Population dynamic and spawning potential ratio of long-barbel sheatsfish (*Kryptopterus limpok*) in Tasik Giam Siak Kecil waters, Bengkalis, Riau Province, Indonesia

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Abstract. Intensive exploitation due to high market demand of long-barbel sheatsfish (*Kryptopterus limpok*), locally known as "selais fish", has continuously occurred throughout the year, so that it could threaten resources sustainability. Scientific assessment on population dynamic and spawning potential ratio are required as an input to support an apropriate fisheries management. The purpose of this study was to identify population dynamic and spawning potential ratio of the *K. limpok* with survey method. The study was conducted in Tasik Giam Siak Kecil, Bengkalis and surrounding waters based on data collected during period of survey, from April 2017 to November 2017. Result showed that the length at first capture (Lc) of *K. limpok* was 18.9 cm (total length) and the size of length at first maturity (Lm) was 19.9 cm. Sex ratio was slightly unbalance (1.0:1.1). The growth rate parameter (K) was 0.59/year with maximum length (L_∞) of 43.05 cm. The estimate total mortality rate (Z) was 2.61 per year. While yearly ratio of fishing mortality (F) and natural mortality (M) were 1.41 and 1.2 respectively. Recruitment pattern occured throughout the year with one peak in June. The exploitation rate (E) was 0.54 per year and the spawning potential ratio (SPR) was 2.1%. Therefore the stock status was categorized as overfished. In order to ensure the sustainability of *K. limpok*, there is needed to apply the precautionary approach such as reducing existing catch by 8% of the current situation.
Key Words: stock status, fisheries management, sustainability, recruitment, exploitation.

Introduction. Tasik Giam Siak Kecil area is one of the potential fishing ground for inland fisheries resource in Bengkalis Regency. Exploitation of this inland fishery resource in this area has been conducted so long which was influenced by water level fluctuation. Previous researches (Hoggarth et al 1999; Prianto et al 2013; Utomo 2016) reported that the highest catch occurred in dry season and conversely the lowest catch was obtained during wet season due to flooded swamp water.

The long-barbel sheatsfish (*Kryptopterus limpok*) has very high economic value and potential to be cultured (Elvyra 2004; Putra & Pamukas 2011; Agusnimar & Rosyadi 2015). This fish is one of 37 species caught in this area (Husnah et al 2013). The *K. limpok* is categorized as kind of catfish which lives in river and lake in Java, Sumatera, Borneo, and Malaysia (Ng 2003; Kotelat & Whitten 1993).

High market demand of *K. limpok* lead to intensive fishing activity thus jeopardizes the stock sustainability. On the other hand, no enough catch, effort, and biology data of *K. limpok* resource were available. Therefore research about dynamic population, biology, and fishing activity of *K. limpok* resource in Tasik Giam Siak Kecil waters is needed in order to maintain the stock sustainability (Kasim et al 2017).

Material and Method. This research was conducted from April 2017 until November 2017 in Tasik Giam Siak Secil surrounding waters, Bengkalis (Figure 1). Several enumerators were placed in research location and involved to collect monthly data of the *K. limpok* which concerned length and weight measurement, gonad maturity, sexes, and amount of catch.

