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GROWTH COMPARISON OF MAHSEER (*Tor tambroides*) FROM MANNA AND TARUSAN RIVER IN WESTERN SUMATERA RIVER

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ABSTRACT

Mahseer is commonly used as a premium consumption fish with exceptional price, however, these species have encountered dwindle in distribution and abudance. The objective of this study was to investigate and to compare aspects of the interspatial variability of Western Sumatra component growth of mahseer between Manna River and Tarusan River. Mahseer samples were collected from the Manna River, Bengkulu Province and Tarusan River, West Sumatra Province. Monthly sampling was carried out over a period of February to October 2012 in Manna River and February to July 2012 in Tarusan River for detailed growth study. A total of 295 mahseer samples were collected from five sampling sites in Manna River and 495 mahseer samples were collected from three sampling sites in Tarusan River. The results show the age group population estimation of *T. Tambroides* from Manna River and Tarusan River based on the analysis of length-frequencies using the Bhattacharya method, resulted in two different age groups. The theoretical growth curve for length from Manna River, the values are $L\infty$ = 50.45 cm, K = 1.90 yr^{-1}, $t0$ = -0.07 yr^{-1} and Φ = 3.684, and for weight, the values are $W\infty$ = 1395.49 gr, K = 0.71 yr^{-1}, $t0$ = -0.078 yr^{-1} and Φ = 6.148. The parameters of the von Bertalanffy growth curve in length from Tarusan River were $L\infty$ = 31,34 cm, K = 1.70 yr^{-1}, $t0$ = -0.09 yr^{-1} and Φ = 3.21 and $W\infty$ = 634.86 gr, K = 0.48 yr^{-1}, $t0$ = -0.147 yr^{-1} and Φ = 5.282 in weight. The length-weight relationship estimated for Manna River was W = 0,000007TL$^{3.086}$ for females (R^2 = 0.9545, N = 91) and W = 0.0037TL$^{1.882}$ for males. While for Tarusan River, length-weight relationship estimated was = 0.00003TL$^{2.839.}$ Mahseer from Manna River population has better growth parameters than those at Tarusan River.

Keywords: Growth; mahseer; Manna and Tarusan River

INTRODUCTION

Tor tambroides or known by its common name, mahseer, is a member of Cyprinidae, inhabits waterfalls area. Generally, *T. tambroides is* recognized with an elongated large flat torso, a long mental lobe, a relatively small head, greenish brown coloration, a large scales sized 15-20 cm (Kottelat *et al*., 1997). Mahseer is commonly used as a premium consumption fish with exceptional price. This fish has an incredible taste, rich nutrient contents and delicate texture (Anonymous, 2003). However, this species has encountered dwindle in distribution and abudance (Haryono, 2006) and are now threatened due to pollution, habitat loss and overfishing.

Mahseer are well noted for their inability to reproduce in captivity even though artificial propagation through induces maturation and ovulation by using hormonal treatment technique has been attempted (Ingram *et al*., 2005; Haryono, 2006). There is currently a great interest in the biology, culture and conservation of this group of cyprinids (Siraj *et al*., 2007). Nevertheless, little information on the biology of the mahseer species is available for the minimal management usage (Haryono & Subagja, 2008).

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In fisheries management, many biological reference points are estimated using life history parameters, such as those associated with growth dynamics (Quinn & Deriso, 1999). Growth parameter suppositions are basic prerequisites for stock assessment. Growth is a key biological aspect for the assessment of the exploited fish populations and differences in growth by age-class directly influence the initial parameters of analytical methods of assessment. Knowledge of whether differences exist in growth between sexes, areas or depths permits the analysis of the catches while taking these factors into account and thus leads to a more objective estimate of stock abundance (Landa *et al.,* 2002).

