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Identification species, diversity and structure of community of Plankton in two Oxbow Lakes, Jambi Province, Indonesia

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ABSTRACT

The Sipin and Teluk Lakes are two of oxbow lakes located in Jambi Provinces, Indonesia. Both of them useful for many activities such as agriculture, fisheries, transportation etc. for using monitoring aquatic diversity is thus essential. It has a variety of productive habitats that support the availability of fish resources, The research described in this paper was conducted in March and June 2018 with the purpose of assessing the diversity, plankton communities as an indicator to monitor and manage the lakes. The planktons were collected and analyzed in the Laboratory of research instituted for inland fisheries and extension. Plankton sampling using by a net Nu, 25, to calculate the community structure and diversity of plankton used by ecological indices (abundance, dominance, constancy and ecological significance) and diversity indices (Shannon and Simpson diversity). In Sipin lake, a total of 65 species of plankton where are 48 species of phytoplankton and 17 species of zooplankton were recorded, *Phacus* (Mastigopora) has the highest abundance. While, in Teluk lake a total of 59 species of plankton, 39 species of phytoplankton and 17 species of zooplankton were recorded, *Ullotrix* (Chlorophyta) has the highest abundance. Generally, diversity index in two oxbow lake categorized as moderated polluted. However, Teluk lake has more potential for fish resources development better than Sipin Lake if viewed from composition and species of plankton.

Key words *: Diversity, Plankton, Oxbow lake*

Introduction

Many functions of floodplains such as water supply, irrigation, food production, sightseeing, as well as the maintenance of the unique and diverse biota of the entire floodplain ecosystem. In recent decades, the floodplain lakes have been experiencing great pressures by human activities that alter the hydrological, physic-chemical, and biological processes. Therefore, for facilitating conservation and management of these lakes, it is necessary to classify the lakes into similar groups according to certain standards (Pan *et al*., 2014). The oxbow lakes are one of the most common small water bodies, they are often the only type of natural lakes. The oxbow lakes have a significant role in the formation of plankton com-

munities in all river valleys and main streams (Krylov, 2015; Joniak and Kuczyñska-Kippen, 2016; Dembowska and Kubiak-Wojcicka, 2017).

In the process of lake classification based on consideration of multiple factors, selection of good biological indicators is critical, plankton are important components of aquatic ecosystems, they are often used as ecological indicator for fresh water lakes and rivers (Poot-Delgado and Okolodkov, 2016; Jiang *et al.*, 2013; Jiang *et al.*, 2014; Suda *et al.*, 2016; Vasiljeviæ *et al.*, 2017). While the ecosytems was degraded, aquatic organism (fish, plankton and benthic community) could change. The dependence of oxbow ecosystems on hydrological conditions make them vulnerable to anthropogenic influences, particularly isolation, damming, and agriculture activities. Plankton (i.e., phytoplankton and zooplankton) are special because their primary organisms are characterized by short generation times and efficient trophic transfer (Summer *et al.*, 1986). Phytoplankton diversity not only impacts the productivity, stability, resource use efficiency and community turnover in its own trophic level (Giller *et al.*, 2004; Shurin *et al.*, 2007; Ptacnik *et al.*, 2008; Filstrup *et al.*, 2014)

Teluk Lake is a floodplain lake where located in the city of Jambi, It's will be flooded by the river flow and even connected with the Batanghari River. In fact, around the lake people use for domestic activities, agriculture and fish farming. It has an area of ± 68.2 ha with an average depth of 3.7 m, the area will be spread on rainy season.

Sipin Lake is a floodplain lake located in the city of Jambi, where it's surrounded by settlements and is influenced by other urban activities. The total area of Sipin lake is estimated ± 94 ha with an average of depth 1.5 m and it used for domestic activities, fish farming, transportation between villages near the lakes.

The aim of our study was to identify the biodiversity of planktons in two oxbow lakes, during the study, we described structure of oxbow ecosystems.

