Study of aquatic biota and riparian vegetation in the Sebangau River, Central Kalimantan, Indonesia

[1]Lukas Inel, [1]Infa Minggawati, [2]Ardianor

[1] Aquaculture Study Program, Faculty of Fisheries, Palangka Raya Christian University, Central Kalimantan, Indonesia; [2] Water Resources Management Study Program, Department of Fisheries, Faculty of Agriculture, Palangka Raya University, Central Kalimantan, Indonesia. Corresponding author: I. Minggawati, infa41@gmail.com

Abstract. The high abundance of forest vegetation can be an advantage for the aquatic biota from shallow areas or pelagic areas for demersal fish. This research examines the aquatic biota (plankton and fish) and riparian vegetation in the Sebangau River. The results showed that the abundance of phytoplankton and zooplankton ranged from 654 to 1667 ind L^{-1} and from 271 to 677 ind L^{-1}, respectively. The phytoplankton and zooplankton diversity index ranged from 0.629 to 1.189 and from 0.703 to 0.980, respectively, which is included in the low category; their uniformity index was 0.391–0.739 and 0.703–0.980, respectively; the individual distribution of each species was uneven, there was no dominance observed. 83 fish were found during the study; 9 fish species dominated, in particular from the Osphronemidae and Channidae families. The analysis of the riparian habitus vegetation revealed certain dominant types, namely: the herbs and grass were dominated by *Hydrilla verticilla* (168%), the shrubs, bushes and liana were dominated by *Timonius salicifolius* (128%), the trees were dominated by *Shorea balangeran* (186%). Visually there was a very significant correlation between the abundance of phytoplankton and zooplankton, followed by the abundance of fish, with the temperature, ORP, turbidity and pH (Kruskal-Wallis test).

Key Words: plankton abundance, zooplankton abundance, fish community, riparian vegetation.

Introduction. The Sebangau river basin, located in Central Kalimantan, is dominated by peat swamps with river conditions that can be considered as very homogeneous. The Sebangau River, with its peat ecosystem, has black water characteristics and aquatic plants which are dominated by water plants (*Pandanus helicopus*) and lilies (*Hanguana malyana*), which are located along the Sebangau river, in surface waters classified as acidic, with an average pH of 3.6. This is due to the influence of the peat swamp forest, which contains a lot of humic acid (Badjoeri 2018). The floodplain size varies, primarily as a response to the fluctuating water levels in the nearby main rivers (Wetzel 2001). Dissolved solids in the river will be bound by the roots of riparian vegetation, so that the river water looks clear, also preventing sedimentation in the river. This will benefit animals such as fish that like habitats with non-muddy riverbeds (Jones et al 1999; Loomis et al 2000), but also fish that like rushing water such as the tapah fish (*Wallago leeri*). Aquatic plants, as primary producers, have an important role in aquatic ecosystems, providing oxygen and shelter for fish and other aquatic biota, due to the periphyton attachment (substrate) which is beneficial especially for fish larvae (Dwirastina & Etty 2019).

Riparian vegetation grows on the side of a river/lake, acting as a habitat for wild animal life and playing a role in maintaining the health of water catchment areas (Decamps et al 2004). Vegetation has an important role as an erosion buffer preventing drought. Vegetation conditions around the watershed determine the overall quality of the river (Maridi et al 2015). Riparian vegetation is important as wildlife habitat (including fish), supporting food chains, maintaining temperature, stabilizing riverbanks, protecting water quality, maintaining river morphology and controlling flooding (Chang 2006; Lukas et al 2020). Among aquatic biota, the phytoplankton has the function of primary producer: these organisms are able to convert inorganic materials into organic materials through the process of photosynthesis, for that the content of chlorophyll-a is used as a standing stock of phytoplankton which can be used as the primary productivity of a water (Pugesehan 2010).

Fish morphology is closely related to the habitat of the fish in the waters. Before getting to know the shapes of the fish's body, that can indicate the type of its habitat, it is good to know the parts of the fish's body as a whole, along with the measurements used in identification. The fish caught in the Sebangau River are more dominant than the black fish group. Groups of black fish which are inhabitants of swamp fish and these fish are able to live in acidic water conditions and low oxygen content, because these fish have additional breathing apparatus (Agus et al 2005). This study aimed to examine the aquatic biota (plankton and fish) and riparian vegetation in the Sebangau River, at the research location.

