pooled sexes): $\log W = -1.8776 + 2.9399 \log L, R^2 = 0.80$

Based on the analysis of t-test to the regression coefficient (b value), the males fish showed the negative allometric growth ($b < 3$), while the females showed the isometric growth. Moreover, pooled sexes of *S. multiradiatus* showed the isometric growth ($b = 3$).

Relative Condition Factor

Relative condition factor (K_n) of female Papuan seerfish found in the range of 0.504 - 2.266 (1.015 ± 0.192) while the male in the range of 0.570 - 1.538 (1.004 ± 0.160). Based on the analysis of variance (ANOVA), it is found that K_n value was not different significantly ($p > 0.05$) by sexes and length class (Figure 7).

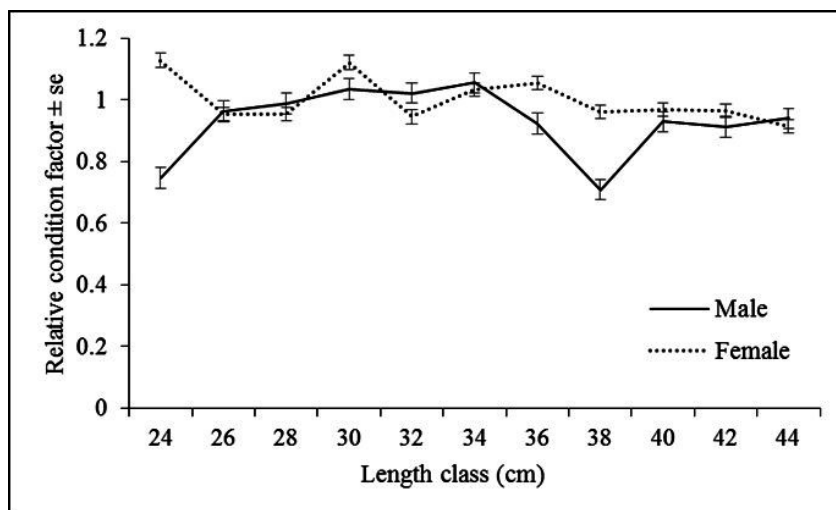


Figure 7. Distribution of Papuan seerfish relative condition factor (K_n) based on the length class in the Merauke waters.

The average of relative condition factor (K_n) of Papuan seerfish were showing a fluctuation between time of observation (temporally) (Figure 8). According

to the analysis of variance (ANOVA), it is found that the K_n value between time of observation was different significantly ($p < 0.05$). The highest of female K_n value

were found on June (1.106) and males on July (1.075), while the lowest of female K_n found on May and male found on September.

Length at First Capture (Lc) and Length at Maturity (Lm)

Analyzing using logistic curve was conducted to estimate the size at capture (Lc) and size at maturity

(Lm) of *S. multiradiatus*. Length at first capture of *S. multiradiatus* was estimated to be 30.8 cm, while length at maturity (Lm) for females was estimated to be 32.7 cm (Figure 9). However, the smallest specimens were recorded in the catch from 22 cm onwards and mature specimens (ripening) were recorded in the catch from 28 cm onwards. This result showed that *S. multiradiatus* were catch before reaching their size at maturity (Lc<Lm).

