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Ichthyofauna Diversity and Its Distribution in a Low-Saline Lake of Indonesia

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ABSTRACT

Lake Siombak is a tidal lake that is an estuary around the lake covered with various mangrove trees. It is interesting to study the fish's spatial and temporal distribution as a unique and distinctive tidal lake ecosystem. This research was conducted for a year (from September 2018 to August 2019). Fish sampling was performed by installing gill nets (mesh size 1 inch) and cast nets (mesh size 0.5 inch). Gill nets and cast nets were installed at high and low tides during the full moon. This research showed that there were 27 species of 20 families. Tilapia, Mudskipper, Indo-pacific tarpon, and mainly Rice Fish are always found in Lake Siombak. The fish group at Lake Siombak consists of freshwater fish (mainly: Tilapia, Catfish, and Snakehead), brackish fish (mainly: Mudskipper, Rice fish, and Indo-pacific tarpon), and marine fish (mainly: Milkfish, Kanda mullet, and John's snapper). The actual resident in Lake Siombak consists of Oryziidae, Tilapia, and mudskipper. Other fish are temporary resident fish except for Lutjanidae and Scatophagidae as visitor fish during high tide and high salinity periods (dry season) and Synbranchidae during low salinity (rainy season).

1. Introduction

Indonesia is known as one of the mega biodiversity countries in the world. Indonesia's biodiversity wealth consists of 16.2% species of birds; 4.6% amphibians; 12.2% of mammals; 7.1% of reptiles; 14.1% of fish, and 10.9% of vascular plants of the whole biodiversity population in the world. One of the contributions of biodiversity in Indonesia is fish, whose biodiversity in Indonesia (14.1%) ranked second after Australia (14.7%) (Butler 2016). Froese and Pauly (2020) estimated around 15% of the world's total fish species. Furthermore, Hutama *et al.* (2016) and Froese and Pauly (2020) estimated about 5000 species of native fish in Indonesian waters. The fish species consist of + 1,300 freshwater species (Hubert *et al.* 2016; Kottelat and Whitten 1996), and the rest are brackish and marine fish species (Froese and Pauly 2020; Hutomo and Moosa 2005). This freshwater fish species is the highest on Asia's continent and even the second richest in the world after Brazil. The species richness reaches + 3,000 species (Kottelat and Whitten 1996).

However, ichthyologists estimated that hundreds of fish species in Indonesia have yet to be found and described (Hutomo and Moosa 2005; Hutama *et al.* 2016). Therefore, the reports from several recent research even mention that endemic fish on the island of Sumatra has increased due to the discovery of new fish species during the last 20 years. The composition of endemic species of Sumatran fish is 66 species consisting of 13 families and is dominated by Cyprinid with 21 species and Osphronemid with 16 species (Prianto *et al.* 2016). Thus, one of the efforts of researchers and academics in Indonesia is to continue researching species identification and geographical and temporal distribution related to fish in Indonesia. This attempt is essential as part of efforts to document and describe the species as part of Indonesia's efforts to manage biodiversity.

One of the important ecosystems and fish habitats in North Sumatra, especially in Medan City, is Lake Siombak. Siombak lake is one of the coastal lakes in Indonesia whose condition is influenced by tidal waters (Muhtadi *et al.* 2017, 2020a). This lake is

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unique and distinctive because this ecosystem is a combination of a lake and an estuary connected to the Malacca Strait as far as 7 km (Muhtadi *et al.* 2020a). This lake's uniqueness is the aquatic organisms, both flora and fauna inhabiting Lake Siombak, consisting of freshwater, brackish, and marine organisms (Leidonald *et al.* 2019). Mangrove trees grow on various sides of the lake border, such as Nipa Palm, Mangrove Apple, and other mangroves (Muhtadi *et al.* 2020b). Other aquatic organisms in this lake include crabs, shrimp, snails, and fish (Leidonald *et al.* 2019; Muhtadi *et al.* 2022; Yulianda *et al.* 2020). This lake has an area of 29 ha with an average depth when the mean sea level is 1.12 during the rainy season and 1.10 during the dry season (Muhtadi *et al.* 2020a). Due to the tide's influence, Muhtadi *et al.* (2020a) described a tidal lake as another term for a coastal lake. The tidal lake is a coastal lake whose water condition is influenced by the dynamics of tides. However, in Indonesia, the term is rarely found because there is hardly any related publication; moreover, the lake is also rare in Indonesia.