Materials and Methods

Study Area

Two Oxbow Lakes have been studied, namely Teluk Lake and Sipin Lakes, Jambi Province-Indonesia, Sampling was carried out in March, June and October 2018, at 5 stations distributed in Teluk Lake, 5 stations in Sipin Lake (Figure 1 and Table 1).

Procedures

The materials and equipment used in the research included GPS, digital calipers, substrate/water samplers, plankton net nu. 25, pull net (25 mm, sample

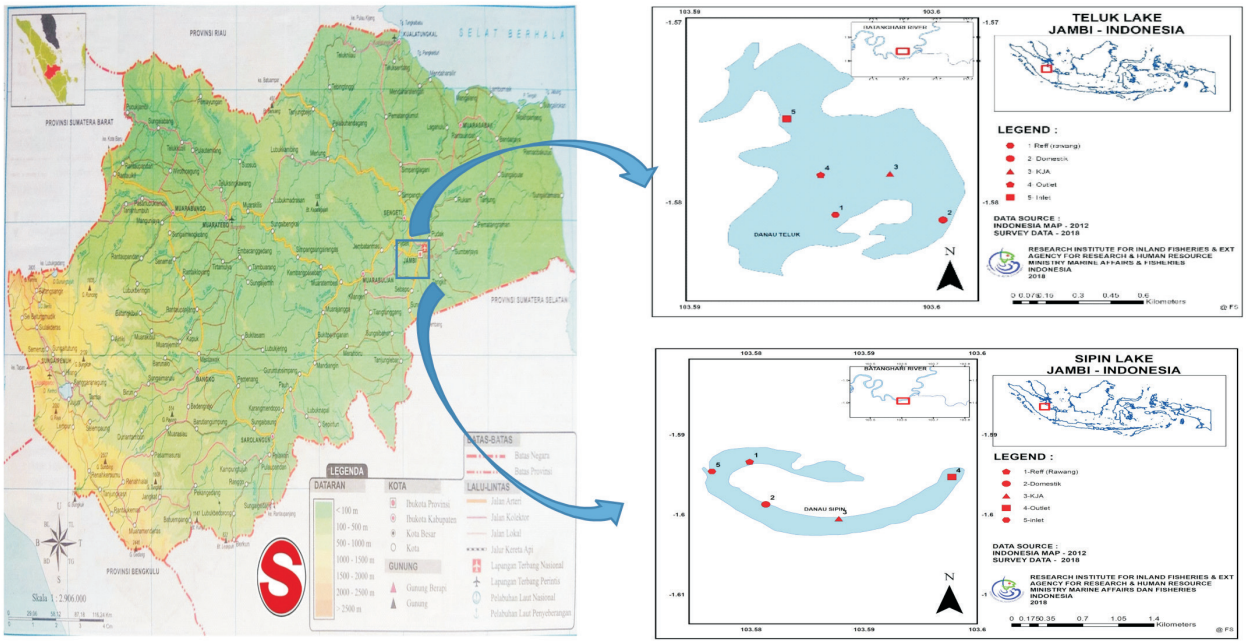

Fig. 1. Map of sampling sites (Teluk and Sipin lakes)

Table 1. Coordinates site of oxbow lakes in Jambi Province (Teluk and Sipin Lakes)

Sampling Sites	Latitude and Longitude
Teluk Lake	
St 1	01p 34' 50,5" N, 103p 35' 45,7" E
St 2	01p 34' 51,5 " N, 103p 36' 01,7" E
St 3	01p 34' 42,3 " N, 103p 35' 53,8" E
St 4	01p 34' 42,5 " N, 103p 43' 45,5" E
St 5	01p 34' 31,3 " N, 103p 35' 38,4" E
Sipin Lake	
St 1	01p 35' 36,2" N, 103p 34' 47,5" E
St 2	01p 35' 55,4" N, 103p 34' 52,6" E
St 3	01p 36' 01,9" N, 103p 35' 15,9" E
St 4	01p 35' 43,1" N, 103p 35' 51,9" E
St 5	01p 35' 40,6" N, 103p 34' 35,5" E

bottles, a cooler box, formalin, Lugol solution and alcohol 80%. The details of the methods and materials are outlined in Table 2.