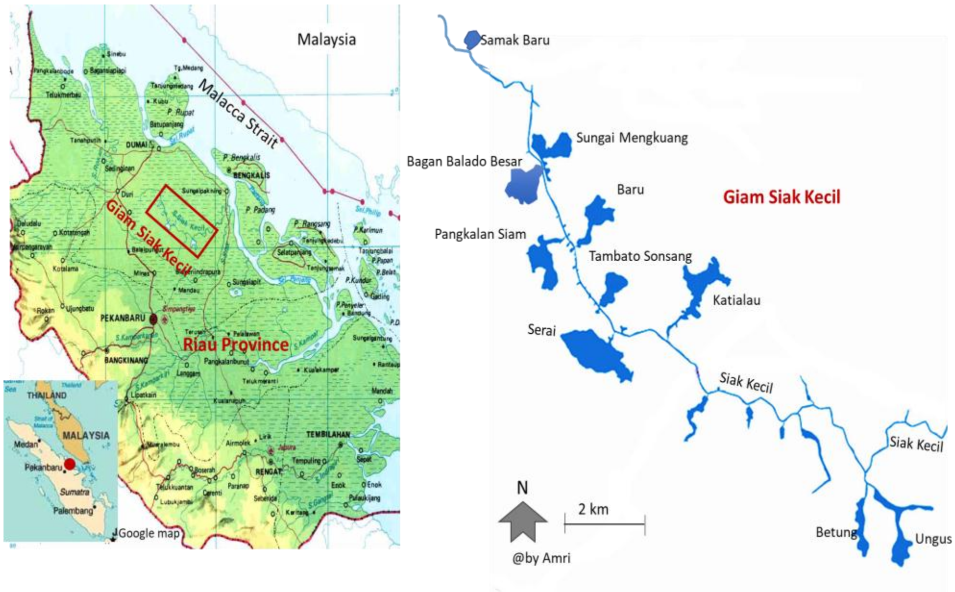

Figure 1. Fishing ground of *Kryptopterus limpok* in Tasik Giam Siak Kecil Waters, Bengkalis, Riau Province, Indonesia.

Length weight relationship was analyzed by equation introduced by Ball & Rao (1984) as follow: $W = a L^b$ where W = body weight (gram), L = total length of fish (cm), a = a constant value and b = the exponential value.

The length at first capture (Lc) was predicted by using logistical function's approach equation illustrated by Sparre & Venema (1992):

$$S_{CL} = \frac{1}{1 + \exp(a - b * CL)}$$

In which: S_{CL} is selectivity fishing gear, a and b are in constant , CL is fish length and value of Lc obtained from a / b.

While the length at first maturity (Lm) is counted based on calculation method introduced by Udupa (1986):

$$m = X_k + \frac{X}{2} - \left\{X \sum p_i\right\}$$

$$anti \ \log \left[m \pm 1{,}96 \sqrt{X^2 \sum \left(\frac{p_i x q_i}{n_i - 1} \right)} \right]$$

Where: m is the Lm logarithm value with Xk is logarithm of mean value when 100% mature, X is the logarithm of mean value, pi is the proportion of mature fish in class i where $p_i = r_i/n_i$; r_i is the amount of mature fish in class i, and ni is the amount of sample in class i, qi = 1-pi.

Growth parameter was calculated using von Bertalanffy growth model Sparre & Venema (1992):

$$L_t = L_\infty\left[1 - e^{K(t - t_0)}\right]$$

Where: L_t = total length of fish at age t year, L_∞ = a theoretical maximum length, K = the growth rate, and t_0 = a theoretical fish age at zero length.

The theoretical of maximum length (L_∞) and growth rate (K) were analyzed by using ELEFAN I and FISAT II methods (Gayanilo et al 2005). While the value of t_0 was predicted based on equation introduced by Pauly (1983):

$$\text{Log}(-t_0) = (-0.3922) - 0.2752 \log CL_\infty - 1.038 \log K$$

Natural mortality (M) was calculated using Pauly equation based on average sea water temperature (Pauly et al 1984):

$$\text{Log } M = (-0.0066) - 0.279 \log CL_{\infty} + 0.6543 \log K + 0.4634 \log T$$

Total mortality (Z) was counted based on length converted catch curve assessment on FISAT II program (Pauly 1983; Gayanilo et al 2005). In addition, fishing Mortality (F) and exploitation rate (E) was assessed using an equation introduced by Sparre & Venema (1992):

$$F = Z\text{-}M; \text{ and } E = F/Z$$

Spawning potential ratio (SPR) was estimated using fish length data based (Hordyk et al 2014). Data input used in SPR analysis was the ratio of M/K, asymptotic length (L_{∞}), the proportion of 50% and 95% mature fish (L_{50}, and L_{95}), and fish length. Finally, estimation of *SPR* was based on comparison of mature potential between fished ($SSBR_{fished}$) and unfished ($SSBR_{unfished}$) according to equation introduced by Goodyear (1993):

$$SPR = \frac{SSBR_{fished}}{SSBR_{unfished}}$$

Results. Figure 2 illustrates that length frequency of *K. limpok* during the research had dominant individuals in class 20-23 cm with total length ranging from 7 cm until 38 cm.