Thus, Lake Siombak is a flooded ecosystem (lotic system) and is directly connected to the coast and ocean so that it is the estuary (coastal lagoon), which is the habitat for various flora and fauna (Leidonald *et al.* 2019; Muhtadi *et al.* 2020b, 2020c, 2021, 2022; Yulianda *et al.* 2020). Ecologically, coastal lagoon acts as a life support system for various aquatic organisms and terrestrial organisms (Djihouessi *et al.* 2019; Gbaguidi *et al.* 2016) on the coast as a feeding ground, nursery ground and as spawning ground (Baptista *et al.* 2019; 2020; Berkström *et al.* 2020; Jaxion-Harm and Speight 2016; Lett *et al.* 2019; Ocana-Luna and Sánchez-Ramírez 2016). In socio-economic terms, the coastal lagoon is a livelihood source for coastal communities (Reis-Filho *et al.* 2011). The coastal lagoon has long been used as a fishing ground area (Clara *et al.* 2018; Reis-Filho *et al.* 2011) and can be an ecotourism area (Clara *et al.* 2018; Patrolia *et al.* 2017).

They are considering the role of the coastal lagoon as a habitat for various aquatic and terrestrial organisms. It is crucial to make the coastal lagoon a source of germplasm in the world, especially in the tropics (Djihouessi *et al.* 2019; Gbaguidi *et al.* 2016). It is necessary for research related to the distribution of fish communities in lake Siombak as inventory and fish documentation in tidal lake Indonesia. This activity is the first step in managing fish biodiversity in Indonesia. Research on the fish community in Indonesian tidal lakes is still limited quickly (once sampling) (Hasudungan *et al.* 2008; Leidonald *et al.* 2019). In this case, the experts predicted the migratory species at certain seasons would migrate and enter the estuary and surrounding regions, including coastal lakes (Djihouessi *et al.* 2019; Manzo *et al.* 2016; Mohanty *et al.* 2015; Oluwajoba *et al.* 2017; Padilla-Serrato *et al.* 2017; Rodrigues *et al.* 2015). Mohanty *et al.* (2015) even obtained about 271 species of fish (85.49%) in Chilika lake is a migratory species.

Therefore, it describes the whole tidal lake ecosystem, representing two seasons (at least one year) with a broader spatial coverage (including surrounding ecosystems, rivers, and mangrove areas). Meanwhile, several comprehensive overseas studies on coastal lakes have been carried out, especially regarding seasons (temporal) in several years, such as in the lagoon of Lagos (Nigeria) (Emmanuel and Chukwu 2010), the coastal lagoon of Mar Chiquita (Bruno *et al.* 2013), Lake Chilika (India) (Mahanty *et al.* 2015), and Lesina Lagoon (Italy) (Manzo *et al.* 2016), and Lake Nokoue (Benin) (Djihouessi *et al.* 2019; Lalèyè *et al.* 2003). As a result, this study was conducted to obtain the distribution of fish communities in Indonesian tropical tidal lakes. This study aims to determine the species and diversity of fish spatially and temporally in Lake Siombak, North Sumatra, Indonesia, as one of the tropical tidal lakes in Indonesia and one of the first steps in managing the tidal lake ecosystem.

2. Materials and Methods

2.1. Study area

This research was carried out in Lake Siombak, Medan City, North Sumatra Province, from September 2018–August 2019. There were eight data collection spots within the lake and three spots outside the lake (Figure 1). The tools used in this research is GPS Garmin Oregon 65 with accuracy up to 3 m, gill nets with a mesh of 1.5-inch, nets, stationery, and boats.

2.2. Procedures

Fish sampling was conducted every month at the full moon. Fish samples were taken at high tide and low tide. The gill net (mesh size 1 inch) was carried out at night when the water started to tide and was lifted in the morning when the water started to

