Fish community structure and distribution at Lake Siawan, West Kalimantan, Indonesia

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Abstract. Freshwater fish in Kalimantan is the highest among Indonesian islands, with many endemic species. Therefore, a fish population study was conducted in Lake Siawan, West Kalimantan, for the purpose of determining fish diversity, abundance, local distribution, species status, and its habitat. Five sampling stations were designated and the catch per unit of efforts (CPUE) approach was adopted to get the samples. The fish caught were counted to get the species diversity and abundance. There were 57 species from 13 families that were recorded, with Cyprinidae as the dominant family with 34 species, followed by Bagridae with 4 species. Station 1 and station 5 were recorded as the highest and the lowest fish diversity, respectively. The most abundant species were Brevibora dorsiocellata and Rasbora tormieri. Four species have wide distribution and almost all of the fish found was native species. Three endemic species recorded were Hampala bimaculata, Leptobarbus hosii and Puntigrus anchisporus.

1. Introduction
Indonesia has a rich biodiversity, including fish. Marine and freshwater fish diversity in Indonesia was reported to be more than 4,700 species [1]. Ohee [2] reported 400 freshwater fish species from Papua, while Kottelat et al. [3] recorded 900 species of West Indonesia and Sulawesi. Nowadays, a total number of Indonesian freshwater fish is 1,248 species [4]. Moreover, Dudgeon [5] stated that Indonesian freshwater fish diversity reached 1,700 species. This biodiversity which is not complete was recorded but many species were introduced to Indonesia. This pose a potential threat to native species, for example the introduced species such as common carp (Cyprinus carpio) and nile (Oreochromis niloticus) caused a decline in an endemic species population in Sulawesi lakes.

Kalimantan or Borneo has a vast diversity of fauna, which some of them are endemic to this region. Thus, this island was given a status as a center of origin of Indomalaya fauna [6]. The freshwater fish of Kalimantan was firstly comprehensively enumerated by Kottelat et al. [3] who recorded 394 species, with 38% of them are endemic. High species diversity was compared to other islands in Indonesia, considering diverse aquatic systems in Kalimantan i.e. rivers, lakes, and swamps that functioned as a fish habitat.

Many authors have reported fish diversity of Kalimantan even though only at certain locations and specific aspects [7, 8, 9, 10, 11, 12, 13, 14]. According to these reports, there were many rivers and lakes that were not reported yet; one of them was Lake Siawan in Kapuas Hulu Regency, West Kalimantan. Kapuas watershed with a total area of 39,000 ha [15] sheds water into this lake. This lake
was part of the conservation efforts in West Kalimantan in 2003 after Head of the Kapuas Hulu District announced the formation of ‘Conservation District’ in Indonesia.

Lake Siawan is interesting to be studied because it is part of Kapuas watershed and probably has various fish species. Beside that, this lake is a habitat for Asian arowana strain super red (*Scleropages formosus*); famous for its body form and coloration that make it very pricey. The price could reach million IDR for the fish size approximately 15 cm. Asian arowana was protected by Indonesian regulation and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) list Appendix I. The forest surrounding the Siawan Lake is a conservation area with many fauna to be conserved, including fish. However, about an half of the upper Kapuas watershed is potential to be critical areas [16]. An urgent action is needed to prevent such damage to the watershed, as a degraded watershed is a source of many catastrophic events, as stated by Lusiana et al. [17] that threats to the hydrological function of Upper Kapuas watershed which include erosion, sedimentation, and water pollutions are caused by deforestation, mining activity, and other anthropogenic activities. Therefore, based on these factors, the study was conducted to determine fish diversity, abundance, local distribution, species status, and its habitat types.

