Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 6, No. 6, p. 324-333, 2015
http://www.innspub.net

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RESEARCH PAPER
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Biodiversity of lebak deling swamp in Pampangan, Ogan Komering Ilir Regency, South Sumatera Province, Indonesia

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Article published on June 17, 2015

Key words: Biodiversity, Ecological characters, Lebak Deling Swamp, South Sumatra.

Abstract

Investigation on biodiversity of Lebak Deling swamp in Pampangan, Ogan Komering Ilir Regency, South Sumatra Province was carried out from March to September 2011, focused on evaluating the diversity of benthic organisms, planktons, aquatic plants, fish and other wild animals in the swamp ecosystem. Five sampling stations were selected within Lebak Deling swamp area, i.e., Lebak Sebubuk, Lebak Murti, Lebak Serdang, Lebak Purun, and Lubuk Deling. The results of this study showed that the Lebak Deling swamp was inhabited by nine species of benthic organism, 26 species of zooplankton, 16 species of phytoplankton, 23 species of aquatic plants, 30 species of fishes, three species of reptilians, nine species of birds and six species of mammals. Comparisons in diversity among sampling points were made based on Similarity Index. The analysis indicated that zooplankton and macrobenthic invertebrates had low similarity, while phytoplankton had high similarity. The results of this study confirm that the Lebak Deling swamp is still relatively natural; high diversity in Lebak Deling may be related to permanently submerged, high macrophytes covering and less human intervention.

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Introduction

Lowland swamp is distinguished by the presence of water, often has unique soils that differ from adjacent uplands, support vegetation adapted to the wet condition and are characterized by an absence of flooding intolerant vegetation (Mitsch and Gosselink, 1986). Lowland swamp plays roles in the landscape by providing unique habitats for a wide variety of flora and fauna. Many thought of lowland swamp as sinister and forbidding, with little economic value throughout most of recorded history; swamps were also considered as marginal land because the land was usually, wet and muddy, and was a habit of dangerous wild animals.

The total area of lowland swamp in Indonesia is about 33 million hectares grouped into tidal swamp and non tidal swamp. Lebak Deling swamps in Pampangan Sub-district of Ogan Komering Ilir Regency is an example of freshwater swamp ecosystem which is utilized for agriculture, horticuluture, capture fisheries, fish culture, buffalo and duck husbandry. The swamps has specific water characteristic with black color influenced by peat soils and water levels fluctuated according to precipitation rates (Muthmainnah *et al.*, 2012).

Information about biodiversity is an important part of a management plans on swamp ecosystems. Studies of biodiversity in swamp ecosystems were limited to scattered works on organisms that have been largely restricted to some of the major swamps of river systems. This current research focused on the diversity of benthic organisms, plankton, aquatic plants, fishes and other wild animals in the swamp ecosystem with black water.

Materials and methods

Study Site

Investigation on biodiversity of Lebak Deling swamp in Pampangan Ogan Komering Ilir Regency, South Sumatra Province was carried out from March to September 2011. Analysis of water, and identification of plankton, benthic organism, aquatic plants and fish was made at the Research Institute for Inland Fisheries. Sampling was conducted in 1). Lebak Sebubuk; 2) Lebak Murti; 3) Lebak Serdang; 4) Lebak Purun; and 5) Lubuk Deling (Figure 1).

