The significance of the ecosystem value and its effect on the fish distribution in Sibau sub-watershed

RAE Putra¹*, Aripin¹, A Andono¹ and A Mahmud¹
Betung Kerihun and Danau Sentarum National Parks, Putusibau 78714, Kapuas Hulu District, West Borneo Province, Indonesia

*Corresponding author
Email: rizqi.a4.32@gmail.com

Abstract. Betung Kerihun National Park (TNBK) is the largest conservation area in West Kalimantan which has an area of 816,693.40 ha with high species diversity, both flora and fauna. One of the constituent ecosystems in TNBK region is its watershed. TNBK region has four sub-watersheds which acts as a receiving area and divert rain water from tributaries to the main river (Kapuas River), namely Embaloh, Sibau, Mendalam and Kapuas sub-watersheds. The objective of this study is to evaluate the sub-watershed ecosystem value which affect to distribution of the fish. The Sibau sub-watershed, one of the four sub-watersheds in TNBK plays as supporting ecosystems which have a high influence on the distribution of fish species. This zone also has a function as a site for the local people activity and become as a buffer area. Fish monitoring data in 2018 conducted on three rivers i.e. Peang River, Menyakan River and Sibau River which located on the traditional zones show a high status indi diversity. There are 25 species of fish which successfully recorded in the fish distribution monitoring with a total of 242 individuals. The common species were Batu fish (Labocheilos falcifer), Seluang fish (Rasbora voltzii), and Kenyuar fish (Luciosioma setigerum). The biophysical conditions of the river in the Sibau sub-watershed seem suitable for the habitat of many fish species. The determinant factors were water temperature, turbidity, river canopy and pH. The obtained fish can also be categorized as a bioindicators of a waters by considering of those aspects. Most of the fish species are directly or indirectly dependent on the forest or river in providing food such as plant materials (leaves, flowers, fruits) or invertebrates. Sibau sub-watershed has a rich of vegetation, as well the type of alluvial soils that make up the land. The alluvial soils have better fertility rates than other types of soils. In addition, high rainfall (2,863 - 5,517 mm/year) and dense river canopy also have an important influence on fish life in the Sibau sub-watershedwaters.

Keywords: TNBK, fish, sub-watershed, traditional zone
1. Introduction

Betung Kerihun National Park (TNBK) as stated by the Minister of Forestry No. 3075/Menhut-VII /Code/2014 has an area of 816,693.40 ha with high biodiversity. Conservation Area Management and conservation of natural resources and ecosystems have been regulated in the Law No. 5 of 1990 on the conservation of Natural Resources and Ecosystems with the main focus is to maintain the natural resources in the region.

TNBK region supported by the existence of sub-watershed, namely Embaloh, Sibau, Mendalam and Kapuas sub-watersheds. Vegetation and good water quality of a sub-zone greatly affect the survival of animals (in this case, is fish) live in a sub-watershed, especially at Sibau sub-watershed. The Sibau sub-watershed, in the administration of the territory, included in the management of the National Park Management Section II Tanjung Kerja, Field National Park Management Area I Mataso.

The overall width of Sibau sub-watershed reaches of 132,380.90 ha with consisted of three (3) major rivers, namely Sibau River, Menyakan River, and Peang River which include of the extensive traditional zone of 6,521.21 ha. This traditional zone, intended for rural communities to utilize of natural products therein. Dependence on natural resources use in the traditional zone, especially fish, is being an important concern. This manner relates to the balance of the aquatic ecosystem with fish as living subjects which living in this system.

The existence of Sibau sub-watershed is supported by the condition of rivers constituent. The rivers are said to be in good condition in terms of the number of animals which inhabit the river area. So it is necessary to control the distribution of the fish species to support the preservation of these animals and the ecosystem around it as well as the local people.