2. Materials and Methods

2.1. Study area

The study was conducted at Lake Siawan, located at a base camp in the Pontu Village, Bunut Hilir District, Kapuas Hulu Regency, West Kalimantan (figure 1) in December 2010. Five sampling stations were designated to obtain representative of fish community, which were:

Station 1: Northern (N: 00°48.007’ and E: 112°39.983’)
Station 2: Southern (N: 00°46.119’ and E: 112°40.369’)
Station 3: Western (N: 00°46.716’ and E: 112°39.352’)
Station 4: Eastern (N: 00°46.097’ and E: 112°41.669’)
Station 5: Central (N: 00°47.092’ and E: 112°39.604’)

![Figure 1](https://Mapcarta.com)

2.2. Samples collection and identification

The study was conducted by interviewing the local people around Lake Siawan about fish diversity, species status, and habitat types; then the information was further clarified in the field. Fish sampling was done at five sampling stations using a survey method of catch per unit effort (CPUE). Fishing gear used was gill nets (20 m x 2 m) with mesh size of 0.5, 1.0, and 1.5 inches. The gill nets were installed for a duration of four hours, then followed by cast nets with diameter of 4 meters.

Fish specimens were collected and preserved in 5-10% formalin at Ichthyology Laboratory of Research Center for Biology-LIPI. Fish specimens were cleaned and soaked in waters for about 3-4
hours, then placed in 70% alcohol. Species identification was made by referring to guide books [16, 17, 18, 19, 20, 21, 22], and further verified based on literatures [1, 23, 24]. Habitat parameters were observed covered temperature, pH, and dissolved oxygen using instruments (thermometer, pH meter, and DO meter), but water color and others physical by visual.

2.3. Data analysis
The abundance of fish species was calculated according to Misra in Rachmatika et al. [25] as follows:

\[ \text{Abundance} = \frac{N_i}{N \cdot St_i} \]

Where, \( N_i \) = number of individuals of species - \( i \) were found; \( N \cdot St_i \) = number of stations with species - \( i \) occurrence.

The local distribution or frequency of incidence (FOI) of each species was estimated according to Muchlisin and Azizah [26]; Muchlisin et al. [27]) as follows:

\[ \text{FOI} = \frac{N_i \cdot St}{N \cdot St} \times 100 \]

Where, FOI = Frequency of incidence (%), \( N_i \cdot St \) = total number of locations where the species \( i \) were found, \( N \cdot St \) = total number of sampling locations.

The biological indices were estimated using the software package in Multivariate Ecological Research (Primer E) version 6. The Shannon-Wiener diversity index was calculated as follows:

\[ H' = -\sum P_i \ln P_i \]

Where, \( H' \) = Shannon-Wiener diversity index, \( P_i = \frac{N_i}{N} \) (\( N_i \) = total number of individual of species \( i \), \( N \) = total number of individual of all species). The diversity index expresses the species richness and shows how individual species distributed in a community. According to Odum [28], Shannon-Wiener diversity index is classified into three levels; low (\( H' < 2 \)), moderate (2<\( H' < 4 \)), and high (\( H' > 4 \)).

Margalef’s species richness index (\( d \)) was estimated according to the formula reported by Magurran [29] as follows:

\[ d = \log N (S-1) \]

Where, \( d \) = species richness, \( S \) = total number of species, \( N \) = total number of individuals of all species. According to Magurran [29], \( d \) values less than 3.5 indicate low species richness, values between 3.5–5.0 indicate moderate species richness, and values higher than 5 indicate high species richness.

The Pielou evenness index (\( E \)) was calculated according to Southwood [30]:

\[ E = \frac{H'}{\ln S} \]

Where, \( H' \) = diversity index, \( S \) = number species.

Presence or absence of species at each site was used to construct a site by site similarity matrix based on Shannon-Wiener [28, 30] as follow:

\[ IS = \frac{2n}{nA+nB} \times 100 \]

Where, IS: Similarity index (%); \( 2n \) = number of species found at both Stations A and B, \( nA \) = number of species found at Station A, \( nB \) = number of species found at Station B.