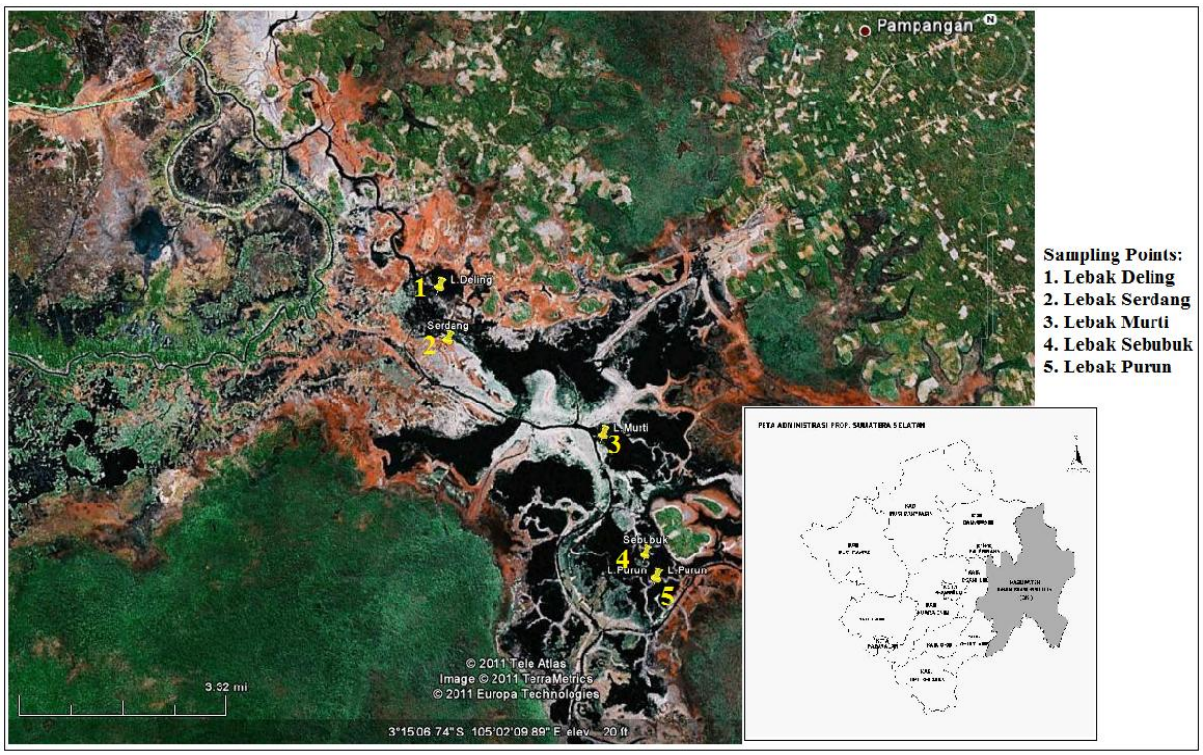

Fig. 1. Map of research location (Insert: Ogan Komering Ilir Regency).

Field Sampling

Benthic organisms were sampled by Eckman grab according to Lind (1979), bottom sediments were taken with 5 grabs in each sampling point. Separating benthic organism from non-living materials was conducted by sieves with the smallest mesh of 0.2 mm. Collected benthic organisms were preserved by 10% formaline and stained with Rose Bengal solution. Identification was done using binocular microscope and using reference books of Burch and Younghun (1992) and Macan (1959).

Observation of phytoplankton was carried out according to Lind (1979) and APHA (1982), 100 L of swamp water were taken by composite from surface to 1 m deep and filtered through No.20 plankton net with 60 um mesh size, and 50 ml filtrate collected in 100 ml bottle and 20 ml formalin added to the samples. Plankton identification was conducted in laboratory using microscope with 100 and 400 magnifications.

Identification of aquatic plants was done by comparing morphology of plant habitus (root, stem, leave, fruit and flower) to reference books by Soerjani & Wirjaharja (1973) and Steenis (1981). Fish samples were collected by several fishing gears (gillnet, cast net, seine net, pot trap, box trap, static pole and line, collecting box), and the sample preserved by 10% formaline. The type of fish was identified by comparing morphology and meristemic features to reference books by Kottelat *et al.* (1993) and Weber and de Beaufort (1931). In addition, the diversity of reptile, birds and mammals was categorized by quick survey through-out swamp area. The animals were recorded by taking photograph and comparing with reference photographs.

Water quality parameters observed were: water temperatur (^oC), air temperatur (^oC), current velocity ($m.sec^{-1}$), pH, CO_2 ($mg.L^{-1}$), alkalinity (mg $CaCO_3.L^{-1}$), hardness (mg $CaCO_3L^{-1}$), conductivity (mS), Total N ($mg.L^{-1}$), Total P ($mg.L^{-1}$), TDS ($mg.L^{-1}$), chlorophyll ($mg.L^{-1}$), depth (m), and transparancy (m). Carlson's *trophic state index* (TSI) (Carlson, 1977) was used to evaluate fertility level.

