https://doi.org/10.33472/AFJBS.6.6.2024.1364-1376

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

BIOLOGICAL INDICATORS OF WATER QUALITY: THE ROLE OF MACROINVERTEBRATES AS WATER QUALITY INDICATORS IN SELECTED WATER BODIES OF KANYAKUMARI DISTRICT

Y. C. Viji[1*] and S. Mary Josephine Punitha[2]

[1]Research Scholar (19127042192002), Department of Marine Science, Centre for Marine Science and Technology, Manonmaniam Sundaranar University, Rajakkamangalam, Kanniyakumari District, Tamilnadu, India - 629 502. *Corresponding Author: ycviji@gmail.com

[2]Associate Professor, Department of Marine Science, Centre for Marine Science and Technology, Manonmaniam Sundaranar University, Rajakkamangalam, Kanniyakumari District, Tamilnadu, India- 629 502.

*Corresponding Author Email: ycviji@gmail.com

Article History

Volume 6,Issue 6, 2024
Received:20 Feb 2024
Accepted : 28 Mar 2024
doi: 10.33472/AFJBS.6.6.2024.1364-1376

Abstract:

This study explores the distribution of macroinvertebrates as bioindicators of water quality in three chosen ponds within Kanyakumari District. Macroinvertebrate communities are prevalent in various aquatic environments globally, playing pivotal roles in ecosystem ecology. The research focuses on the seasonal variation of macroinvertebrates in these ponds across 2020 and 2021. The analysis, based on the BMWP index, indicates a pollution gradient in the ponds, with aquatic insects dominating the macroinvertebrate community. The paper presents an overview of macroinvertebrates as indicators of water quality in Vembanoor, Parvathipuram, and Putheri ponds over a two-year period. The findings reveal a decline in water quality from 2020 to 2021, marked by reduced macroinvertebrate density and increased pollution levels. Urgent conservation measures are necessary to safeguard water quality for future generations.

KEYWORDS: Macroinvertebrates, Bioindicators, Vembanoor Pond, Putheri Pond, Parvathipuram Pond, BMWP, Pollution, Water Quality.

INTRODUCTION

Bioassessment has been essentially used to survey wellbeing of water bodies since it relies upon living life forms that are presented to the coordination of conditions in the watershed (Bellucci *et al.,* 2013). These living life forms are the bioindicators. Bioindicators are organic entities utilized for finding ecological quality (Clarke *et al.,* 2003). There are numerous organic entities that have been utilized to evaluate water quality. Macroinvertebrates are connected emphatically to nearby stressors, as a result of their long life history and restricted portability (Cheimonopoulou *et al.,* 2011). However there are a few macroinvertebrates records that have been created to assess sea-going conditions . In the present study, the Biological Monitoring Working Party (BMWP) was to assess the natural wellbeing of Vembanoor, Parvathipuram and Putheri Ponds of Kanyakumari District. The Functioning Party (BMWP) list was created in 1976 and suggested for use in stream contamination reviews . As per Uherek and Gouveia , the BWMP isn't simply straightforward and simpler to apply yet additionally decreases the expenses when contrasted with physico-chemical examinations, which might require test handling in research centers; likewise it requires restricted work to create exact and repeatable consequences of natural checking. Albeit numerous freshwater bodies are observed by physico-chemical parameters, Sharma et al and Maret underscore that the macroinvertebrates are the most well-known faunal arrays for bioassessment since they give more solid appraisal of long haul natural modifications in the nature of sea-going biological system contrasted with its quickly evolving physico-chemical qualities.

MATERIALS AND METHODS

Study Area and Selection of Sites

Kanyakumari district has a varied topography with sea on three sides and the mountains of the Western Ghats bordering the northern side. Geologically, the landmass of the district is much younger when compared to the rest of state – faulted as late as 2.5 million years during the Miocene, after which numerous transgression, as well as regression of sea, had shaped the western coast of the district. In Kanyakumari district, there exist 2,123 major ponds. Among

them, 1,105 ponds have reached their full capacities and 538 ponds have attained 75% of their capacities.Ponds are frequently manmade or expanded beyond their original depths and bounds by anthropogenic causes. Vembanoor wetland has an average depth of 12-13 m with the surface area of the lake fully covered by floating and rooted vegetation ((Priyatharsini *et al.,* 2016).