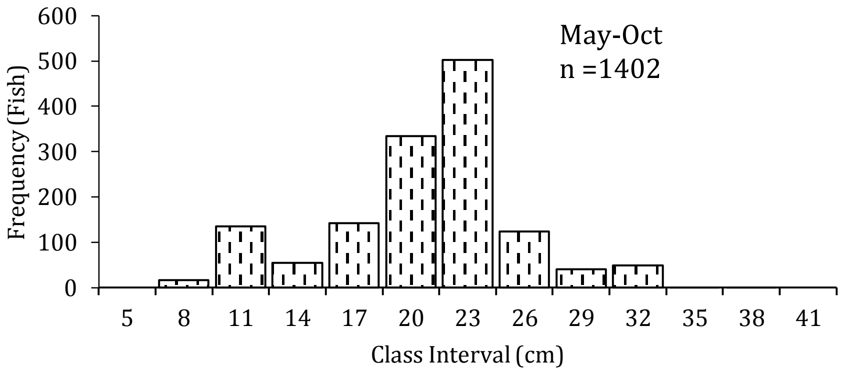

Figure 2. Length frequency of *Kryptopterus limpok* in Tasik Giam Siak Kecil waters, Bengkalis.

Population dynamics. Length-weight relationship analysis showed that *K. limpok* had negative allometric growth with b = 2.5475. It meant that the length growth was faster than that of fish weight (Figure 3).

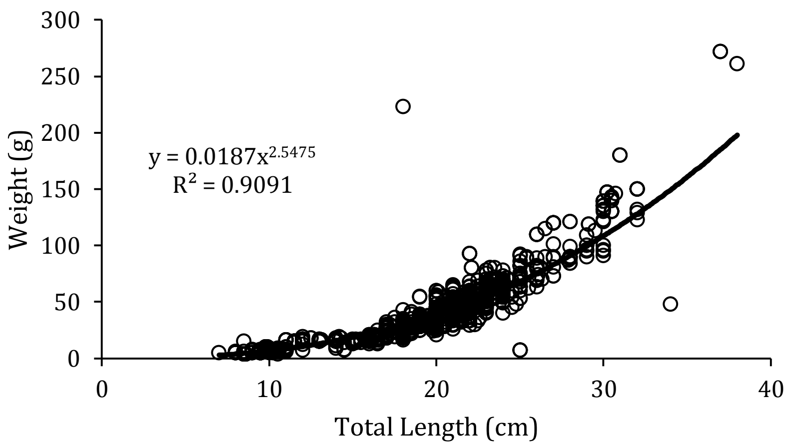

Figure 3. Length-weight relationship of *Kryptopterus limpok* in Tasik Giam Siak Kecil waters, Bengkalis.

Chi-square analysis of sex ratio of *K. limpok* indicated an unbalanced condition (1.0:1.1). Another biological assessment illustrated that sizes of length at first capture (Lc) and length at first maturity (Lm) were 18.9 cm and 19.9 cm respectively (Figure 4). This condition of Lc lower than Lm indicated that most of fish has been caught before performing spawning activity.

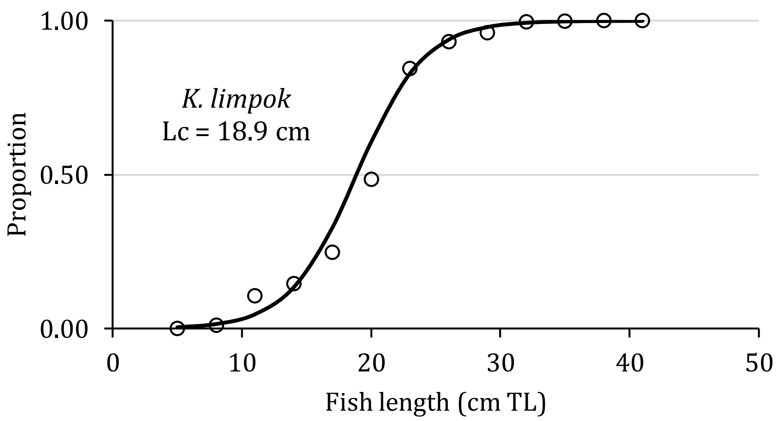

Figure 4. The length at first capture (Lc) of *Kryptopterus limpok* in Tasik Giam Siak Kecil waters, Bengkalis.