Data Analysis

Similarity Index (Jaccard Index) (Magguran, 1988) was used for analysing similarity of planktons and benthic organism: $C_j = j / (a + b - j)$

where:

j = the number of species common to both side

a = the number of species in site A

b = the number of species in site B

The values for similarity index are:

0 – 0.74 = if both of the community are different

0.75 – 0.99 = if both of the community are almost the same

1 = if both of the community identical.

Results and discussion

Results

The biodiversity of the swamp consisted of nine species of benthic organism, 26 species of zooplankton, 16 species of phytoplankton, 23 species of aquatic plants, three species of reptiles, six species of mammals, nine species of birds and 30 species of fishes (Table 1, 2, 3, 4, 5, and 6).

Table 1. Density of benthic organisms ($individuals.m^{-3}$) at research locations.

No	Order	Family	Species	Research Location				
				1	2	3	4	5
1	Coleoptera	Elimidae	*Ampumixis* sp	-	-	10	35	-
2			*Stenelmis* sp	10	5	-	10	-
3		Psephenidae	*Psephenus* sp	-	5	-	-	-
4	Diptera	Chironomidae	*Chironomus* sp	45	65	15	-	35
5		Dolichopodidae	*Dolichopodi* sp	10	-	5	-	10
6	Trichoptera	Hydropsychidae	*Hydropsyche* sp	-	10	-	-	10
7		Philopotamidae	*Chimarra* sp	-	-	-	10	-
8		Psychomyiidae	*Tinodes* sp	-	-	-	5	5
9		Hydropsychidae	*Ceratopsyche* sp	25	-	-	-	-

Similarity index constructed from five sampling points of benthics organism, phytoplankton and zooplanktons shows that benthics organism and zooplanktons has very low similarity while phytoplankton has high similarity (Table 7).

The water can be grouped as ultraoligotroph with very low fertility with acid reaction, and low in alkalinity and hardness (Table 8).

Table 2. Density of zooplankton (individuals.L^{-1}) at research locations.

				Research Location				
No	Order	Family	Species	1	2	3	4	5
1	Cladocera	Bosminidae	*Bosmina* sp	5.2	-	-	-	0.4
2		Saturniidae	*Polypemus* sp	0.4	-	-	-	-
3		Curculionoidae	*Diapanosoma* sp	0.4	2.4	-	-	-
4			*Dipleuchanis* sp	0.4	0.4	-	0.8	-
5		Cyrodae	*Leydigia* sp	10.4	0.4	-	1.6	2.0
6			*Alona* sp	2.0	-	-	-	-
7		Leptodorydae	*Leptodora* sp	0.4	-	-	-	-
8			*Moina* sp	0.4	0.4	-	-	-
9	Copepoda	Diaptomidae	*Diaptomus* sp	2.8	2.0	0.4	1.2	1.6
10			*Cyclops* sp	-	4.8	-	-	-
11		Acartiidae	*Acartiella* sp	1.2	-	-	-	-
12	Bledoidea	Philodinidae	*Philodina* sp	0.4	-	-	-	0.4
13	Collothaceae	Collothecidae	*Cupelopagis* sp	0.4	-	-	-	-
14	Ploima	Brachionidae	*Macrochaetus* sp	3.6	-	-	-	-
15			*Anuraeopsis* sp	-	0.4	0.4	0.4	-
16			*Cyrtonia* sp	-	-	-	1.6	-
17			*Plationus* sp	-	-	-	0.4	-
18		Lecanedae	*Lecane* sp	-	0.4	-	-	0.4
19		Testudinellidae	*Testudinella* sp	-	0.4	-	-	-
20		Lepadellidae	*Colurella* sp	-	-	-	0.4	-
21			*Lepadella* sp	-	-	-	0.4	-
22		Dicronophoridae	*Dicranoporus* sp	-	-	-	0.4	-
23			*Scridium* sp	-	-	-	0.4	-
24		Ashplanshidae	*Asplancha* sp	-	-	-	0.4	-
25		Trichocercidae	*Trichocerca* sp	0.4	-	0.4	-	-
26	Bourguetierinida		*Polyartha* sp	-	-	-	0.4	-

