International Journal of Advanced Science and Research
ISSN: 2455-4227
Impact Factor: RJIF 5.12
www.allsciencejournal.com
Volume 3; Issue 4; July 2018; Page No. 22-25

Relationship of water quality parameters and depth with fish density in Kenyir Lake, Malaysia

Suharmili Rosle[1], Sakri Ibrahim[2*], Muhamad Nizam Yusof[3]
[1-3] University College Bestari, Putera Jaya, Permaisuri, 22100 Setiu, Terengganu, Malaysia

Abstract
This study was conducted to determine the relationship between water quality parameters, depth of water and fish distribution in Cicir, Perpek and Terengganu rivers of Kenyir Lake, Malaysia. Water temperature and dissolved oxygen were measured using an S-C-T meter and YSI-meter at depths of 0, 2.5, 5 and 10m at 0900, 1800 and 2200 hours. Fish were sampled using gillnets with different meshsizes of 5.08, 6.35, 7.62 and 10.16cm. Dissolved oxygen and water temperature recorded a higher value in upper layer and decreased in the deeper layer. Deepest water (10 m) recorded 1194 individuals while surface water layer recorded 313 individuals**.** There were 2330 individuals from 13 species caught in this study. *Hampala macrolepidota* was the most dominant (879 individuals) and followed by *Cyclocheilichthys apogon* (376 individuals). The least dominant species was *Mastacembelus armatus* (1 individual). Overall, this study showed that fish density has inverse relationship with water quality parameters.

Keywords: fish density, water quality parameters, gillnets and Kenyir Lake

1. Introduction
Reservoirs and lakes play an important role in daily life because they provide multipurpose function for domestic, industrial needs, hydropower, fishing, recreational activities, flood control, storage basin for municipal and agriculture [1, 2]. In Malaysia, not less than 73 man-made lakes have been created with Kenyir Lake as the largest man-made lake in South East Asia, having a total water surface area of about 38,000 hectares [2, 3]. The lake was designed to generate hydro-electricity [4]. The inflow of the river water and generation of the power station produce underwater current which causes the mixture of top and bottom water column. The lake replenishes its water supply from nine main rivers which flow into the lake namely Tembat, Ketiar, Leper, Pertang, Kerbat, Lasir, Belimbing, Terenggan and Kenyir Rivers. Kenyir Lake has a very diverse range of terrestrial and aquatic habitats that support interesting species of flora and fauna [5]. It is also a home for numerous species of freshwater fishes and exotic wildlife [6]. Being a reservoir, the water level of a lake varies with season. It is reported to be at high level during monsoon period and low level during dry season [7, 8]. Kah-Wai and Ali [9] mentioned that due to the depth of Kenyir Lake, it has a higher range of water temperature when compared to Chenderoh Lake in Perak. Water quality parameters give a huge effect on fertility and development of aquatic organisms. Non-optimum water quality parameters and poor management practices can cause stress to fish and thus make them more susceptible to disease outbreaks [10, 11]. Earlier study by Dowling and Wiley [12] that dissolved oxygen is a baring factor for aquatic organisms and can give effect on fish distribution. In addition, Garcia and Boncoeur [13] reported that fishing activity will become more efficient if the problems on water quality could be overcome. Recently, Kamaruddin, Mustafa Kamal, Christianus and Daud [7] reported fish diversity in Pengkalan Gawi-Pulau Dula, a section of Kenyir Lake and found the *Barbodes gonionutus* was the most dominant fish species, followed by *Notopterus* sp. and *Hampala macrolepidota*. However, there is no study has been conducted on water quality parameters and depth of water in relation to fish diversity in Kenyir Lake. Hence the objective of this study is to determine the relationship between water quality parameters, depth of water and fish density in Kenyir Lake, Malaysia. These data are hoped to provide information for government and other bodies in order to manage and conserve this lake in more effective way.

2. Materials and methods
2.1 Sampling sites
This study was conducted at three rivers namely Cicir, Perpek and Terenggan, a river section of Kenyir Lake. They were 30 minutes passed Pengkalan Gawi.

2.2 Water quality measurements and fish samplings
Water temperature and dissolved oxygen were measured at four levels of depth (0, 2.5, 5 and 10 m) with three different times (0900, 1800 and 2200 hours) for one year. The temperature was measured with an S-C-T meter (Model: YSI 33), while dissolved oxygen with an YSI-oxygen meter (Yellow Spring Instrument). Fish sampling was conducted using gillnets with different mesh sizes of 5.08, 6.35, 7.62 and 10.16 cm at all the three stations. Enmeshed fish were collected from the nets after 4 hours. All fish caught were identified to species using standard taxonomic keys following Mohsin and Ambak; Hua [14, 15]. In order to determine the species composition, the numbers of fish species in the samples and the number of individuals in each species were computed.

