Species Diversity, Richness and Evenness of Fishes from Are-laung-wei-tode Lake in Sagaing Township, Sagaing Region, Myanmar

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Abstract
Species diversity, richness and evenness of fishes from Are-laung-wei-tode Lake were recorded during January to December 2015. A total numbers of 45 species and 70890 individuals were recorded. The highest diversity (0.1121) in September and the lowest (0.2312) in April were recorded. Regarding the highest evenness value (0.6495) was found in December. The lowest evenness value (0.4396) was found in July. Relative results of the diversity indices evaluated during the study periods, indicated that (d), (D), (H'), (N1) and (N2) were high, either in the month of September, which fall in the mid rainy season, during which fresh stock of fish were replenished by the inflow of water from the main river. On the seasonal basis, the lowest diversity values were recorded in hot season and the highest values were recorded in rainy season. This research was indicated the ecosystem of Study Lake is healthy and habitat is stable.

1. Introduction
Fishes form one of the most important groups of vertebrates, influencing its life in various ways. Millions of human being suffer from hunger and malnutrition and fishes from a rich source of food and provide a meal to tide over the nutritional difficulties of man. Fish diet provides proteins, fat and vitamins A and D. A large amount of phosphorous and other elements are also present in it. They have a good taste and are easily digestible [1].

Freshwater ecosystem and their resources are an indispensable part of human life and activity, and health of those freshwater ecosystems is visible in the wellbeing of the fish assemblage they support. In lotic environment, the diversity, community structure and species assemblages are influenced by various biotic and abiotic variables [2].

Biodiversity is essential for stabilization of ecosystem, protection of overall environmental quality for understanding intrinsic worth of all species on the earth. Declining river flow rate (discharge) have been a major cause of species loss and are likely to be further reduced by warming temperatures, reduced precipitation and increased water withdrawal for agriculture and other human uses. Future declines can therefore negatively affect freshwater biodiversity. Inland waters and freshwater biodiversity constitute a valuable natural resource, in economic, cultural, aesthetic, scientific and educational terms. Their conservation and management are critical to the interests of all human nations and governments [3].

Species diversity is important in the conservation of endangered species. To save a species from extinction, high species diversity should be maintained. No species can exist alone and they need another for their persistence; a high diversity at one tropic level is increasing the diversity of another [4].

Proportional diversity (H') is sensitive not strongly affected by rare species, and it has a border region of sensitivity than the Simpson's dominance index [5]. The Simpson's dominance index, O represents infinite diversity and 1, no diversity. Evenness is a measure of the relative abundance of the different species making up the richness of an area [6].

Ayeyawady River flows from north to south through Myanmar and represented the largest river and most important commercial waterway. The floodplain of the Ayeyawady River is highly and plays an important role in the ecology of the rivers system. The floodplain fauna includes a diverse and productive fish community which provided an important food source for villages along the river. The study area is the segment of Ayeyawady, situated in Sagaing Township, Sagaing Region. Are-laung-wei-tode Lake is connected with the Ayeyawady River during rainy season however becomes a continuous stretch of water body during the peak rainy season. Thus, Are-laung-wei-tode Lake was chosen as the study area as one the floodplain of Ayeyawady segment to investigate species richness of fish and to determine the diversity of fish from Are-laung-wei-tode Lake.

2. Materials and methods
2.1 Study area and study period
Are-laung-wei-tode Llake is situated in Sagaing Township, Sagaing Region. It is located between 21°56' 03.00"N and 96° 42.81"E. The specimen collection was conducted from January to December 2015.

2.2 Specimen collection and preservation
Specimens were collected monthly by the used of beach seine net (Wum Pu Gyi). Data of fish was noted and colored photographed taken soon after catch. The external characters and measurements were noted in fresh state. The fish were preserved in different formalin according to size

of the specimens for the future identification.

2.3 Identification and Classification
Fishes were identified with the help of keys in Talwar and Jhingran [7], Ferraris [8] and Jayaram [9]. The classification of fish was followed after Jayaram [9].

2.4 Data Analysis
The collected data during January to December 2015 was represent the monthly data of a year, for analysis of the species richness, diversity and evenness of fish species. The collected data were analyzed for the diversity index based on four methods: Maragalef [10], Simpson [11], Shannon-Wiener [12] and Hill [13] as given in Ludwig and Reynolds [14].

