[IFRJ] Editor Decision

2 messages

Indonesian Fisheries Research Journal <ifrj.puslitbangkan@gmail.com> 22 February 2018 at 09:48
To: "Mrs. Meuthia Aula Jabbar" <meuthia.aula@gmail.com>

Mrs. Meuthia Aula Jabbar:

We have reached a decision regarding your submission to Indonesian Fisheries Research Journal, "REPRODUCTIVE BIOLOGY OF THE RED BIGEYE (Priacanthus macracanthus cuvier, 1829; Family Priacanthidae) IN PALABUHANRATU BAY, INDONESIA".

Our decision is: Resubmit for Reviews

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Meuthia Aula Jabbar <meuthia.aula@gmail.com> 22 February 2018 at 10:15
To: Indonesian Fisheries Research Journal <ifrj.puslitbangkan@gmail.com>

Dear Editor,

Thank you for the information.

Warm regards,
Meuthia
[Quoted text hidden]

REPRODUCTIVE BIOLOGY OF THE RED BIGEYE (*Priacanthus macracanthus* cuvier, 1829; Family Priacanthidae) IN PALABUHANRATU BAY, INDONESIA

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ABSTRACT

The reference data of reproductive biology have important roles for fishery management. Different waters will provide different overview of fisheries biological aspects. The red bigeye (*Priacanthus macracanthus*) is an economically important demersal fish species in Indonesia. The objective of this study is to estimate the spawning season and reproductive potency and also to evaluate how the key management related to the species and selectivity of fishing gear. Red bigeye (*Priacanthus macracanthus)* was collected from bottom gillnetter and hand liner. Measurements of red bigeye's somatic were conducted to evaluate the fishery aspects while the observation of its gonadic were done to evaluate reproductive aspects. The result showed sex ratio no significant differences between males and females except in September to December. The growth pattern indicated negative allometric. The spawning seasons were around June-July and December-January. Fecundity was estimated to be 230 000 - 178 000 eggs. Key management obtained length at first maturity (Lm) value was to be 21.9 cm TL which is smaller than length at first capture (Lc) 22.4 cm TL for bottom gill netter and 23.1 cm TL for average fishes caught by hand liner. Therefore it is recommended to close the area during the spawning period. In the case of catch, it is important to pay attention to the size of fish allowed to be captured more than the Lm value.

Keywords: Fecundity; *Priacanthus macracanthus*; Reproduction; Sex ratio; Spawning season

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INTRODUCTION

The Priacanthidae (commonly known as bigeyes) are tropical fish comprising 4 genera *Cookeolus*, *Heteropriacanthus*, *Priacanthus*, and *Pristigenys*. The Genus *Priacanthus* consists of 12 species (Froese & Pauly, 2017) and *Priacanthus macracanthus* Cuvier, 1829 is an important species targeted by inshore fishers in Indonesia.

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The red bigeye, *P. macracanthus*, is widely distributed in the Indo-West Pacific, East Indian region, southern and northern Japan, west coasts of Australia northward to Andaman Sea, south to Australia and New Caledonia. Typically, red bigeyes inhabits nearshore reefs (Starnes, 1999; Ramachandran & Varghese, 2009; Allen & Erdmann, 2012; White *et al.*, 2013) where it is targeted by bottom gillnet fishers in Indonesia.

Priacanthus macracanthus supports important fisheries and dependent communities in Indonesia. It is used not only as marketed fresh but also in dried, salted, and as fish balls (Starnes, 1999; Sivakami *et al.*, 2003). By products of red bigeyes e.g. surimi can be utilized as an alternative feed material of animal protein in aquaculture (Safitri *et al.*, 2016). Information on reproductive biology can assist with sustainable management of this species.

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The information of fish reproductive biology is one of the important parameters in understanding sustainability responses to existing fishing pressures (Lambert, 2008; Lowerre-Barbieri *et al.*, 2011). Some aspects of biology for red bigeyes have been reported previously in several waters such as in India (Rao, 1983), demographic analysis in Tungkang Waters-Taiwan (Liu *et al.*, 1992), including feeding in Hongkong (Lester, 1968), parasitism in South China Sea (Lester & Watson, 1985), reproductive biology in East China Sea (Oki & Tabeta, 1999) and north-eastern off Taiwan (Liu *et al.*, 2001; Liu *et al.*, 2002). However, reproductive biology in Palabuhanratu Bay has never been reported.

The objective of this study was to provide the information related reproductive biology including length-weight relationship, sex ratio, sexual maturity stages, gonado somatic index (GSI), size of oocytes, oocyte development based on histological examination, fecundity, length at first maturity (Lm) and length at first captured (Lc) for red bigeyes in Palabuhanratu Bay. It is expected that the results of this study can be used as

baseline information and input parameters for ~~the~~ further assessment of the stock in this region.

MATERIALS AND METHODS

Samples of red bigeyes (419 specimens, 243 males and 176 females) were obtained from the catch of local fishers including bottom gillnet and hand line in the Palabuhanratu Bay (Figure 1). Random samples were collected each month from May 2016 to April 2017 at Palabuhanratu fishing port, southern Java island, Indonesia. Whole weight (to the nearest 0.1 g) and total length (to the nearest 0.1 cm) were measured. Gonads were removed and weighed to the nearest 0.01 g. Gonads were preserved in Guilson's fluid for further examination of fecundity and oocyte diameter.

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Mesh size ?

Observation of biological aspects was conducted in Fishery Laboratory of Palabuhanratu National Fishing Port. ~~Observation of~~ fecundity measurements was conducted in Laboratory of Fish Biology, Department of Aquatic Resources Management-Bogor Agricultural University and Fish Biology Laboratory in Research Institute for Marine Fisheries, Jakarta. Histological examination of ovaries was done in Histology Laboratory, Installation of Ornamental Fish Cultivation, Depok.

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Thirty five ovaries representing sexual maturity stage III and IV were selected to confirm homogeneity or heterogeneity of the oocyte diameter and to estimate fecundity. As much as 0.1 g of each ovary (the anterior, middle, and posterior) were placed in sedgewick rafter cells for enumeration of oocytes. All oocytes were measured under magnification of projector 10 x 10 to observe the oocytes diameter and 4 x 10 to enumerate eggs. Histological examination followed (Mumford, 2007) with minor modification. Ovaries were maintained in a 10% formalin solution for a minimum of 48 hours before processing. A total of 10 gonads were sectioned at 3 µm thickness and stained with haematoxylin and eosin.

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Length – weight relationship was depicted by

$$W = aL^b, \quad \text{.....(1)}$$

where : W is total body weight (g),

L is the total length (cm),

a and b are functional regression coefficients of W and L (Sparre & Venema, 1998).

T-test was performed ~~used~~ to test the null hypothesis that 'b' was isometric.

Sex ratio was presented as: (number of females)/(number of pooled sexes).

Write down in standard formula

Xxxx ..... (2)

Chi-square test used to identify differences between observed and expected values in sex ratio.