There have been descriptions of existence of different sub-population mahseer to the west Sumatra River due to isolation process (Wibowo & Siswanta, 2012), whithin some cases point to the hypotesis of different growth groups. The alternative hypotesis that the growth differences in the mahseer may be attributed to the existence conservation area and different fishing. The objective of this study was to investigate and to compare aspects of the interspatial variability of Western Sumatra component growth of mahseer between Manna River and Tarusan River.

MATERIAL AND METHODS

Mahseer samples were collected from the Manna River and Tarusan River. Monthly sampling was carried out over a period of February to October 2012 in Manna River and February to July 2012 in Tarusan River (Figure 1) for detailed growth study. All fish were measured, both total length (TL) and standard length (SL), with a pertinence of 1 mm and weighted with accuracy 1 g. Sex was assigned by macroscopic inspection of the gonad.

Opportunistic collections of samples were used to portray broad-scale variation in the mean length-at-age and growth pattern of mahseer in Manna River, Bengkulu Province and Tarusan River, West Sumatra Province. Eight sampling sites spread over two rivers were selected. A total of 295 mahseer samples were collected from five sampling sites in Manna River (Figure 2) and 495 mahseer samples were collected from three sampling sites in Tarusan River (Figure 3). Most of the samples were caught with cast net and net throughout research surveys. Samples were then fixed in 10% formaldehyde and then transferred to 70% ethanol for long-term storage.

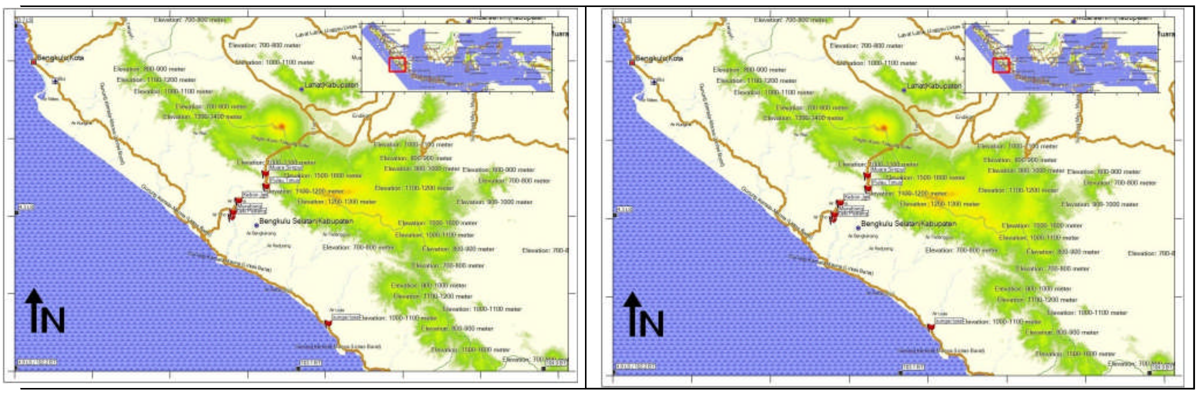

Figure 1. Map shows the locations of the research are the Research location (Manna River Bengkulu (left) dan Tarusan River Sumatera barat (right).

We analyzed monthly samples length frequency distributions for Manna River and Tarusan River using FISAT II ELEFAN (Gayanilo *et al.,* 1988). Length frequency distribution is structured of a limited composite of density functions, which reflect the size structure of diverse age components in the sample. Age was defined from length-frequency data, applying Bhattacharya's (1967) method, as in FISAT II ELEFAN (Gayanilo *et al*., 1988). Bhattacharya's method for the analysis of length frequency distributions is applied to separate possible constituent components and to estimate the mean values and their variances, it may serve primarily to identify age groups, the assumption being that modal groups in the length frequency distribution represent year classes or cohorts (Goonetilleke & Sivasubramaniam, 1987).

Bhattacharya's method based on assumed normal distributions of the components in a composite length frequency distribution was modelled as follows:

$$Fc\ (x) = \frac{ndl}{s\sqrt{2\ pi}} \exp\left[\frac{-\left(x - \bar{x}\right)^2}{2s^2}\right]$$

Described by 4 parameters; n (number), s (SD), $\bar{x}$ (mean) and dl (class interval).

