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FISH COMMUNITY IN PENGKALAN GAWI – PULAU DULA SECTION OF KENYIR LAKE, TERENGGANU, MALAYSIA.

KAMARUDDIN, I.S.[1], A.S. MUSTAFA KAMAL[1*], A. CHRISTIANUS[1], S.K. DAUD[2] AND L. YU ABIT[1]

[1]Department of Aquaculture, Faculty of Agriculture and [2]Department of Biology, Faculty of Science, Universiti Putra Malaysia, 43400, UPM Serdang, Selangor, Malaysia.

**Corresponding author: akuakultur_upm@hotmail.com*

Abstract: A study of species diversity of fish population was carried out at Pengkalan Gawi- Pulau Dula section of Kenyir Lake, Terengganu. Fish sampling at three (3) stations was conducted monthly from February 2008 to January 2009 using gill nets. A total of 274 fishes from 13 species were collected in this study. The most abundant fish species collected were *Barbodes schwanenfeldii* (Lampam Sungai) (35.77 %), followed by *Notopterus* sp. (Belida) (27.37 %) and *Hampala macrolepidota* (Sebarau) (16.06 %). The other species identified in this study were *Hemibagrus nemurus* (Baung) (8.03%), *Channa micropeltes* (Toman) (4.4%), *Pristolepis faciatus* (Patong) (3.65%), *Cyclocheilichthys apogon* (Temperas) (1.46%), *Osteochilus hasselti* (Terbol) (1.09%), *Osteochilus vitatus* (Rong) (0.73%), *Chela anomalura* (Lalang) (0.36%), *Labiobarbus lineatus* (Kawan) (0.36%), *Channa striatus* (Haruan) (0.36%) and *Probarbus jullieni* (Temoleh) (0.36%). The Shannon-Weaver index showing the fish diversity index was 1.71, Pielou's Evenness index was 0.66 and Margalef's Species Richness index was 4.92 respectively. Most of the species found in this study were similarly reported in other studies in Kenyir Lake. It is hoped that the results of this study will be useful in contributing towards the management of the lake in a sustainable manner for future generations.

KEYWORDS: Abundance, Species diversity, Fish population, Reservoir management, Kenyir Lake

Introduction

The need for hydroelectric power, irrigation, flood mitigation, drinking water and recreational opportunity has led to the construction of many reservoirs. Dams and reservoirs in Malaysia, which are constantly increasing in numbers, play an important role not only in electric and water supply but also in providing a source of fish to the local community, for research, sustainable aquaculture and maintenance of fish diversity (Yusoff and Ambak, 1999). Hence, reservoirs constitute important resources for all types of fisheries activities including fish culture, recreational and commercial fisheries (Oglesby, 1985).

Malaysia has great potential to develop its inland recreational and commercial fisheries due to the high abuncance and diversity of fish species in the country's resources. The latest research done by Chong *et al.* (2010), listed a total of 521 species of freshwater fish inhabiting Malaysian freshwater ecosystems. However, the freshwater fish caught in Malaysia have declined over the past few years. Over-exploitation and habitat degradation, as an example, have depleted the stocks and reduced the replacement rate in the population (Khan *et al*., 1996). This has led to the development of some management programmes to conserve and to increase needs for the freshwater fish population. In the current climate of global changes with forecasted shortfalls in freshwater supply in this new era, it is becoming increasingly important to safeguard and maintain, through good management and conservation, all large freshwater bodies such as lakes and reservoirs to ensure constant freshwater supply, especially in the Asia-Pacific region which has the lowest amount of available freshwater (ILEC, 2007).

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It is important to know the fish species diversity, abundance and distribution in the reservoirs in order to develop management and conservation programmes. Studies of spatial and temporal patterns of diversity, distribution and species composition of freshwater fishes are useful to examine factors influencing the structure of the fish community (Galactos *et al*., 2004). The distribution and composition of the fish species in each habitat were closely associated with various factors such as the availability of food, breeding sites, water current, depth, topography and physicochemical properties of water (Harris, 1995). Fish species are also an important indicator of ecological health. The abundance and health of fish will show the health of water bodies (Hamzah, 2007). This is supported by Zainudin (2005) who claimed that fish species diversity can be used as a biological indicator to show the level of aquatic pollution contributing to environmental quality.