Length frequency data analysis indicated that the growth rate (K) of *K. limpok* was 0.59 per year and length infinity (L_∞) reached about 43.05 cm (Figure 5). Thus von Bertalanffy growth curve equation become: Lt=43.05 [1-e $^{-0.(t + 0.29)}$].

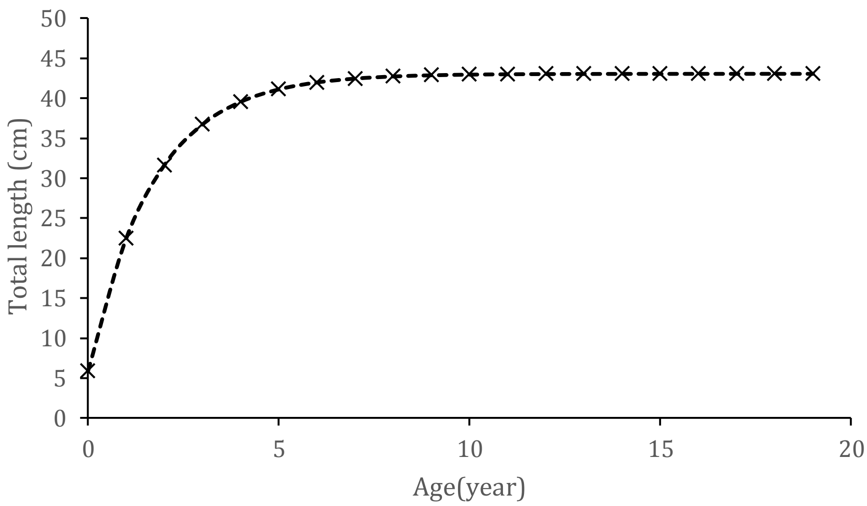

Figure 5. von Bertalanffy growth curve of *Kryptopterus limpok* in Tasik Giam Siak Kecil waters, Bengkalis.

Catch curve performance was predicted by using growth rate parameters which has been counted, namely length infinity (L_∞) and growth rate (K). It was found that total mortality (Z) was 2.61 per year (Figure 6). While by using equation introduced by Pauly (1983), natural mortality (M) was counted to be 1.20 per year. Hence fishing mortality (F) was 1.41 per year.

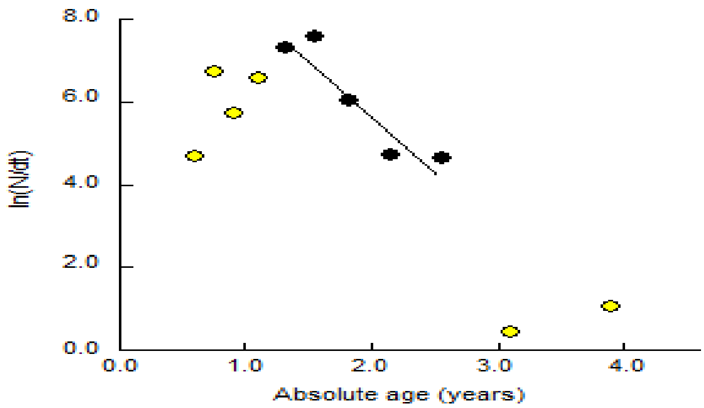

Figure 6. The catch curve of *Kryptopterus limpok* in Tasik Giam Siak Kecil waters, Bengkalis.

Having known that values of Z and F as illustration of total and fishing mortalities respectively, then value of exploitation rate (E) was obtained as high as 0.54 per year. High value of E (>0.5) indicated that exploitation of *K. limpok* in Tasik Giam Siak Kecil surrounding waters has reached overfishing level. In addition, there was single curve recruitment pattern which illustrated that spawning activity occurred during the year with a peak in June (Figure 7).