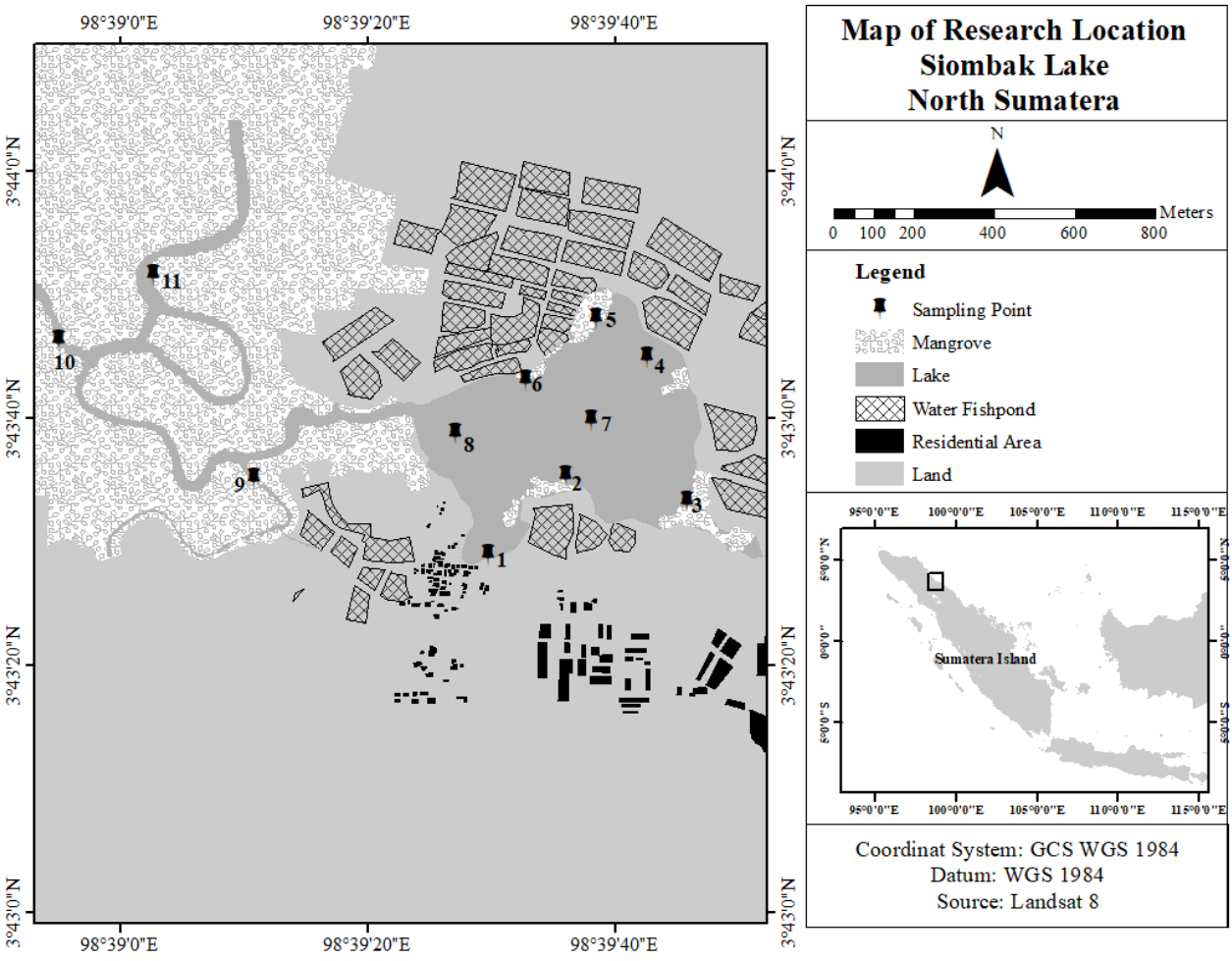

Figure 1. Research location in Siombak Lake, Medan, North Sumatra, Indonesia

recede (as fish data at high tide). Then it was kept installed until the afternoon, and it was raised again when the water started to tide again (as fish data at low tide). At the same time, nets (0.5-inch mesh size) were directly installed and harvested at high tide (as fish data at high tide) and low tide (as fish data at low tide).

2.3. Taxonomic Identification and Classification

Fish sample identification referred to the book Kottelat *et al.* (1993), and Kottelat (2013). We followed Dewantoro and Rachmatika (2016) and Global Invasive Species (Database http://www.iucngisd.org/gisd/) for the native and invasive fish category in Indonesia. Other categories, such as migratory species and freshwater or brackish fish, referred to Kottelat *et al.* (1993) and Kottelat (2013).

2.4. Data analysis

Data analysis consisted of analysis of the spatial and temporal distribution of fish, fish categories, fish community structure, tidal effects on fish abundance and presence, and indications of Siombak lake as a nursery and feeding ground. The spatial distribution of fish was analyzed descriptively and presented in a map of the spatial distribution of fish processed with the help of Quantum GIS 1.8 free. The temporal distribution of fish was analyzed descriptively and presented in graphical form processed with the help of Microsoft Excel 2016. Fish categories were also analyzed descriptively and processed with Microsoft Excel 2016. Tidal effects on fish abundance and presence and indications of Siombak lake as a nursery and feeding ground were analyzed descriptively and compared with the results of related studies.

The structure of fish communities was mainly related to 3 main attributes, namely: Shannon-Wiener function (H'), evenness (e), and dominance (C) (Krebs 2014; Odum and Barrett 2005). The diversity index (H') was used to get a mathematical representation of the organism's population. This index could make it easier to analyzed information on the number of individuals of each species in a community. The evenness index (E) described how big the balance was in an ecosystem.