Fish as an aquatic bioindicator is considered being an important aspect for managing sub-watershed area. There are many factors which may cause limiting to the type of fish in the waters, particularly in sub-watershed area, for example are heavy water flow, water base substrate, fluctuations in water temperature and the extent of water bodies. However, many of fish species are directly or indirectly dependent on the forest and river inproviding food in the form of plant materials (leaves, flowers, fruits) or invertebrates.

In the TNBK area, there are found 112 species of fish belonging to 41 genera and 12 tribes. The diversity of species of fish from the condition of vegetation making up rivers in the sub-watershed, therefore it provides a suitable habitat for the survival of many species of fish.

The recent problem of Betung Kerihun National Park (TNBK), is how to manage the better sub-watershed area, from the upstream to downstream as a reservat habitat for various species of fish. In addition, the fish habitat was managed in tradition zone which allow the community around the area to access it.

2. Methods

The data used consist of primary data and secondary data. The primary data was the fish distribution in the traditional zone Sibau sub-watershed. While the secondary data was the water resources of Sibau sub-watershed. Location data collection for fish were Peang River, Menyakan River, and Sibau River (as the traditional zone of Sibau sub-watershed).

The primary data collection used the observation method. Data collection on fish species using stocking nets was carried out at every sampling location for 10 times of fishing time included on the small rivers of three major rivers in the Sibau sub-watershed (Peang river, Sibau river and Menyakan river).

Secondary data obtained through literature studies, which were consisted of the tree canopy density, turbidity, river depth, water discharge, river’s canopy, forest floor, pH, dissolved oxygen, water temperature and water transparency.

The tree canopy density are measured by using a plot which had size of 400 m$^2$ (20 x 20 m). The measured parameter were type of trees, trunks diameter (cm), and crown diameter (m).
Turbidity is measured by using *Secchi Disc* method. The results of a reading from a secchi disc can be converted into the concentration of sediment:

\[
\text{Concentration of sediment} (\text{mg/l}) = (3.357.6 * D^{-1.3844})
\]

Where,  
- \(D\) = The depth of Secchi disc (cm)

The rivers section area is measured by depth of river which depth of river is divided into many sections.

\[
\text{The rivers section area} (A) = L_1D_1 + L_2D_2 + \ldots + L_nD_n
\]

Where,
- \(A\) = The rivers section area (m²)
- \(L\) = Sections width (m)
- \(D\) = Sections depth (m)

*Water discharge* is measured using a buoyant medium to measuring its velocity (V). Afterward, result will multiplied by rivers section area (A):

\[
Q = V . A
\]

Where,
- \(Q\) = Water discharge of rivers (m³/sec)
- \(V\) = Buoyant velocity (m/sec)
- \(A\) = The rivers section area (m²)

River canopy is measured by using measuring plot (400 m in length and width depend on the type of river).

\[
\text{CC} = \frac{AV}{AP} \times 100\%
\]

Where,
- \(CC\) = Canopy cover (%)
- \(AV\) = Vegetation area (m²)
- \(AP\) = Plot area (m²)

Floor forest is measured by using measuring plot (1 m x 1 m). The parameter taken are the type of trees and the thickness of litter (cm). Measurement of the pH water is using the measuring liquid of pH. Afterward, result are compared to the table of color based on pH table. Measurement of dissolved oxygen (DO) is using liquid measuring of DO. Afterward, result are compared to table of color based on DO table. Measurement of the water temperature is using a thermometer which dipped into the water at least for 5 minutes. Measurement on the tested parameters refers to Regulation of the Director General of Forest Protection and Nature Conservation (PHKA) No. P.07 / IV-SET / 2014. The regulation contains guidelines for the inventory of water resources in the national park area [1].