(i) For Margalef's species Richness Index (1958),

$$d = \frac{S-1}{Ln\ (N)}$$

(ii) For Simpson's index (1949),

$$D = \sum_{i=1}^{s} \frac{n_i\ (n_i - 1)}{n(n - 1)}$$

(iii) For Shannon-Wiener's index (1949),

$$H' = -\sum_{i=1}^{s} \left[\frac{n_i}{n}\right] Ln \left[\frac{n_i}{n}\right]$$

(iv) For Hill's diversity numbers (1973),
Number 0: $N_0 = S$
Number 1: $N_1 = e^{H'}$
Number 2: $N_2 = 1/D$

The measure of fish species evenness or equitability or relative species abundances was determined by using the evenness index of modified Hill's ratio (1973).

$$E = \frac{\left[\frac{1}{D}\right]-1}{e^{H'-1}} = \frac{N_2-1}{N_1-1}$$

3. Results
A total of 70,890 individuals accounted from 45 species confined to 34 genera, 18 families and eight orders were recorded from Are-laung-wei-tode Lake during the study period of January to December 2015. The highest number of 45 species and the highest number of individuals (10499) were recorded in December. The lowest number of 22 species and the lowest number of individuals (1190) were recorded in May (Table 1).

In Margalef's species richness index (d), the highest value (4.7560) was recorded in September and the lowest value (2.7426) was recorded in April. (Table 1, Figure 1). The highest value Simpson's index diversity D (0.1121) and the lowest value (0.2312) were recorded in September and April respectively (Table 1 and Figure 2). In Shannon-Wiener's index value H′ (2.6994) was highest in September and the lowest value (1.9250) was recorded in April (Table 1 and

Figure 3). In Hill's diversity number, the highest value N_1 of (14.8712) was recorded in September and the lowest value of (6.8550) in April (Table 1 and Figure 4). The value of Hill number value N_2 (8.9185) highest in September, the lowest value (4.3250) was recorded in April (Table 1 and Figure 5). Regarding the highest evenness value (0.6495) was found in December. The lowest evenness value (0.4396) was found in July (Table 1 and Figure 6).

On the seasonal basis, during the study period, the highest species richness d (4.3903). Simpson's index diversity D (0.1477), Shannon-Wiener's diversity H′ (2.4908), Hill diversity indices N_1 (12.0714) and N_2 (6.7696) were recorded in rainy season. However, the evenness value (0.5906) was noted in cold season. The lowest species richness d (4.2327), Simpson's index diversity D (0.1489), Shannon-Wiener's diversity H′ (2.3744), Hill diversity indices N_1 (10.7443) and N_2 (6.7180) were noted in hot season except the evenness value. The E values (0.5221) was noted in rainy season (Table 2).

4 Discussion
Species diversity, richness and evenness of fish were recorded from Are-Laung-Wei-Tode Lake during January to December 2015. A total of 70,890 individuals accounted from 45 fish species were recorded. The highest number of fish species (45) and highest number of individuals (10499) were found in December. It is due to the most of the fish aggregated in lake at these months and the peak fishing activities were observed during these months. The lowest fish species (22) and the lowest individuals (1190) were found in May. This is because the water level reduced during these months and some of the fishes might house gained entrance into the river with the needing water causing decline in catchability.

Subramanyam and Sambamurthy [15] stated that species richness is the number of species in a community. Each species is not likely, however, to have the same number of individuals. In the study period, the highest value of Margalef's index (d) was recorded in September and lowest in April. The month of September happened to be mid rainy season and as mentioned above new stock of fish were replenished with the water from the main river during this rainy season, species richness no doubt will become high (vice versa).

In the present study, diversity has been measured using two indices, viz, Simpson's (D) and Shannon-Wiener's (H′) indices. Simpson's index (D) mentioned that a great number of species increase diversity and more even or equitability distribution among even or equitability distribution among species will also increase diversity [4].

In Shannon-Wiener, function of (H′) called Heterogeneity test, it was suggested that it combines the concept of number of species and relative abundance into a single concept of species heterogeneity which is higher in a community when the species are equally abundant [14].