3. Results
In the present study, the water quality parameters have

influenced by water depth. Dissolved oxygen (DO) decreased as water depth increased (Table 1). The DO values in the present study ranged between 3.55-8.87 mg L^{-1}. Overall, the lowest value was recorded at deepest layer (10 m) while the highest value was recorded at surface water.

Table 1: Mean value of dissolved oxygen (mg L^{-1}) at different water depth (m) at each sampling station.

Time (h)	1830			2200			0900		
Station	**S1**	**S2**	**S3**	**S1**	**S2**	**S3**	**S1**	**S2**	**S3**
Depth (m) Dissolved oxygen (mg L^{-1})									
0	8.16±0.05	8.58±0.03	8.16±0.05	8.39 ±0.03	8.58 ±0.04	8.87±0.05	7.87±0.04	8.27±0.04	8.16 ±0.03
2.5	8.16±0.06	8.06±0.06	8.16±0.07	9.97±0.06	8.35±0.07	7.87±0.05	7.78±0.04	7.97±0.05	7.97±0.03
5.0	8.16±0.04	7.09±0.05	8.06±0.04	7.78±0.04	7.68±0.03	7.87±0.04	7.68±0.03	7.87±0.05	7.97±0.05
10.0	4.61±0.04	4.03±0.05	4.13±0.04	3.94±0.03	3.55±0.05	3.94±0.06	4.13±0.05	4.32±0.06	4.03±0.04

The water temperature value in this study ranged between 28.0 – 31.7 ºC (Table 2). Water surface had a higher temperature value compared to the lower layer at all sampling stations. The highest (31.7 ºC) and lowest temperature (28.0 ºC) was recorded at water surface and 10 m depth at station 3 on 1830 hours, respectively.

Table 2: Mean value of water temperature (ºC) at different water depth (m) at each sampling station.

Time (h)	1830			2200			0900		
Station	**S1**	**S2**	**S3**	**S1**	**S2**	**S3**	**S1**	**S2**	**S3**
Depth (m) Mean temperature (ºC)									
0	31.5±0.04	31.6±0.06	31.7±0.06	30.9±0.04	30.8±0.03	31.1±0.04	30.2±0.06	30.2±0.05	30.2±0.05
2.5	30.5±0.06	30.5±0.04	30.4±0.04	30.4±0.03	30.7±0.04	30.4±0.06	30.2±0.04	30.2±0.04	30.2±0.03
5.0	30.0±0.07	30.0±0.03	30.1±0.05	30.1±0.04	30.1±0.06	30.1±0.05	30.0±0.04	30.2±0.03	30.2±0.04
10.0	28.3±0.03	28.2±0.05	28.0±0.06	28.3±0.05	28.3±0.06	28.3±0.07	28.3±0.03	28.3±0.05	28.4±0.06

Table 3 showed the distribution of fish species at 4 different depths. Overall, 2330 individuals were recorded in this study. The number of fish caught increased with the increase of water depth. There were 313 individuals caught at the surface water (0 m) while 1194 individuals at the most prolific layer (10 m depth). In the present study, *Hampala macrolepidota was* recorded as the most dominant species of all depths with 879 individuals. This was followed by *Cyclocheilichthys apogon* as the second most dominant species with 376 individuals. *Mastacembelus armatus* was only recorded once making it the least dominant species. In this study, fish abundance was higher in the deeper layer (10 m) of water where temperature was 28.27 ºC and DO was relatively low (4.07 mg L^{-1}).

Table 3: Total fish distribution with water quality and depth at all sampling station.

	Depth (m)				
Species	**0**	**2.5**	**5.0**	**10.0**	**Total**
Hampala macrolepidota	210	109	101	459	879
Cyclocheilichthys apogon	50	56	56	210	376
Puntius schwanenfeldii	5	103	100	141	349
Chela anomalura	14	27	55	149	245
Mystus nemurus	0	40	42	117	199
Labiobarbus lineatus	5	50	24	53	132
Osteochilus vittatus	4	8	21	28	61
Osteochilus hasselti	19	5	5	6	35
Mystacoleusus arginatus	3	0	2	22	27
Pristolepis fasciatus	0	0	10	2	12
Tor tambroides	3	1	1	5	10
Channa micropeltes	0	3	1	1	5
Mastacembelus armatus	0	0	0	1	1
Total number of fish at each depth	313	402	421	1194	2330
Mean DO (mg L^{-1})	8.33	8.25	7.79	4.07	
Mean temperature (°C)	30.91	30.38	30.08	28.27	