Material and Method

Description of the study sites. This research was carried out in the Sebangau River, Central Kalimantan, especially in the Perupuk Tunggal area, in January 2021. The location and sampling points were divided into 4 observation stations (Figure 1).

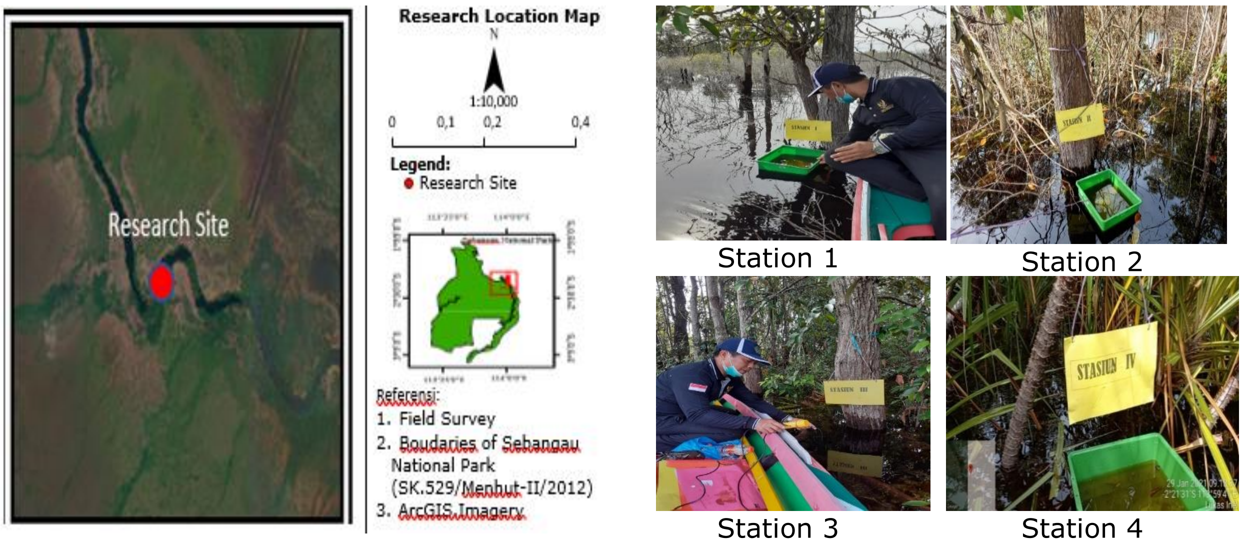

Figure 1. Research location and 4 observation stations on the Sebangau River, Central Kalimantan.

Statistical analysis. The abundance of plankton is calculated based on the formula (APHA 2005), as follows:

$$K = \frac{N\ x\ At\ x\ Vt}{Ac\ x\ Vs}$$

Where:
N - number of observed plankton;
At - SRC surface cross-sectional area (mm^2);
Ac - wide of observation (mm^2);
Vt - volume of concentrate in the sample bottle (30 mL);
Vs - concentrate volume in SRC (mL).
The dominance index (D) is calculated using Simpson's formula (Odum 1993), as follows:

$$D = \sum (ni/N)^2$$

Where:
D - Simpson's dominance index;

ni - number individuals of each species;
N - number individuals all of species;

The uniformity index (E) is calculated by Shannon-Wienner formula (Bengen 1999), as follows:

$$E = H'/Hmax$$

Where:
E - species uniformity index;
H' - Shannon-wienner diversity index;
H_{max} - maximum diversity index (LnS);
S - number of species.

The diversity index is calculated by the formula (Ludwig & Reynolds 1988), as follows:

$$H' = -\sum_{i=1}^{s} - pi\ Lnpi$$

Where:
H' - index of species diversity;
S - number of types;
Pi - ni/N;
Ni - number of individuals of the i-th type;
N - total number of individuals.

The condition factor (Kn), according to Effendie (2002), for fish with an allometric growth pattern, is calculated using the relative condition factor, namely:

$$K = \frac{W}{aL^b}$$

Where:
K - condition factor;
W - fish weight;
L - length of fish;
a & b - constant of the length weight relationship (a is the intercept, b the slope).