The growth parameters were estimated from the mean lengths by quarter and their suitable ages. The model utilized to estimate mahseer growth is the von Bertalanffy (1938) growth function. The von Bertalanffy growth function has been widely used in growth studies and fisheries management due to its simplicity, the biological meaning of its parameters and possible algebraic incorporation of those parameters into yield models (Beverton & Holt, 1957). The equation is

$$L_t = L_\infty (1 - e^{-K(t-t_0)}) \text{.................................}(1)$$

Where *Lt* is the length at age t, L_∞ the maximum length which species can attain, k the instantaneous growth coefficient, *t* the age and *t0* the point at which von Bertalanffy's curve intersects the axis. The von Bertalanffy growth function for weight was also used, the formula is as follows.

$$W_t = W_\infty (1 - e^{-K(t-t0)})^b \quad \text{..............................}(2)$$

Where *Wt* is the weight at age t, W_∞ the maximum weight which species can attain, k the instantaneous growth coefficient, *t* the age and *t0* the point at which von Bertalanffy's curve intersects the axis.

The value of *Lt*/*Wt* and L_∞ / W_∞ offered automatically by ELEFAN as in the FISAT II by scanning of *Lt*/ *Wt* and L_∞ / W_∞ values routine. The ELEFAN program uses a nonparametric method to fit the von Bertalanffy growth curve through modes. The best curve will pass through the maximum possible number of modes, which is detected by the high value of the scoring function (Siddeek & Johnson, 1997). To compare the estimated growth parameters, the growth performance index *Φ* (Pauly & Mumo, 1984) was calculated using equation, *Φ* = log (K) + 2log () for comparing different fits.

The comparison of the size attained at the different ages between the two sexes over all period was compared with a *t*-Test as in the SPSS 10 program. Before *t*-test was first applied; the F test (*Levene's test)* assesses the hypothesis homogeneity. If the length distributions at sex were homogeny then *t*-test will use equal variance assumed and equal variance not assumed if the variance is unequal across the groups (Sokal & Rohlf, 1995). The length/weight relationship, W = aL, were calculated whether separately or combined for the two sexes with respect to the samples based on the conditions of *t*-test. The comparison of the regression coeficient (β) between groups of sample was done using *t*-test (p>0,05).

RESULTS AND DISSCUSION

Results

The length frequency distribution of *T. tambroides* from Manna River, during period February to October 2012 is be seen in Figure 2. Length frequency varied from 93 to 480 mm. In general, the analysis of mahseer samples in February, March and April have produced the best estimation of the growth. There were slight increase mean of the lenght frequency, which determined growth pattern of this species. This was supposed, in as much as the length distributions of those 3 months were derived from a number of specimens and presented little gaps, two facts that enable a good use of length-based analysis. The analysis of *T. tambroides* from Tarusan River, during period of February to July 2012 is shown in Figure3. Length frequency varied from 118 to 298 mm presented no better results, very few growth patterns were detected. Therefore it was not adequate for length-based analysis, providing statistically less appropriate results.

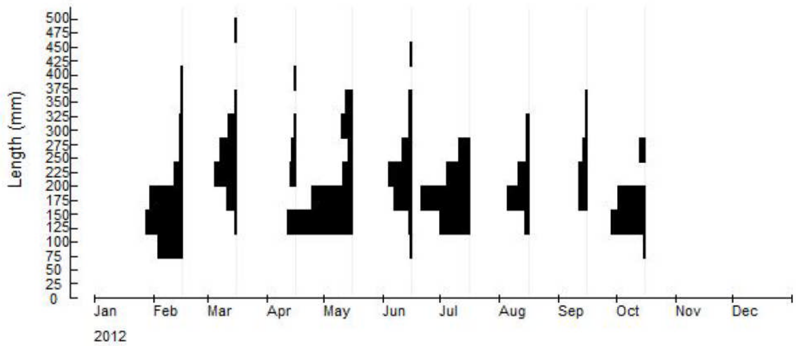

Figure 2. Length-frequency distribution of Manna River's *Tor tambroides* from February 2012 to October 2012.