Fish diversity was calculated using the diversity index of Shannon and Wiener (1963) in Krebs (2014) with the following formula:

$$H' = - (\sum pi \log_2 pi)$$

Explanation:
H' = species diversity index
ni = number of individuals of each species
N = number of all individuals
Pi = important Probability for each species = ni/N

The equitability index (E) was calculated by following the equation (Krebs 2014):

$$E = H'/H` max$$

Explanation:
E = shannon-wienner uniformity index
H = species balance
H`max = maximum diversity index ($\log_2 S$)
S = total number of species

The dominance index is calculated according to the Simpson index in Odum and Barret (2005):

$$C = \sum \left(\frac{ni}{N}\right)^2$$

Explanation:
C = index of dominance
ni = number of individuals of each species
N = total individual community

3. Results

3.1. Species Richness

During the study, 27 species of 20 families were caught and identified (Table 1). Gobiid had more than fish from other families, i.e., there were four species.

Table 1. Types of fish caught in the Siombak Lake

Family	Latin name	Local name	Common name
Adrianichthyidae	*Oryzias javanicus*	Medaka	Javanese ricefish
Ambassidae	*Ambassis buruensis*	Serinding	Buru glass perchlet
Anguillidae	*Anguilla bicolor*	Dungdung	Shortfin eel
Aplocheilidae	*Aplocheilus panchax*	Kepala Timah	Panchax minnow
Bagridae	*Mystus gulio*	Lundu	Long whiskers catfish
Belontiidae	*Trichopodus pectoralis*	Sepat siam	Snakeskin gourami
	Trichopodus trichopterus	Sepat rawa	Gold gourami
Eleotridae	*Butis gymnopomus*	Lontok	duckbill sleeper
	Ophiocara porocephala	Lontok	Spangled gudgeon
Channidae	*Channa striata*	Gabus	Snakehead murrel
Chanidae	*Chanos chanos*	Bandeng	Milkfish
Cichlidae	*Cichlasoma trimaculatum*	Louhan	Three spot cichlids
	Oreochromis niloticus	Nila	Nile tilapia
	Oreochromis mossambicus	Mujaer	Tile mosambique
Clariidae	*Clarias batrachus*	Lele	walking catfish
Gobiidae	*Acentrogobius viridipunctatus*	Tembakul	Spotted green goby
	Boleophthalmus boddarti	Tembakul	The Mudskipper
	Brachygobius xanthozonus	Tembakul	Bumblebee goby
	Periophthalmodon schlosseri	Tembakul	Giant Mudskipper
Hemiramphidae	*Zenarchopterus buffonis*	Julung-Julung	Striped-nose halfbeak
Loricariidae	*Pterygoplichthys pardalis*	Sapu-Sapu	Suckermouth catfish
Lutjanidae	*Lutjanus johnii*	Kakap	John's snapper
Megalopidae	*Megalops cyprinoides*	Bulan-Bulan	Indo-Pacific tarpon
Mugilidae	*Valamugil engeli*	Belanak	Kanda mullet
Pangasiidae	*Pangasius nasutus*	Patin	Panga's catfish
Scatophagidae	*Scatophagus argus*	Ketang	Spotted scat
Synbranchidae	*Monopterus albus*	Belut	Asian swamp eel

Another family found in Lake Siombak is Cichlid, which has three species. The number of fishes caught in this study was more than in the previous study in 2016 (only nine species). This result might be because the research time was longer, which was one year (representing two seasons). In this study, three spot cichlids were caught (*Cichlasoma trimaculatum*) from the Cichlid family of an ornamental fish rarely found in natural waters in Indonesia. Therefore, it was likely that the residents would release the fish into the lake. Cichlid was an invasive species that quickly breeds in Indonesian waters. Tilapia fish had long been cultivated fish in Indonesia by spreading into the waters. Tilapia fish were invasive from Africa or America. Some other invasive fish found at the study site including *Trichopodus tricopterus* and *Pterygoplichthys pardalis*.

3.2. Spatial Distributions

The number of fish species and the total number of fishes caught at stations 5 and 8 are higher than in other stations (Figure 2-3). The number of fish species identified is 14-15 at low tide and 16-17 at high tide. The total number of fishes caught was 2,179 fish (ebb tide) and 6,212 fish (flood tide) in which, at stations 3 and 8, it reached 52% at low tide and 74% at high tide (Table 2-3). Station 8 was a Watergate as the entrance and exit of lake water so that many fish were caught there, while station 3 was where mangrove conditions were best on the edge of Lake Siombak. Generally, higher mangrove diversity results in higher fish diversity.