4. Discussion

Dissolved oxygen level has an inverse relationship with depth. This findings was similar with [16]. The author stated that during periods of thermal stratification, dissolved oxygen levels are usually greatest near the surface then drop with increasing depth. In addition, Resnick [17] found that DO and temperature at Como River, Kenyir Lake decreased as water depth increased. RAMP [18] stated that temperature in lakes can vary with depth depending on level of light penetration and mixing characteristics. Chandrasekhar [19] stated that two main sources of dissolved oxygen in an aquatic ecosystem come from diffusion from air and photosynthesis. Comparatively, Como river, had lower value (6.15-6.74 mg L^{-1}) from the surface to the 6 m depth [20]. Other study by Kamaruddin, Mustafa Kamal, Christianus and Daud [7] found that Dula Island, a section of Pengkalan Gawi in the same lake had lower value (5.0 mg L^{-1}) of dissolved oxygen.

The present study showed that water temperature is much cooler at deeper layer. This was similar with the earlier findings by Smith and Bella [21] which reported that water is much cooler below the thermocline level (metalimnion) because it does not mix with the epilimnion (upper lake). Nevertheless, this layer (metalimnion or middle lake) is where the temperature changes most rapidly with depth, more so than it does in the epilimnion or the hypolimnion (bottom lake). Atmospheric driven phenomenon such as rain and wind cause water in the epilimnion to mix regularly [16].

The most dominant species recorded in the present study was *Hampala macrolepidota.* This was similar with earlier findings by Yusoff, Zaidi and Ambak; Zakaria, Yaacob and Noor [1, 22] which stated that *Mystus nemurus* and *Hampala macrolepidota* were the most dominant species in Kenyir Lake. The occurrence of highest species abundance in the deepest layer of water in the present study might be due to lack of food in pelagic zone [1]. However, *Hampala*

macrolepidota could also be found near submerged logs, overhanging trees and weedy spots and they usually come out at dawn and dusk to look for their prey [23]. However, the numbers of these sport fishes has depleted due to poachers activities [24].

This study showed that fishes were abundance even at lower dissolved oxygen content. This was similar with the findings by Matthews, Hill, and Schellhaass [25] in Lake Texoma that fish were abundance at 8–12 m depth of water where temperature was 28.5 ºC and dissolved oxygen was relatively lower than the upper level. This might be due to the natural behavior of fish that thermoregulate behaviorally. In lakes, temperature profile is a key regulator of fish habitat selection [26].

Earlier findings by Holz and Hoagland [27] found that most fish need a minimum of 3 mg L^{-1} of dissolved oxygen to survive. Similarly, other studies have shown nearly all fish elude DO content of below 4 mg L^{-1} [28]. While the deepest water layer provided the lower DO and temperature, this study also found that fish density was higher in deepest depth.

5. Conclusions

From this study, it can be concluded that fish density has inverse relationship with dissolved oxygen (DO) and water temperature. Water quality parameters particularly dissolved oxygen and water temperature are still within tolerable limit to support the diversity of many fishes species in the Kenyir Lake. The results of this study could also be good guides for local fishermen for effective fishing operations.

6. Acknowledgements

The authors would like to express a warm appreciation to boatmen and Central Terengganu Development Authority Ministry of Rural and Regional Development's staffs for cooperation during the samplings period in Kenyir Lake.