Table 1: Description of three sampling sites showing their GPS readings and their respective physical parameters

Site No	Pond Name	Location	Area	Perimeter
1	Vembanoor Pond	8.181355, 77.376212	176,945.69 m² (1,904,627.54 ft²)	2.21 km (1.38 mi)
2	Paarvathipuram Pond	8.190200, 77.398790	15,128.67 m² (162,843.68 ft²)	529.51 m (1,737.25 ft)
3	Putheri Pond	8.206700, 77.431459	378,503.51 m² (4,074,177.85 ft²)	2.80 km (1.74 mi)

Vembanoor is a small Village/hamlet in Rajakkamangalam Block in Kanyakumari District of Tamil Nadu State, India (Fig.1) .It is located 8 KM towards west from District headquarters Nagercoil, 4 KM from Rajakkamangalam, 736 KM from State capital Chennai. Parvathipuram pond is located on NH 66 about five KM from Nagercoil central and 60 km from Thiruvananthapuram(Fig). Putheri Lake receives water from a canal outlet of Pechiparai Dam meant for irrigation. Much local agricultural runoff is also received by this lake . It partially fulfills drinking water needs of the locals, is used for irrigation and also helps to recharge the ground water aquifer (Esakkimuthu et al. 2015).

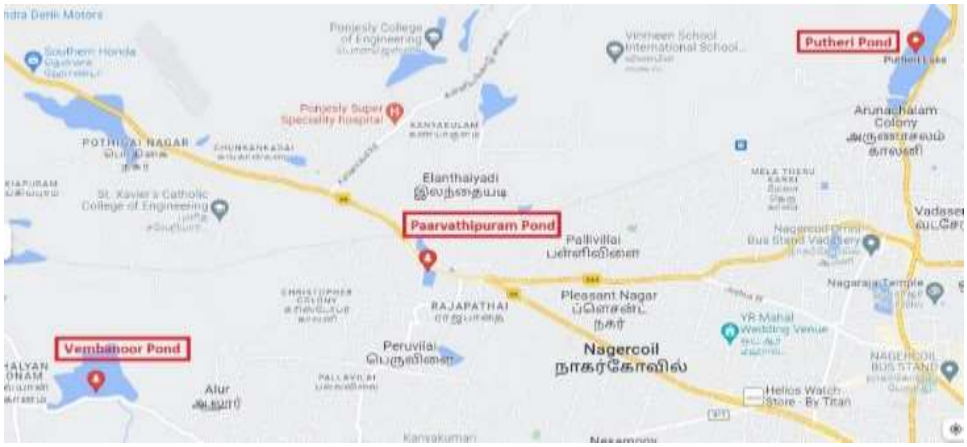

Fig.1. Location Map of Study Area

Field and laboratory work

Sample collections were made in three different seasons (Pre monsoon, SW monsoon and NE monsoon) in each season a sampling effort of 30 minutes was made. The ponds were grouped in to three sites during the collection of samples .In each site the sampling of macroinvertebrates were done in three zones ,upper zone, middle zone and lower zone. Macroinvertebrate density in each zone is recorded. Water samples were collected in 5-L sterile plastic containers for physicochemical analysis from each sampling station. And also samples were collected using 500 µm D-net. The samples were then placed in labelled bottles with screw caps and preserved in 96% alcohol. These were transferred to the laboratory where they were processed.and were examined thoroughly, under optical equipment.They were identified at the taxonomic level of the family. The data of the identified organism were grouped by season, so we obtained a few families, genera, and individuals for each sampling season. Water quality was determined inVembanoor, Parvathipuram and Putheri ponds, using Biological Monitoring Working Party.

Biological Monitoring Working Party (BMWP) Study

The Biological Monitoring Working Party (BMWP) Score is a method to measure the biological quality of rivers using invertebrates as indicators. This score is widely used by organisations such as the Environment Agency to monitor water quality in rivers. Any invertebrates caught are identified to family level. Each family is then given a score between 1 and 10. The index does not take into account the abundance of each family, simply the presence or absence of each family at the site. The score each family gets reflects their tolerance of pollution (different aquatic invertebrates have different tolerances to pollutants). The overall BMWP Score for a site is the sum of all of the scores of each family present at that site. Values greater than 100 are associated with clean water bodies, whilst heavily polluted rivers score less than 10.