3.3. Temporal Distribution

Temporally, the fish population during the dry season (Feb-Jul) was more than the rainy season (Aug-Jan). However, species richness in the dry season (except in March) was lower than in the rainy season. (Figure 4). Temporary resident fish included fish that settle in the rainy season (8 species: 29.63%), which were freshwater and dry season fish (9 species: 33.33%), which were brackish fish, but there were also temporary resident fish that could be present in the dry and rainy season, namely *Megalops cyprinoides* and *Mystus gulio*. Both fish species were brackish fish that prefer freshwater. Meanwhile, marine fish were visitors during high tide and high salinity (dry season), and freshwater fish during low salinity (wet season).

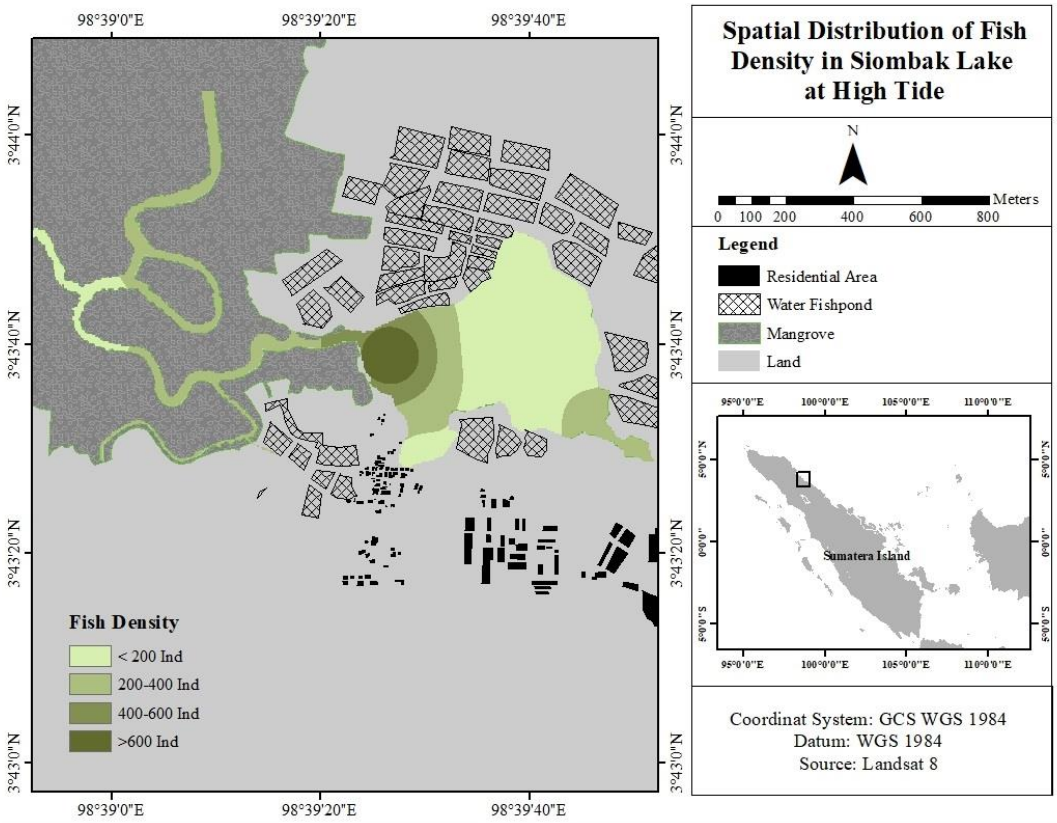

Figure 2. Map of abundance of fish caught at high tide

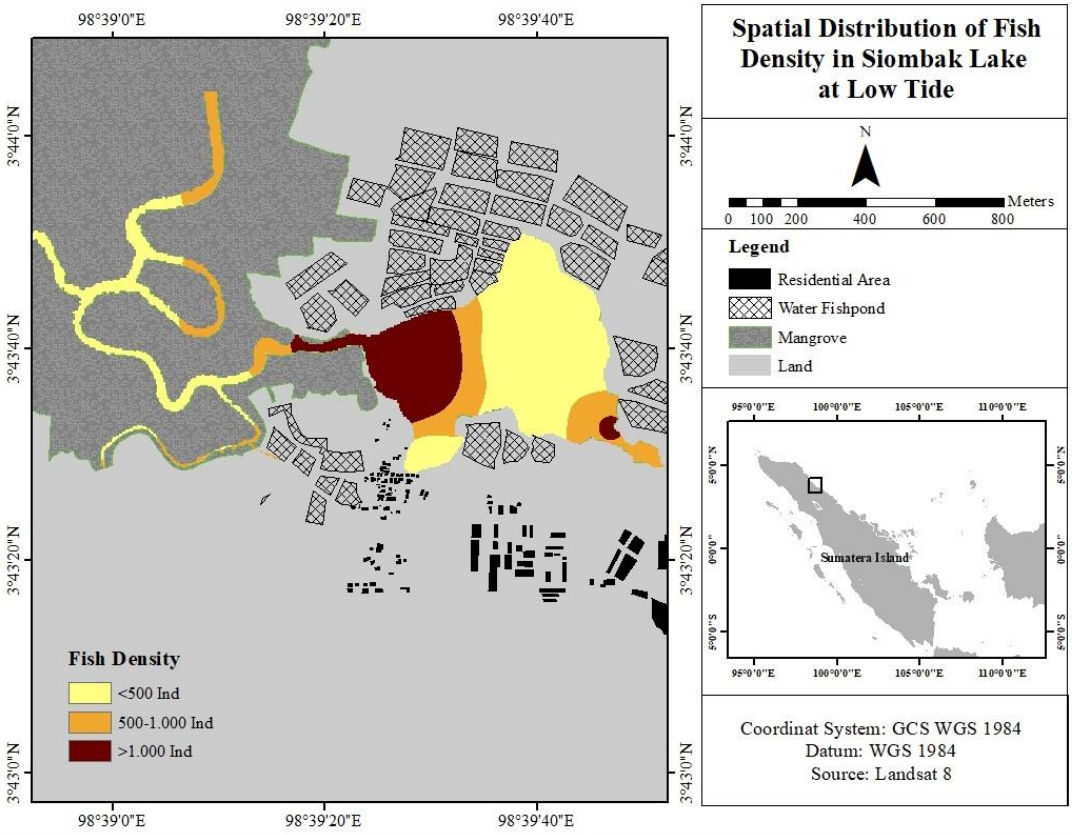

Figure 3. Map of abundance of fish caught at low tide

Table 2. Spatially of index of fish communities in Lake Siombak

Station	Community index					
	Diversity (H')		Evenness (C)		Dominance (C)	
	High tide	Low tide	High tide	Low tide	High tide	Low tide