7. References

1. Yusoff FM, Zaidi MZ, Ambak MA. Fisheries and Environmental Management of Kenyir Lake, Malaysia. FAO, Rome, 1995, 112-128.
2. Zati S, Salmah Z. Lakes and reservoir in Malaysia: management and research challenges. Proceedings of Taal the 12th. World Lake Conference, 2007.
3. Zulkafli AR, Ahmad Ashhar O. Fish fauna in Tasik Kenyir, 2017, www.fri.gov.my/pppat/kenyirweb.
4. Ambak AK, Jalal KC. Fisheries Management and Ecology. Blackwell Science Ltd, 1998, 173-176.
5. Wahizatul AA, Hoon Ai G. Aquatic insect communities in relation with water quality of selected tributaries of Tasik Kenyir Terengganu. Journal of Sustainability Science and Management. 2016; 11(2):11-20.
6. Sayed MZH, Mohd Azmi A. Treasures of Kenyir, Malaysia. Penerbit UMT, Terengganu, 2005, 80.
7. Kamaruddin IS, Mustafa Kamal AS, Christianus A, Daud SK. A study on dissolved oxygen, pH and temperature of the lake water in Pengkalan Gawi-Pulau Dula Section of Kenyir Lake, Terengganu. Towards a Healthier and Sustainable Future: International Annual Symposium on Sustainability Science and Management (UMTAS), Universiti Malaysia Terengganu. 2010; 9(2):482-486.
8. Rauf M, Ahmad N U, Ullah S, Khan M. Physiochemical investigation of River Kabulat at Michini, Khyber Pakhtunkhwa, Pakistan. Journal of Biodiversity and Environmental Sciences. 2015; 7(3):280-291.
9. Kah-Wai KB, Ali AB. Chenderoh Reservoir, Malaysia: Fish community and artisanal fishery of a small Mesotrophic Tropical Reservoir, 2017, http://aciar.gov.au. 19.
10. Boyd CE, Tucker CS. Pond Aquaculture Water Quality Management. Kluwer Academic Publisher, Massachusetts, 1998, 225.
11. Zamri-Saad M, Amal MNA, Siti-Zahrah A, Zulkafli AR. Control and prevention of *streptococcosis* in cultures tilapia in Malaysia: A review. Pertanika Journal of Tropical Agricultural Sciences. 2014; 37(4):389-410.
12. Dowling DC, Wiley MJ. The Effects of Dissolved Oxygen, Temperature and Lowstream Flow on Fishes: A Literature Review. Aquatic Biology Section Technical Report, Illinois, 1998, 61.
13. Garcia SM, Boncoeur J. Overcoming Factors of Unsustainability and Overexploitation in Fisheries : Selected Papers on Issues and Approaches. International Workshop on the Implementation of the International Fisheries Instruments and Factors of Unsustainability and Overexploitation in Fisheries. FAO, Rome, 2005, 352.
14. Mohsin AKM, Ambak MA. Freshwater Fishes of Peninsular Malaysia. Penerbit Universiti Pertanian Malaysia, Selangor, 1983, 284.
15. Hua SC. A Field Guide to the Fish of Tasek Bera Ramsar Site, Pahang, Malaysia. Wetlands International-Malaysia Programme, Pahang, 2002, 99.
16. Sutton A. Relating Dissolved Oxygen Concentration to Fish Distribution in Jarecki Lake. University of Nebraska-Lincoln, 2010, 1-21.
17. Resnick JA. Preliminary site investigation of the Lake Kenyir watershed. Pluralidae. 2015; 4 (2):85-93.
18. RAMP. Water quality indicators: temperature and dissolved oxygen. http://www.ramp-alberta.org. 3 Oktober, 2014.
19. Chandrasekhar SVA. Limnological Studies on Kondakarla Lake Vissakha District. Andra Pradesh. Daya Publishing House, New Delhi, 2006, 202.
20. Najiah M, Aqilah NI, Lee KL, Khairulbariyyah Z, Mithun S, Jalal KCA, *et al*. Massive mortality associated with *Streptococcus agalactiae* infection in cage cultured red hybrid tilapia *Oreochromis niloticus* in Como River, Kenyir Lake, Malaysia. Journal of Biological Sciences. 2012; 12(8):438-442.
21. Smith SA, Bella DA. Dissolved oxygen and temperature in a stratified lake. Journal (Water Pollution Control Federation). 1973; 45(1):119-133.
22. Zakaria MZ, Yaacob KKK, Noor JM. Fishes of Lake Kenyir, Terengganu (Malaysia), Collected in 1992. Universiti Putra Malaysia, Selangor, 1997, 137-141.
23. Thestar. When the sebarau come out to play, 2016, https://www.thestar.com.my.
24. NST. Save the fish in Tasik Kenyir, 2017 https://www.nst.com.my.
25. Matthews JW, Hill LG, Schellhaass SM. Depth distribution of striped bass and other fish in Lake Texoma

(Oklahoma-Texas) during summer stratification. Journal of Transactions of the American Fisheries Society. 2011; 11(4):84-91.
26. Matthews WJ. Patterns in Freshwater Fish Ecology. Springer Science & Business Media, Oklahoma, 2012, 263.
27. Holz JC, Hoagland KD. Effects of phosphorus reduction on water quality: comparison of alum-treated and untreated portions of a hypereutriphic lake. Journal of Lake and Reservoir Management. 1999; 15(1):70-82.
28. McDermot D, Rose KA. An individual-based model of lake fish communities: application to piscivore stocking in Lake Mendota. Elsevier Science. 2000; 125(1):67-102.