Discussion

Lebak Deling swamps are utilized by many sectors such as agriculture, horticulture, capture fisheries, fish culture, and buffalo and duck husbandry. The swamps has specific water characteristic with black color influenced by peat soils in the watershed and water level fluctuated according to precipitation rates.Water-level fluctuation has effect on fish migration from swamp to river and vice versa.

Benthic organisms found in Lebak Deling swamp consist of three species of Coleoptera, two species of Diptera and four species of Trichoptera. Laakso (1965) stated that Chironomid larvae (Diptera) are found only in fine silt sediment, while Gao *et al.* (2011) stated that abundance of benthic organism was related to the concentration of Chlorophyll-a and nitrate. Gastropods were not found in Lebak Deling perhaps due to a lack in calcium in the sediment (Kamal *et al.*, 1982).

Table 3. Density of phytoplankton (cells.L^{-1}) at research locations.

				Research Location				
No	Order	Family	Species	1	2	3	4	5
1	Pennales	Naviculaceae	*Navicula* sp	36.0	14.4	2.0	-	2.4
2		Flagilariaceae	*Synedra* sp	15.2	16.8	2.0	6.0	6.8
3			*Fragilaria* sp	9.6	11.6	-	-	-
4			*Diatoma* sp	22.0	-	4.4	-	36.0
5		Oocystaceae	*Ankistrodesmus* sp	17.6	17.6	4.8	-	12.8
6	Oedogoniales	Oedogoniaceae	*Oedogonium* sp	12.4	2.8	2.4	-	2.4
7	Zygnematales	Zygnemataceae	*Desmidium* sp	1.6	12.8	0.8	-	3.2
8			*Zygnema* sp	1.6	36.4	-	2.8	6.0
9			*Closterium* sp	-	-	-	-	0.4
10			*Spirogyra* sp	5.6	10.4	-	2.8	3.6
11	Ulothricales	Ulothricaceae	*Ulothrix* sp	26.0	79.6	5.2	6.0	7.6
12	Nostocales	Nostocaceae	*Anabaena* sp	9.6	-	-	-	2.0
13	Chlorococcales	Oscillatoriaceae	*Oscillatoria* sp	14.0	3.2	10.0	-	2.0
14	Volvocales	Volvocaceae	*Volvox* sp	0.4	-	-	-	-
15	Tribonemales	Tribonemataceae	*Tribonema* sp	6.8	-	2.0	-	-
16	Tetrasporales	Palmellaceae	*Palmella* sp	22.8	-	1.2	-	8.8

There were 26 species of Zooplankton found in Lebak Deling swamp dominated by Rotatoria class. According to Neves *et al.* (2003) abundance of zooplankton depends on availability of phytoplankton because under normal conditions the major part of zooplankton's diet is phytoplankton. Holopainen (1992) stated that low biomass of zooplankton was an effect of low pH which cause low food availabilty.

Lebak Deling swamp water with low pH, and low alkalinity and hardness is inhabited by 16 species of phytoplankton dominated by Chlorophyceae. Patriono *et al.* (2005) also found in Teloko swamp with acidic water that Chlorophyceae is the dominant group of phytoplankton (26%) while Cyanophyceae is only 0.55%. Prescott (1951) stated that Chlorophyceae are usually abundant in water with pH lower than seven while Cyanophyceae usually live in slightly alkaline waters. Payne (1986) also mentioned that Desmidiaceae is a group of phytoplankton found in acidic water and some group of Bacillariophyceae do not survive in alkaline waters.

Similarity indices of phytoplankton were relatively high among sampling points while macrobenthic and zooplankton communities had low similarity, indicating that the phytoplankton communities within five sampling points were composed of mostly the same species. Different species usually have different behaviour and require different food; hence low species diversity may cause competition where resources are limited. Different density of same species is more important than different species in different location. Wolda (1981) stated that the different species usually behave differently and can have strongly variable effects on their resources such as food. A numerical difference, therefore, between two localities in one species may be much more 'important' than the difference in another species. Differences in 'importance' between species have not been considered here, but the difference between samples could be weighed according to some attribute of the species like size.