Data Analysis

The diversity of Plankton communities in oxbow lakes is known through several attributes such as the diversity index of Shannon-Wiener (H'), Evenness (E) and Dominance (D) (Krebs, 1989). The Diversity index (H') is used to obtain a mathematical picture of the organism's population, H' can facilitate the analysis of information on the number of individuals of each species within a community (Odum and Barrett, 2004). Plankton diversity was calculated by the Diversity index (Odum and Barrett, 2004) by the formula:

$H' = - (\Sigma\ pi \ln pi)$

Where:

H' = Index of species diversity

ni = Individual quantity from each species

N = Quantity of individual

Pi = Necessary probability for each species = ni/N,

Index of Diversity is used to describe how much the balance in an ecosystem, the evenness of individuals caught (equitability) was calculated by following the equation:

$E = H'/H'\ max$

Where:

E = Index of evenness of Shannon-Wienner

H= The balance of species

H' max = Index of maximum diversity (ln S),

S = Species total amount

Index of Dominance was used to get information about species dominating at each habitat, Index of Dominance illustrates the species composition in the community, Index of Dominance was calculated following a method by Simpson in Krebs (1989),

$C = \Sigma\ (ni/N)^2$

Where:

C = Index of dominance

ni = Individual amount from each species

N = Community individual total

Results and Discussion

Structure of the Community of Planktons

Abundance of planktons was determined in two oxbow lakes with five locations representative of along Sipin and Teluk lakes, where are populations presented as the number of individuals of a species per liter. In Sipin lake, a total of 65 species of plankton where are 48 species of phytoplankton and 17 species of zooplankton were recorded. *Phacus* (Mastigopora) has the highest abundance occurred in those habitats with the abundance 9.5% (Table 3). Pangestu (2019) recorded 15 species of zooplankton in Sipin Lake. Saragih *et al.* (2018) mention that the number of phytoplankton in Sipin lake were dominated by *Spirulina sp* (Cyanophyta) and *Scenedesmus sp* (Chlorophyta). We know that the plankton has an important role in the food chain. Plankton diversity and abundance is much affected by factors in the environment quality of oxbow lake habitats, such as turbidity level, current velocity, and both physical and chemical conditions of the water. Plankton are good indicators of changes in water quality because they are strongly affected by environmental conditions, and having short life cycles, their communities often respond quickly to water quality changes.

Furthermore, in Teluk lake a total of 59 species of

Table 2. Required data, source and sampling method

Aspect of Study	Data Requirement	Data Sources	Sampling Methods	Tools and Materials
Biotic Diversity	Plankton Diversity	Oxbow lakes (Teluk and Sipin Lakes)	Purposive sampling	Plankton net mesh size nu 25 Materials: alcohol, lugols Solution, bottles sampler.