Gonado somatic index (GSI) was calculated by

: GSI = (gonad weight/gutted body weight) x 10^2. .....(3)

Fecundity (F) was estimated from the equation:

$F =$ ..... (4)

Where : (number of oocytes stage 3 or 4 (0.1 g ovary in 1 ml diluent water) x ovary weight preserved in Guilson's fluid)/(0.1 g ovary's sample).

The fecundity and length relationship was expressed by the allometric equation of

$$F = a\,L^b \text{ ..... (5)}$$

where a and b are estimated parameters .

The length at first capture (Lc) was estimated from,

$$S_L\text{est} = 1 / (1 + \exp (S_1 - S_2 \times L)), \text{ ..... (6)}$$

where Lc=S_1 / S_2; $S_L$est is logistic curve;

S_1 and S_2 are constants (Sparre & Venema, 1998). The Spearman-Karber method for estimating the length at first maturity,

$$m = xk + X/2 - (X \times \Sigma pi), \quad \ldots\ldots (7)$$

where m, logarithm of length at first maturity; xk, logarithm of the middle value of the last class of 100% mature specimens; X, difference of logarithm of mean value; pi, comparison of mature gonads per length class (Udupa, 1986).

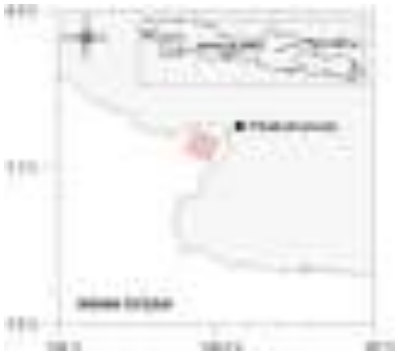

Figure 1. Fishing ground (marked red) for the red bigeyes in Palabuhanratu Bay, West Java, Indian Ocean.

RESULTS AND DISCUSSION

Results

Length-Weight Relation

Total length of male red bigeyes sampled varied from 13.5-32.5 cm, and total weight varied between 42 and 532 g; and for females 15-31.5 cm TL with total weight 56-430 g. The length-weight relationships were estimated to be: $W = 6.92 \times 10^{-2} \times TL^{2.47}$ for males (Figure 2a) and W = $W = 5.36 \times 10^{-2} \times TL^{2.58}$ for females (Figure 2b). Their type of growth were negative allometric (each sex).

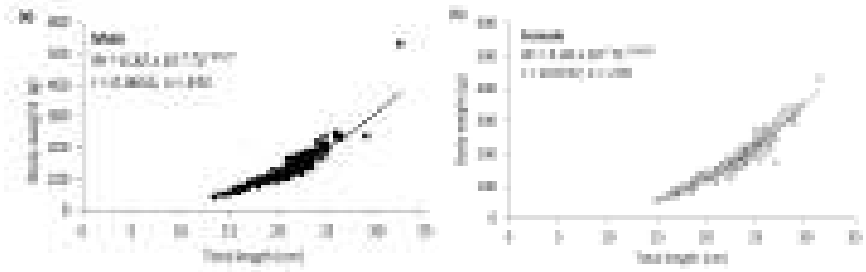

Figure 2. Length-weight relationships of red bigeye. (a) males, (b) females.

Sex Ratio

~~Monthly sex ratio showed dominance of males in the population~~. The females ratio varied seasonally and from all samples was 0.42 (176 / 419). The lowest sex ratio of females was 0.22 in November 2016 and the highest in May 2016 at 0.64 (Figure 3).

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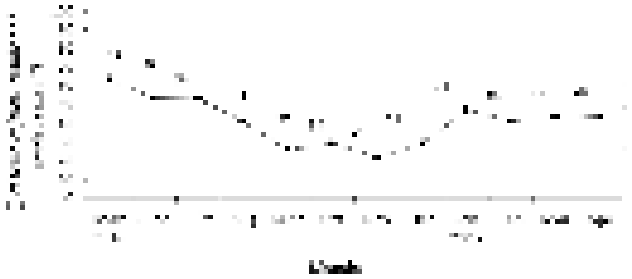

Figure 3. Monthly fluctuation in sex ratio of red bigeyes. Label numbers indicated total number of sample.

Based on sampling, the total number of males was dominant comparing to the females. Furthermore the evaluation of the sex ratio with Chi-square showed that monthly sex ratio were no significant different between males and females except during September, October, November and December (See Appendix 1).

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Gonad Maturity Stages

Both male and female, stage IV were found in every month. The males with the highest stage IV obtained in July (50%) and January (56%) (Figure 4a) while the female were in July (67%) and December (58%) (Figure 4b). It is estimated that the spawning

season of red bigeyes occupy in May-April. The peaks of spawning occur around June/July and December/January.

(a) Male (b) Female

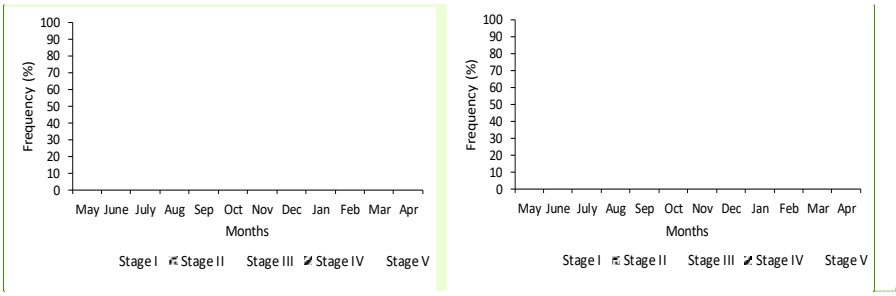

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Figure 4. Percentage occurance of different stages of red bigeye's gonades. (a) males, (b) females.

Gonad Somatic Index (GSI)

The GSI average of males have two peaks were in July and March (2.54 and 1.56 respectively). The female also had bimodal in July and December (5.05 and 2.61 respectively) (Figure 5). Gonado Somatic Index for male and female shows that spawning season happened around July/August and December/January when GSI showed decreasingly after the peak value.

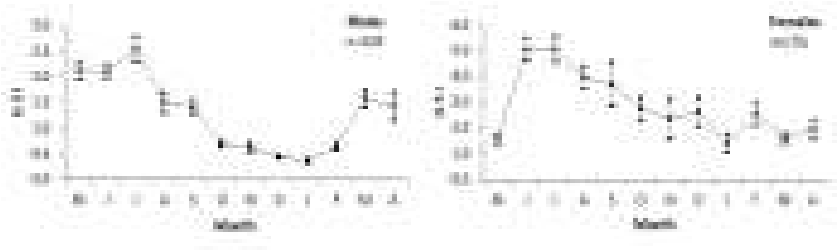

Figure 5. Monthly gonadosomatic index (GSI) of red bigeyes (data are means ± standard deviation).

Size of Oocytes

Oocytes d~~D~~iameter were measured~~ments~~ based on ~~of oocytes~~ from ovaries ~~of~~ with maturity stages of III and ~~stage~~ IV. The oocytes frequency distribution (Figure 6) shows that each stage have one peak and two peaks pooled (both stages). This indicated that the

distribution of oocytes consist of more than one group. The mode ~~in~~ of stage III was about 0.3 mm, then~~.~~ ~~This mode progresses~~shifted to 0.4 and 0.5 mm in Stage IV. This ~~is~~ indicated that the spesies was chategorized as multiple spawner.