Aquatic plants sampled consisted of 23 species dominated by the family Cyperaceae (25%) and Poaceae (21%). Aquatic plants have important role in supplying food for aquatic animals. Allochtonous organic matter is the main energy source for organisms in bottom sediments (Graca and Canhoto, 2006).

Table 4. Aquatic plant present at research locations.

Family	No	Species	Local Name
Butomaceae	1	*Limnocharis flava* (L.) Buch.	Genjer
Cyperaceae	2	*Cyperus rotundus* L.	Teki
	3	*Eleocharis dulcis* (Brum.) Tri.	Purun
	4	*Eleocharis ochrostachys* Steud.	Purun tikus
	5	*Fimbristylis annua* Gaudichi	Belidang
	6	*Fimbristylis littoralis* Gaudichi	Adas-adasan
Convolvulaceae	7	*Ipomoea aquitica* L.	Kangkung
Lemnaceae	8	*Lemna perpusilla* L.	Kiambang
Leguminosae	9	*Mimosa nigra* L.	Kayu malu
Melastomaceae	10	*Melastoma affine* D.Don.	Senduduk
Najadaceae	11	*Najas indica* Wild. Cham.	Lumut siarang
Nymphaceae	12	*Nymphaea nouchali* L.	Teratai Putih
	13	*Nelumbium nelumbo* L.	Teratai Besar
Pandanaceae	14	*Pandanus helicopus* (Parkinson)	Rasau
Pontederiaceae	15	*Eichhornia crassipes* Mart. Solms.	Eceng gondok
	16	*Monochoria vaginalis* (Burm.f.)	Eceng
Poaceae	17	*Axonopus compressus* (Sw.)P.Beauv.	Rumput pahit
	18	*Leersia orizoides* L.	Padi-padian
	19	*Leersia hexandra* Swartz	Benta
	20	*Paspalum commersonii* L.	Kumpai
	21	*Paspalum conjugatum* L.	Kumpai
Polypodiaceae	22	*Stenochlaena palustris* L.	Pakis udang
Butomaceae	23	*Nephrolepis exaltata* L.	Paku sepat

Although Lebak Deling swamp is considered as having low productivity with black acidic water, it has relatively high fish diversity where 30 species of fish were found. It is well known that most Southeast Asian rivers are dominated by Cyprinids and Balitorids (Bhat, 2003). Sulistiyarto *et al.* (2007) reported in Rungan river floodplain, Palangkaraya, Centre Kalimantan, found 50 species of fish from 19 families, dominated by Cyprinidae (19 species) and Siluridae (9 species). Peter *et al.* (1994) conducted an intensive survey in part of the North Selangor peat swamp forest which yielded 47 fish species, of which 14 are probably stenotopic taxa. While in Paya Beriah Peat Swamp Forest, Shah *et al.* (2006) found 32 species of fish from 13 families and 23 genera with the dominant species being *Trichogaster trichopterus*.

The fish community in a water body is influenced by morphology of the water body and its productivity level as well as its Chlorophyll-a concentration (Mechner *et al.*, 2005). Aquatic plants and plant litter also provide food and shelter for fish even in low productivity conditions. Distribution of fish in an aquatic system is also influenced by water current and level of environmental degradation (Bain and Finn, 1988). Lebak Deling swamp, as lake-like with rounded shape and wide littoral zone covered by dense aquatic plants, is a suitable habitat of many members of the Cyprinidae and Channidae families. Water availability and agriculture or animal husbandry may also influence fish diversity in Lebak Deling swamp. This finding indicates that Snakehead fish of Genus Channa might be tolerable to acidic black water in swamp with peat soils. Payne (1986) mentioned that swamp dweller fish are tolerant to low pH condition and high CO_2 level.