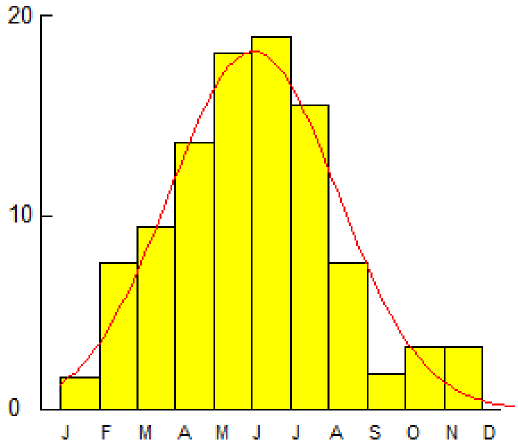

Figure 7. Recruitment pattern of *Kryptopterus limpok* di Tasik Giam Siak Kecil waters, Bengkalis.

Spawning potential ratio (SPR). Spawning potential ratio (SPR) method analysis was based on biological and growth parameters data. They were length at first maturity (Lm), von Bertalanffy growth equation, length-weight relationship, and early cohort number. It was found that the SPR of *K. limpok* in mature condition was 2.1% (<20%) (Figure 8). This value was obtained from extrapolation between fish length and SPR below and above the Lm value. This result indicated that the status of *K. limpok* stock has already been in overfishing stage.

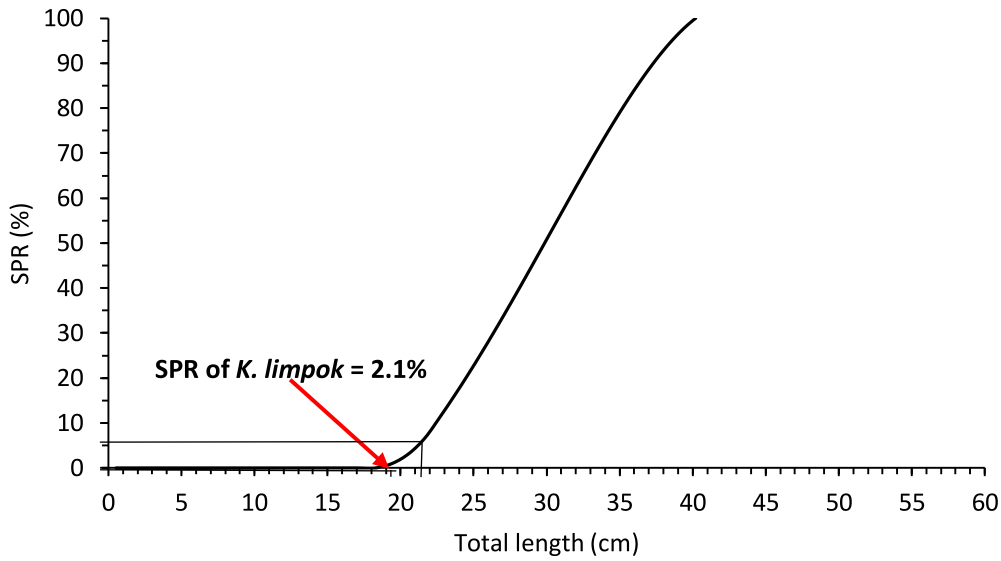

Figure 8. Spawning potential ratio (SPR) chart *Kryptopterus limpok* in Tasik Giam Siak Kecil waters, Bengkalis.

Discussion. Growth pattern of *K. limpok* in Tasik Giam Siak Kecil waters can be determined by using length-weight relationship analysis. The t test has indicated that the characteristic of *K. limpok* growth is a negative allometric. The growth pattern of *K. limpok* shows that the growth of body length is faster than that of body weight. Same results have been reported by research conducted in Way Kiri river, Lampung (Putri 2016) and Batu lake, Pulang Pisau (Aryantoni et al 2014). Internal and external factors would influence fish growth as illustrated by Effendie (2002) which stated that internal factors were usually difficult to be controlled such as descents, gender, age, and disease. While external factors influencing fish growth are temperature and food availability.