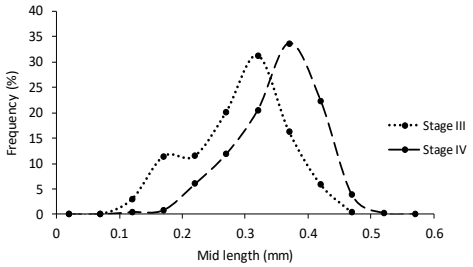

Figure 6. Oocytes diameter of red bigeyes sampled between June 2016 and February 2017

Fecundity

Fecundity was estimated based on ~~from~~ 35 ovaries with different oocytes frequency distribution modes. Fecundity expressed as the number of oocytes with ~~mainly~~ diameter of > 0.3 mm, and following equation (4) the estimation ranged from ~~28~~ 28,700 (TL = 24.5 cm) to 806,900 (TL = 26 cm) with a mean of ~~230~~ 230,000 ± ~~178~~ 178,000.

Oocyte Development

Development of oocytes for the red bigeye were determined based on histological examination. Through its development can be estimated at least there are five stages of sexual maturity as described below (Figure 7).

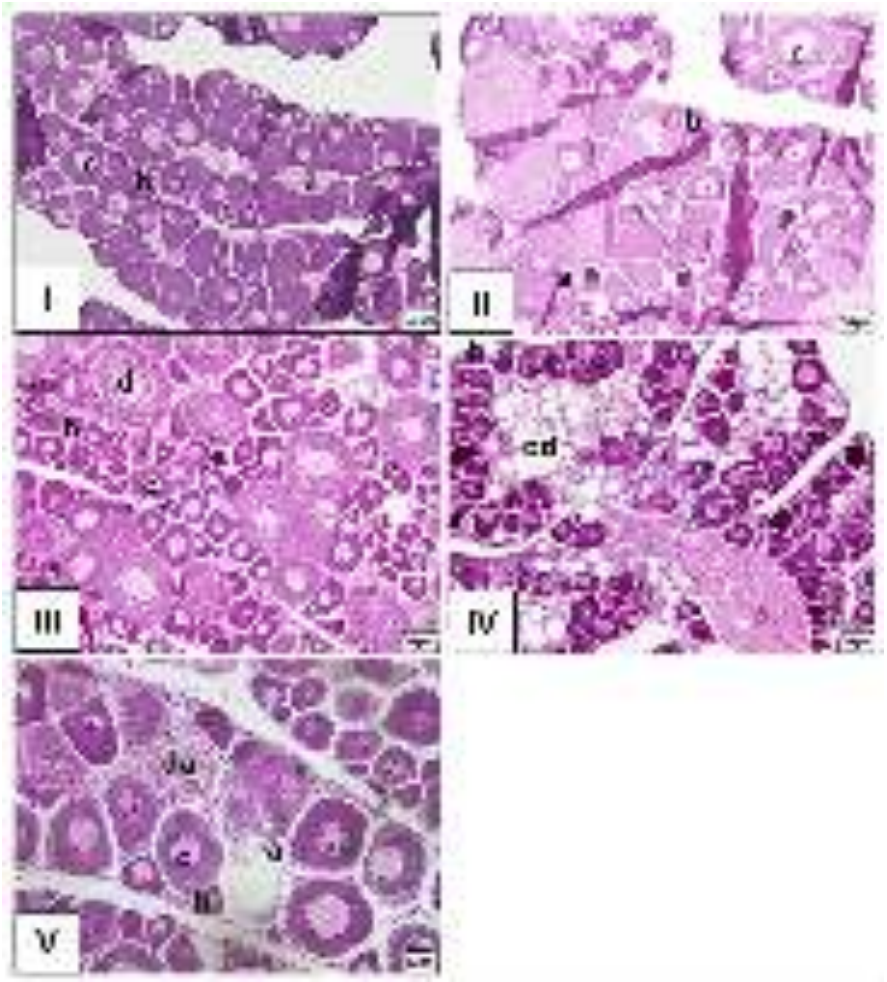

Figure 7. Histological examination of ovaries of the red bigeye. (I) & (II) Primary growth oocytes, (III) Vitellogenesis, (IV) Post ovulatory, (V) Advanced; (a) Tissue of Tunika albuginea, (b) Stage II oocyte, (c) Stage III oocyte, (d) Fully yolk oocyte, (da) Atresia of fully yolk oocyte, (od) Coalescent stage oocytes with lipid droplets combined into larger oil droplets.

Primary growth oocytes in stage I and II characterized by the development of nucleolus. Stage III described by the occurrence of egg yolk deposition process, characterized by the increasing volume of cytoplasm derived from exogenous vitelogenin

that form the yolk into fully yolk oocyte. Stage IV characterized by coalescent phase of oocytes with lipid droplets combined into larger oil droplets. Stage V depicted by atresia of fully yolk oocyte.

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

Estimation Lc value of bottom gill net was 22.4 cm TL (Figure 8) and the hook size used for hand line were number 10-11 (information of local fishers) which the average size of fish caught by hand line was 23.1 cm TL. While the Lm value was 21.9 cm TL (21.0,-22.8 cm TL).

Figure 8. Length at first capture (Lc) of red bigeye from bottom gillnet fishery.

Discussion

This present study showed that length-weight relationship of males and females were negative allometric which means increasing of length is faster than its weight. Several studies on length-weight relationship of red bigeyes have been carried out elsewhere including: the south China Sea (Lester & Watson, 1985), Guei-Shan Island (Joung & Chen, 1992), western region (Indonesia) (Pauly *et al.*, 1996), west and east coast of Peninsular Malaysia and coast of Sarawak (Ahmad *et al.*, 2003), Beibu Gulf (Wang *et al.*, 2011) and southwestern Taiwan (Weng *et al.*, 2017). Mostly those studies showed similar pattern of length and weight relationships.

The predicted spawning season of red bigeyes around June/July and December/January. It was supporting by the macroscopic feature of ovary that indicated mature ovaries appearing mostly in June/July and January/February, development of GSI values from high to low occurred in July/August and December/January and measurements of oocyte diameter revealed 1 or 2 modes from June to February, and that hydrated oocytes were also found during this period. The spawning season were also corresponds to Jabbar *et al.* (2017) which states that the recruitment of this species occurs in August-September and February-March. It shown by the appearance of small fishes in September that assumed they were 1+ month old.

The monthly changes sex ratio were no significant different between males and females except during September, October, November and December. The sex ratio in December also fit with the spawning season in this area.

Wu *et al.* (2012) revealed a relationship between sex ratio during spawning season and fecundity. High fecundity's species to have a low sex ratio during spawning e.g. the white-tongued crevalle, *Uraspis helvolus* (Chiou & Chen, 1993). In contrast, low fecundity species have high sex ratios in their spawning season, e.g. the notchedfin bream, *Nemipterus peronii* (Wu *et al.*, 2008), the Japanese butterfish, *Psenopsis anomala* (Wu et al., 2012), and as shown in the present study.