In the study period, the values of Simpson index of diversity (D) and Shannon's index (H′) were highest in September and lowest in April.

As the species diversity index and species richness index depend upon the number of species as well as the number of individuals in each species and contributes equally to the values of species diversity index and species richness

index [14], hence if any one of these two variables decreases or increase, it will affect the overall values of species diversity index and species richness index.

In the study period, the value of (d), (D) and (H′) were highest in September. Although number of species in September was not the highest number. This may be due to these three indexes calculated on the basis of the number of species and the total number of individual recorded for the species. The lowest values of (d), (D) and (H′) were found in April; this may be assumed as less water bodies and some fish species may have local movement.

According to Hill's diversity number, during the study period, the highest value of abundance species (N_1) and very abundance species (N_2) were recorded in September and the lowest values in April. The disparity in the values of (N_1) and (N_2) between two study period rest on a number of factors including the success in hatchability and the variety of fish species that had gain access into the Are-laung-wei-tode Lake. The highest evenness value (E) was recorded in December and the lowest value in July. It also indicated that the ecological condition of Are-laung-wei-tode Lake is stable, to maintain the abundance of the fish species.

Seasonally abundance of fish population and species were recorded in the cold season while the lowest number of fish populations and species were recorded in the hot season. Sandar Maung [16] recorded the maximum number of species and the highest number of fish in cold season. She mentioned that the migratory fishes which entered into the floodplain from Ayeyawady River and thus, probably creating surviving favourable conditions for the fish in the Ayeyawady River. Since Are-laung-wei-tode Lake is associated with the Ayeyawady River migratory fishes might enter into Are-laung-wei-tode Lake and form favourable habitat for fishes during the cold season. The highest values of (d), (D), (H′), (N_1) and (N_2) were observed in rainy season. This may be due to the fact that most of the fishes breed in early rainy season and the highest diversity value may thus be related to the breeding time. The behavior of fishes in relation to water level of differed seasons influenced the dispersal of fishes. The highest evenness value (E) was observed in cold season.

Nwe Nwe Thein [17] recorded that the highest value of (d), (D), (H′), (N_1), (N_2) and (E) in July (rainy season) and lowest in April (hot season). This may be the fact, that the water level of study area was sharply declined in the hot season. The number of fish species in the lake is related to surface area and climatic variations. So, that seasonal flooding seemed to be an important factor that influenced the assemblage and composition of fish.

In the present study, the species richness and diversity indices evaluated showed same pattern of fluctuation with highest in the rainy season and lowest in the hot season, and alluded to the impact of environmental factors on such fluctuation. In the study area, the presence of different species throughout the year and the rich in fish species and individuals indicated that the ecosystem of Are-laung-wei-tode Lake is healthy and the habitat, stable.
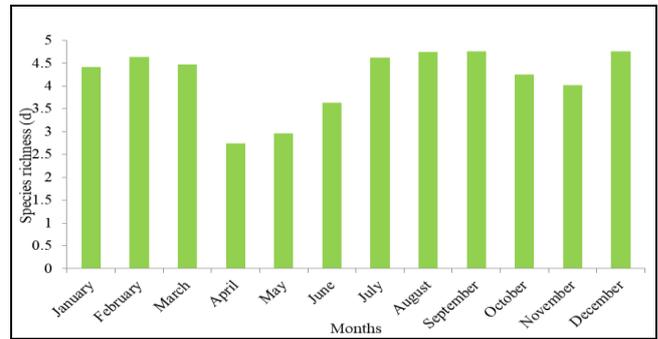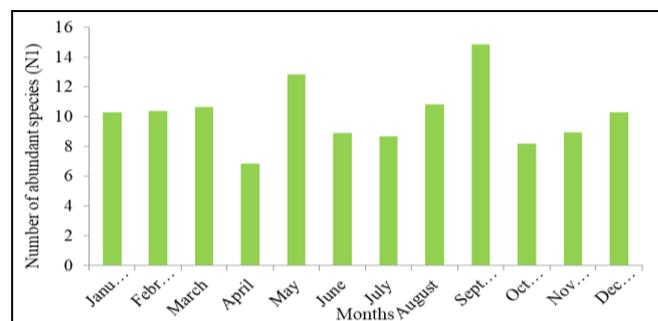