1	2.63	2.4	0.76	0.65	0.21	0.29
2	2.96	2.45	0.83	0.74	0.17	0.25
3	0.78	1.06	0.20	0.33	0.79	0.69
4	2.09	2.80	0.63	0.81	0.34	0.20
5	2.57	3.22	0.64	0.87	0.30	0.13
6	2.21	2.36	0.70	0.68	0.31	0.32
7	1.80	1.94	0.70	0.75	0.34	0.36
8	1.29	0.83	0.32	0.21	0.47	0.80
9	0.59	0.28	0.19	0.11	0.85	0.93
10	2.10	2.15	0.91	0.93	0.26	0.25
11	0.54	0.47	0.17	0.17	0.86	0.88

Table 3. Temporally of index of fish communities in Lake Siombak

Month	Community index					
	Diversity (H')		Evenness (C)		Dominance (C)	
	High tide	Low tide	High tide	Low tide	High tide	Low tide
Sep	2.03	2.29	0.59	0.76	0.38	0.28
Oct	1.37	2.56	0.43	0.85	0.55	0.20
Nov	1.99	2.24	0.55	0.65	0.39	0.31
Dec	2.56	1.57	0.69	0.52	0.25	0.51
Jan	2.69	1.88	0.71	0.51	0.23	0.49
Feb	2.58	2.40	0.7	0.63	0.22	0.36
Mar	0.59	2.33	0.15	0.67	0.86	0.33

Table 3. Continued

Month	Community index					
	Diversity (H')		Evenness (C)		Dominance (C)	
	High tide	Low tide	High tide	Low tide	High tide	Low tide
Apr	1.11	1.05	0.34	0.33	0.69	0.72
May	1.82	1.46	0.51	0.46	0.50	0.58
Jun	0.56	1.20	0.19	0.38	0.85	0.66
Jul	0.32	0.64	0.11	0.28	0.93	0.82
Aug	1.19	1.37	0.38	0.43	0.66	0.60