Levelling for category of abundance and local distribution was calculated as follows: Category ranges = total score/number of category; as shown showed in table 1 and table 2.
Table 1. Category of fish abundance

| Category       | Abundant range (%) |
|----------------|--------------------|
|                | Min    | Max    |
| Very abundant  | 49.57  | 65.75  |
| Abundant       | 33.38  | 49.56  |
| Rather abundant| 17.19  | 33.37  |
| Not abundant   | 1.00   | 17.18  |

Table 2. Category of local distribution.

| Category      | Distribution range (%) |
|---------------|------------------------|
|               | Min | Max |
| Spread        | 60  | 80  |
| Quite spread  | 40  | 60  |
| Not spread    | 20  | 40  |

3. Results and Discussion

3.1. Fish diversity

This study collected 982 fish specimens from 57 species and 13 families. Cyprinidae was the dominant family based on the number of species (34 species), followed by Bagridae with 4 species, and other families with 1-3 species (table 3). Cyprinidae was the most dominant because this family has the highest number of species and widely distributed in the world [3, 32, 33]. This family has 3,162 species across the continents except Australia [1]. The fish composition of the present study falls under various of species. Siawan is a small lake compared to Sentarum, the second lake has a surface area of 80,000 ha that increased to 132,000 ha with 146 species and total 212 species based on other survey [10]. The number of species recorded in Sentarum areas was 97 species [8]. This present study was conducted during the rainy season which increased the water level of Lake Siawan and caused flood the fish spread (figure 2). Fish composition and abundance of inland water commonly higher at dry than rainy season (34, 35).

Figure 2. Condition of Lake Siawan at rainy season

High water level caused the fish community to be widely spread that make catch process become more difficult compared to the dry season. Therefore, field survey during dry season should be conducted to get a complete fish composition data of Lake Siawan. This lake covers the upper part of the Kapuas basin, which is high in fish diversity [9], with 300 fish species recorded [24].

Based on interviews with local fishermen, it was informed that fish community of Lake Siawan reached 77 species. Whereas, the identification of the collected specimens recorded 57 species only.
Species that were not found in the present study and have economic value viz. *Balantiocheilos melanopterus*, *Labeo chrysophekadion*, *Macrochirichthys macrochirus*, *Chromobotia macracanthia*, and *Toxotes jaculatrix*. Moreover, the occurrence of exotic species, *Scleropages formosus* or super red arowana in Lake Siawan makes it an important habitat for freshwater fishes in West Kalimantan.