The fecundity of red bigeyes in the present study was predicted from 28 700 to 806 900 which more than that in south-western Taiwan (110 000-320 000) (Liu et al., 1992), east China Sea (70 000-230 000) (Oki & Tabeta, 1999), north-eastern Taiwan (70 000-200 000) (Liu et al., 2001) and that in southwestern Taiwan around 3 decades later (2 058-181 468) (Weng et al., 2017). This difference is thought to be related to water conditions and food availability. Fecundity of fish will changes when the environment changes.

The length at first capture (Lc) this spesies caught by bottom gill net (22.4 cmTL) and hand line (23.1 cmTL) were bigger than length at first maturity (Lm) 21.9 cm, that means mostly of red big eye capture already spawned at least once (Figure 9).

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About 51% of catch (by bottom gill net and hand line) were immature (Figure 9) which the average length of mature fishes during sampling periode were around 22 cmTL. This value is in accordance to the estimation of the Lm value 21.9 cmTL. Lm values in several areas were ranged 17-22 cm for genus *Priacanthus* (Liu et al., 1992; Oki & Tabeta, 1999; Liu et al., 2001; Sivakami *et al.*, 2001; Weng et al., 2017).

By comparing the values of both key management Lc and Lm, it seems that the mesh size of bottom gillnet and the hook size of hand line quite safe for the red bigeye's resource.

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Concluding, utilization of red bigeyes with consideration of fish size quota that allowed to caught, season and also fishing area. For management policies may include closing area during peak season June/July and December/January in the region of the spawning area. It is not only to prevent capture of matured females, but also to keep the larvae from the damage. Lc value is higher than Lm value for bottom gillnet and hand line which means mostly of catch by those gears were in mature condition that had spawn once. Monitoring of the bottom gillnet's mesh size dan hand line's hook size is needed and determination of the individual size of fish caught to be above the Lm value.

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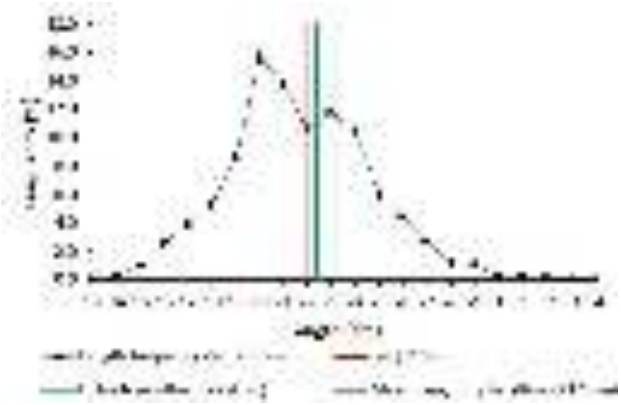

Figure 9. Lm and Lc value of red bigeye in bottom gillnet and hand line fisheries

By comparing the values of both key management Lc and Lm, it seems that the mesh size of bottom gillnet and the hook size of hand line quite safe for the red bigeye's resource.

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CONCLUSION

The increasing of the red bigeye's body length in Palabuhanratu Bay was faster than its weight while fecundity is low and sex ratio was mostly equal between males and females. The spawning season have two peaks around June/July and December/January. Lc value is bigger than Lm value for bottom gillnet and hand line which means mostly caught fishes by those gear were in mature condition that had spawn once. Monitoring of the bottom gillnet's mesh size dan hand line's hook size is necessary as well as the necessity of closing season during peaks of spawning period.

ACKNOWLEDGEMENTS

The authors thankfully acknowledge Indonesia Marine and Fisheries Education Center for their financial support to complete the study. Authors are also thankful to

Indonesia Research Institute for Marine Fisheries for helping and facilitating mainly in the beginning of the research. We would like to thank Dr. Paul McShane for his willingness to read the manuscript and gives the constructive comments.

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APPENDIX

Table 1. Sex ratio of red bigeyes in Palabuhanratu Bay during May 2016-April 2017 (pooled) by using Chi-square test

Months	Males	Females	Total	χ^2
May	12	21	33	2.45
June	28	32	60	0.27
July	16	18	34	0.12
August	26	18	44	1.45
September	23	8	31	7.26 *
October	24	10	34	5.76 *
November	18	5	23	7.35 *
December	29	12	41	7.05 *
January	18	16	34	0.12
February	20	14	34	1.06
March	16	12	28	0.57
April	13	10	23	0.39
Pooled	243	176	419	10.71 *

* Significant at 5% level

[IFRJ] Editor Decision

2 messages

Indonesian Fisheries Research Journal <ifrj.puslitbangkan@gmail.com> 15 March 2018 at 11:57
To: "Mrs. Meuthia Aula Jabbar" <meuthia.aula@gmail.com>

Mrs. Meuthia Aula Jabbar:

We have reached a decision regarding your submission to Indonesian Fisheries Research Journal, "REPRODUCTIVE BIOLOGY OF THE RED BIGEYE (Priacanthus macracanthus cuvier, 1829; Family Priacanthidae) IN PALABUHANRATU BAY, INDONESIA".

Our decision is: Resubmit for Review

Prof. Dr. Ir. DEA. Ngurah Nyoman Wiadnyana
Pusat Riset Perikanan
ngurahwiadnyana14@gmail.com

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Center for Fisheries Research and Development
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Pasir Putih II street, North Ancol , North Jakarta 14430
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Meuthia Aula Jabbar <meuthia.aula@gmail.com> 15 March 2018 at 15:43
To: Indonesian Fisheries Research Journal <ifrj.puslitbangkan@gmail.com>

Dear Editor,

Thank you for the information.

Best regards,
Meuthia

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REPRODUCTIVE BIOLOGY OF THE RED BIGEYE (*Priacanthus macracanthus* cuvier, 1829; Family Priacanthidae) IN PALABUHANRATU BAY, INDONESIA

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Meuthia Aula Jabbar*[1,2)], Mohammad Mukhlis Kamal[2)], Mennofatria Boer[2)], Ali Suman[3)], I Nyoman Suyasa[1)]

[1]*Department of Aquatic Resources Management, Jakarta Fisheries University, Indonesia.*
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ABSTRACT

The reference ~~data~~ point of reproductive biology have important roles ~~for~~ in developing a baseline information for fishery management. Different waters will provide different overview of fisheries related to its biological aspects. The red bigeye (*Priacanthus macracanthus*) is ~~an~~ one of economically important demersal fish species in Indonesia. To support the biological status of this species, a regular field observation were carried out during May 2016 to April 2017 in Palabuhanratu bay, south of west Java. The objective of this study is to estimate the spawning season and reproductive potency and also to evaluate how the key management related to the species and selectivity of fishing gear. Numbers of ~~Red~~ red bigeye (*Priacanthus macracanthus)* specimen was collected from bottom gillnetter and hand liner. ~~Measurements of red bigeye's somatic were conducted to evaluate the fishery aspects while the observation of its gonadic were done to evaluate reproductive aspects.~~ Basic information related to length-weigth, bio-reproduction (maturity) were collected regularly to determine GSI, Fecundity and its impact of fishing (Lc, Lm) to evaluate the recent stok status. The result showed ~~sex ratio~~ no significant differences between males and females except in September to December. The growth pattern indicated negative allometric. The predicted of spawning seasons were around June-July and December-January. Fecundity was estimated to be 230,000 – 178,000 eggs. Key biological reference point were ~~management~~ obtained i.e length at first maturity (Lm) value was to be 21.9 cm TL which is smaller than length at first capture (Lc) 22.4 cm TL for bottom gill netter and 23.1 cm TL for average fishes caught by hand liner. Therefore it is recommended to close the area during the spawning period. In the case of catch, it is important to ~~pay attention~~apply the precautionary approach with emphasizes to the size of fish allowed to be captured more than the Lm value (?? cmTL).