3. Results

3.1 Fish data

The obtained data were fish species and number of individuals of each of the fish species. The Peang River has three small rivers where used as locations for collecting data. Meanwhile, the Bagong River with 3 different locations. From figure 1 above, species of fish found in the Bagong (1) River were Batu fish (*Labocheilos falcifer*) (7 individuals), Seluang fish (*Rasbora voltzii*) (4 individuals) and Kenyuar fish (*Luciosioma setigerum*) (2 individuals). In the sampling location of Bagong (2) River, were found samples consisted of White Semah fish (*Tor tambra*) (9 individuals), Batu fish (*Labocheilos falcifer*) (6 individuals), and Kenyuar fish (*Luciosioma setigerum*) (6 individuals). While on the sampling location of Bagong (3) River, it were found of Batu fish (*Labocheilos falcifer*) (3 individuals). Batu fish (*Labocheilos falcifer*) and Kenyuar fish (*Luciosioma setigerum*) are distributed evenly in the three tributaries. Fish data recorded in Peang river can be seen in figure 1.
Figure 1. Distribution of fish (9 species have been found) in the Peang River

Menyakan River has three small rivers which used as locations for data sampling namely Bantan River, a Menyakan River segment and No River. From figure 1, Many species of fish was found in Bantan River as Batu fish (*Labocheilos falcifer*) (15 individuals), Bantan / Banta fish (*Osteochilus microcephalus*), Kepiat fish (*Cirrhinus molitorella*) and Kenyuar fish (*Luciosioma setigerum*) (each of 3 individuals). In Menyakan River, commonly found Batu fish (*Labocheilos falcifer*) (8 individuals), Kepiat fish (*Cirrhinus molitorella*) (7 individuals), Temunit fish (*Labeo chrysopekadion*) and Saye fish (*Dorosoma petenense*) (each of 3 individuals). While in the No river, the common fish species was Kepiat fish (13 individuals). From figure 1, Bantan / Banta fish (*Osteochilus microcephalus*), Batu fish (*Labocheilos falcifer*) and Kepiat fish (*Cirrhinus molitorella*) were found as the most three common fish which spreading evenly in the three small rivers. Fish data recorded in Menyakan River can be seen in figure 2.

Figure 2. Distribution of fish (12 species have been found) in the Menyakan River.

The sampling locations in Sibau river were three small rivers namely Benrap River, Kabo River and Suruk River. From figure 2, many species of fish were found in the Benrap River as Seluang fish
(Rasbora voltzii) species (10 individuals), Tetek fish (Epalzeorhynchos sp) (9 individuals) and Kenyuar fish (Luciosoma setigerum) (6 individuals). Kabo River fish species were commonly found as Kenyuar fish (Luciosoma setigerum) (4 individuals) and Batu fish (Lobocheilos falcifer) (3 individuals). Whereas in Suruk River, fish species that were found as Seluang fish (Lobocheilos falcifer) (22 individuals), Batu fish (Lobocheilos falcifer) (20 individuals) and Semah white fish (8 individuals). From figure 2 the Batu fish (Lobocheilos falcifer), Seluang fish (Lobocheilos falcifer) and Semah White fish (Tor tambr) were the most three fish spreading evenly in the three tributaries, meanwhile in case of River Sibau is shown in figure 3.

![Figure 3. Distribution of fish (19 species have been found) in Sibau river.](image)

3.2 **Bio-physic characteristic**

3.2.1 **River depth**

River depth measurement results in the traditional zone Sibau sub-watershed shown that the downstream part of the Sibau has a width shorter than the middle section and the upstream section of the Sibau. It makes the downstream becomes formed more creek that joined to the Sibau River. Measurement results of the depth of water levels in rivers, showed that in the middle of the Sibau has the highest level of depth. The measure of the depth of the river closely relates to the capability of light penetration in the water column which affect the number and type of aquatic biota [2]. The result of the depth and width of the river in Sibau sub-watershed is depicted in figure 4 and 5.
Phytoplankton requires sunlight for photosynthesis, while solar radiation will decrease according to increasing depth. Therefore, phytoplankton will only be present in the areas or depths where sunlight can still penetrate water bodies [3].