**Table 3. Fish composition of Lake Siawan, West Kalimantan**

| No. | Species                      | St.1 | St.2 | St.3 | St.4 | St.5 | Total number of individuals | Number of station species found | Spec. abund. | FOI (%) | IUCN Status |
|-----|------------------------------|------|------|------|------|------|----------------------------|--------------------------------|--------------|----------|-------------|
| 1   | *Ambyrhyynchichthys truncatus* | 2    | -    | -    | 1    | 3    | 2                          | 1.50                           | 40.0         | LC       |             |
| 2   | *Barbonymus schwanefeldii*    | 2    | 1    | -    | 2    | 7    | 12                         | 3.00                           | 80.0         | LC       |             |
| 3   | *Crossocheilus oblongus*      | -    | -    | 3    | -    | 3    | 1                          | 3.00                           | 20.0         | LC       |             |
| 4   | *Cyclocheilichthys apogon*    | 39   | 1    | 4    | -    | 1    | 45                         | 11.25                          | 80.0         | LC       |             |
| 5   | *Hampala bimaculata*          | 3    | 1    | -    | -    | 2    | 6                          | 2.00                           | 60.0         | NE; E    |             |
| 6   | *Hampala macrolepidota*       | 1    | -    | -    | -    | -    | 1                          | 1.00                           | 20.0         | LC       |             |
| 7   | *Labiobarbus ocellatus*       | 1    | -    | -    | -    | -    | 1                          | 1.00                           | 20.0         | LC       |             |
| 8   | *Leptobarbus hoevenii*        | 2    | -    | -    | -    | -    | 2                          | 2.00                           | 20.0         | NE       |             |
| 9   | *Leptobarbus hoffii*          | 1    | -    | -    | -    | -    | 1                          | 1.00                           | 20.0         | DD; E    |             |
| 10  | *Luciosoma setigerum*         | 2    | -    | -    | -    | -    | 2                          | 2.00                           | 20.0         | DD       |             |
| 11  | *Luciosoma trinema*           | 2    | -    | -    | -    | -    | 2                          | 1.00                           | 20.0         | NE       |             |
| 12  | *Osteochilias vittatus*       | 3    | 1    | 3    | -    | -    | 7                          | 2.33                           | 60.0         | LC       |             |
| 13  | *Osteochilias kannepii*       | 1    | -    | -    | -    | -    | 1                          | 1.00                           | 20.0         | NE       |             |
| 14  | *Osteochilias microcephalus*  | 1    | 1    | -    | 2    | -    | 4                          | 3.33                           | 60.0         | LC       |             |
| 15  | *Osteochilias melanopleura*   | 2    | 1    | -    | -    | 3    | 6                          | 2.00                           | 60.0         | LC       |             |
| 16  | *Osteochilias schlegelii*     | 1    | -    | 1    | -    | -    | 2                          | 1.00                           | 40.0         | DD       |             |
| 17  | *Osteochilias bleekeri*       | -    | 1    | 1    | -    | -    | 2                          | 1.00                           | 40.0         | NE       |             |
| 18  | *Osteochilias waandersii*     | -    | -    | -    | 1    | -    | 1                          | 1.00                           | 20.0         | LC       |             |
| 19  | *Oxygaster anomolura*         | 21   | 73   | -    | 25   | -    | 119                        | 39.67                          | 60.0         | LC       |             |
| 20  | *Parachela hypophthalmus*     | 23   | -    | -    | -    | 1    | 24                         | 12.00                          | 40.0         | LC       |             |
| 21  | *Parachela oxygastroide*      | 6    | 51   | -    | 25   | -    | 82                         | 27.33                          | 60.0         | LC       |             |
| 22  | *Puntigrus anisopterus*       | -    | -    | 2    | -    | -    | 2                          | 2.00                           | 20.0         | NE; E    |             |
| 23  | *Puntioplites bulu*           | 3    | -    | -    | -    | 3    | 3                          | 3.00                           | 20.0         | DD       |             |
| 24  | *Desmopontius gemelius*       | 4    | 4    | -    | 5    | -    | 13                         | 4.33                           | 60.0         | NE       |             |
| 25  | *Striunius lineatus*          | -    | 5    | -    | -    | -    | 5                          | 5.00                           | 20.0         | NE       |             |
| 26  | *Puntigrus tetrazona*         | -    | 5    | 1    | 3    | -    | 9                          | 3.00                           | 60.0         | NE       |             |
| 27  | *Desmopontius trifasciatus*   | -    | 2    | -    | -    | -    | 2                          | 2.00                           | 20.0         | NE       |             |
| 28  | *Puntioplites waandersi*      | 8    | -    | -    | -    | -    | 8                          | 8.00                           | 20.0         | LC       |             |
| 29  | *Rasbora borneensis*          | -    | -    | 2    | -    | 1    | 3                          | 1.50                           | 40.0         | NE       |             |
| 30  | *Rasbora cephalotaenia*       | -    | -    | -    | 2    | -    | 2                          | 2.00                           | 20.0         | LC       |             |
| 31  | *Brevibora dorsiocellata*     | 87   | 43   | 54   | 79   | -    | 263                        | 42.75                          | 80.0         | EN       |             |
| 32  | *Rasbora dusonensis*          | 16   | 29   | -    | 2    | -    | 47                         | 15.67                          | 60.0         | NE       |             |
| 33  | *Rasbora tornierii*           | -    | -    | 52   | -    | 52  | 1                          | 52.00                          | 20.0         | LC       |             |
| 34  | *Rasbora trilineata*          | 28   | 61   | 25   | -    | 57  | 171                        | 42.75                          | 80.0         | LC       |             |
| 35  | *Syncrossus hymenophysa*      | -    | 4    | -    | -    | 2    | 6                          | 3.00                           | 40.0         | LC       |             |
St.1 recorded highest diversity followed by St.2 with $H'$ of 2.72 and 2.01, respectively (table 4). The diversity of those stations was categorized as moderate, whereas St.3, St.4, and St.5 with $H'$ ranged between 1.32 to 1.70 were categorized as a low diversity [28]. The number of species at St.1 and St.2 were 41 and 19, respectively. Habitat condition at St.1 near the inlet of the lake in the vicinity of Pontu Village, therefore it supported many fish species both permanently and temporarily because it is connected with Kapuas river.