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Keywords: *Priacanthus macracanthus*; Reproduction; Sex ratio; Fecundity; Spawning season

INTRODUCTION

The Priacanthidae (commonly known as red bigeyes) are the tropical fish comprising 4 genera i.e. *Cookeolus*, *Heteropriacanthus*, *Priacanthus*, and *Pristigenys*. The Genus *Priacanthus* consists of 12 species (Froese & Pauly, 2017) and *Priacanthus macracanthus* Cuvier, 1829 is an economically important demersal spesies targeted by inshore fishers in Indonesia, which the trend of the annual landings generally not less than 800 tonnes (DGCF-MMFA, 2016).

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For the whole country at about 43,000 tonnes with a value of 483 billion IDR (DGCF, 2016)

Where the value (800) coming from

correspondence author:
e-mail: meuthia.aula@gmail.com

The red bigeye, *P. macracanthus*, ~~is~~ widely distributed in the Indo-West Pacific, East Indian region, southern and northern Japan, west coasts of Australia northward to Andaman Sea, south to Australia and New Caledonia. Typically, red bigeyes inhabits nearshore reefs (Starnes, 1999; Ramachandran & Varghese, 2009; Allen & Erdmann, 2012; White *et al.*, 2013) where it is targeted by bottom gillnet fishers in Indonesia. Especially in Palabuhanratu, the red bigeyes were found more than 50% caught by the gear (PPNP, 2015).

The benefits of this species are greatly felt by the Asian communities include Indonesia. It is used not only as marketed fresh, in dried and salted but also preferable species for surimi production and a potential source of natural antioxidant from fish skin gelatin hydrolysate (Starnes, 1999; Sivakami *et al.*, 2003; Phanturat *et al.*, 2010). Byproducts of solid waste of *P. macracanthus* surimi (such as …..) can be utilized as nutrition content in aquaculture alternative feed material (Safitri *et al.*, 2016).

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Regarding the advantages, it is important to study the reproductive biology of this species. Besides, the information of fish reproductive biology is one of the important parameters in understanding sustainability responses to existing fishing pressures (Lambert, 2008; Lowerre-Barbieri *et al.*, 2011). Some aspects of biology for red bigeyes have been reported previously in several waters such as in India (Rao, 1983), demographic analysis in Tungkang Waters-Taiwan (Liu *et al.*, 1992), including feeding in Hongkong (Lester, 1968), parasitism in South China Sea (Lester & Watson, 1985), reproductive biology in East China Sea (Oki & Tabeta, 1999) and north-eastern off Taiwan (Liu *et al.*, 2001; Liu *et al.*, 2002). However, reproductive biology in Palabuhanratu Bay has never been reported.

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The objective of this study was to provide the information related reproductive biology including length-weight relationship, sex ratio, sexual maturity stages, gonado somatic index (GSI), size of oocytes, oocyte development based on histological examination, fecundity, length at first maturity (Lm) and length at first captured (Lc) for red bigeyes in Palabuhanratu Bay. It is expected that the results of this study can be used as baseline information and input parameters for further assessment of the stock in this region.

MATERIALS AND METHODS

Samples of red bigeyes (419 specimens, 243 males and 176 females) were obtained from the caught of local fishers including bottom gillnet (84%) and hand line (16%) in the Palabuhanratu Bay (Figure 1). Random samples were collected each month from May 2016 to April 2017 at Palabuhanratu fishing port, southern Java island, Indonesia. Whole weight (to the nearest 0.1 g) and total length (to the nearest 0.1 cm) were measured. Gonads were removed and weighed to the nearest 0.01 g. Gonads were preserved in Guilson's fluid for further examination of fecundity and oocyte diameter.

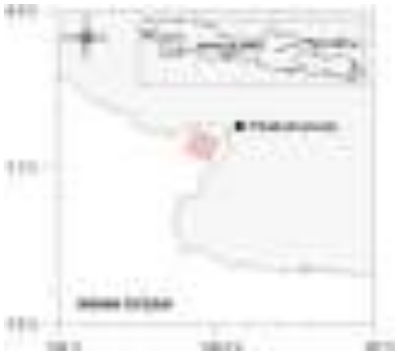

Figure 1. Fishing ground (marked red) for the red bigeyes in Palabuhanratu Bay, West Java, Indian Ocean.

Observation of biological aspects was conducted in Fishery Laboratory of Palabuhanratu National Fishing Port. Fecundity measurements was conducted in Laboratory of Fish Biology, Department of Aquatic Resources Management-Bogor Agricultural University and Fish Biology Laboratory in Research Institute for Marine Fisheries, Jakarta. Histological examination of ovaries was done in Histology Laboratory, Installation of Ornamental Fish Cultivation, Depok.

Thirty five ovaries representing sexual maturity stage III and IV were selected to confirm the oocyte diameter and to estimate fecundity. As much as 0.1 g of each ovary (the anterior, middle, and posterior) were placed in sedgewick rafter cells for enumeration of oocytes. All oocytes were measured under magnification of projector 10 x 10 to observe the oocytes diameter and 4 x 10 to enumerate eggs. Histological examination followed (Mumford, 2007) with minor modification. Ovaries were maintained in a 10% formalin solution for a minimum of 48 hours before processing. A total of 10 gonads were sectioned at 3 µm thickness and stained with haematoxylin and eosin.

Length – weight relationship was depicted by:

$W = aL^b$, ……..……(1)

where: W is total body weight (g)

L is the total length (cm)

a and b are functional regression coefficients of W and L (Sparre & Venema, 1998).

T-test was performed to test the null hypothesis that 'b' was isometric.

Sex ratio was presented as:

$\sum F/\sum F+M$ …….. (2)

where: F is females, M is males

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See standard reference ….

Chi-square test used to identify differences between observed and expected values in sex ratio.

Gonado somatic index (GSI) was calculated by:

$GSI = (Wg/Wt) \times 10^2$ ……...…….…….(3)

where: Wg is gonad weight (g)

Wt is gutted body weight (g)

Fecundity (F) was estimated from the equation of (Reference??):

$F = (G \times X)/Q$…….…….. (4)

where: G is ovary weight preserved in Guilson's fluid

X is number of oocytes stage 3 or 4 (0.1 g ovary in 1 ml diluent water)

Q is 0.1 g ovary's sample

The fecundity and length relationship was expressed by the allometric equation of (reference ??)