Table 2: Biological Monitoring Working Party

Class	BMWP score	Category	Interpretation
I	>150	Good	Very clean water
	101-150		clean or not significantly altered
II	61-100	Acceptable	Clean but slightly impacted
III	36-60	Questionable	Moderately impacted
IV	15-35	Critical	Polluted or impacted
V	<15	Very critical	Heavinly polluted

Source: Fredrick and Hudson (2016)

RESULTS AND DISCUSSION

A sum of about 34 macroinvertebrate species belonging to three Phylum Annelida, Arthropoda and Mollusca under four classes and 14 orders were experienced. Table 1 and Table 2 showed the BMWP scores of macroinvertebrates in Vembanoor Pond in Pre Monsoon, SW Monsoon and NE Monsoon season in the year 2020 and 2021.

During the study period of 2020, the BMWP values of Vembanoor Pond was recorded with a maximum of 151 in Premonsoon period indicating the water quality in the upper zone ie, surface water is very clean. The middle zone also reveals the water is clean with a medium score 103. The minimum score of 15 is recorded in the lower zone of Vembanoor Pond which showed the water is polluted. In the SW monsoon period the upper zone has a value of 23 and the lower zone has a value of 27 which shows the water quality is impacted. The middle zone is moderately impacted with a score of 50.The water quality in NE monsoon season of 2020 indicated clean but slightly impacted condition in upper(76) and middle zones(86) respectively. The lower zone showed a value of 13 which is heavily polluted. The results indicate that the lower strata of Vembanoor pond is impacted by pollutants than the upper zones.

During the period of investigation in 2021, the BMWP values of Vembanoor Pond was recorded with a maximum value of 126 in Premonsoon period. This indicates the water quality in the upper zone ie, surface water is very clean. The middle zone also showed the water is clean but slightly impacted with a medium score of 88. The minimum score of 13 is recorded in the lower zone of Vembanoor Pond which showed the water is polluted. In the SW monsoon period the upper zone has a value of 26 and the lower zone has a value of 17 which shows the water quality is polluted. The middle zone is moderately impacted with a score of 60. The water

quality in NE monsoon season of 2021 indicated clean but slightly impacted condition in upper (83) and middle zones(81). The lower zone showed a value of 12 which is heavily polluted. The results indicate that the lower strata of Vembanoor pond is impacted by pollutants than the upper zones. When comparing the BMWP scores of Vembanoor Pond in 2020 and 2021. The results indicated the polluted condition advances as years pass on .

BMWP Score of Vembanoor Pond during Pre-Monsoon, SW Monsoon &NE Monsoon seasons of 2020 &2021

Table 3: Biological Water Quality at Vembanoor Pond in 2020

	Vembanoor Pond								
	Pre Monsoon			SW Monsoon			NE Monsoon		
	VE001	VE002	VE003	VE001	VE002	VE003	VE001	VE002	VE003
	Upper	Middle	Lower	Upper	Middle	Lower	Upper	Middle	Lower
Family richness	34	27	7	7	15	9	33	28	6
Number of individuals	438	546	241	40	160	115	288	363	74
BMWP Score	151	103	15	23	50	27	76	86	13
Significance	Very Clean Water	Clean Water	Polluted or impacted	Polluted or impacted	Moderately impacted	Polluted or impacted	Clean but slightly impacted	Clean but slightly impacted	Heavily polluted

Table 4: Biological Water Quality at Vembanoor Pond in 2021

	Vembanoor Pond								
	Pre Monsoon			SW Monsoon			NE Monsoon		
	VE001	VE002	VE003	VE001	VE002	VE003	VE001	VE002	VE003
	Upper	Middle	Lower	Upper	Middle	Lower	Upper	Middle	Lower
Family richness	30	23	10	7	20	11	31	6	8
Number of individuals	442	431	208	50	170	97	250	353	70
BMWP Score	126	88	13	26	60	17	83	81	12
Significance	Clean Water	Clean but slightly impacted	Polluted or impacted	Polluted or impacted	Moderately impacted	Polluted or impacted	Clean but slightly impacted	Clean but slightly impacted	Heavily polluted

A sum of about 34 macroinvertebrate species belonging to three Phylum under four classes and 14 orders were experienced. Table 3 and Table 4 shows the BMWP scores of macroinvertebrates

in Vembanoor Pond in Pre Monsoon,SW Monsoon and NE Monsoon season in the year 2020 and 2021. In the study period of 2020, the maximum values in BMWP score were recorded in the Premonsoon season of Parvathipuram Pond in the upper zone (103).