Among the species found, the bonylip barb (*Osteochilus* spp.) was the most diverse with 7 species and rasboras (*Rasbora* spp.) with 6 species (table 3). These genera have many species and widely distributed in Sundaland [3, 18, 22]; *Rasbora* was reported to have 60 species in the world and 18 species in Indonesia [3].

| No. | Family: Bagridae | Species | St.1 | St.2 | St.3 | St.4 | St.5 | Total number of individuals | Number of station species found | Spec. abund. | FOI (%) | IUCN Status |
|-----|------------------|---------|------|------|------|------|------|-----------------------------|---------------------------------|----------------|---------|--------------|
| 36  | Mystus nigriceps  | 2       | -    | -    | -    | -    | 2    | 1                           | 2.00                            | 20.0             | NE      |              |
| 37  | Mystus bimaculatus| 16      | -    | -    | -    | -    | 16   | 1                           | 16.00                          | 20.0             | NE      |              |
| 38  | Pseudomystus stenomus | 1      | -    | -    | -    | -    | 1    | 1                           | 1.00                            | 20.0             | LC      |              |
| 39  | Leiocassis micropogon | 1     | -    | -    | -    | -    | 1    | 1                           | 1.00                            | 20.0             | NE      |              |
| 40  | Kryptoperus macrocephalus | 6    | -    | -    | 3    | -    | 9    | 2                           | 4.50                            | 40.0             | LC      |              |
| 41  | Ompok eugeneiatus  | 3      | -    | -    | -    | -    | 3    | 1                           | 3.00                            | 20.0             | NE      |              |
| 42  | Ompok hypophthalmus | 2      | -    | -    | -    | -    | 2    | 1                           | 2.00                            | 20.0             | NE      |              |
| 43  | Pseudeutropius brachypopterus | 1    | -    | -    | -    | -    | 1    | 2                           | 1.00                            | 40.0             | NE      |              |
| 44  | Claris nieuhofti | 3      | -    | -    | -    | -    | 3    | 1                           | 3.00                            | 20.0             | LC      |              |
| 45  | Claris tejsmanni | 4      | -    | -    | -    | -    | 4    | 1                           | 4.00                            | 20.0             | NE      |              |
| 46  | Xenentodon canciloides | -    | -    | 1    | -    | -    | 1    | 1                           | 1.00                            | 20.0             | LC      |              |
| 47  | Ambassis kopsii | -      | -    | -    | -    | 1    | 1    | 1                           | 1.00                            | 20.0             | NE      |              |
| 48  | Parambassis macrocephalus | 2 | -    | 2    | -    | -    | 4    | 2                           | 2.00                            | 40.0             | NE      |              |
| 49  | Pristolepis fasciata | -    | -    | -    | 1    | -    | 1    | 1                           | 1.00                            | 20.0             | LC      |              |
| 50  | Pristolepis groiti | 2      | 1    | -    | -    | -    | 3    | 2                           | 1.50                            | 40.0             | NE      |              |
| 51  | Osphronemus goramy | 1      | -    | -    | -    | 2    | 3    | 2                           | 1.50                            | 40.0             | LC      |              |
| 52  | Trichopodus leerii | 2      | -    | -    | -    | -    | 2    | 1                           | 2.00                            | 20.0             | NT      |              |
| 53  | Trichopodus pectoralis | 1    | -    | -    | -    | -    | 1    | 1                           | 1.00                            | 20.0             | LC; I   |              |
| 54  | Channa strisa | 2      | -    | -    | -    | -    | 2    | 1                           | 2.00                            | 20.0             | LC      |              |
| 55  | Channa micropeltes | 2      | -    | -    | 1    | -    | 3    | 2                           | 1.50                            | 40.0             | LC      |              |
| 56  | Channa lucius | 3      | -    | -    | -    | -    | 3    | 1                           | 3.00                            | 20.0             | LC      |              |
| 57  | Macropogon aculeatus | -    | -    | 3    | -    | -    | 3    | 1                           | 3.00                            | 20.0             | NE      |              |