Table 3. Plankton Population and Abundance in Sipin Lake

Organism	March					June					RA
	St 1	St 2	St 3	St 4	St 5	St 1	St 2	St 3	St 4	St 5	(%)
Phytoplankton (Cell/L)											
Bacillariophyceae											
Cyclotella	-	-	-	-	960	320	840	-	200	-	0.42
Cymbella	360	-	-	1,720	-	-	-	40	-	-	0.39
Diatoma	520	560	720	-	1,960	360	160	-	400	120	0.88
Rhoicosphenia	-	-	-	1.520	800	-	-	200	-	-	0.46
Synedra	1.200	-	320	-	920	40	280	40	280	-	0.56
Fragilaria	-	-	-	-	-	-	-	-	-	40	0.01
Eunotia	-	-	-	-	-	-	680	40	600	3,360	0.85
Navicula	-	-	-	-	-	-	200	-	-	200	0.07
Nitszhia	-	-	-	-	-	-	-	-	-	320	0.06
Surirella	-	-	-	-	-	-	-	200	-	40	0.04
Asterionella	-	-	-	-	-	-	200	40	-	-	0.04
Coconeis	-	-	-	-	-	160	240	440	40	-	0.16
Coscinodiscus	-	-	-	-	-	80	-	-	40	80	0.04
Chlorophyceae											
Ankistrodesmus	-	400	-	15,200	12,000	280	-	2,480	40	320	5.61
Ulotrix	760	560	13,600	-	5,560	1,280	320	40	800	640	4.30
Closterium	-	560	-	1.800	-	-	200	-	-	-	0.47
Mougeotia	2,200	-	2,120	720	560	-	-	120	-	-	1.04
Chodatella	1,160	520	-	-	-	40	-	-	200	80	0.37
Crucigenia	-	-	-	-	-	-	-	160	-	-	0.03
Tetraedron	760	360	920	960	-	80	-	640	-	200	0.72
Scenedesmus	-	960	1,560	240	1,760	280	720	-	320	1,000	1.25
Spondylosium	-	-	-	520	-	-	-	120	-	-	0.12
Staurastrum	2,440	280	1,960	-	-	-	200	40	40	800	1.05
Cosmarium	-	-	-	920	1,120	40	280	1,920	280	640	0.95
Pediastrum	5,800	3,000	5,320	-	-	1,280	-	-	200	640	2.97
Micractinium	-	1,480	-	-	-	-	-	880	-	-	0.43
Coelastrum	-	-	-	-	-	-	-	-	-	800	0.15
Endorina	-	-	-	-	-	1,000	-	80	-	2,000	0.56
Melosira	-	-	-	-	-	-	400	-	-	-	0.07
Oocystis	-	-	-	-	-	-	-	320	-	320	0.12
Pandorina	-	-	-	-	-	-	-	840	2,400	7,040	1.88
Raphidium	-	-	-	-	-	-	-	800	440	600	0.34
Selenastrum	-	-	-	-	-	40	480	-	280	520	0.24
Spaerocystis	-	-	-	-	-	-	-	-	-	1,840	0.34
Stephanodiscus	-	-	-	-	-	-	-	760	-	800	0.28
Cyanophyceae											
Botryococcus	7,600	-	-	-	-	-	-	-	-	-	1.39
Eudorina	1,520	1,000	2,600	3,440	-	-	-	120	-	-	1.59
Microcystis	3,240	3,880	4,240	-	-	-	-	-	400	-	2.15
Sphaerocystis	-	-	-	-	-	-	-	840	-	-	0.15
Spirulina	1,400	-	-	-	-	240	120	200	-	-	0.36
Anabaena	-	-	-	-	-	-	1,800	1,200	1,240	1,200	0.99
Aphaocapsa	-	-	-	-	-	-	-	3,840	1,280	-	0.94
Gloeocapsa	-	-	-	-	-	200	-	400	640	-	0.23
Gomphosphaeria	-	-	-	-	-	640	760	1,040	640	-	0.56
Merismopedia	-	-	-	-	-	600	4,480	4,880	640	1,240	2.16
Oscillatoria	-	-	-	-	-	1,920	600	-	1,200	-	0.68
Microcystis	-	-	-	28,440	-	-	-	22,800	-	-	9.36
Zoo Plankton (Ind/L)											