Kenyir Lake is one of the reservoirs in Malaysia that need serious attention in its management and conservation of its fishery resources. Kenyir Lake is the biggest man-made lake in Malaysia with a surface area of about 36,900 hectares (Figure 1). It lies at latitude 4° 41' north and longitude 102° 40' east. This man-made lake was initially inundated in 1986 to generate hydroelectric power, receiving water inputs from two main rivers – the Terengganu River and the Terengan River (Furtado *et al*., 1977). The lake has an average depth of 37 meters with a maximum depth of 145 meters. There are 340 islands in the lake, more than 14 waterfalls and numerous rapids and rivers. Its beautiful landscape and the surrounding natural environment provide a pleasant recreational retreat for urban residents.

Jackson & Marmulla (2001) reported an annual catch of 720 metric tonnes in Kenyir Lake. This figure was calculated based on Yusoff *et al*. (1995) findings which has reported a yield of 20 kg/ha/year. However, due to the excessive fishery exploitations, the lake is overfished. The latest estimated fish production by the Department of Fisheries Malaysia in 2007 was only 105.13 tonnes. Currently commercial fishing activities have been banned by the Department of Fisheries Malaysia in order to protect the fish stocks in the lake.

Detailed studies on Kenyir Lake are still lacking. It is partly for this reason that we were inspired to conduct the current study on Pengkalan Gawi – Pulau Dula section in Kenyir Lake so as to determine the current conditions of the lake. This study sought to ascertain the species diversity of fish populations that constitute the fish stock in this section of Kenyir Lake.

Materials and Methods

This study was conducted at the Pengkalan Gawi – Pulau Dula section of Kenyir Lake from Pengkalan Gawi (Gawi Jetty) in the north to Pulau Dula (Dula Island) in the south (Figure 1). The section is only a small part of the lake with an area at about 30 km². It is located at the main entrance for visitors to Kenyir Lake where a boat jetty is available. Fish were sampled monthly at three sampling stations set up in the study section of the lake. These stations are designated as Station A, Station B and Station C. Station A was located near Pulau Dula to the south of Pengkalan Gawi. This is the furthest station from Pangkalan Gawi. Station B was located near Sungai Ikan (Ikan River) to the southwest of Pengkalan Gawi. Meanwhile station C was the nearest station to Pengkalan Gawi and located near Pulau Pupi (Pupi Island) to the southeast of Pengkalan Gawi.

Fish samples were collected for one year from February, 2008 to January, 2009. Fish sampling was conducted using gill nets (mesh size measuring 2.0, 2.5, 3.0 and 4.0 inches) at all the three stations. The gill nets were set at dusk and hauled the next morning. All fish caught were identified to species using standard taxonomic keys following Mohsin & Ambak (1983) and Hua (2002). To determine the species composition, the numbers of fish species in the samples and the number of individuals in each species were enumerated.

Three community indices were utilised to determine fish community structure: species diversity, species evenness and species richness.