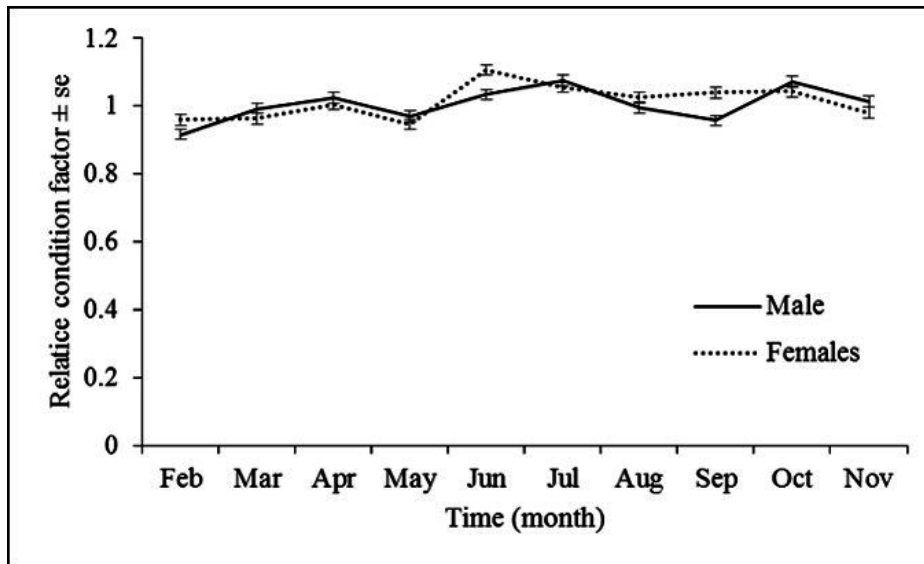


Figure 8. Temporal distribution of Papuan seerfish relative condition factor (K_n) in the Merauke waters.

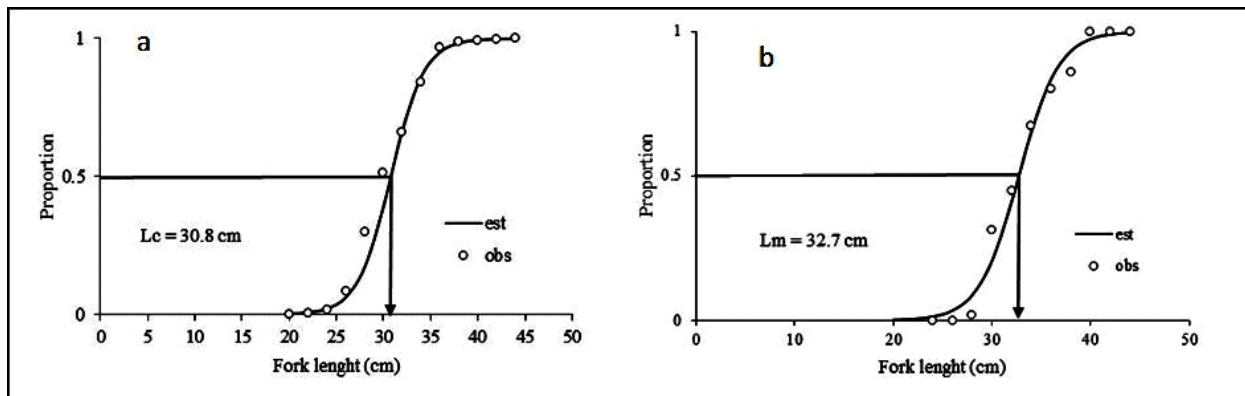


Figure 9. Length at capture (Lc) and length at maturity (Lm) of *S. multiradiatus* in the waters of Merauke.

Discussion

Formerly, Papuan seerfish (*Scomberomorus multiradiatus*) was known as an endemic species to the Gulf of Papua (Papua New Guinea) waters but in this study we also found this species in the Merauke waters of Indonesia which is caught by fisherman using the gillnet. Juan-Jorda *et al.*, (2012) reported that in addition to the Gulf of Papua, the spread of these fish was also in Timor Sea in the Indo-Pacific. This study revealed that the migration of this species reached the Merauke waters and this finding strengthen the

statement of Randall (1995) that the genus of *Scomberomorus* migrate along the coastline.

The fork length of Papuan seerfish from Merauke waters ranged from 22 cm to 49 cm and their body weight ranged from 120.1 g to 908 g. The size structure of Papuan seerfish in this study was greater than maximum published length and weight which was 35 cmFL and 500 g (Collete, 2001; Juan-Jorda *et al.*, 2013; Froese & Pauly, 2018). However, Papuan seerfish is the smallest species in the genus of *Scomberomorus*. The others *Scomberomorus* species

such as *S. commerson*, *S. guttatus*, *S. koreanus*, *S. lineolatus*, *S. munroi*, *S. queenslandicus*, *S. semifasciatus* and *S. sinensis* were commonly found in the commercial catch with fork length greater than 50 cm (Collette, 2001). Length frequency analysis showed that the catch size was dominated by the fork length class from 28 cm to 34 cm, while the size smaller than 28 cm and higher than 34 were caught in the lower portion.

The sex ratio of fish in a population is used as a basic knowledge of reproductive biology (Holden & Raitt, 1974) and picturing how fish maintain their population or also known as indicator of population ability to survive through recruitment (Johnson, 1994). The monthly sex ratio of Papuan seerfish from Merauke waters fluctuates where the ratio was significant on February-March and August while the overall sex ratio showed in the equal condition. Sex ratio of fish might be varied within species. Effendi (2002) stated that the variation on the sex ratio could be affected by three factors, i.e. difference in the sex behavior, environmental condition, and fishing ground. Moreover, temperature was known as the most common environmental cue affecting the sex besides density, pH, and hypoxia (Baroiller *et al.*, 2009).