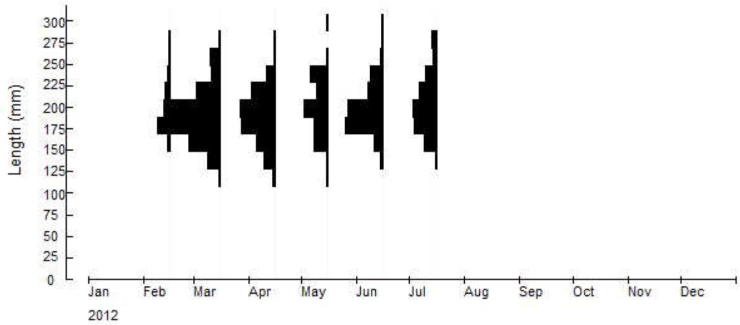

Figure 3. Length-frequency distribution of Tarusan River's *Tor tambroides* from February 2012 to October 2012.

Age group population estimation of *T. Tambroides* from Manna River in Figure 4 and Tarusan River in Figure 5 based on the analysis of length-frequencies using the Bhattacharya method, resulted in two different age groups and indicated by formation of two normal curves.

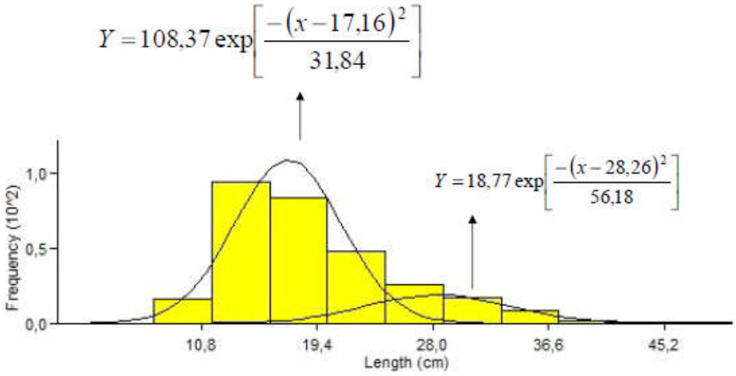

Figure 4. Total number of aged groups in Manna River based on the analysis of length-frequencies using the Bhattacharya method.

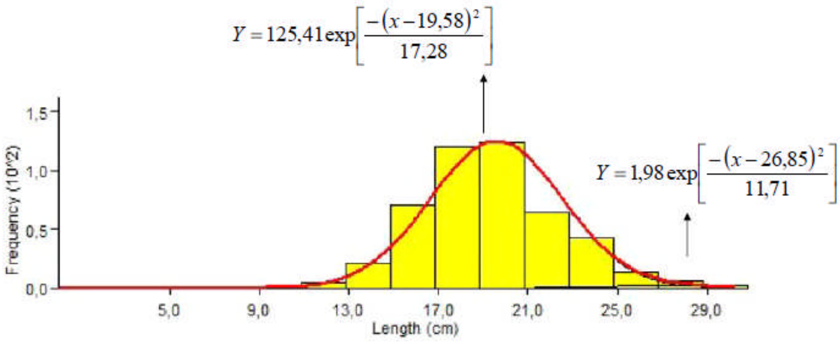

Figure 5. Total number of aged groups in Tarusan River based on the analysis of length-frequencies using the Bhattacharya method

The theoretical growth curve for length from Manna River is presented in Figure 6; the values are L_∞ = 50.45 cm, K = 1.90 yr^{-1}, $t0$ = -0.07 yr^{-1} and Φ = 3.684, and for weight is presented in Figure7; the values are W_∞ = 1395.49 gr, K = 0.71 yr^{-1}, $t0$ = -0.078 yr^{-1} and Φ = 6.148.