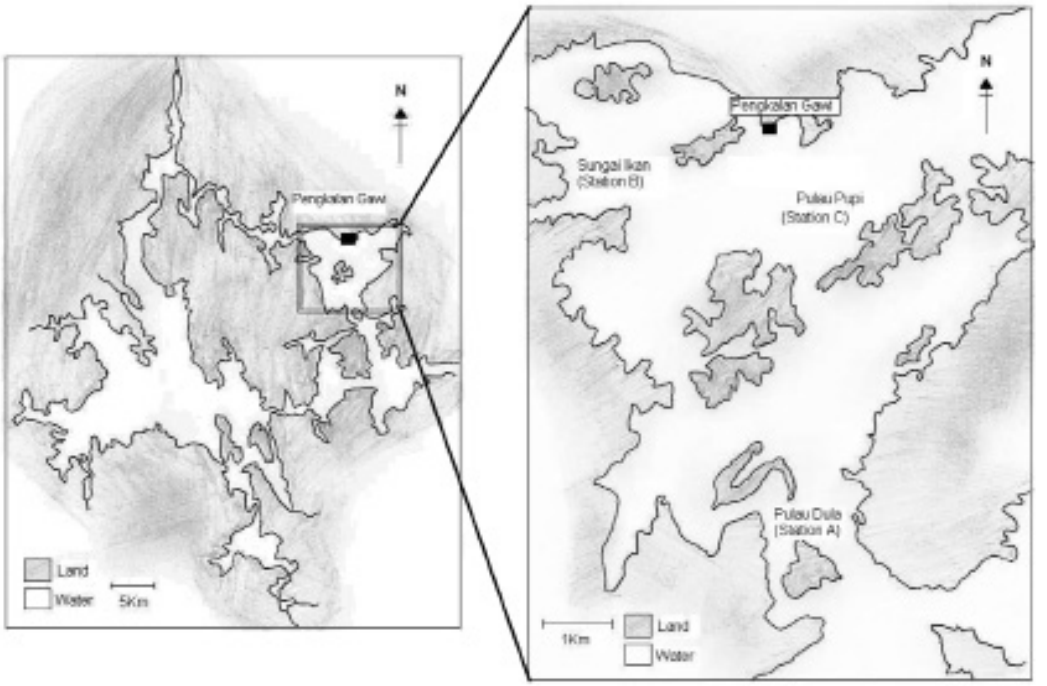

Figure 1. Kenyir Lake in Terengganu is the biggest man-made lake in Malaysia. The square box shows the location of Pengkalan Gawi- Pulau Dula section.

Fish species diversity was calculated using the Shannon-Weaver Index (1963) as follows:-

[1] $H' = - \sum Pi \ln Pi$

Where:-
H' = diversity index.
Pi = ni/N = number of individuals within species (ni) divided by the total number of individuals (N).
ln = normal log.

The species evenness was calculated using Pielou's Evenness Index (1969) as follows:-

[2] $E' = H' / H' max$

Where:- :-
H' = number derived from Shannon-Weaver index formula.
H' max = lnS = is the maximum value of H'.

While fish species richness was calculated using the Margalef's Index (1958):-

[3] $D = (S - 1) / (\log N)$

Where:-
S = number of species
N = total number of individuals

Results and Discussion

A total of 274 fish individuals comprising 13 species from 5 families were sampled from Pengkalan Gawi – Pulau Dula section of Kenyir Lake, Terengganu throughout the entire study period (Table 1). The most abundant species was *Barbodes schwanenfeldii* (Cyprinidae) comprising 35.8% of the total fish caught, followed by *Notopterus* sp. (Notopteridae) (27.4%) and *Hampala macrolepidota* (Cyprinidae) (16.1%). The dominance of cyprinids in tropical reservoirs has been observed in Sri Lankan reservoirs, where the family formed over 50% of the species present (Amarasinghe, 1992). *Channa micropeltes,* the most famous game fish, represented only 4.4% of the total fish landed. The remaining nine species each comprised approximately about 8.0% or less of the total sample (Table 1).

The results showed that only 13 species of fishes were found in the Pengkalan Gawi- Pulau

Table 1. Table showing the list of fish species caught and the percentage composition for fish population in Pengkalan Gawi – Pulau Dula section of Kenyir Lake, Terengganu. From February 2008 to January 2009.

Fish species	Family	No. of individual	Percentage of fish (%)
Barbodes schwanenfeldii	Cyprinidae	98	35.77
Notopterus sp.	Notopteridae	75	27.37
Hampala macrolepidota	Cyprinidae	44	16.06
Hemibagrus nemurus	Bagridae	22	8.03
Channa micropeltes	Ophicephalidae	12	4.38
Pristolepis fasciatus	Nandidae	10	3.65
Cyclocheilichthys apogon	Cyprinidae	4	1.46
Osteochilus hasselti	Cyprinidae	3	1.09
Osteochilus vittatus	Cyprinidae	2	0.73
Chela anomalura	Cyprinidae	1	0.36
Labiobarbus lineatus	Cyprinidae	1	0.36
Channa striatus	Ophicephalidae	1	0.36
Probarbus jullieni	Cyprinidae	1	0.36

Dula section of Kenyir Lake. This result differs when compared to previous studies, where Yap (1992) and Ambak & Jalal (1998) reported 36 species from 13 families caught in the Kenyir Reservoir. Furtado *et al*. (1977) and Yusoff *et al*. (1995) reported that there were 35 species of fish from 13 families sampled in Kenyir Lake that mainly consisted of riverine species. The differences reported in this study when compared to the previous studies may be due to the fact that the present study was conducted only in one section of the lake and not throughout the whole lake.