Sex ratio of *K. limpok* in Tasik Giam Siak Kecil waters showed an unbalanced condition where female fish were dominant. This phenomenon also occurred in several areas such as Way Kiri river, Lampung (Putri 2016), Kampar Kiri river (Simanjuntak et al 2008), and Siak and Kampar rivers (Nurullah et al 2013). Ball & Rao (1984) added that in normal condition, sex ratio supposed to be balanced (1.0:1.0). However, unbalanced condition of sex ratio could happen due to several factors such as schooling behavior, migration, and fishing activity (Suman 2004; Edrus & Syam 2004).

Size at maturity stage of *K. limpok* is important to be known because fishing activity not only should let young fish to escape but also high quantity of mature fish to release in order to make mature fish able to spawn before recapture (Sudjastani 1974). Having mentioned that size of Lm (19.9 cm) was bigger than size of Lc (18.9 cm), this condition was probably caused by several factors such as food availability, temperature, and salinity. Udupa (1986) stated that size at maturity stage varies between and internal species. While differences Lc size was possibly due to different habitat and water depth. Different water condition such as shallow and deep water as well as flooded swamp and river body water would give different size of catch (Muflikhah et al 2006). The phenomenon of lower Lc value than Lm value would not give chance the fish conducting spawning activity in order to provide recruitment process. Hence this condition would disturb long term sustainability of *K. limpok*.

Sparre & Venema (1992) reported that the lower the growth coefficient (K), the longer the time needed to achieve its asymptotic length (L_∞) and vice versa. The growth rate (K) of *K. limpok* in Tasik Giam Siak Kecil waters (0.59 per year) with L_∞ = 43.05 cm was categorized as slow growth type. In contrast, research in Kampar river, Riau found that the fish was categorized as fast growth type with K = 0.8 per year and L_∞ = 40 cm (Suman et al 2009). The different growth parameters were probably caused by different value of asymptotic length of fish from different research location (Widodo & Suadi 2006). Knaepkens et al (2002) and Effendie (2002) stated that different values of growth parameters (K and L_∞) were caused by the present of internal and external factors such as descents, parasites, disease, temperature, and food availability.

The total mortality rate (Z) is a sum of the natural mortality rate (M) and the rate of fishing mortality (F) (Sparre & Venema 1992). The F value of *K. limpok* in Tasik Giam Siak Kecil waters was higher than the M value. This indicates that most of *K. limpok* in Tasik Giam Siak Kecil waters died due to capture. Then the utilization rate (E) of *K. limpok* can be predicted by using the F value which is an illustration of capture pressure and Z value which is a picture of total mortality, which was high (0.54 per year). This value is categorized to be higher than the optimal rate according to the criteria introduced by Pauly et al (1984) which states that the optimal rate of exploitation is 0.5. In addition, the utilization rate of *K. limpok* has been counted to be 108%, which means that it is already in overfished level. In order to maintain the source of *K. limpok* in Tasik Giam Siak Kecil waters, the reduction of fishing efforts must be carried out by around 8% of the current efforts.

Generally, *K. limpok* in Tasik Giam Siak Kecil waters conduct recruitment activity throughout the year with a peak in June. This informed that significant increase in the population of *K. limpok* occurred in that period compared to the previous population (Muflikhah et al 2006). Based on the peak period of recruitment, it seems that the highest additional new population member was taken place in the transition season from the rainy season to the dry season the conditions of the aquatic environment were clear and the temperature was relatively cold (Marini & Husnah 2011), which lead to the optimal reproduction of *K. limpok* to be conducted.

The spawning potential ratio (SPR) is the relative reproductive index used to determine the status of fish stocks that have been under fishing pressure (Mace & Sissenwine 1993 in Prince et al 2015; Walters & Martell 2004; Prince et al 2015) SPR is also known as a measure of the level of reproductive capacity of a resource that has declined from its original condition or unexploited condition (Smallwood et al 2013). The analysis of the SPR of *K. limpok* in Tasik Giam Siak Kecil waters was 2.1% and this indicated that the status of *K. limpok* stock is at the stage of overfishing. This is in accordance with fisheries stock status criteria based on SPR, which are classified into 3 groups, namely under exploited (SPR>40%), moderate (20<SPR<40%), and over exploited/overfishing (SPR<20%) (Walters & Martell 2004; Prince et al 2015).