The parameters of the von Bertalanffy growth curve in length from Tarusan River were L_∞ = 31.34 cm, K = 1.70 yr^{-1}, $t0$ = -0.09 yr^{-1} and Φ = 3.21, Figure 8. and W_∞ = 634.86 gr, K = 0.48 yr^{-1}, $t0$ = -0.147 yr^{-1} and Φ = 5.282 in weight, Figure 9.

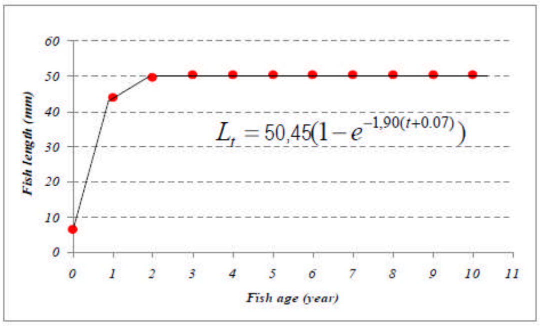

Figure 6. *T. Tambroides*: theoretical growth in length in Manna River

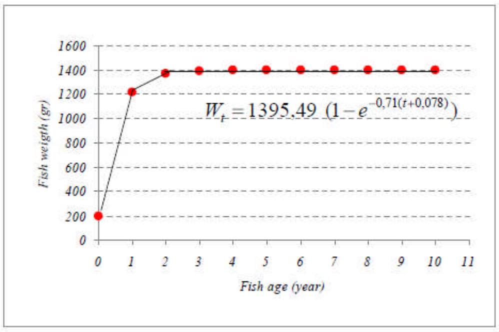

Figure 7. *T. Tambroides*: theoretical growth in weight in Manna River

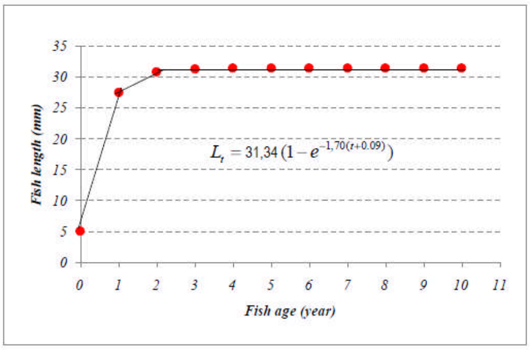

Figure 8. *T. Tambroides*: theoretical growth in length in Tarusan River

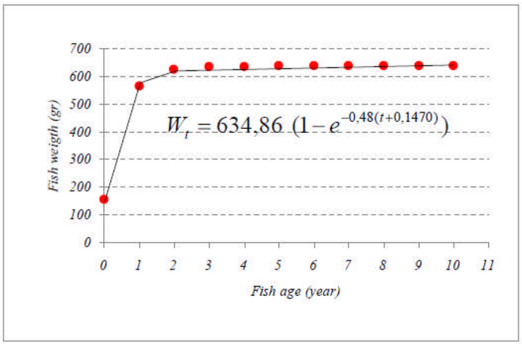

Figure 9. *T. Tambroides*: theoretical growth in weight in Tarusan River

The mean weight for the females from Manna River are higher (W = 173.24 gr) than those for males (82.24 gr) and the differences were significant for all cases using *t*-test (p>0.05). While from Tarusan River the females are slightly higher (W = 85.46 gr) than those for male (85.26 gr), the differences were not significant for all cases using *t*-test (p>0.05), Table 1.

Table 1. The comparison between sex groups using *t*-test (p>0.05)

Sample	db	T calculation	T table	conclusion
Males-Females Manna River	259	3,456	1.969	significant
Males-Females Tarusan River	344	0,033	1.97	non significant

The length-weight relationship estimated for Manna River is $W = 0.000007TL^{3.086}$ for females ($R^2 = 0.9545$, N = 91), Figure 10, and $W = 0.0037TL^{1.882}$ for males ($R^2 = 0.6357$, N = 168), (Figure 11). While for Tarusan River, length-weight relationship estimated is = $0.00003TL^{2.839}$ ($R^2 = 0.792$, N = 346), Figure 12. The regression coefficients different significantly (*t*-test) for Manna River and Tarusan River, (Table 2).