**Note:** Spec. abund: species abundant, Loc.dist. = Local distribution, E = endemic, N.R = New record, I = Introduced species, EN = Endangered, NT = Near threatened, LC = Least concern, NE = Not evaluated, DD = Data deficient
Table 4. Fish community structural indices of Lake Siawan, West Kalimantan

| Station | St.1 | St.2 | St.3 | St.4 | St.5 | Total |
|---------|------|------|------|------|------|-------|
| Number of species | 41 | 19 | 12 | 13 | 14 | 57 |
| Number of individuals | 309 | 289 | 99 | 203 | 82 | 982 |
| Diversity index (H’) | 2.72 | 2.01 | 1.44 | 1.70 | 1.32 | 2.62 |
| Richness index | 6.98 | 3.18 | 2.39 | 2.26 | 2.95 | 8.13 |
| Evenness index | 0.73 | 0.68 | 0.58 | 0.66 | 0.50 | 0.65 |
| Simpson's Index of Diversity (1-D) | 0.88 | 0.83 | 0.64 | 0.75 | 0.51 | 0.87 |

The similarity index among stations was low between 3.85-28.00%. The highest similarity value (28.00%) was between St.2 and St.4, followed by similarity between St.1 and St.2 (27.66%) (table 5). Habitat condition at St.2 and St.4 was similar therefore highest fish similarity was recorded, whereas the lowest was between St.4 and St.5 (3.85%).

Table 5. Similarity index (%) among stations of Lake Siawan, West Kalimantan

| Station | St.2 | St.3 | St.4 | St.5 |
|---------|------|------|------|------|
| St.1    | 27.66 | 12.77 | 17.39 | 22.22 |
| St.2    | -    | 24.00 | 28.00 | 26.92 |
| St.3    | -    | -    | 8.70  | 13.04 |
| St.4    | -    | -    | -    | 3.85  |

3.2. Abundance and local distribution (FOI)

Fish abundance of Lake Siawan ranged between 1.00 to 65.75 individuals per station. *Brevibora dorsiocellata* and *Rasbora tornieri* were very abundant, followed by *Rasbora trilineata* and *Oxygaster anomalura* (categorized as abundant), while *Parachela oxygastroides* was rather abundant (table 6). There were 52 fish species of Lake Siawan in abundance, ranged between 1 to 17.18 individuals per stations were categorized as ‘not abundant’. These levels showed that both *Brevibora dorsiocellata* and *Rasbora tornieri* are adapted to live in the habitat condition of Lake Siawan. Both fish species show schooling behavior and take shelter among vegetation.

Table 6. Abundance categories of fish in Lake Siawan, West Kalimantan

| Category       | Abundant ranges | Number of Species | Species                                    |
|----------------|-----------------|------------------|--------------------------------------------|
|                | Min             | Max              |                                            |
| Very abundant  | 49.57           | 65.75            | 2 *Brevibora dorsiocellata and Rasbora tornieri* |
| Abundant       | 33.38           | 49.56            | 2 *Rasbora trilineata and Oxygaster anomalura* |
| Rather abundant| 17.19           | 33.37            | 1 *Parachela oxygastroides*                |
| Not abundant   | 1.00            | 17.18            | 52                                          |
| Total species  |                 |                  | 57                                          |

Based on the distribution level, almost all species were not spread, 4 species were spread, while 9 species were quite spread (table 7). Species that had spread distribution were *Barbonymus schwanenfeldii*, *Cyclocheilichthys apogon*, *Brevibora dorsiocellata*, and *Rasbora trilineata*. While, quite spread species were *Hampala bimaculata*, *Osteochilus vittatus*, *Osteochilus microcephalus*, *Osteochilus melanopleura*, *Oxygaster anomalura*, *Parachela oxygastroides*, *Desmountius gemellus*, *Puntigrus tetrazona*, and *Rasbora dusonensis*. 
3.3. Species status
Information on species status (endemics, rare population, utilization, and the threat of trade) is needed to manage fish resources in Lake Siawan for sustainable use. Based on geographic distribution, almost all species were categorized as common species because of their wide distribution, for example Osphronemus goramy, Helostoma temmincki, Osteochilus vittatus, and Channa striata. Species with limited distribution or endemic to Kalimantan were Hampala bimaculata, Leptobarbus hosii, and Puntigrus anchisporus (figure 3) [3]. Leptobarbus hosii was also categorized as new record for West Kalimantan because it was reported to be limited in North Borneo previously [3, 17, 31].