The Importance Value Index (INP) is the sum of the relative density (KR), relative dominance (DR), and relative frequency (FR) (Qirom et al 2019):

INP (%) = (KR %) + (DR %) + (FR %)

The analysis of the linkage of riparian plants to biota, environment and fish resources in the black water of the Sebangau River, used the Kruskal-Wallis Test, that is a rank-based nonparametric test whose purpose is to determine whether there are statistically significant differences between two or more groups of independent variables on the dependent variable with a numerical data scale (interval/ratio) and ordinal scale. Kruskall Wallis can be used for more than 2 variables (Siegel 1956):

$$K = (N-1)\frac{\sum_{i=1}^{g} n_i(\bar{r}_{i\cdot} - \bar{r})^2}{\sum_{i=1}^{g}\sum_{j=1}^{n_i}(r_{ij} - \bar{r})^2}$$

Where:
ηi - the number of observations in the group;
Rij - rank (among all observations) observation j from group i;
N - the number of observations in all groups.

Results. The results of the analysis of plankton and fish are described below. Plankton are aquatic microorganisms that live floating along with the currents and movements of water. It is divided into two groups, namely phytoplankton which includes microscopic plants and zooplankton which is in the form of microscopic animals. In aquatic ecosystems, phytoplankton are plants that determine water productivity. Besides that, plankton can be used as an indicator of changes in aquatic environmental conditions, for example the entry of pollutants into the waters. The results of the plankton analysis are shown in Table 1.

Table 1

Plankton analysis results (ind L^{-1}) in the Sebangau River (January 2021)

Organism	*Station*			
	I	*II*	*III*	*IV*
Phytoplankton				
Chlorophyta				
Cosmarium sp.	-	-	23	-
Mougeotia sp.	270	135	203	203
Oedogonium sp.	23	-	-	23
Scenedesmus sp.	23	-	45	-
Spirogyra sp.	765	360	1373	675
Cyanophyta				
Hapalosiphon sp.	167	66	250	194
Bacillariophyta				
Eunotia sp.	23	23	23	-
Cryptophyta				
Cryptomonas sp.	113	113	-	23
Number of taxa	6	5	5	4
Individual L^{-1}	1,217	654	1,667	924
Diversity (H’)	1.067	1.189	0.629	0.743
Uniformity (E)	0.596	0.739	0.391	0.536
Domination (D)	0.455	0.379	0.695	0.585
Zooplankton				
Rotifera				
Asplanchna sp.	-	45	-	-
Euchlanis sp.	-	-	45	-
Monommata sp.	-	-	23	-
Lecane sp.	23	-	45	-
Lepadella sp.	-	23	-	-
Polyarthra sp.	23	45	23	23
Cladocera				
Alonella sp.	45	45	45	45
Acantholeberis sp.	23	45	45	-
Acroperus sp.	23	-	-	-
Bosmina sp.	23	-	-	23
Chydorus sp.	45	-	45	-
Copepoda				
Macrocyclops sp.	-	-	23	-
Nauplii sp.	135	68	-	293
Number of taxa	8	6	9	5
Individual L^{-1}	340	271	339	677
Diversity (H’)	1.087	1.748	2.154	1.132
Uniformity (E)	0.869	0.976	0.980	0.703
Domination (D)	0.218	0.520	0.120	0.382

Fish population structure and condition factors (Kn). The structure of the fish population in the Sebangau River can be determined by analyzing the species of fish, the length and weight of fish specimens, their feeding habits, sex ratio and types food, for sampling sessions performed during deep and low tides. The fish population distribution of the 83 collected specimens can be seen in Figure 2.