$F = a L^b$ ……...…….. (5)

where: L is the total length (cm)

a and b are estimated parameters

Sparre & Venema (1998) described the length at first capture (Lc) was estimated from:

$S_L est = 1 / (1 + \exp (S_1 - S_2 \times L))$ ……..……. (6)

where: $Lc = S_1 / S_2$

$S_L$est is logistic curve;

S_1 and S_2 are constants

The Spearman-Karber method for estimating the length at first maturity (Udupa, 1986):

$m = xk + X/2 - (X \times \Sigma pi)$ ……..……..……. (7)

where: *m* is logarithm of length at first maturity

xk is logarithm of the middle value of the last class of 100% mature specimens

X is difference of logarithm of mean value

pi is comparison of mature gonads per length class

RESULTS AND DISCUSSION

Results

Length-Weight Relation

Total length of male red bigeyes sampled varied from 13.5-32.5 cm, and total weight varied between 42 and 532 g; and for females 15-31.5 cm TL with total weight 56-430 g. The length-weight relationships were estimated to be: $W = 6.92 \times 10^{-2} \times TL^{2.47}$ for males (Figure 2a) and $W = 5.36 \times 10^{-2} \times TL^{2.58}$ for females (Figure 2b). Their type of growth were negative allometric (each sex).

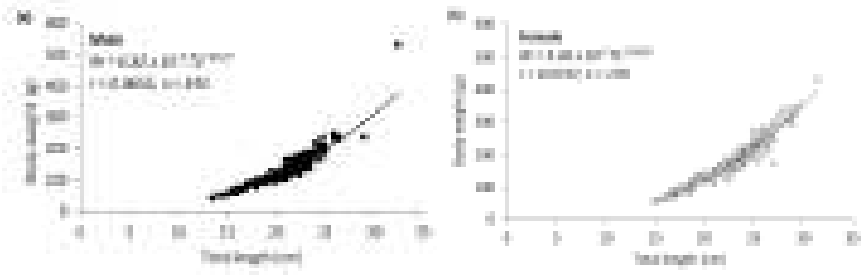

Figure 2. Length-weight relationships of red bigeye. (a) males, (b) females.

Suggestion:

Since the authors keep the observation data, please add a table shows a monthly length weight relationship and explore the varians of b values

Table ?? monthly variabilities of length weight parameters

Month	Male			Female		
Parameters	n	a	b	n	a	b
May						
June						
etc						

Sex Ratio

Based on sampling, the total number of males was dominant comparing to the females. The females ratio varied seasonally and from all samples was 0.42 (176 / 419). The lowest sex ratio of females was 0.22 in November 2016 and the highest in May 2016 at 0.64 (Figure 3).

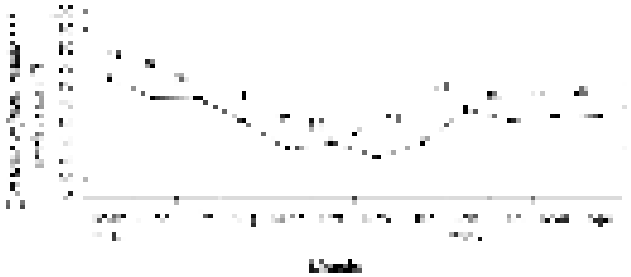

Figure 3. Monthly fluctuation in sex ratio of red bigeyes. Label numbers indicated total number of sample.

Furthermore the evaluation of the sex ratio with Chi-square showed that monthly sex ratio were no significant different between males and females except during September, October, November and December (See Appendix 1).

Gonad Maturity Stages

Both male and female, stage IV were found in every month. The males with the highest stage IV obtained in July (50%) and January (56%) (Figure 4a) while the female were in July (67%) and December (58%) (Figure 4b). It is estimated that the spawning season of red bigeyes occupy in May-April. The peaks of spawning occur around June/July and December/January.

(a) Male (b) Female

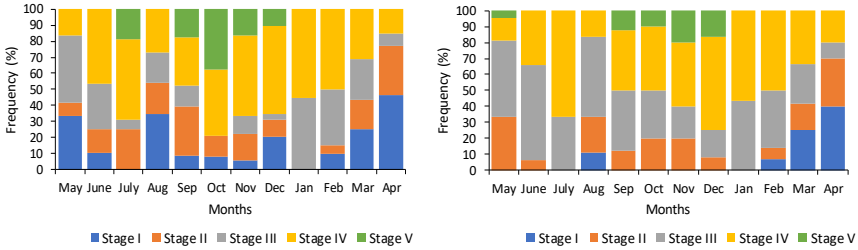

Figure 4. Percentage occurance of different stages of red bigeye's gonades. (a) males, (b) females.

Gonad Somatic Index (GSI)

The GSI average of males have two peaks were in July and March (2.54 and 1.56 respectively). The female also had bimodal in July and December (5.05 and 2.61 respectively) (Figure 5). Gonado Somatic Index for male and female shows that spawning season happened around July/August and December/January when GSI showed decreasingly after the peak value.

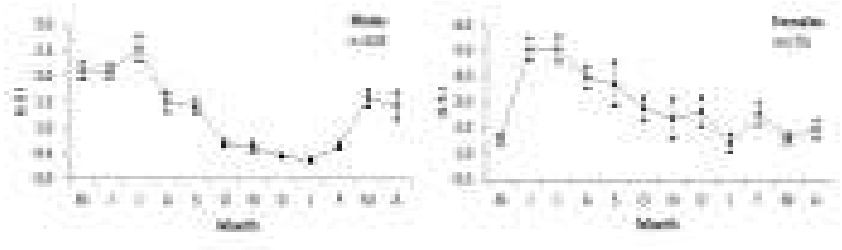

Figure 5. Monthly gonadosomatic index (GSI) of red bigeyes (data are means ± standard deviation).

Size of Oocytes

Oocytes diameter were measured based on ~~from~~ ovaries with maturity stages of III and IV. The oocytes frequency distribution (Figure 6) shows that each stage have one peak and two peaks pooled (both stages). This indicated that the distribution of oocytes consist of more than one group. The mode of stage III was about 0.3 mm, then shifted to 0.4 and 0.5 mm in Stage IV. This indicated that the spesies was chategorized as multiple spawner.

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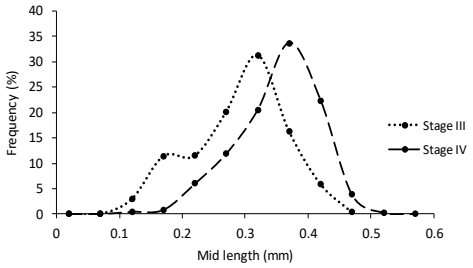

Figure 6. Oocytes diameter of red bigeyes sampled between June 2016 and February 2017

Fecundity

Fecundity was estimated based on 35 ovaries with different oocytes frequency distribution modes. Fecundity expressed as the number of oocytes with diameter of > 0.3 mm, and following equation (4) the estimation ranged from 28,700 (TL = 24.5 cm) to 806,900 (TL = 26 cm) with a mean of 230,000 ± 178,000.