Gonado-somatic index (GSI) is a common methods to assess reproductive condition in fisheries biology besides microscopic gonadal staging, macroscopic gonadal staging, oocyte-size frequency distribution and sex steroid measurement (Lowerre-Barbieri *et al.*, 2011). In this study, the GSI of females was higher significantly ($p < 0.05$) than males. In females, the highest GSI value was obtained in the mature stage, which was higher significantly than those of others stage while the least GSI value were obtained in the immature stage. This phenomenon was associated with the heavier weight of ovaries which contained the eggs.

The length-weight relationship is useful in fisheries research, where it's parameters value use to (1) estimate weight from length observation because direct weight measurement can be time consuming and potential sources of uncertainty, (2) estimate the condition of fish, (3) calculate the growth, biomass, production of population, and spawning potential ratio, and (4) compare the fish growth between regions (Stergiou & Moutopoulos, 2001; Sinovic *et al.*, 2004; Froese, 2006; Velamala *et al.*, 2018). The length-weight relationship shows that from the pooled data, the growth coefficient (b) of this species was 2.94 and statistically equal to the 3 ($b = 3$). So the growth pattern of this species was isometric, which is means that the length and weight grow at approximately the

same rate and the adult proportion are not different significantly from those juvenile. Moreover, Ricker (1975) stated that the characteristic of isometric growth was unchanging body form and unchanging specific gravity.

Scomberomorus guttatus, which is in the same genus with *S. multiradiatus* showed isometric growth in the Cilacap and adjacent waters (Restiangsih *et al.*, 2016) and Moro waters part of Kepulauan Riau (Noegroho *et al.*, 2018), while Anulekshmi *et al.* (2018) found that *S. guttatus* from north-eastern Arabian sea had an negative allometric growth. The differences in the fish growth pattern could be caused by the biological factors such as gonadal development, feeding habit, growth phase and sexes (Froese, 2006; Tarkan *et al.*, 2006) and ecological factors such as season, water quality, temperature, salinity, acidity (pH), geographical position and sampling techniques (Zargar *et al.*, 2012).

The relative condition factor of Papuan seerfish tend to be higher in the females than males but statistically not different between sexes and length class, while the relative condition factor was significantly different temporally. The highest K_n found on June while the lowest found on September. This phenomenon related to the reproductive condition where the spawning peak season based on the gonad maturity index occurred on the late of east monsoon (August). In the reproductive period, fish condition tend to decrease due to their need to spend more energy for spawning. Generally, condition factor used to assess the health, productivity and biological condition of fish population (Blackweel, 2000). Moreover, condition factor also reflects the changes of fish condition throughout a year and indirectly be used as marker of environmental changes (Raharjo *et al.*, 2011).

This study found that length at first capture lower than length at maturity ($L_c < L_m$). This result indicates that Papuan seerfish in Merauke waters was threatened because it caught before conduct the reproduction proses for the first time. A good fishing activity that support the recruitment process should be targeting to catch fish with the size as minimum as length at maturity. Catching the fish which is lower than size at maturity will be lead to decrease the fish stock resources due to the hindrance of the recruitment process (Henriques, 1999 *in* Pinheiro & Oliveira, 2006). For the sustainability of this resources and applying precautionary approach of fisheries management, it is suggested to apply the minimum catch size which is greater than size at maturity. This study suggest that the minimum catch size for Papuan seerfish is 33 cm.

CONCLUSION

Papuan seerfish (*Scomberomorus multiradiatus*) is an endemic species to the Papuan waters from Gulf of Papuan in Papua New Guinea to Merauke waters in Indonesia. This species caught using gillnet. The maximum length and weight of Papuan seerfish from Merauke waters are 49 cm and 908 g and this size became the largest published size ever. The sex ratio was in an equal condition and the growth pattern as isometric. Spawning occurs all year around and reach its peak on August. The relative condition factor of Papuan seerfish tend to be low in the reproductive periods. Papuan seerfish from Merauke waters were caught before reaching their size at maturity. For the sustainability of this resources, it is suggested to apply the minimum catch size in 33 cm.

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