3.2.2 Water discharge

Table 1. Water discharge of Sibau sub watershed.

| Locations  | Cross-section area (m²) | River Flow velocity (m/s) | Water discharge (m³/s) |
|------------|-------------------------|---------------------------|------------------------|
| Headwaters | 45.5                    | 1.30                      | 59.18                  |
| Middle     | 113.01                  | 1.27                      | 143.66                 |
| Downstream | 71.54                   | 1.94                      | 138.92                 |

Results of field measurements at three sampling locations at Sibau River, showed that the water dischargedin the upstream section Sibau of 59.18 m³/s, the middle section 143.66 m³/s, and the lower reaches of the Sibau of 138.92 m³/s. It seemed that in the middle of the Sibau produced the highest water flow compared with the upstream and downstream. Probably, it caused by the larger cross section in the middle of the Sibau than the other two parts of the river.

3.2.3 Canopy of river

The Canopy of a riveris a part of the tree canopy which covers along to the river flow. This canopy will influence the sunlight on the surface of the river water which will affect the optical properties of water. The measurement results in the third section of the river canopy Sibau river is described in table 2.

Table 2. Data spacious canopy river Sibausub watershed.

| Locations | Plot Size (m²) | Canopy Size (m²) | Percentage (%) |
|-----------|---------------|-----------------|----------------|
| Headwaters| 500           | 80              | 16.00          |
| Middle    | 820           | 196             | 23.90          |
| Downstream| 980           | 15              | 1.53           |
Field measurements on the diverse vegetation at the sampling locations showed that canopy percentage was highest in the central part of the Sibau, and lowest at the downstream part of Sibau River. This fact had no relation with the level of canopy density which resulted from vegetation grow on the marge of the Sibau.

3.2.4 Tree canopy
Tree canopy density is an indicator of vegetation that are above the soil surface. Where the canopy density is one of the factors that affect the rate of erosion, because the canopy can hold or reduce the force of falling water when raining. The denser vegetation cover, the strength of the rain that falls to the ground will be smaller, so the risk of erosion would be lower.

![Figure 5. Data tree canopy in Sibau sub-watershed.](image)

From the field observations regarding the level of canopy density, both in the upstream, midstream, and downstream relative overall Sibau River vegetation with dense canopy. The types of vegetation, the height level of samplings, poles, and the heights of the trees were quite diverse. The vegetation which has a dense canopy in the watershed gave a great importance function because can reduce the impact of rain fall which causing to erosion.

3.2.5 Forest floor
The condition of the forest floor in an area also affected the level of vulnerability to erosion. Open forest floor condition will be more prone to erosion, because of surface runoff during a rain forest floor will be stronger led to attract a layer of soil. If the soil layer swept away the surface of the forest floor, it will cause the erosion. Therefore, the presence of plants in the forest floor has similar role with canopy density in term of preventing the erosion.
Figure 6. Data of plants and litter thickness in forest floor of Sibau sub-watershed.

From figure 6, showed that in the middle of the Sibau-watershed has the thickest litter (averagely of 8.6 cm). The thicker litter and more variety of plant species (found such as Meranti, Tengkawang, and Kumpang) were advantageous for erosion preventing.

3.2.6 Potential of hydrogen (pH)

Figure 7. The average of potential hydrogen (pH) in Sibau sub-watershed.

Figure 7, showed that the pH of the Sibau sub-watershed ranged of 6.8 up to 7. The pH of the water normally used to determine the pollution index to assess the level of acidity and alkalinity [4]. The ideal pH value for allowing the life of aquatic organisms is range of 7 to 8.5. If water conditions are highly acidic or highly alkaline will affect the survival of the organism. As it would lead to disruption of metabolism and respiration.

3.2.7 Dissolved oxygen (DO)

Dissolved oxygen in the water is an important factor which being a regulator of the metabolism on the organism as well as for growing and multiplying. Sources of dissolved oxygen in water comes from the diffusion of oxygen from the atmosphere, current, or the flow of water through rainwater and
photosynthetic activity by aquatic plants and phytoplankton [5]. Dissolved oxygen in the water at least 2 mg/l is sufficient to support a normal life aquatic organisms [6].