Sukimin (2009) also stated that peat swamp with vegetation provided organic matter which become natural food for insects, shrimp and fish, and through the food chain provide food for bigger fish. Aquatic plants also provide shelter and substrate for spawning fish.

Table 5. Wild animals present at research locations.

Class	Family	No	Species	Local Name
Reptilia	Varanidae	1	*Varanus salvator* (Laurenti)	Biawak
	Scincidae	2	*Mabuya multifasciata* (Kuhl)	Kadal
	Boidae	3	*Python reticulatus* (Schneider)	Ular
Mammalia	Sciuridae	1	*Callosciurus notatus* (Boddaert)	Tupai
	Cercopithecidae	2	*Macaca fascicularis* (Raffles)	Kera
	Vivveridae	3	*Pardoxurus hermaphroditus* (Pallas)	Musang
	Pteropidae	4	*Pteropus vampyrus* (Erleben)	Kalong
	Rodentia	5	*Sundamys muelleri* (Jentink)	Tikus sawah
	Suidae	6	*Sus scrofa* (Linnaeus)	Babi hutan
Aves	Rallidae	1	*Amaurornis phoenicurus* (L. Rein.)	Ayam-ayaman
	Anantidae	2	*Anas gibberifrons* (Linnaeus)	Belibis
	Ardeidae	3	*Ardea cinerea* (Linnaeus)	Kuntul Abu
		4	*Bubulcus ibis* (Linnaeus)	Kuntul Kerbau
	Meropidae	5	*Merops viridis* (Linnaeus)	Layang-layang
	Ciconiidae	6	*Ciconia episcopus* (Boddaert)	Bangau
		7	*Mycteria cinereus* (Raffles)	Bangau
	Accipitridae	8	*Icthyophaga ishthyaetus* (Horsfield)	Elang Rawa
		9	*Milvus migrans* (Boddaert)	Elang Hitam

Table 6. The fish present at research location.

Order	Family	No	Species	Local Name
Cypriniformes	Cyprinidae	1	*Cyclocheilichtys apogon* (Val.)	Keperas merah
		2	*Cyclocheilichtys armantus* (Val.)	Keperas putih
		3	*Osteochilus hasselti* (C.V.)	Palau
		4	*Osteochillus schlegelii* (Blkr.)	Semuruk
		5	*Puntius hexazona* (Weber de Beaufort)	Elang
		6	*Puntius lineatus* (Duncker)	Kemuringan
		7	*Puntius tetrazona* (Bleeker)	Pirik Cawang
		8	*Parachela oxygasteroides* (Blkr.)	Siamis
		9	*Rasbora borneensis* (Bleeker)	Seluang
Perciformes	Nandidae	10	*Nandus nebulosus* (Gray)	Setambun
	Pristolepididae	11	*Pristolepis fasciata* (Bleeker)	Kepor/Sepatung
	Anabantidae	12	*Anabas testudineus* (Bl.)	Betok
	Belontiidae	13	*Belontia hasselti* (Cuvier)	Selincah
		14	*Trichogaster pectoralis* (Regan)	Sepat siam
	Helostomatidae	15	*Helostoma temminckii* (Cuvier)	Sapil
	Channidae	16	*Channa lucius* (K.v.H.) C.V.	Bujuk
		17	*Channa striata* Bloch	Gabus
		18	*Channa marulioides* (Bleeker)	Jalai
		19	*Channa pleuropthalmus* (Bleeker)	Serandang
		20	*Channa melanosoma* (Bleeker)	Serko
		21	*Channa micropeltes* (Cuvier)	Toman
Siluriformes	Bagridae	22	*Mystus nemurus* (C.V)	Baung
		23	*Mystus wolffi* (Bleeker)	Lundu
	Clariidae	24	*Clarias nieuhofi* (C.V)	Keli Panjang
	Pangasiidae	25	*Pangasius djambal* (Bleeker)	Patin
	Schilbidae	26	*Pseudeutropius brachypopterus* (Bleeker)	Riu
	Siluridae	27	*Kryptopterus macrochepalus* (Bleeker)	Lais Tapah
		28	*Kryptopterus schilbeides* (Bleeker)	Lais Kukur
		29	*Wallago leerii* (Bleeker)	Tapah
Tetraodontiformes	Tetraodontidae	30	*Tetraodon sp*	Buntal