![Leptobarbus hosii](image1)
![Hampala bimaculata](image2)
![Puntigrus anchisporus](image3)

**Figure 3.** Endemic species of Lake Siawan, West Kalimantan

Referring to Indonesian protected regulation [36], the protection species in the present study is not found. However, local fishermen reported that Lake Siawan is a habitat for knife fish (Chitala borneensis) and Asian bonytongue (Scleropages formosus). S. formosus is prohibited to be caught from natural habitat as mentioned in Appendix I CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora). During 1970s, Asian bonytongue was abundant and consumed by local people and made as salted fish. Its condition changed fast after determined as protected fish. This was happened not only in Lake Siawan but also in other habitats of Asian bonytongue in West Kalimantan especially in upper part of Kapuas basin. The decline of Asian bonytongue population was mainly impacted by overfishing because it has high price after protected. Similarly, population of Balantiocheilos melanopтерus and Chromobotia macracantha are also declining. Population declined these species impacted to both overfishing for ornamental fish. These species are important and famous for ornamental fish. Almost all fish species of Lake Siawan are indigenous species except Trichopodus pectoralis that is originated from Thailand. Therefore, its species is categorised as introduced species.

Conservation status based on IUCN (International Union for Conservation of Nature and Natural Resources) categorised almost all species were under ‘not priority to conserve’; they were under the status of ‘least concern (LC)’, ‘not evaluated (NE)’, and ‘data deficient (DD)’ (table 3). Species which should be given a priority to be preserved was Trichopodus leerii with the status of ‘near threatened (NT)’.

3.4. Habitat
The results showed that Lake Siawan was homogenous with high water level and have closed and open habitat of vegetation (figure 4). Water quality parameters of Lake Siawan measured were temperature with the range of 28-30°C, pH 4.2-6.4 and dissolved oxygen 3.6-6.2 ppm. The color of water was brownish and the weather was cloudy to bright (table 8). Lake Siawan was acidic because

| Category       | Spread | Quite spread | Not spread |
|---------------|--------|--------------|------------|
| Distribution (%) Min | 60     | 40           | 20         |
| Species number | 4      | 9            | 44         |

**Table 7.** Distribution level (%) of fish community in Lake Siawan, West Kalimantan
pH recorded was lower than 6.4. Optimum dissolved oxygen was also recorded. Pescod [37] stated that optimum condition for aquatic biota are dissolved oxygen of higher than 3 ppm, pH ranges 6.8 to 8.8, and temperature of 25°C to 30°C. Based on these parameters, Lake Siawan is categorized as natural peatland forest.

**Table 8.** Water quality at sampling stations of Lake Siawan, West Kalimantan.

| Parameter     | St.1 | St.2 | St.3 | St.4 | St.5 |
|---------------|------|------|------|------|------|
| pH            | 5.7 – 6 | 5.2 – 5.8 | 5 – 6.4 | 4.2 – 4.4 | 4.8 – 4.9 |
| Temperature (°C) | 29 | 28 | 29 | 29 | 30 |
| DO (ppm)      | 3.9 – 4.1 | 3.6 – 4.1 | 4.9 – 5.0 | 4.1 – 4.3 | 6.1 – 6.2 |
| Water color   | brownish | brownish | brownish | brownish | brownish |
| Weather       | bright | bright | cloudy | cloudy | cloudy |

**Figure 4.** Riparian vegetation of Lake Siawan

**4. Conclusion**
The fish community of Lake Siawan is diverse, the most abundant species are *Brevibora dorsiocellata* and *Rasbora tornieri*. Distribution among species are mostly not spread. Three endemics species of Kalimantan were recorded: *Hampala bimaculata*, *Leptobarbus hosii*, and *Puntigrus anchisporus*. Habitat condition of Lake Siawan is suitable for living of fish based on water quality and fish community.

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