Table 3. *Continued ...*

Organism	March					June					RA
	St 1	St 2	St 3	St 4	St 5	St 1	St 2	St 3	St 4	St 5	(%)
Mastigophora											
Clamydomonas	5,000	4,400	18,000	2,600	-	-	-	-	-	-	5.48
Difflugia	-	-	-	-	-	1,000	2,000	5,400	3,200	3,000	2.67
Euglena	5,600	2,800	4,400	3,800	1,600	2,000	-	-	8,600	4,000	5.99
Peridinium	4,800	-	-	2,800	-	6,000	-	2,200	1,600	4,000	3.91
Phacus	4,000	13,600	5,000	4,800	-	1,0200	-	400	12,000	2,000	9.50
Trachelomonas	-	-	-	-	-	4,600	3,000	2,000	8,000	7,600	4.60
Monogononta											
Coleps	-	-	1,600	4,600	200	-	-	-	-	-	1.17
Polyarthra	2,600	3,000	1,800	5,600		-	-	-	-	-	2.37
Anureopsis	-	-	-	-		4,000	-	400	1,1800	3,000	3.51
Hexartha	-	-	-	-		2,000	-	1,400	-	-	0.62
Pleusoma	-	-	-	-		-	-	400	-	-	0.07
Trichocerca	-	-	-	-		2.000	-	-	3.000	1,000	1.10
Rotifer											
Asplanchna	-	800	2,400	-	-	-	-	-	-	-	0.58
Trichocerca	4,600	-	2,000	-	-	-	-	-	-	-	1.21
Crustacea											
Brachionus	6,600	11,600	13,600	4,800	-	-	-	-	-	-	6.69
Nauplius	3,400	-	4,000	6,400	-	-	-	-	-	-	2.52
Diaptomus	-	-	-	-	-	-	-	-	-	600	0.11
Ciliata											
Baladyna	-	-	-	-	-	-	-	-	-	375	0.07

Note: St 1= Refrence site. St 2= Domestic site . St 3= Cages site . St 4= Outlet site St 5= Inlet site; RA = Relative Abundance (%)

plankton where are 39 species of phytoplankton and 17 species of zooplankton were recorded. *Ullotrix* (Chlorophyta) is the highest species diversity occurred in those habitats with the abundance 13.46% (Table 4). Junardi *et al.* (2019) stated that the Chlorophyta is needed for natural food for fish. Beside that, zooplankton group is dominated by *Peridium* (mastigopora) with the abundance 12.0%.

Plankton Diversity

A total of four zooplankton and three phytoplankton taxa were found in Sipin Lake, whereas in Teluk Lake were found five zooplankton and three phytoplankton (Table 5). In Sipin Lake the density of zooplankton and phytoplankton range between 5,000 Ind/L – 52,800 Ind/L and 8,880 cell/L - 33,360 cell/L. In other sites, the density of zooplankton and phytoplankton range between 3,600 Ind/L – 51,200 Ind/L and 3,720 cell/L - 45,640 cell/L.

The values for the diversity index (H ') of plankton obtained in the two of oxbow lakes Sipin and Teluk, ranged between 0.7-2.6 and 1.2-2.1. It showed that some of location in Sipin lake were degraded by pollution, while in Teluk lake showed that categorized as good water quality with diversity index (H') >1.2 and dominate by Ulothrix (chloropyta) and peridium (mastigopora). Ulothrix is a genus of non-branching filamentous green algae, which it's could increase of dissolve oxygen in waters. According to Saragih *et al.*, (2018), diversity of phtyoplankton in Sipin Lake can be classified as moderate with index 1.0<H'<3.0. According to Probosunu (2008) values for the diversity index in the range 0.81 <H '<1.60 are classified as low. Based on the diversity index (H ') values we obtained, the degree of pollution can be considered moderate (1.0 <H' <1.5) (Probosunu, 2008). Therefore, Diversity index in two oxbow lake categorized as moderated polluted with the index 0.8 < H' < 3.0 and 1.0<H'<2.5.

Odum (1993) stated that the evenness can be description of how big is the spread of similarity of the number of individuals at the community level. The evenness index value (E) in two of oxbow lakes temporarily ranged from 0.08 to 0.14, the evenness (E) near of zero and it's show that the domination