The most abundant fish species inhabiting the Pengkalan Gawi- Pulau Dula section of Kenyir Lake was *B. schwanenfeldii.* This is similar to the results from past studies. Thalathiah *et al*. (1993) and Ambak & Jalal (1998) reported that the most abundant fish species in Kenyir Lake was *B. schwanenfeldii.* The littoral zone is colonized successfully by broad generalists with flexible food and reproductive requirements such as *B. schwanenfeldii* while the open water (pelagic) environment of the reservoir is usually empty (Ambak & Jalal, 2006). In addition, *Notopterus* sp. and *H. macrolepidota* were also present in the monthly samples (Figure 2). This clearly shows that this section was also dominated by these two species. Yusoff *et al*. (1995) reported that *H. macrolepidota* was the most abundant species in their study in Kenyir Lake. From the data obtained, *B. schwanenfeldii* (77.8%), *Notopterus* sp. (43.8%) and *H. macrolepidota* (32.4%) were dominant at Pulau Dula (Station A), Sungai Ikan (Station B) and Pulau Pupi (Station C) respectively. Other species showed variation in their composition at all stations in this study (Figure 3).

Probarbus jullieni which was sampled in this study was not reported from previous studies [Furtado *et al*. (1977), Yusoff *et al*. (1995) and Ambak & Jalal (1998)]. This species was, however, mentioned in a later study by Ambak & Jalal (2006). *P. jullieni* was introduced by the Department of Fisheries Malaysia as a potential for sport fishing in Kenyir Lake. This was done under one of the regulation and conservation programmes towards maintaining and enhancing

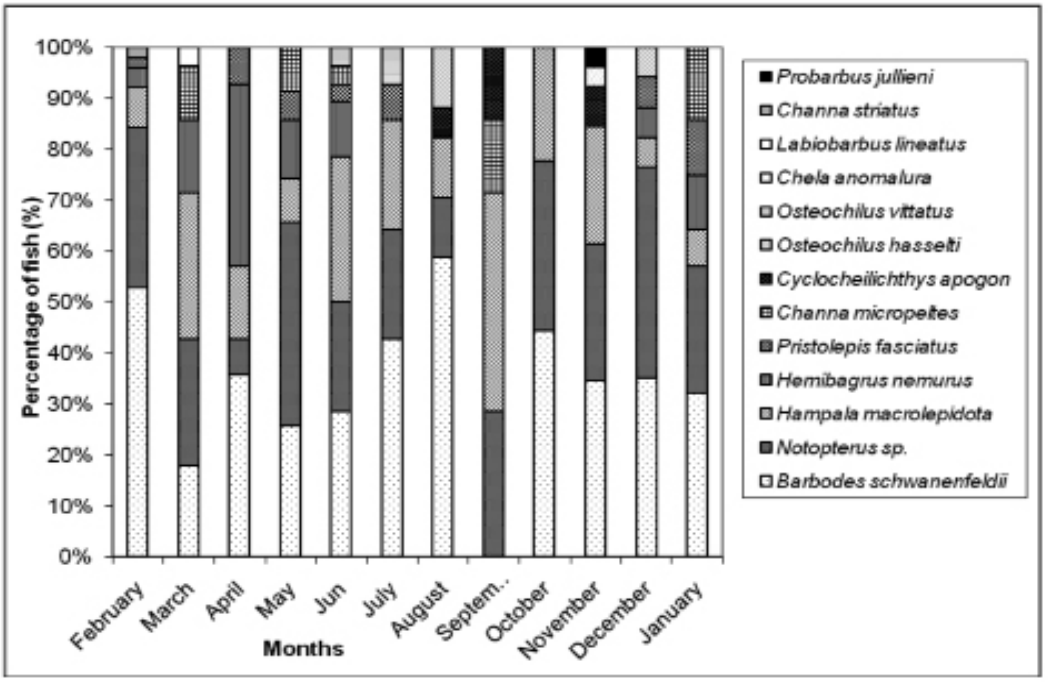

Figure 2. Monthly percentage composition of thirteen (13) fish species of fish sampled at Pengkalan Gawi – Pulau Dula section of Kenyir Lake, Terengganu. From February 2008 to January 2009.