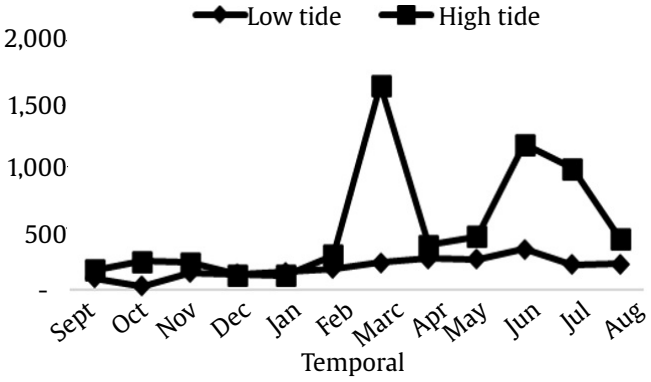

Figure 4. Total fish caught based on temporal in Siombak Lake

3.4. Species Categories

Generally, fish found in Lake Siombak were estuary fish (brackish), namely Ambassid, Bagrid, Eleotrid, Gobiid, Hemiramphid, Megalopid, and Oryziidae. However, many freshwater fishes were from the Aplocheilid, Belontiid, Channid, Cichlid, Clariid, Pangasiid, and Synbranchidae families. In contrast, marine fish consisted of Kanda mullet (Mugilid), Milkfish (Canidae), John's snapper (Lutjanid), and Spotted butterfish (Scatophagidae). Thus, there were 12 species (44.44%) of freshwater fish, 11 species (40.74%) of brackish fish, and four species (14.82 %) of marine fish. Fish in Chilika Lake (India) consisted of 35.65% (113 species) freshwater fish, 43.85% (139 species) brackish fish, and 20.50% (65 species) marine fish.

The fish found in Lake Siombak consisted of real residents, temporary residents, and migratory fish. There were 5 (18.52%) species of fish that were real fish resident at Lake Siombak, namely, Tilapia (*Oreochromis mosambicus* and *Oreochromis niloticus*), Javanese Rice fish (*Oryzias javanicus*), and Mudskipper (*Boleophthalmus boddarti* and *Periophthalmodon schlosseri*) as many as 7 species (25.93%) were temporary residents and as many as 15 species (55.56%) were migratory fish. These five species were fish that were always found in every month of observation. Especially, Gobiid (Mudskipper) was a fish whose entire life cycle was in the estuary region. At Lake Siombak, it was found Shortfin Eel (Anguillid), a catadromous fish.

3.5. Diversity Index

The diversity index of fish in Lake Siombak varies from low (0.20) to moderate (2.24) (Table 2-3). Spatially, the high diversity index was found at Stations 2 and 5 (H'>2), and the low diversity index was found at Stations 3, 8, 9, and 11 (H'<1). Temporarily, the fish diversity index at high tide ranged from 0.32-2.58, and at low tide, it went from 0.64-2.56. In general, fish diversity in the rainy season (Sep-Jan) is higher than in the dry season (Feb-August) (Table 2-3).

4. Discussion

4.1. Spatial and Temporal Distribution

The composition of fish caught in Lake Siombak at both high and low tide is dominated by *Oryzias javanicus* (Adrianichthyidae), which reached 75.70% and 59.66%. Furthermore, Tilapia fish reached 8.30% at low tide, and Glass perch lets reached 24.61% at high tide. Kottelat *et al.* (1993) and Kottelat (2013) stated that *Oryzias javanicus* was often found in brackish and mangrove waters. The results of research conducted by Yusof *et al.* (2013) found that *Oryzias javanicus* was widely distributed in mangrove waters on the west coast of Peninsular Malaysia and in the mangrove and estuary areas of Lombok Island (Dewantoro 2018). These fish were generally found swimming in large numbers (in groups) in river mouths or mangroves' edges in calm waters (Pratama *et al.* 2015).

Although *Oryzias javanicus* had a high population at the study site, Tilapia and Indo-pacific tarpon fish had the most extensive distribution in Lake Siombak. Tilapia was a fish that had been widely adopted in Indonesia and could breed quickly. Tilapia fish were

freshwater but had a broad tolerance to salinity levels (Euryhaline) (Dewantoro and Rachmatika 2016; Kottelat *et al.* 1993). Meanwhile, Indo-Pacific tarpon could live in the sea or freshwater, but they were often found in brackish water areas. These fish enjoyed living mainly in estuaries, beaches, mangrove swamps, lagoons, or lakes. These fish were predominantly in the estuary and mangrove areas in the juvenile phases, but mature fish and spawning were in seawater (Froese and Pauly 2020). Research by Redjeki (2013) found that abundance in vegetated waters of *Rhizophora* sp. (mangrove) was higher than that in the vegetated waters of *Cyperus* sp. (bush). According to Rajpar and Zakaria (2014), the high and low diversity of fish species was influenced by mangroves' presence capable of sustaining a living and associated aquatic fauna in them. Furthermore, Putri *et al.* (2017) stated that habitat variation and conditions significantly affect the diversity of species of organisms that live in it.