Table 4. Plankton Population and Abundance in Teluk Lake

Organism	March					June					RA
	St 1	St 2	St 3	St 4	St 5	St 1	St 2	St 3	St 4	St 5	(%)
Fitoplankton (Cell/L)											
Bacillariophyceae											
Diatoma	-	80	-	-	120	1,600	-	-	-	600	0.62
Cyclotella	160	-	-	-	-	-	800	400	1,400	1,560	1.12
Bacteriastrum	-	-	-	-	-	1,200	-	-	-	-	0.31
Fragilaria	-	-	-	-	-	40	400	-	1,160	400	0.52
Navicula	80	-	120	320	320	-	-	-	3,200	-	1.05
Stauroneis	-	-	-	-	-	-	-	-	920	-	0.24
Tabellaria	-	160	-	-	-	-	-	-	-	-	0.04
Surirela	-	200	80	160	40	40	-	-	-	-	0.13
Synedra	-	-	-	240	600	-	400	-	800	1,560	0.93
Chlorophyceae											
Actinastrum	720	920	-	120	480	-	-	-	400	-	0.68
Ankistrodesmus	-	-	-	-	-	200	-	-	-	-	0.05
Ulotrix	20,880	8,000	5,280	8,520	4,480	40	-	1,080	2,760	920	13.46
Closterium	680	1,520	1,120	-	720	-	120	-	200	-	1.13
Mougeotia	2,800	1,680	-	5,280	4,560	40	-	120	4,800	2,880	5.74
Chodatella	800	-	80	200	-	-	480	80	-	1,000	0.68
Tetraedron	-	240	-	-	480	80	800	1,000	-	-	0.67
Scenedesmus	560	1,440	1,080	-	160	-	160	-	3,760	-	1.86
Spondylosium	-	-	2,120	4,680	3,120	320	-	-	-	-	2.65
Staurastrum	3,360	120	-	-	-	280	-	400	-	1,080	1.36
Cosmarium	-	-	-	-	840	-	160	200	1,600	1,000	0.98
Pediastrum	2,240	-	-	-	-	-	-	-	-	-	0.58
Coelastrum	-	-	-	-	-	-	-	1,280	-	-	0.33
Clamydomonas	-	-	-	-	-	1,680	-	-	-	-	0.44
Endorina	-	-	-	-	-	520	-	-	-	-	0.13
Oocystis	-	-	-	-	-	4,600	-	-	1,400	-	1.55
Pandorina	-	-	-	-	-	-	-	640	-	2,760	0.88
Pediastrum	-	-	-	-	-	-	-	1,920	-	1,920	1.00
Raphidium	-	-	-	-	-	-	-	400	-	-	0.10
Rivularia	-	-	-	-	-	280	-	-	1,800	-	0.54
Selenastrum	-	-	-	-	-	-	200	2,280	360	3,560	1.66
Spirogyra	-	-	-	-	-	-	-	-	320	-	0.08
Stephanodiscus	-	-	-	-	-	-	-	600	-	-	0.16
Cyanophyceae											
Botryococcus	-	-	-	5,720	-	-	-	-	-	-	1.48
Eudorina	3,320	-	1,680	2,720	520	-	-	-	-	-	2.14
Sphaerocystis	3,560	-	-	2,520	-	-	-	-	-	-	1.58
Spirulina	-	1,360	-	-	-	-	-	-	-	-	0.35
Anabaena	-	-	-	-	-	480	-	-	-	1,000	0.38
Merismopedia	-	-	-	-	-	-	200	-	760	-	0.25
Oscillatoria	-	-	-	-	-	11,400	-	960	20,000	-	8.39
Zoo Plankton (Ind/L)											
Mastigophora											
Clamydomonas	2,600	-	-	-	-	5,400	3,000	1,000	2,000	3,200	4.46
Difflugia	1,800	-	-	-	-	-	4,000	2,000	-	8,600	4.25
Euglena	2,400	1,000	400	800	-	2,200	4,000	6,000	-	1,600	4.77
Peridinium	1,400	-	-	-	2,400	400	2,000	10,200	-	12,000	7.36
Phacus	3,400	1,600	-	-	-	2,000	7,600	4,600	3,000	8,000	7.83