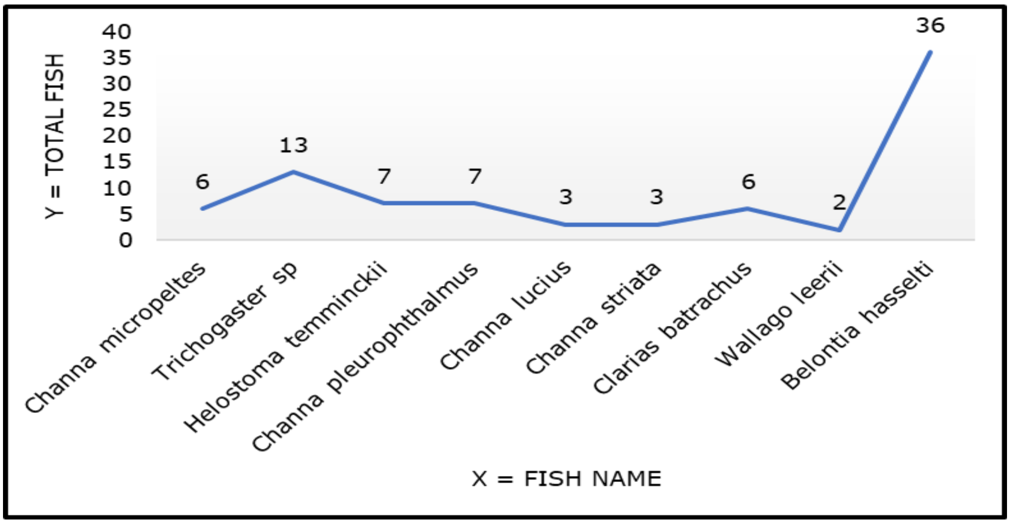

Figure 2. Total fish caught.

The condition factor of the fish caught in the Sebangau river for the first and second sampling can be seen in Table 2.

Table 2

Conditions of fish caught in the Sebangau River

Species	*Condition factor (Kn)*
Sepat (*Trichogaster* sp)	1.09
Ocellated snakehead (*Channa pleurophthalmus*)	1.03
Toman (*Channa micropeltes*)	1.03
Catfish (*Clarias batrachus*)	1.05
Kissing gourami (*Helostoma temminckii*)	1.01
Javan combtail (*Belontia hasselti*)	0.51
Wallago (*Wallago leerii*)	19.94
Snakehead fish (*Channa striata*)	0.77
Kehung (*Channa lucius*)	1.01

Riparian vegetation and Wallis Kurskal analysis for p value. The dominance of a species is indicated by a high INP value, which determines a high density and frequency of the species (Purnawan et al 2021). The INP values at the study site on the habitus of herb and grass, shurbs bush and liana, and Trees are sequentially presented in Table 3.

Table 3

Vegetation analysis on Peat Swamp forest habitus types

Habitus	*Latin name*	*K*	*KR (%)*	*F*	*FR (%)*	*INP (%)*
Herbs, grass	*Hydrilla verticillata*	188.000	86	9.000	82	168
	Diplachne sp	28.000	13	1.000	9	22
	Ischaemum sp	3.000	1	1.000	9	10
Shurbs, bush, liana	*Timonius salicifolius*	4.240	59	360	69	128
	Pandanus helicopus	2.840	39	80	15	55
	Uncaria nervosa Elmer	80	1	40	8	9
	Spatholobus littoralis	80	1	40	8	9
Trees	*Shorea balangeran*	288	98	18	88	186
	Barringtonia sp	5	2	3	13	14

Visually there is a relationship between phytoplankton, zooplankton and fish, it can be seen in the results of the Kruskal-Wallis analysis in Table 4.

Table 4

Results of Kruskal-Wallis analysis for p value

Parameter	*P value*	*Descriptions*
Depth	0.1489	>0.05
WT (temperature)	0.02092	<0.05*
DHL (EC)	0.2454	>0.05
Electrical conductivity of ORP (mV)	0.02092	<0.05*
TDS	0.7728	>0.05
Salt content or water salinity	0.1266	>0.05
Turbidity	0.02092	<0.05*
pH	0.02092	<0.05*
DO	0.2482	>0.05
Phytoplankton	0.08326	>0.05
Zooplankton	0.3865	>0.05
Fish	0.1913	>0.05
Vegetation density	1	>0.05

*significant difference.

Discussions. The results of the laboratory analysis (Table 1) showed that the number of phytoplankton species at the 4 sampling locations was as follows: 6 species at Station I, 5 species at station II and III, and 4 species at station IV. The abundance of phytoplankton ranged from 654 to 1,667 ind L^{-1}. The results of the zooplankton analysis showed that there were 8 species at station I, 6 species at station 2, 9 species at station 3, and 5 at station 4, with an abundance of zooplankton between 271 and 677 ind L^{-1}. The diversity index (H'), uniformity index (E) and dominance index (D) showed that the diversity of phytoplankton ranged from 0.629 to 1.189 and for zooplankton it ranged from 0.703 to 0.980, which was included in the low category. According to Masson (1981), a value of $H' \leq 1$ belongs to the low diversity category. The phytoplankton uniformity index ranged from 0.391 to 0.739 and for zooplankton it ranged from 0.703 to 0.980, which indicated that the distribution of individuals for each species was uneven. The dominance index <1 showed an absence of dominant phytoplankton and zooplankton species for all observation stations in the waters of the Sebangau river.