Conclusions. Length growth was faster than weight growth (negative allometric) and the size of length at first capture (Lc) was lower than that of length at first maturity (Lm) and in the long run will not guarantee the sustainability of resources. The fish was characterized by low growth and high mortality rates. Recruitment pattern occurred throughout the year with the peak in June. Exploitation rate (E) and spawning potential ratio (SPR) values were 0.54 and 2.1% per year respectively and the stock was categorized as at overfishing condition. Management access must be applied by reducing amount of catch as much as 8% from existing condition in order to maintain stock sustainability. In addition, social economic research should be conducted in order to get more accurate stock prediction.

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References

Agusnimar, Rosyadi, 2015 Growth and survival of *Kryptopterus lais* treated with thyroxine hormone. Journal Akuakultur Indonesia 14(1):38-41.

Aryantoni, Tantulo U., Buchar T., 2014 Length-weight relationship, reproduction, and feeding of Baji Selais Fish (*Kryptopterus palembangensis*) in Batu Lake, Pulangpisau Regency. Natural Resource and Environment Study Program, Postgraduate Program, University of Palangkaraya, 22 p.

Ball D. V., Rao K. V., 1984 Marine fisheries. New Delhi : Tata Mc. Graw-Hill Publishing Company Limited, pp. 5–24.
Edrus I. N., Syam A. R., 2004 Catch analysis of traditional trap toward mangrove crab fishing trial in Maluku. Journal of Indonesia Fisheries Research 10(4):7-86.
Effendie M. I., 2002 Fisheries biology. Pustaka Nusatama Foundation, Yogyakarta, 136 p.
Elvyra R., 2004 Habitat and reproduction aspect of Selais. Individual Paper. Postgraduate Program, Bogor Agriculture University, Bogor, Idonesia, 12 p.
Gayanilo F. C. Jr., Sparre P., Pauly D., 2005 FAO-ICLARM Stock Assessment Tools II (FiSAT II). Revised version. User's guide. FAO Computerized Information Series (Fisheries). No. 8, Revised version, FAO Rome, 168 p.
Goodyear C. P., 1993 Spawning stock biomass per recruit in fisheries management: foundation and current use. In: Risk evaluation and biological reference points for fisheries management. Smith S. J., Hunt J. J., Rivard D. (eds), pp. 67-81, Canadian Special Publication of Fisheries and Aquatic Sciences, 120 p.
Hoggarth D. D. V., Cowan J., Halls A. S., McGregor J. A., Garaway C. A., Payne A. I., Wallcomme R. L., 1999 Management guidelines for Asian foodplain river fisheries. FAO Fisheries Technical Paper 384/2, FAO, Rome, Italy.
Hordyk A., Ono K., Valencia S., Loneragan N., Prince J., 2014 A novel length-based empirical estimation method of spawning potential ratio (SPR), and test of its performance, for small-scale, data-poor fisheries. ICES Journal of Marine Science 72(1):217-231.
Husnah, Ditya Y. C., Marini M., Koeshendrajana S., Samiaji J., Arisna D., Juniarto R. S., 2013 Component identification for utilization fisheries arrangement in Tasik Giam Siak Kecil flooded swamp, Riau Province. Final Report, Research Institute for Inland Fisheries, Palembang, Indonesia, 66 p.
Kasim K., Prianto E., Husnah, Triharyuni S., 2017 Fisheries resource management ecosystem approach in Tasik Giam Siak Kecil flooded swamp. Journal of Indonesia Fisheries Policy 9(2):115-124.
Knaepkens G., Knapen D., Bervoets L., Hanfling B., Verheyen E., Eens M., 2002 Genetic diversity and condition factor: a significant relationship in Flemish but not in German populations of the European bullhead (*Cottus gobio* L.). Heredity 89:280-287.
Kottelat M., Whitten T., 1993 Freshwater fishes of Western Indonesia and Sulawesi. Periplus edition.
Marini M., Husnah, 2011 Water level fluctuation and catch relationship in Giam Siak Kecil Water, Riau Province. Journal of Indonesia Fisheries Research 17(3):221-228.
Muflikhah N., Nurdawati S., Aida S. N., 2006 Development prospectus of Baung Fish (*Mystus nemurus* C.V.). Bawal 1(1):11-18.
Ng H. H., 2003 A review of the *Ompok hypophthalmus* group of Silurid catfishes with the description of a new species from South-East Asia. Journal of Fish Biology 62:1296-1311.
Nurullah, Windarti, Putra R. M., 2013 Otolith circle growth type of selais Fish (*Ompok hypophthalmus*) caught in Siak and Kampar Rivers, Riau Province. Technical Paper, Fisheries and Marine Faculty, Riau University, Pekanbaru, Indonesia, 13 p.
Pauly D., 1983 Some simple methods for the assessment of tropical fish stocks. FAO Fisheries Technical Paper No. 254, 52 p.
Pauly D., Ingles J., Neal R., 1984 Application to shrimp stocks of objective methods for the estimation of growth, mortality and recruitment related parameters from length frequency data (ELEFAN I and II). In: Penaeid shrimp - their biology and management. Pp. 220-234, Fishing News Book Limited, Farnham-Surrey-England.
Prianto E., Kamal M. M., Muchsin I., Kartamihardja E. S., 2013 Fisheries management strategy in Lubuk Lampam flooded swamp water, Ogan Komering Ilir Regency, South Sumatera. Journal of Indonesia Fisheries Policy 5(2):57-66.
Prince J., Victor S., Kloulchad V., Hordyk A., 2015 Length based SPR assessment of eleven Indo-Pacific coral reef fish populations in Palau. Fisheries Research 171:42-58.