Oocyte Development

Development of oocytes for the red bigeye were determined based on histological examination. Through its development can be estimated at least there are five stages of sexual maturity as described below (Figure 7).

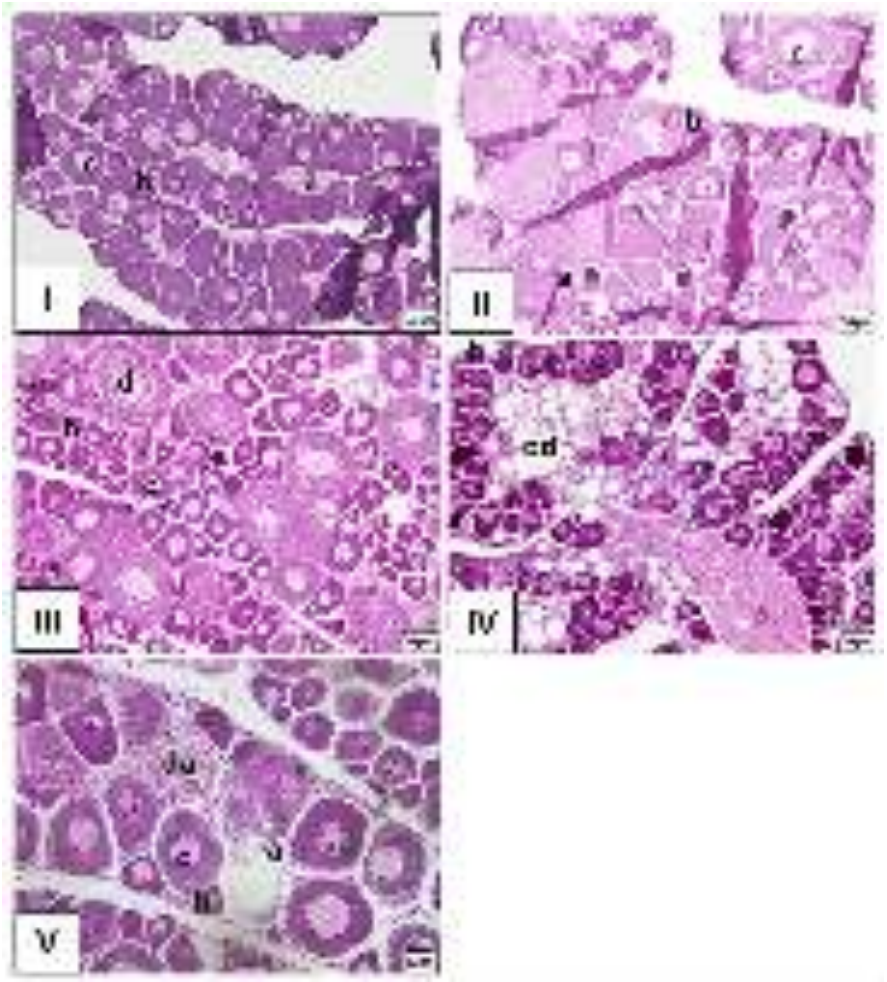

Figure 7. Histological examination of ovaries of the red bigeye. (I) & (II) Primary growth oocytes, (III) Vitellogenesis, (IV) Post ovulatory, (V) Advanced; (a) Tissue of Tunika albuginea, (b) Stage II oocyte, (c) Stage III oocyte, (d) Fully yolk oocyte, (da) Atresia of fully yolk oocyte, (od) Coalescent stage oocytes with lipid droplets combined into larger oil droplets.

Primary growth oocytes in stage I and II characterized by the development of nucleolus. Stage III described by the occurrence of egg yolk deposition process, characterized by the increasing volume of cytoplasm derived from exogenous vitelogenin

that form the yolk into fully yolk oocyte. Stage IV characterized by coalescent phase of oocytes with lipid droplets combined into larger oil droplets. Stage V depicted by atresia of fully yolk oocyte.

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

Estimation Lc value of bottom gill net was 22.4 cm TL (Figure 8) and the hook size used for hand line were number 10-11 (information of local fishers) which the average size of fish caught by hand line was 23.1 cm TL. While the Lm value was 21.9 cm TL (21.0,-22.8 cm TL).

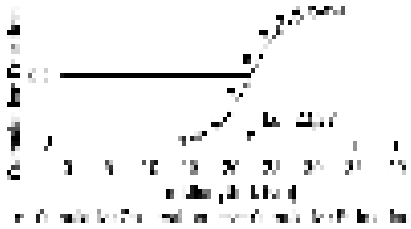

Figure 8. Length at first capture (Lc) of red bigeye from bottom gillnet fishery.

Discussion

This present study showed that length-weight relationship of males and females were negative allometric which means increasing of length is faster than its weight. Several studies on length-weight relationship of red bigeyes have been carried out elsewhere including: the south China Sea (Lester & Watson, 1985), Guei-Shan Island (Joung & Chen, 1992), western region (Indonesia) (Pauly *et al.*, 1996), west and east coast of Peninsular Malaysia and coast of Sarawak (Ahmad *et al.*, 2003), Beibu Gulf (Wang *et al.*, 2011) and southwestern Taiwan (Weng *et al.*, 2017). Mostly those studies showed similar pattern of length and weight relationships.

The predicted spawning season of red bigeyes around June/July and December/January. It was supporting by the macroscopic features of ovary that indicated mature ovaries appearing mostly in June/July and January/February, development of GSI values from high to low occurred in July/August and December/January and measurements of oocyte diameter revealed 1 or 2 modes from June to February, and that hydrated oocytes were also found during this period. The spawning season were also corresponds to Jabbar *et al.* (2017) which states that the recruitment of this species occurs in August-September and February-March. It shown by the appearance of small fishes in September that assumed they were 1+ month old.

The monthly changes sex ratio were no significant different between males and females except during September, October, November and December. The sex ratio in December also fit with the spawning season in this area.

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Wu *et al.* (2012) revealed a relationship between sex ratio during spawning season and fecundity. High fecundity's species to have a low sex ratio during spawning e.g. the white-tongued crevalle, *Uraspis helvolus* (Chiou & Chen, 1993). In contrast, low fecundity species have high sex ratios in their spawning season, e.g. the notchedfin bream, *Nemipterus peronii* (Wu *et al.*, 2008), the Japanese butterfish, *Psenopsis anomala* (Wu et al., 2012), and as shown in the present study.

The fecundity of red bigeyes in the present study was predicted from 28,-700 to 806, 900 which more than that in south-western Taiwan (110,-000-320,-000) (Liu et al., 1992), east China Sea (70,–000-230,-000) (Oki & Tabeta, 1999), north-eastern Taiwan (70,-000-200,–000) (Liu et al., 2001) and that in southwestern Taiwan around 3 decades later (2, 058-181,–468) (Weng et al., 2017). This difference is thought to be related to water conditions and food availability as suggested by (reference ??). Fecundity of fish will changes when the environment changes.