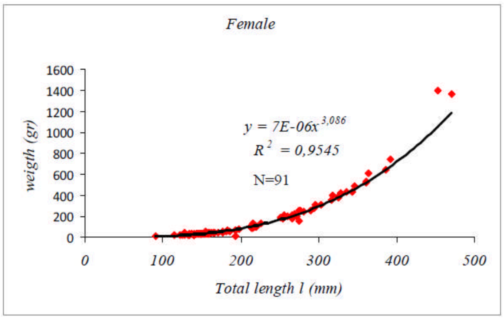

Figure 10. The females length-weight relationship estimated for Manna River

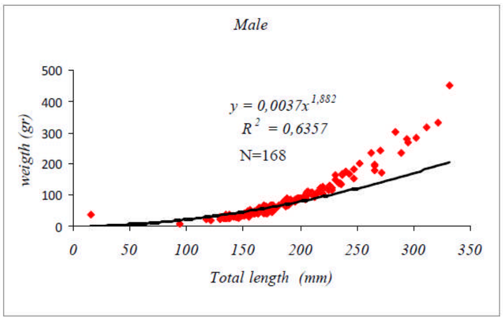

Figure 11. The females length-weight relationship estimated for Manna River

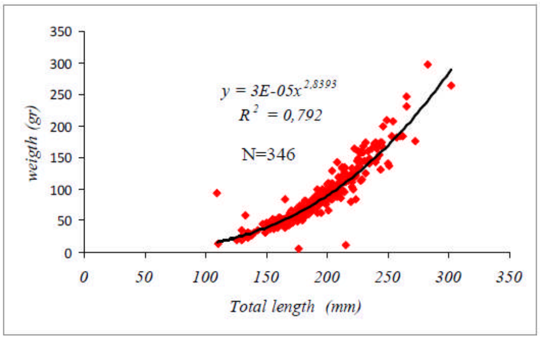

Figure 12. The length-weight relationship estimated for Tarusan River

Table 2. The comparison of regression coefficients using *t*-test (p>0.05)

Sample	db	t calculation	ttable	conclusion
females Manna River	89	5.375	1.987	significant
Males Manna River	166	58.4	1.974	significant
Mahseer, Tarusan River*	344	10.063	1.967	significant

(* Comparison in size between males and females Mahseer, Tarusan River is significant, so it can be merged, the calculations in Table 1)

Discussion

Length-frequency methods are affected by various factors (e.g. width of the class interval, sample size), which must be taken into consideration in the analyses (Mytilineou & Sardi, 1975). Our results are not generally consistent, regarding class interval. The length-based analysis does not provide adequate information to determine mahseer's growth pattern, because the representation of both small and large individuals in the samples was very low or zero. Gear selectivity influencing the representativeness of a population, could be consider as the explanations (Mytilineou & Sardi, 1975). In our case, the use of cast nets having a bar mesh of 1.5 and 3.5 inch does not seem to support catch of small individuals and the fact that large mahseer stay in deep water habitat may cause difficulty catching. Thus the absences of the small and large individuals in the analysis produce gaps in the length-frequency distribution.

The analysis of length frequency, using Bhattacharya method, resulted in two different age groups in both locations. Realibility of Bhattacharya method was informed by Castro (1990), that the method is easier than other modern methods and could be applied in a more objective way than other graphical methods. Consequently, Bhattacharya with the advantages offered nowadays by computer programs, could be considered an objective, quick, easyly applied and adequate method for length-based analysis. The difference between age group showed that the mahseer in western Sumatra River coming from spawning period two times during the year, which define the strategy for recruitment of the population. A recruitment event within a population is generally the result of spawning individuals of the population members (Krebs, 1994).