In both the rainy and dry seasons (except March), the highest fish population is Rice fish (57.7-75.3%). Thus, spatially and temporally, Rice fish were dominant in Lake Siombak. Therefore, Lake Siombak was a suitable habitat and suitable for Rice fish. In March, Glass Buru perch fish was dominated by 91.5%. This fish was found clustered very much in the lake's mouth with the size of a still juvenile fish. March was the peak of salty drought (salinity value of 15 ppt on the surface) (Muhtadi *et al.* 2020a), so in this month, fish, such as Spotted scat, Spangled gudgeon, and snapper were found more in brackish/marine fish, while the bargaining fish population was decreasing.

4.2. Effect of Tides on Fish Abundance and Distribution

The distribution of fish populations and species richness was more prevalent at high than low tide. The main factor that could cause differences in fish diversity at high and low tide was the availability of habitat/niches for fish communities (Paperno *et al.* 2018). Reis-Filho *et al.* (2011) found in their research that the number of species, the number of fish, and the richness and diversity of fish were significantly higher in the full moon than those in ebb tides. Kang and King (2013), Kimball *et al.* (2015), and Paperno *et al.* (2018) mentioned that fish found in lakes that were directly related to the sea would experience different movements according to place and time. The difference in abundance at high and low tide was caused at high tide when many fish are carried to the lake by tidal currents and avoid low tide by being on the side of lake waters. This condition was due to the part of the lake, an estuarine area where the fish found a suitable place for growth.

4.3. Lake Siombak as a Nursery and Feeding Ground

Tilapia, Mudskipper, Rice fish, and Indo-Pacific Tarpon fish were always caught spatially and temporally. This fact showed that Lake Siombak (as an estuary area) was the fish's primary habitat. In this case, the strong suspicion that the fish (except Megalops cyprinoides) were fish whose entire life cycle was at Lake Siombak as estuarine waters, while other fish created Lake Siombak as a nursery and feeding ground. In this study, the fish in the Mugilid and Ambassid families were mainly caught in juvenile phases. These fish were associated with mangrove forests during juvenile, but as adults, they tend to gather along the coast near the mangrove forest (Berkström *et al.* 2020). This view was supported by Guimarães *et al.* (2014) and Hartz *et al.* (2019), which stated that fish communities in mangrove and estuary waters were dominated by several types of fish even though the types of fish caught were relatively large. All types of fish caught at the research station were relatively juvenile in size. Mangrove and estuary ecosystems were known as nursery and feeding ground care areas; thus, most fish samples were juvenile, especially migratory fishes (migratory temporary).

The abundance of fish in mangrove and estuarine waters was closely related to herbivores' feeding habits and epiphytic carnivores (Redjeki 2013). Furthermore, Igulu *et al.* (2014), Lett *et al.* (2019), and Baptista *et al.* (2020) explained that the presence of fish larvae and juveniles in estuaries was the functional role of estuaries and mangroves as spawning, nursery, and feeding ground. Therefore, juvenile fish were often found in the area around the mangrove. Herbivorous and epiphytic carnivore's species tended to be in shallow water and among mangroves, where there were epiphytic phytoplankton and bottom surface fauna. Igulu *et al.* (2014) showed that the herbivorous and epiphytic carnivorous fish tended to migrate locally and temporarily since the movement was driven by food. Thus, these fish' existence was related to the

ability of mangrove and estuary areas to provide food. Based on the research results of Muhtadi *et al.* (2020c), the diversity and abundance of plankton in Lake Siombak are very high, reaching 15.09 million cells/m^3 of phytoplankton and 3.74 million individual/m^3 of zooplankton.

4.4. Diversity Index

In this study, it was found that a high diversity index value indicated that there was no guarantee that uniformity would be high. This result indicated a high abundance of fish, and species richness did not guarantee high uniformity. This situation was caused by one of the dominant species, Rice fish and Buru glass perch, left on stations 3 and 8. This phenomenon also applies temporally during the dry season. The abundance of fish and the richness of many species had a lower species diversity than in the rainy season. In the rainy season, the diversity index reached more than once (H'>1), while in the dry season, less than once (H'<1).

The low value of fish diversity at stations 3, 8, 9, and 11 included the dry season, as evidenced by the high value of fish domination at the four stations (C>0.5). So, the similarity index value was shallow (E value <0.5) compared to other stations (especially stations 2 and 5), including during the rainy season. However, fish populations and species richness were lower; the composition and proportion of individuals among species were more evenly distributed. This data could be seen from the higher similarity index value (E value>0.75) with low dominance (C value<0.30). Statistical tests in the 5% confidence range and t-tests showed that the dominance index increased if the diversity and similarity index decreased. It showed that the similarity index diversity influenced the dominance index.

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