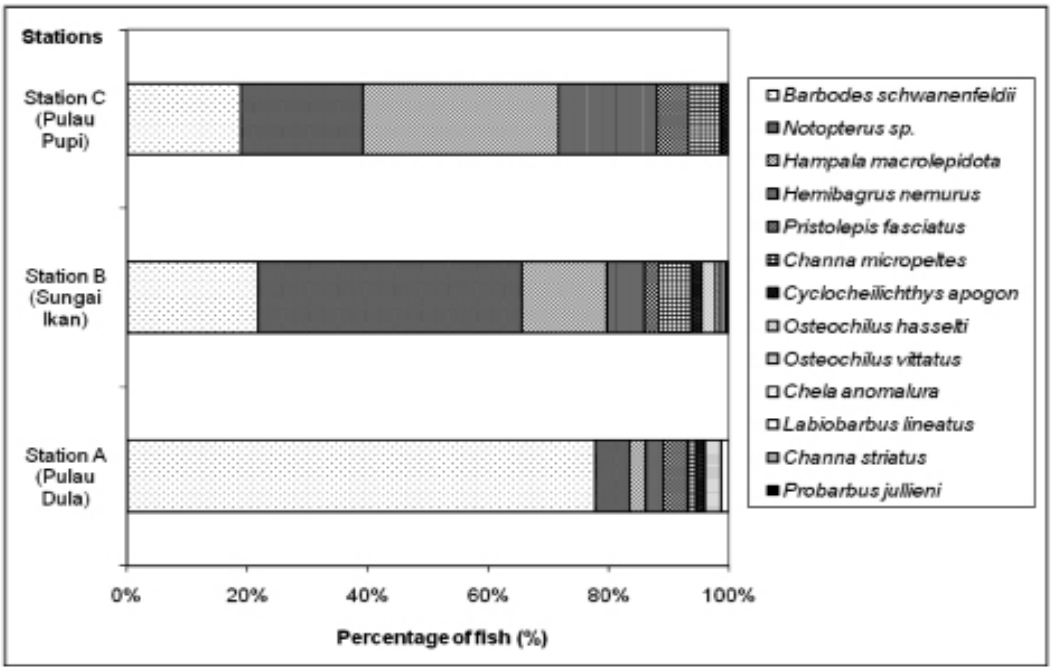

Figure 3. Percentage species composition of fish sampled based on stations at Pengkalan Gawi–Pulau Dula section of Kenyir Lake, Terengganu. From February 2008 to January 2009.

the fishery resources in the lake. Current samples of *P. jullieni* indicate that the fish has somewhat successfully adapted to conditions in Kenyir Lake, especially in Pengkalan Gawi- Pulau Dula area. In the past, fish stocking of various fish species was done which included the introduced *P. jullieni*, which was previously not found both in Kenyir Lake and in the freshwater systems of Terengganu (Ambak & Jalal, 2006).

In terms of number of fish species caught (S) at the study stations, there were 11 species of fish found in Sungai Ikan compared to only 9 species in Pulau Dula and 7 species found in Pulau Pupi. In terms of number of individual fish (n), Sungai Ikan had the highest with 128 individual fish. Meanwhile, for monthly variations, the highest number of species caught (S) was recorded in the month of June with 7 species and the highest number of individual fish captured (n) was recorded in the month of February with 51 individuals (Table 2).

The highest Catch per Unit Effort (CPUE) (fish/net) between sampling stations for the duration of the study period was recorded in Sungai Ikan with a reading of 10.67 fish/net. This was followed by Pulau Pupi (6.17 fish/net) and Pulau Dula (6.00 fish/net) (Table 2). The results of CPUE at each station in this study measures the fishing success for the average gill net in each particular station. Lydon *et al.* (2008) reported that the CPUE data for a single species (walleye) in Otsego Lake was 11 fish/net and this was considered normal among central New York lakes. In comparison to this, the CPUE data in this study clearly indicates that Kenyir Lake is moderately productive in terms of fish catch. This was highlighted by Yusoff *et al*. (1995) where it was stated that amongst the potential environmental problems in Kenyir Lake is a decrease of species diversity and fish landings due to habitat destruction and overfishing.

Three peaks of monthly CPUE were recorded in February (17.00), May (11.67) and January 2009 (9.33). The lowest monthly CPUE was recorded in September (2.33). These fluctuations may be attributed to the monsoon season that

Table 2. Table showing the number of fish species, number of fish individual, the three fish indices and the Catch per Unit Effort (CPUE) at each month and station in Pengkalan Gawi – Pulau Dula section of Kenyir Lake. From February 2008 to January 2009.