Observations on zooplankton were also carried out to characterize the ecological properties of the zooplankton community in the Sebangau River ecosystem. The zooplankton community in the Sebangau River showed different dynamics in the density of biomass, vertical distribution and community composition, due to the alternation of the rainy season with the dry season, which regulated the different physico-chemical conditions in the Sebangau River. The larger zooplankton, especially cladocera, there is a tendency to increase in density, due to the influence of moonlight throughout January 2021, according to the opinion of Gliwicz (1986). The density fluctuations pattern can be related with intra-biocoenotic interactions between the larger zooplankton (adult copepods and cladocera) and rotifers. The existence of rotifers is usually suppressed by copepods through predation interactions (Gilbert 1988). Therefore, it can be hypothesized that the inverse density relationship between cladocera and rotifers is due to the influence of the lunar cycle on the fish feeding intensity with larger zooplankton, according to size-selective predation mechanisms (Brooks & Dodson 1965). The distribution of heterotrophic bacteria in the lake is spatially evenly distributed, during the rainy season, while the abundance of bacteria in the lake is higher than in the dry season (Bodjoeri 2018).

During the observations in January 2021, in the Sebangau River, 9 species of fish were identified, consisting of: 7 species of *Helostomatidae* (kissing gourami fish), 49 species of *Osphronemidae* (three spout gourami fish and javan combtail fish), 2 species of *Siluridae* (wallago fish), 6 species of *Clariidae* (catfish) and 19 species of *Channidae* (toman, ocellated snakehead, snakehead fish and kehung fish). It is possible that these fish species eat zooplankton intensively. From the graph above, it can be seen the number of fish caught for each species; the dominant fish caught are javan combtail fish and three spout gourami fish (Figure 1). Minggawati et al (2020) stated that the local fish originating from the Sebangau river consist of wallago fish (*Wallago leeri*), Asian redtail catfish (*Hermibagrus capitulum*), saluang fish (*Rasbora argyrotaenia*) and three spout gourami fish (*Trichogaster trichopterus*).

The range of the condition factor was 0.77–19.94; the lowest value of the condition factor was found in the Snakehead fish and the highest was found in the Wallago fish, as shown in Table 2. The K value in slightly flat-bodied fish ranges from 2.0 to 4.0, while in fish that are less flat it ranged from 1.0 to 3.0 (Effendie 2002). The fish factor condition was physiologically influenced by the development of gonads and fat, as well as by the availability of food and environmental influences. The condition factor of the fish caught in the Sebangau River, dominated by fish that are less fat or more fat, with a value ranging between 1.01 and 19.94. However, there were also 2 species of fish, out of 9 analyzed, with a condition factor less than 1, namely javan combtail fish of 0.51, which means flat fish (not fat). Fish with the condition factor value between 0and 1 are classified as flat or not fat fish (Effendie 1997). The dominant food was fish juveniles, for the meat eaters, in proportion of: 75% in wallago fish (*Wallago leeri*), 28% in catfish (*Clarias batrachus*), 99% in snakehead fish (*Channa striata*), 95% in ocellated snakehead fish (*Channa pleurophthalmus*), and 87% in kehung fish (*Channa lucius*). Meanwhile, for Javan combtail fish and Kissing Gourami fish, the composition of food was dominated by plant species, that are 17% and 59%, respectively.

This study identified several habitus compilers in the peat swamp forest on the riverbank: in the herbs and grass habitus, there were *Diplachne* sp., *Hydrila vericillata* and *Ishaemum* sp.; in the habitus of shrubs, bush and lianas, there were *Pandanus helicopus, Spatholobus litoralis, Timonius salicifolius* and *Uncaria nervosa Elmer*; in the tree habitus, there were *Barringlonia* sp. and *Shorea balangiran*. The highest number of individual species in the herbs and grass habitus was *H. verticillata*, with a total of 188 individuals. The highest number of individual species in the habitus of Shrubs, Bush and Lianas was arranged, namely *T. salicifolius*, which was of 106 individuals. Meanwhile, the highest number of individual species in the tree habitus was *S. balangeran*, with 115 individuals (Table 3).