With respect to theoretical growth curve, the von Bertalanffy growth model generated from ELEVEN II presented samples from Manna River had greater value of $L\infty$/ $W\infty$, K and Φ when compared to those from Tarusan River. In Manna River, the *t*-test showed statistically significant difference of the size attained at the different ages between the two sexes over all period. There may be a differential gonad weight between sexes in the population giving larger gonad for females. However, there was no significant size difference between sexes for Tarusan River's population. Mahseer from Manna River population has higher slope of length-weight relationship than those at Tarusan River.

The possiblity of difference as in line with Pauly (1979) information that growth parameters may vary below the species level, possibly separating groups of population with larger genetic distance. In fact, mahseer distributed in Manna and Tarusan River are reproductively isolated and mixing between populations from the two geographical area is not possible. Above facts indicate and assuming better description of mahseer growth parameters from Manna River population.

Apart from a higher growth, mahseer from Manna River also show higher spawning frequency and length at first maturity than those from Tarusan River (Wibowo & Kaban, 2014). Higher values for some life history properties of Manna River mahseer population may thus due to pronounced growth performance in comparison to the Tarusan River. In spite the above indications other processes, such as density-dependence and size-selective mortality (Sinclair *et al*., 2002), may generate geographical differences on the apparent growth trajectory. Size-selective mortality may result from fishing gear and or fisherman selectivity and cause evolutionary change in growth through persistent removal of the larger individuals from populations (Law, 2000). Swain *et al*. (2003) provide an example that size-selective mortality may part have a variable influence on the length-at-age of neighbour fish stocks depending on their abundance and exploitation level. In our case, overall abundance and catch levels vary extensively in the study area. It also need to take account that the presence of protected area in Tarusan River have the potential to influence the population density and fishing mortality on growth pattern which need to be further study.

Overall, mahseer growth evidences large spatial variability that needs to be taken into account for stock assessment and stock structure analyses. Our results show persistent differences in length-at-age of western Sumatra River, with the same presented differences in weight. Weight-at-age is expected to vary directly with length-at-age and influence maturity-at-age. Such differences support the current procedure of area-stratification used in biological sampling and calculation of catch, weight and maturity-at-age for assessment purposes (ICES, 2006).

CONCLUSION

The length-based analysis does not provide adequate information to determine mahseer's growth pattern, because the representation of both small and large individuals in the samples was very low or zero. Age group population estimation of *T. Tambroides* from Manna River and Tarusan River based on the analysis of length-frequencies using the Bhattacharya method, resulted in two different age groups and indicated by formation of two normal curves.

The theoretical growth curve for length from Manna River, the values are $L\infty$ = 50.45 cm, K = 1.90 yr^{-1}, $t0$ = -0.07 yr^{-1} and Φ = 3.684, and for weight, the values are $W\infty$ = 1395.49 gr, K = 0.71 yr^{-1}, $t0$ = -0.078 yr^{-1} and Φ = 6.148. The parameters of the von Bertalanffy growth curve in length from Tarusan River were $L\infty$ = 31.34 cm, K = 1.70 yr^{-1}, $t0$ = -0.09 yr^{-1} and Φ = 3.21 and $W\infty$ = 634.86 gr, K = 0.48 yr^{-1}, $t0$ = -0.147 yr^{-1} and Φ = 5.282 in weight.

The mean weight values for the females from Manna River are higher than those for males and the differences were significant. While from Tarusan River the females are very slightly higher than those for male the differences were not significant. The length-weight relationship estimated for Manna River was $W = 0.000007TL^{3.086}$ for females (R^2 = 0.9545, N = 91) and $W = 0.0037TL^{1.882}$ for males. While for Tarusan River, length-weight relationship estimated was = $0.00003TL^{2.839.}$ Mahseer from Manna River population has better growth parameters than those at Tarusan River.

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