Table 4. *Continued ...*

Organism	March					June					RA
	St 1	St 2	St 3	St 4	St 5	St 1	St 2	St 3	St 4	St 5	(%)
Monogononta											
Coleps	-	400	-	-	800	-	-	-	-	-	0.31
Polyarthra	4,000	400	200	-	-	-	-	-	-	-	1.19
Anureopsis	-	-	-	-	-	400	3,000	4,000	-	11,800	4.98
Hexartha	-	-	-	-	-	1,400	-	2,000	-	-	0.88
Pleusoma	-	-	-	-	-	400	-	-	-	-	0.10
Trichocerca	-	-	-	-	-	-	1,000	2,000	-	3,000	1.55
Rotifer											
Asplanchna	800	400	-	-	-	-	-	-	-	-	0.31
Keratella	1,200	-	-	600	-	-	-	-	-	-	0.47
Trichocerca	1,000	1,200	-	-	-	-	-	-	-	-	0.57
Ciliata											
Baladyna	-	-	-	-	-	-	3,000	-	-	3,000	1.55
Crustacea										-	
Brachionus	2,400	1,000	2,400	-	-	-	-	-	-	-	1.50
Cyclops	1,400	600	-	400	-	-	-	-	-	-	0.62
Nauplius	2,800	-	600	-	-	-	-	-	-	-	0.88
Diaptomus	-	-	-	-	-	-	600	-	-	-	0.16

Note: St 1= Refrence site. St 2= Domestic site . St 3= Cages site . St 4= Outlet site St 5= Inlet site; RA = Relative Abundance (%)

by a certain type of plankton. The condition indicated the lakes area are unstable cause by environment pressure. Wahyuni *et al.* (2013) stated that increased of turbidity, and reduced of phytoplankton photosynthesis due to decreased dissolved oxygen and heavy metal toxicity and it's caused unstable area condition.

The dominance index is used to determine whether there is a single species dominating a community the dominance index ranges between value of 0 and 1. If the index value is close to zero, it means that there is no species dominating. On the other hand, if E value is close to 1, it means that at least there was one species dominating. The results

Table 5. Diversity of plankton and evenness in Oxbow lake

Parameter	March					June				
	St 1	St 2	St 3	St 4	St 5	St 1	St 2	St 3	St 4	St 5
Sipin Lake										
Number of Taxa	7	7	7	7	7	5	4	5	5	6
ZooPlanton (Ind/L)	36,600	36,200	52,800	35,400	1,800	5,000	5,000	12,200	25,575	24,840
PhytoPlanton (Cell/L)	28,960	13,560	33,360	28,440	25,640	8,880	12,960	22,800	12,600	24,840
Diversity Index (H')	1.3	0.7	1.1	1.9	1.0	2.1	1.5	2.1	1.5	2.6
Evennes Index (E)	0.13	0.07	0.11	0.18	0.10	0.22	0.16	0.21	1.10	0.25
Dominance (D)	0.58	0.20	0.28	0.43	0.22	0.48	0.32	0.43	0.48	0.43
Teluk Lake										
Number of Taxa	3	3	3	3	3	3	3	3	3	3
ZooPlankton (Ind/L)	25,200	6,600	3,600	1,800	3,200	12,200	28,200	31,800	5,000	51,200
PhytoPlankon (Cell/L)	39,160	15,720	11,560	30,480	16,440	11,400	3,720	11360	45,640	20,240
Diversity Index (H')	2.1	1.2	1.6	1.6	1.5	1.8	1.2	1.3	1.7	1.7
Evennes Index (E)	0.04	0.03	0.02	0.08	0.08	0.13	0.12	0.13	0.14	0.13
Dominance (D)	0.11	0.08	0.05	0.16	0.19	0.24	0.21	0.23	0.23	0.22

of the calculation of plankton abundance obtained the value of the dominance index (D) of plankton for each species of each station. In two of oxbow lakes value of Dominance (D) index range from 0.08-0.58 and 0.08-0.23. Relatively, the index value of dominance (D) < 0.5, it showed that there were no species of phytoplankton dominating.

Conclusion

In Sipin lake, a total of 65 species of plankton where are 48 species of phytoplankton and 17 species of zooplankton were recorded, *Phacus* (Mastigopora) has the highest abundance. While, in Teluk lake a total of 59 species of plankton where are 39 species of phytoplankton and 17 species of zooplankton were recorded, Ulothrix (Chlorophyta) is the highest species diversity. Generally, Diversity index in two oxbow lakes can be categorized as moderated polluted. However, Teluk lake has more potential for fish resources development better than Sipin Lake if viewed from composition and type of the species.

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