Figure 8. The average of dissolved oxygen (DO) in Sibau sub-watershed.

Figure 8 show that the dissolved of oxygen (DO) in Sibau sub-watershed ranged of 4-5 mg/l. This range is still enable for supporting microbial life in a waterbody. Waters for aquatic organisms should have an oxygen content which not less than 5 mg/l. Dissolved oxygen levels of less than 4 mg/l may cause unfavorable effects for almost all aquatic organisms [7].

3.2.8 Water temperature
Temperature is an important factor which affects the metabolism of organisms in the water. Sudden changes in temperature or extreme temperature will disrupt the life of the organism that even lead to death. The water temperature has a role in regulating the life of the biota, especially in the metabolic processes. Water temperature also a major factor in aquatic environments because it is a barrier to growth and distribution of animals. The water temperature is suitable for fish growth between day and night is less than 5°C [8].

Figure 9. The average of water temperature in Sibau sub-watershed.

Figure 9, showed that water temperature range of 24 to 25°C from the upstream to the downstream section of the river Sibau. It can be said that there is no difference between the extreme temperatures in the third part of the river Sibau.
3.2.9 Water transparency/turbidity

Water transparency generates by dissolved particles of dust, clay, vegetation fragmentation and plankton in the water. With the water murky light penetration into the water is reduced, so that the spread of the living organisms are not deeper, because the process of photosynthesis can not take place further [9]. Turbidity levels are usually used as a parameter of the water pollution level.

![Figure 10. The average of water transparency/turbidity in Sibau sub-watershed.](image)

Figure 10, showed that the level of the deepest clarity occurs in the middle of the Sibau sub-watershed which reached of 109.67 cm. However, based on the field observations results, all parts of the observed it was still clear even the bottom of the river were still visible. It can be concluded that the depth of Sibau River water transparency was related to the depth of the water surface. The light intensity is a factor of affecting the spread of the fish. If the water is too murky water makes the fish suffer from respiratory [8].

3.3 Composition of fish

Composition of fish depends on the characteristics of the ecological type in each of the region. Sub Sibau sub-watershed is part of the Kapuas watershed, where the Kapuas river basin has a complex ecological level. Sibau sub-watershed has a relatively rapid water flow (over 5 Km /h) [10]. From the graph of the distribution of fish species in Sub Sibau, Batu fish (*Labocheilos falcifer*) is a type of fish that is evenly spread across sub Sibau. Batu fish (*Labocheilos falcifer*) dominated in the three rivers, the river Peang, Menyakan and Sibau. It is influenced by the characteristics of the species of the fish itself. The following species of fish are found in three (3) locations of monitoring the distribution of fish Sub Sibau (Peang River, Menyakan River and Sibau River) can be seen in figure 11.
Figure 11. Composition of fish in Sibau sub-watershed.

The fish can be found in almost all large-sized puddle both freshwater, brackish or salt water at the varying depths, from near surface up to several thousand meters below the water surface. In addition to fish consumption can also be exploited as natural indicator to determine the contamination of a waste. The criteria for fish which can used as bioindicators are capable to live in a suitable climate, sensitive to changes in water conditions, and easily to be found. In general, organisms that can be used as bioindicators should meet the criteria that these organisms have a narrow range of tolerance to environmental changes, have a habit of settling down somewhere or limited pollution [11].

The composition of the fish is determined by various factors. Distribution of fish in the waters of the river is determined by environmental factors. Abiotic factors include the physical and chemical factors such as currents, light, temperature, pH, dissolved oxygen, salinity, wind, BOD and COD [12]. Other determining factors distribution is the availability of the plant [13].

3.4 The significant value of the ecosystem

The importance of the ecosystem is closely related to the both of quality and quantity aspects of waters which includes of the physical, chemical and biological process. Disruption of these processes will lead to the development of the unbalance relationship between those aspects.