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Length at first maturity (Lm) values of the red bigeyes in Palabuhanratu was in ranged 17-22 cm for genus *Priacanthus* as shown in other areas (Liu *et al*., 1992; Oki & Tabeta, 1999; Liu *et al*., 2001; Sivakami *et al.*, 2001; Weng *et al*., 2017). Size structure of the red bigeye in this research from bottom gill net (56%) and hand line (25%) were under the Lm value. The length at first capture (Lc) this spesies caught by bottom gill net and hand line were 22.4 cmTL and 23.1 cmTL, respectively. Those values were higher than its length at first maturity (Lm) 21.9 cm. It means the red bigeye were already spawned at least once before caught by the fishing gear (Figure 9).

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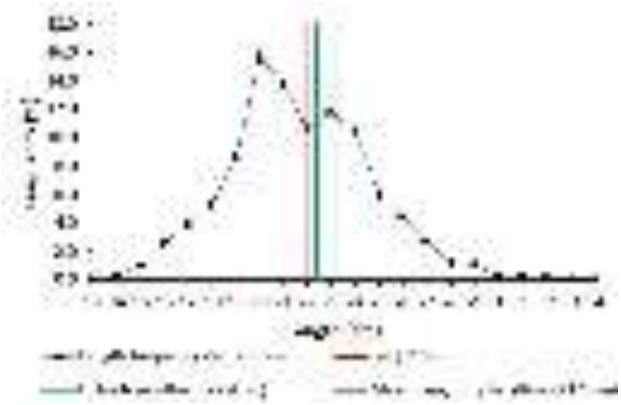

Figure 9. Lm and Lc value of red bigeye in bottom gillnet and hand line fisheries

CONCLUSION

~~Concluding, t~~The utilization of red bigeyes with consideration of fish size quota that allowed to caught, season and also fishing area. For management policies may include closing area during peaks of spawning season, June/July and December/January in the region of the spawning area. It is not only to prevent capture of mature females, but also to keep the larvae from the damage. Lc value is higher than Lm value for bottom gillnet and hand line which means mostly of catch by those gears were in condition have spawn once.

Continuous monitoring is required in relation to the bottom gillnet's mesh size and hand line's hook size and determination of the individual size of fish caught to be above the Lm value.

ACKNOWLEDGEMENTS

We are grateful to anonymous reviewers for their valuable comments. The authors thankfully acknowledge Indonesia Marine and Fisheries Education Center for their financial support to complete the study. Authors are also thankful to Indonesia Research Institute for Marine Fisheries for helping and facilitating mainly in the beginning of the research. We would like to thank Dr. Paul McShane for his willingness to read the manuscript and gives the constructive comments.

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APPENDIX

Table 1. Sex ratio of red bigeyes in Palabuhanratu Bay during May 2016-April 2017 (pooled) by using Chi-square test

Months	Males	Females	Total	χ^2
May	12	21	33	2.45
June	28	32	60	0.27
July	16	18	34	0.12
August	26	18	44	1.45
September	23	8	31	7.26 *
October	24	10	34	5.76 *
November	18	5	23	7.35 *
December	29	12	41	7.05 *
January	18	16	34	0.12
February	20	14	34	1.06
March	16	12	28	0.57
April	13	10	23	0.39
Pooled	243	176	419	10.71 *

* Significant at 5% level

[IFRJ] Editor Decision

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To: "Mrs. Meuthia Aula Jabbar" <meuthia.aula@gmail.com>

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We have reached a decision regarding your submission to Indonesian Fisheries Research Journal, "REPRODUCTIVE BIOLOGY OF THE RED BIGEYE (Priacanthus macracanthus cuvier, 1829; Family Priacanthidae) IN PALABUHANRATU BAY, INDONESIA".

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Vol 24, No 1 (2018)

(June) 2018

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p-ISSN 0853-8980
e-ISSN 2502-6569

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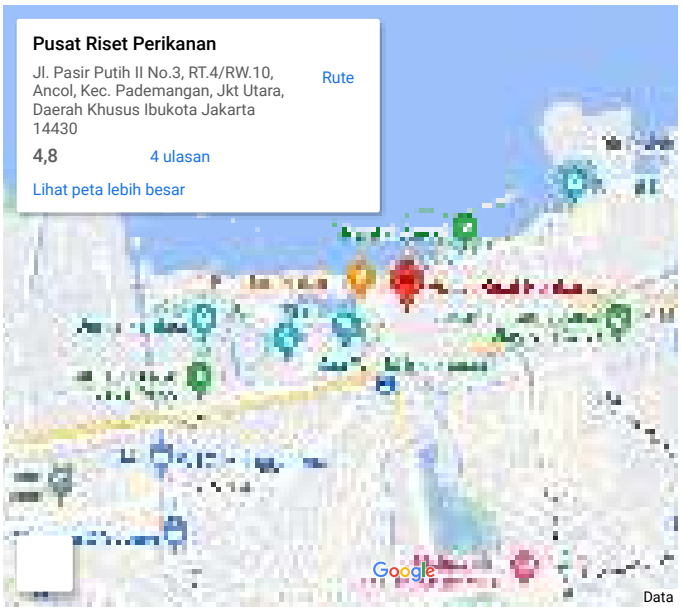
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REPRODUCTIVE BIOLOGY OF THE RED BIGEYE (Priacanthus macracanthus Cuvier, 1829) IN PALABUHANRATU BAY, INDONESIA

Meuthia Aula Jabbar, Mohammad Mukhlis Kamal, Mennofatria Boer, Ali Suman, I Nyoman Suyasa

Abstract

The reference point of reproductive biology play an important roles in developing a baseline information for fishery management. Different waters will provide different overview of fisheries related to its biological aspects. The red bigeye (*Priacanthus macracanthus*) is one of economically important demersal fish species in Indonesia. To support the biological status of this species, a regular field observation were carried out during May 2016 to April 2017 in Palabuhanratu bay, south of West Java. The objective of this study is to estimate the spawning season and potential reproductive stages including to evaluate how the key management related to the species and its gear selectivity. Numbers of red bigeye (*Priacanthus macracanthus)* specimen was collected from bottom gillnetter and hand liner. Basic information related to length-weigth, bio-reproduction (maturity) were collected regularly to determine GSI, Fecundity and its impact of fishing (Lc, Lm) to evaluate the recent stock status. The result showed sex ratio no significant differences between males and females except in September to December. The growth pattern indicated negative allometric. The predicted of spawning seasons were around June-July and December-January. Mean of fecundity was estimated to be 230,000 ± 178,000 eggs. Management keys were obtained i.e. length at first maturity (Lm) value was to be 21.9 cm TL which is smaller than length at first capture (Lc) 22.4 cm TL for bottom gill netter and 23.1 cm TL for average fishes caught by hand liner. Therefore it is recommended to close the waters in the bay area during the spawning period. In the case of catch, it is important to apply the precautionary approach with emphasizes to the size of fish allowed to be captured more than the Lm value (above 21.9 cm TL).

Keywords

Priacanthus macracanthus; reproduction; sex ratio; fecundity; spawning season

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DOI: http://dx.doi.org/10.15578/ifrj.24.1.2018.25-36

p-ISSN 0853-8980
e-ISSN 2502-6569