The vegetation at each level of habitus had certain dominating species: in the herbs and grass habitus, it was *H. verticilla* (168%); in the shrubs, bush and liana habitus, it was *T. salicifolius* (128%); in the tree habitus, it was *S. balangeran* (186%). The herbs and grass habitus had a low species diversity, species richness and high evenness index. The shrubs, bush and liana habitus also had a low species diversity index, wealthiness and high evenness. The tree habitus also had a low species diversity, wealthiness and high evenness index. Water quality data showed that the water temperature ranged between 29.71 and 29.93°C, peat water pH ranged between 4.05-4.66, dissolved oxygen (DO) ranged between 3.29-5.66 ppm, and water depth ranged between 1.0-3.4 m. The pH of Sebangau water was generally acidic, with a pH value ranging from 4.07 to 4.14.

Visually there is a relationship between phytoplankton, zooplankton and fish. With the high abundance of phytoplankton and zooplankton in the waters, there will be an increasingly abundant fish population as well. There are several significant differences in the analysis of water quality, namely: water temperature, ORP electrical conductivity, turbidity, and pH. Factors such as temperature, light intensity, nutrients, and other limiting factors also greatly affect the distribution of phytoplankton and fluctuations in water productivity (Nurdin et al 2020). This is also supported by the final results of the Kruskal Wallis test when the P value <0.05. It can be assumed that the fluctuations in DO and pH concentrations in the Sebangau River are not due to the influence of the seasons, but to the presence of organic matter originating from the forest around the Sebangau River, during heavy rains. The difference in physico-chemical parameters in the Sebangau River is one of the important factors in determining the dynamics of the zooplankton community. The concentration of DO in the Sebangau Lake, which ranges from 3.11 to 7.01 ppm, still supports the metabolic activity of heterotrophic bacteria, which decompose the organic matter in these waters (Badjoeri 2018).

Conclusions. This study provides information about the presence of aquatic biota (plankton and fish), as well as of riparian vegetation in the Sebangau watershed and also the visual linkages between the phytoplankton, zooplankton, fish and water quality. Therefore, it can be used as a basis for managing the water resources in the Sebangau river, Central Kalimantan, Indonesia.

Acknowledgements. The authors would like to thank the good cooperation between the research team from Palangka Raya Christian University and Palangka Raya University. The authors also thank the Sebangau National Park.

Conflict of interest. The authors declare no conflict of interest.

References

Bodjoeri M., 2018 [Abundance and distribution of heterotrophic bacteria in the Sebangau Flood Swamp Lake, Central Kalimantan]. Limnotek 2(1):39-45. [In Indonesian].

Brooks J. L., Dodson S. I., 1965 Predation, body size, and composition of plankton: The effect of a marine planktivore on lake plankton illustrates theory of size, competition and predation. Science 150(3692):28-35.

Chang M., 2006 Forest hydrology: an introduction to water and forests. 2nd edition, Boca Raton, Taylor and Francis, 474 p.

Decamps H., Pinay, Naiman G., Holmes R. J., Quinn G., Gibert J., Hillbricht-Ilkowska J., McClain T., Hanley A., Petts A., Planty T. G., Schiemer A., Tabacchi F. E., Zalewski M., 2004 Riparian zones: where biogeochemistry meets biodiversity in management practice. Polish Journal of Ecology 52(1):3–18.

Dwirastina M., Riani E., 2019 [The composition, abundance and diversity of phytoplankton on Salah Island, the Musi River, South Sumatra]. Sainmatika 6(1):74-80. [In Indonesian].

Effendie M. I., 1997 [Fisheries biology]. Yayasan Pustaka Nusantara Yogyakarta, 162 p. [In Indonesian].

Effendie M. I., 2002 [Fisheries biology]. 2nd Edition. Yayasan Pustaka Nusantara Yogyakarta, 163 p. [In Indonesian].

Gliwicz Z. M., 1986 Predation and the evolution of vertical migration in zooplankton. Nature 320(6064):746-748.

Gilbert J. J., 1988 Suppression of rotifer populations by *Daphnia*: A review of the evidence, the mechanisms, and the effects on zooplankton community structure. Limnol Oceanogr 339(6):1286-1303.