There has been a decrease in the nutritional value of the fish. Thus the coefficient of the nutritional value of fish can give a rough idea of the quality of the waters. It is mean, with the level of availability of nutrients and environmental carrying capacity which may cause a normal function sensory organ of the fish [14]. Organisms that lives in a water depends on many abiotic factors. The relationship between organisms and abiotic factors can be used to determine a water-quality [15].

4. Conclusion

It can be concluded that the waters condition in Sibau sub-watershed are still in good circumstance. It can be revealed from some bio-physical indicators (e.g water temperature, pH, dissolved oxygen, depth, vegetation and biota). Composition of fish in Sibau sub-watersheds were high in diversity. There are 25 species with 242 individuals recorded in three main river of Sibau sub-watershed (Peang, Menyakan and Sibau). According to our finding, there were six species of fish which potentially being used as bio indicator organisms in Sibau sub watershed.
5. References

[1] Indonesia Regulation of the Director General of Forest Protection and Nature Conservation. Guidelines for Inventorying Water Resources in Wildlife Reserves, National Parks, Grand Forest Parks and Nature Tourism Parks also Protected Forests (Jakarta: PHKA. No. P.07/IV-SET/2014)

[2] Odum E P 1996 Dasar-Dasar Ekologi Translated (Yogyakarta: Gadjah Mada Press)

[3] Hutabarat S 2000 Produktivitas Perairan dan Plankton (Semarang: Badan Penerbit Universitas Diponegoro) pp 6-61

[4] Asdak C 1995 Hidrologi dan Pengelolaan Daerah Aliran Sungai (Yogyakarta: Fakultas Pertanian PPSDAL UGM Press)

[5] Novotty V and Olem H 1994 Water Quality, Prevention, Identification and Management of Diffuse Pollution (New York: Van Nostrans Reinhold)

[6] Wardana W A 1995 Dampak Pencemaran Lingkungan (Yogyakarta: Andi Offset)

[7] Efendi H 2003 Telaah Kualitas Air Bagi Pengelolaan Sumber Daya dan Lingkungan Perairan (Yogyakarta: Kanisius)

[8] Cahyono B 2000 Budidaya Ikan Air Tawar (Gurame, Nila, Mas) (Yogyakarta: Kanisius)

[9] Suin N M 2002 Metoda Ekologi (Padang: Universitas Andalas)

[10] Adjie S and Agus D U 2011 Karakteristik Habitat dan Sebaran Jenis Ikan Di Sungai Kapuas Bagian Tengah dan Hilir BAWALI 3 (5) 277-286

[11] Umbara H and Heni S 2006 Faktor Bioakumulasi 210 Pb Oleh Kerang Dara (Anadara granosa), Hasil Penelitian dan Kegiatan Pusat Teknologi Limbah Radioaktif (Jakarta: BATAN ISSN 0852-2979)

[12] Rifai S A N, Sukaya N and Nasution Z 1983 Biologi Perikanan Edisi I (Jakarta: Departemen Pendidikan dan Kebudayaan)

[13] Kottelat M, Kartikasari S N and Whitten A W S 1993 Freshwater Fishes of Western Indonesia and Sulawesi (Yogyakarta: Kanisius)

[14] Pratiwi Y 2010 Penentuan Tingkat Pencemaran Limbah Industri Tekstil Berdasarkan Nutrition Value Coefficient Bioindikator (Yogyakarta: Institut Saint & Teknologi AKPRIND)

[15] Barus T A 1996 Metode Ekologi Untuk Menilai Kualitas Perairan Lotik (Medan: Jurusan Biologi USU FMIPA-USU)

Acknowledgments

This research was supported by Betung Kerihun and Danau Sentarum National Park who provided insight and expertise that greatly assisted the research. We thank to Mr. Ir. Arief Mahmud, M.Si., Mr. Ardi Andono, S.T.P., M.Sc., Mr. Aripin, S.Hut., M.Sc., and everyone who contributed in giving for assistance with particular technique and methodology, also for comments that greatly improved the manuscript. Although any errors are our own and should not tarnish the reputations of these esteemed persons.