Putra I., Pamukas N. A., 2011 Culturing Selais fish (*Ompok* sp.) using aquaponic recirculation system. Journal of Fisheries and Marine 16(1):125-131.
Putri S. M. E., 2016 Growth and reproduction of Selais fish (*Crystopterus lais*) in Way Kiri River, West Tulang Bawang. Undergraduate Thesis, Agriculture Faculty, University of Lampung, Indonesia, 26 p.
Smallwood C. B., Hesp S. A., Beckley L. E., 2013) Biology, stock status and management summaries for selected fish species in south-western Australia. Fisheries Research Report No. 242, Department of Fisheries Western Australia, 180 p.
Simanjuntak C. P. H., Rahardjo M. F., Sukimin S., 2008 Spawning season and fecundity of Selais fish (*Ompok hypophthalmus*) indi rawa banjiran Sungai Kampar Kiri Flooded Swamp River, Riau. Journal of Fisheries Science (2):251-260.
Sparre P., Venema S. C., 1992 Introduction to tropical fish stock assesment. Part I. Manual, FAO Fisheries Technical Paper No. 306/1.
Sudjastani T., 1974 Population dynamic of short mackerel in the Java Sea. Research Institute for Marine Fisheries 1/74:30-64.
Suman A., 2004 Exploitation pattern of endeavour shrimp resources (*Metapenaeus ensis* de Haan) in Cilacap and its adjacent waters. PhD Disertation, IPB University, Bogor, Indonesia.
Suman A., Hidayah T., Widjopriono, Fauziah, Aida S. N., Muthmainnah D., Ulqodri T. Z., Marson, Fahmi Z., Tumiran, Nasution D. H., Supriyadi F., 2009 Stock assessment and fishing gear development according to code of conduct for responsible fisheries (CCRF) in Riau River. Final Report, Common Water Fisheries Research Agency, Palembang, Indonesia.
Udupa K. S., 1986 Statistical method of estimating the size at first maturity of fishes. Fishbyte 4(2):8-10.
Utomo A. D., 2016 Management strategy of flooded swamp fisheries conservation in Sumatera and Borneo. Journal of Indonesia Fisheries Policy 8(1):14-20.
Walters C. J., Martell S. J. D., 2004 Fisheries ecology and management. Princeton University Press, Princeton, USA, 448 p.
Widodo J., Suadi, 2006 Marine fisheries resource management. University of Gadjah Mada (ID): Press, Yogyakarta, Indonesia.

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