Jones G. P., Milicich M. J., Emslie M. J., Lunow C., 1999 Self-recruitment in a coral reef fish. Nature 402:802-804.

Lukas, Hastari B., Ardinaor, Gumiri S., 2020 Diversity of riparian plants of black water ecosystem in the Sebangau River of Central Kalimantan, Indonesia. IOP Conference Series: Earth and Environmental Science 744(1):012040.

Ludwig J. A., Reynolds J. F., 1988 Statistical ecology: A primer on methods and computing. Wiley-Interscience Publication, New York, 337 p.

Loomis J., Kent P., Strange L., Fausch K., Covich A., 2000 Measuring the total economic value of restoring ecosystem services in an impaired river basin: results from a contingent valuation survey. Ecological Economics 33(1):103–117.

Maridi M., Saputra A., Agustina P., 2015 [Role of vegetation for Water and Conservation in Watershed: Case study in 3 sub-Watershed of Bengawan Solo (Keduang, Dengkeng and Samin)]. Prosiding Konservasi dan Pemanfaatan Sumber Daya Alam 1(1):65-68. [In Indonesian].

Minggawati I., Mardnai, Ricke M., 2020 [Biological aspect and economic benefits of fish captured in the Sebangau River Palangka Raya City, Central Kalimantan]. Ziraa'ah. 45(3):335-340. [In Indonesian].

Nurdin J., Irawan D., Syandri H., Nofrita, Rizaldi, 2020 Phytoplankton and the correlation to primary productivity, chlorophyll-a, and nutrients in Lake Maninjau, West Sumatra, Indonesia. AACL Bioflux 13(3):1689-1702.
Pugesehan D. J., 2010 [Chlorophyll-a analysis of phytoplankton (primary productivity) in the coastal waters of Netsepa, Maluku Regency]. Politeknik Perdamaian Halmahera. Tobelo. J. Agroforestri. 5(4):272-278. [In Indonesian].
Purnawan E. I., Jemi R., Kasim H., Uthan L. A., Regalina J., Hamidi A., 2021 Vegetation diversity of *Hevea brasiliensis* agroforest system in Tumbang Mantuhe Village, Gunung Mas Regency, Central Kalimantan, Indonesia. IOP Conference Series: Earth and Environmental Science 886(1):012013.
Qirom M. A., Halwany W., Rahmanadi D., Tampubolon A. P., 2019 [Study on biophysical Peatland Landscape in Sebangau National Park: Case in Mangkok Resort]. Jurnal Ilmu Pertanian Indonesia 24(3):188-200. [In Indonesian].
Siegel S., 1956 Nonprametric statistics for the behavioral sciences. McGraw-Hill. Inc, New York, 328 p.
Utomo A. D., Prasetiyo D., 2005 [Evaluation of catches of several fishing activities in the Barito river, Central and South Kalimantan]. Jurnal Penelitian Perikanan Indonesia 11(2):9-27. [In Indonesian].
Wetzel, 2001 Limnology lake and reservoir ecosystems. Academic Press, San Diego, 850 p.
*** APHA (American Public Health Association), AWWA (American Water Works Association), WPCF (Water Pollution Control Federation), 2005 Standard methods for the examination of water and wastewater. 21st Edition, American Public Health Association, Washington, 1202 p.
*** Core R. T., 2020 R: a language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.

Received: 05 April 2022 Accepted: 23 May 2022. Published online: 08 June 2022.
Authors:
Lukas Inel, Aquaculture Study Program, Faculty of Fisheries, Palangka Raya Christian University, RTA. Milono Streer Km 8.5, Central Kalimantan, Indonesia, e-mail: lukasinel@gmil.com
Infa Minggawati, Aquaculture Study Program, Faculty of Fisheries, Palangka Raya Christian University, RTA. Milono Streer Km 8.5, Central Kalimantan, Indonesia, e-mail: infa41@gmail.com
Ardianor, Water Resources Management Study Program, Department of Fisheries, Faculty of Agriculture, Palangka Raya University, Central Kalimantan, Indonesia, e-mail: ardianor@fish.upr.ac.id

How to cite this article:
Inel L., Minggawati I., Ardianor, 2022 Study of aquatic biota and riparian vegetation in the Sebangau River, Central Kalimantan, Indonesia. AACL Bioflux 15(3):1293-1301.