Fig 1: Monthly comparison on Margalef's species richness (d) of fish in Are-laung- wei-tode Lake during January to December 2015
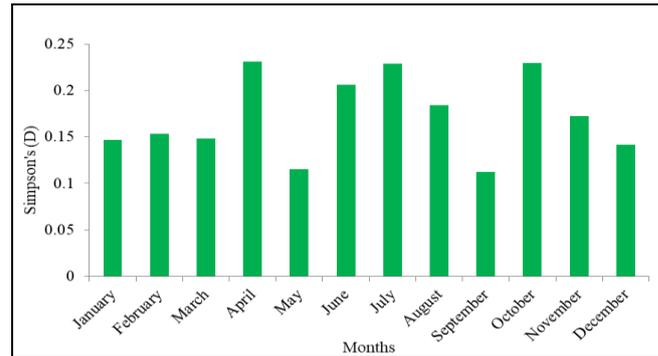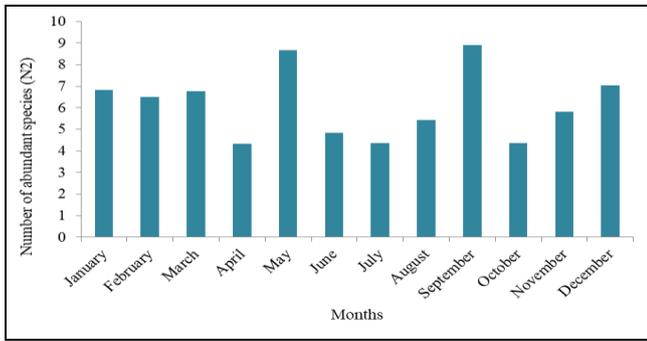

Fig 2: Monthly comparison on Simpson Diversity index (D) of fish in Are-laung- wei-tode Lake during January to December 2015
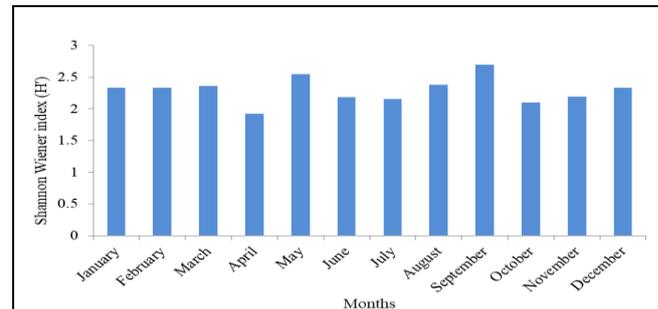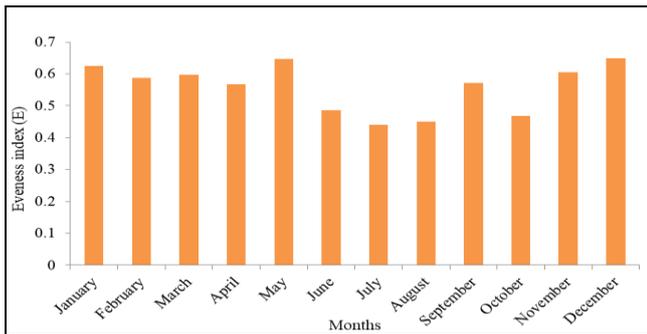

Fig 3: Monthly comparison on Shannon-Wiener index (H′) of fish in Are-laung- wei-tode Lake during January to December 2015

Fig 4: Monthly comparison on number of abundant species (N_1) of fish in Are-laung- wei-tode Lake during January to December 2015

Fig 5: Monthly comparison on number of very abundant species (N₂) of fish in Are-laung-wei-tode Lake during January to December 2015

Fig 6: Monthly comparison on Evenness index (E) of fish in Are-laung-wei-tode Lake during January to December 2015

5. Conclusion

The highest number of fish species and individuals recorded in the cold season. The species richness and diversity followed show the same pattern of fluctuation with highest in the rainy season and lowest in the hot season. The highest evenness value was observed in cold season. Therefore, the presence of different species throughout the year and the rich in fish species and individual indicated that the ecosystem of Are-laung-wei-tode Lake is healthy and habitat is stable.

6. Acknowledgements

7. References

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