Beside fish, there were many kinds of wild animals in Lebak Deling swamp such as reptiles, birds and wild mammals, showing that the swamp is still relatively natural. The high diversity in Lebak Deling may be related to permanently submerged, high macrophytes covering and less human intervention. The other

natural swamp in South Sumatra Province is Lubuk Lampam swamp, that the inland fishery resources in the floodplain commonly higher than the other inland waters type i.e. swamp forest (*rawang)*, flooded grassland (*lubuk kumpai*) and river segment (*batanghari)* (Samuel, 2008).

Table 7. Similarity index of benthic organism, zooplankton and phytoplankton.

Name of swamps	Benthic Organism	Zooplankton	Fitoplankton
Lebak Sebubuk : Lebak Murti	0.50	0.43	0.80
Lebak Sebubuk : Lebak Serdang	0.57	0.23	0.80
Lebak Sebubuk : Lebak Purun	0.44	0.23	0.42
Lebak Sebubuk : Lubuk Deling	0.50	0.31	0.86
Lebak Murti : Lebak Serdang	0.43	0.33	0.70
Lebak Murti : Lebak Purun	0.44	0.28	0.57
Lebak Murti : Lubuk Deling	0.50	0.42	0.78
Lebak Serdang : Lebak Purun	0.50	0.28	0.26
Lebak Serdang : Lubuk Deling	0.57	0.25	0.78
Lebak Purun : Lubuk Deling	0.44	0.23	0.47

Table 8. Water quality of Lebak Deling Swamp.

	Research Location				
Parameter	1	2	3	4	5
Water temperature (^oC)	30.5	30.5	29.5	32.5	30.5
Air temperature (^oC)	29.5	32.0	26.5	29.5	29.5
Currect velocity ($m.sec^{-1}$)	7.4	14.2	9.3	8.4	0
pH	4.5	4.5	4.5	4.5	4.5
CO_2 ($mg.L^{-1}$)	12.32	12.32	11.44	18.48	13.20
Alkalinity (mg $CaCO_3.L^{-1}$)	1.5	1.5	2.0	1.8	1.8
Hardness (mg $CaCO_3.L^{-1}$)	3.5	3.5	3.5	3.2	3.8
Conductivity (mS)	50	30	40	80	40
N-Total ($mg.L^{-1}$)	0.182	0.245	0.189	0.245	0.245
P-Total ($mg.L^{-1}$)	0.0597	0.0368	0.0454	0.0654	0.0597
TDS ($mg.L^{-1}$)	20	20	20	40	20
Chlorophyll ($mg.L^{-1}$)	0.0093	0.0083	0.0083	0.0095	0.0107
Depth (m)	1.4	2.3	2.03	0.6	2.6
Transparancy (m)	0.2	0.2	0.2	0.2	0.2
Carlson's trophic state index	10.478	7.785	8.794	10.985	10.929

However, it is hard for keeping natural swamp because the droughts may raise waters temperature and reduce dissolved oxygen, imposing adverse physical conditions on fish in the pools, but the black fish appear to survive. Another reason causing the degradation on swamp ecosystem which losing the biodiversity is human intervention by building some canals and embankments. They will be changed the hydrological pattern of the swamp. The implications of these findings, in maintaining the fish populations suggest that attention must focus on preventing further degradation of habitats.

Conclusion

The following conclusions can be derived from the study: (1) Although Lebak Deling swamp is has low fertility (ultraoligotroph) with black water, the swamp is inhabited by many species of plants and animals, 9

species of benthic organism, 26 species of zooplankton, 16 species of phytoplankton, 23 species of aquatic plants, 3 species of reptiles, 6 species of mammals, 9 species of birds and 30 species of fishes; (2) High biodiversity would considere that Lebak Deling swamp is a relatively natural ecosystem.

Acknowledgement

The present study was funded by Ministry of Marine Affairs and Fisheries Republic of Indonesia.

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