Months and Stations	Number of fish species	Number of fish	Shannon-Weaver index	Pielou's Evenness index	Margalef's Richness index	CPUE (fish/net)
Months						
February 2008	6	51	1.18	0.66	2.93	17.00
March	6	28	1.65	0.92	3.46	9.33
April	5	14	1.39	0.86	3.49	4.67
May	6	35	1.55	0.87	3.24	11.67
June	7	28	1.64	0.84	4.15	9.33
July	5	14	1.40	0.87	3.49	4.67
August	5	17	1.23	0.76	3.25	5.67
September	4	7	1.28	0.92	3.55	2.33
October	3	9	1.06	0.96	2.10	3.00
November	6	26	1.51	0.84	3.53	8.67
December	6	17	1.40	0.78	4.06	5.67
January 2009	6	28	1.66	0.93	3.46	9.33
Stations						
Pulau Dula (A)	9	72	0.97	0.44	4.31	6.00
Sungai Ikan (B)	11	128	1.66	0.69	4.75	10.67
Pulau Pupi (C)	7	74	1.67	0.86	3.21	6.17

Table 3. Fish diversity indices of fish population in Pengkalan Gawi-Pulau Dula section of Kenyir Lake. From February 2008 to January 2009.

Fish Diversity Indices	Shannon-Weaver index value	Pielou's Evenness index value	Margalef's Richness index value
Value	1.71	0.66	4.92

Kenyir Lake experiences yearly which may have affected the fish abundance within the study area. The rainy season is generally from November to March and the hot season is from May to October annually (Ambak & Jalal, 1998). According to Abiodun & Miller (2007), the CPUE data was influenced also by the catchability of the gear employed and the abundance of fish in that area.

Overall, the fish species diversity value using the Shannon-Weaver index showed a value of 1.71. The species evenness value using Pielou's Evenness index was at 0.66 and the species richness value using Margalef's index was 4.92 (Table 3). According to Kah-Wai & Ali (2001), the species diversity indices using Shannon-Weaver index in Chenderoh Reservoir at two sampling station were 3.32 and 3.21. Meanwhile, Yap (1982) in her study at Bukit Merah Reservoir reported that the species diversity index value was 3.12. This clearly showed that the species diversity indices values using Shannon-Weaver index in this study is rather low when compared to the values obtained from other reservoirs. Zakaria *et al*. (1999) found that species richness, species diversity and species survival in aquatic habitats were affected by several environmental factors, such as the physicochemistry of the water, topographical, hydrological characteristics and habitat destruction.

Environmental factors are somehow affected by other factors such as lake size, lake mean depth and the trophic status of the lake. According to data obtained from Ambak & Jalal (2006), the total area of Kenyir Lake is 36,900 ha and this is larger in comparison to the Bukit Merah Reservoir (3,526 ha) and Chenderoh Reservoir (2,591 ha). The mean depth of Kenyir Lake is also deeper (37 m) when compared to the Bukit Merah and Chenderoh Reservoirs which have a recorded depth of 23 m and 9 m respectively. Shallow and smaller reservoirs tend to be more productive than the larger and the deeper ones (Ambak & Jalal, 2006). Larger lakes such as Kenyir are classified as oligotrophic lakes and such lakes have low biological productivity (Kah-Wai & Ali, 2001). The unproductiveness or low biological productivity of Kenyir Lake may be a contributing factor to the lower values of fish diversity indices in this study as when compared to studies conducted in more productive lake systems.

Overall, Sungai Ikan (Ikan River) station showed the highest in terms of number of individual fish (128 fishes), the highest number of species landed (11 species) and the highest values in Species Richness (value of 4.75) (Table 2). This might be due to the location of this station, as it is located at the river mouth of Sungai Ikan. The majority of the fish species still dominate the rivers and the areas near the river mouth where nutrients are found in abundance (DOF, 1994). Sedimentation and siltation, food, nutrients and a high concentration of dissolved oxygen were fluxed together with the currents of the river into the lake. This condition is almost similar to the conditions in the Chenderoh Reservoir where Ali & Lee (1995) found that the most productive area in terms of fish catch was at the mainstream section of the reservoir.

Conclusion

From the results of the study, it can be concluded that the single largest composition of species in the sample was *B. schwanenfeldii* (35.8%). This was followed by *Notopterus* sp. (27.4%), *H. macrolepidota* (16.1%) and *Hemibagrus nemurus* (8.0%). The remaining nine species were of insignificant composition. The Shannon-Weaver index value in this study area was 1.71, Pielou's Evenness index value was 0.66 and Margalef's

Species Richness index value was 4.92. We can conclude that the fish species inhabiting in this section would also most likely inhabit other sections of the lake. The findings of this study are expected to benefit the planning and management towards sustainable fishery and conservation programmes of Kenyir Lake, Terengganu.

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