The middle zone is clean but slightly impacted (76) and the lower zone is moderately impacted (53).In the SW Monsoon season ,the upper zone is clean but slightly impacted(62) and the middle and lower zones are moderately impacted and showed a BMWP score of 58 and 49 respectively. During the NE Monsoon season the upper and middle zones recorded a score of 88 and 61 indicating the water is clean but slightly impacted.

The lower zone showed a value of 30 revealing the polluted nature of water. This result emphasizes that the water quality is deteriorating day by day. In the study period of 2021, the maximum values in BMWP score were recorded in the Premonsoon season of Parvathipuram Pond in the upper zone (89) which is clean and slightly impacted. The middle zone is also clean but slightly impacted (63). The lower zone is moderately impacted(43).

In the SWmonsoon season, the upper zone is clean but slightly impacted(51) and the middle and lower zones are moderately impacted and showed a BMWP score of 47 and 57 respectively. During the NE monsoon season the upper and middle zones recorded a score of 85 and 61 indicating the water is clean but slightly impacted .The lower zone showed a value of 30 revealing the polluted nature of water. This result emphasizes that the water the quality is being in a polluted state than before i.e. in 2020.

BMWP Score of Parvathipuram Pond during Pre-Monsoon, SW Monsoon &NE Monsoon seasons of 2020 &2021

Table 5: Biological Water Quality at Parvathipuram Pond in 2020

	Parvathipuram Pond								
	Pre Monsoon			SW Monsoon			NE Monsoon		
	PA001	PA002	PA003	PA001	PA002	PA003	PA001	PA002	PA003
	Upper	Middle	Lower	Upper	Middle	Lower	Upper	Middle	Lower
Family richness	26	18	16	19	17	14	34	23	12
Number of individuals	318	220	365	170	165	239	282	106	150
BMWP Score	103	76	53	62	58	49	88	61	30
Significance	Clean Water	Clean but slightly impacted	Moderately impacted	Clean but slightly impacted	Moderately impacted	Moderately impacted	Clean but slightly impacted	Clean but slightly impacted	Polluted or impacted

Table 6: Biological Water Quality at Parvathipuram Pond in 2021

	Parvathipuram Pond								
	Pre Monsoon			SW Monsoon			NE Monsoon		
	PA001	PA002	PA003	PA001	PA002	PA003	PA001	PA002	PA003
	Upper	Middle	Lower	Upper	Middle	Lower	Upper	Middle	Lower
Family richness	27	17	23	19	18	11	31	21	13
Number of individuals	201	211	353	131	159	233	177	105	150
BMWP Score	89	63	43	51	47	57	85	61	30
Significance	Clean but slightly impacted	Clean but slightly impacted	Moderately impacted	Clean but slightly impacted	Moderately impacted	Moderately impacted	Clean but slightly impacted	Clean but slightly impacted	Polluted or impacted

A sum of about 34 macroinvertebrate species belonging to three Phylum under four classes and 14 orders under five classes were experienced. Table 5 and Table 6 shows the BMWP scores of macroinvertebrates in Vembanoor Pond in Pre Monsoon, SW Monsoon and NE Monsoon season in the year 2020 and 2021.

In Putheri Pond during the Premonsoon period of 2020 the upper and middle zones of water showed the BMWP values of 22 and 17 which indicates the impacted condition of the water body. In the same season, the lower zone of water is heavily polluted (5).The quality of water in accordance with macroinvertebrates showed that the three zones are heavily polluted (14 , 3 & 3) in the SW monsoon season. In the NE monsoon season, upper zone is impacted with a score of 20 and the middle and lower zones are with a score of 3 and 11

respectively . The results during the study period of 2020 specified the polluted condition of Putheri Pond.

In Putheri Pond during the Premonsoon period of 2021 the upper and middle and lower zones of water showed the BMWP values of 10, 12 and 5 respectively which indicates the heavily polluted condition of the water body. In SW monsoon period the quality of water in accordance with macroinvertebrates showed that the three zones are heavily polluted (9,2 & 0). In the NE monsoon season also upper zone ,middle and lower zones are with a score of 11,0 and10 respectively . The results during the study period of 2021 specified the polluted nature of Putheri Pond .

BMWP Score of Putheri Pond during Pre-Monsoon, SW Monsoon &NE Monsoon seasons of 2020 &2021

Table 7: Biological Water Quality at Putheri Pond in 2020

	Putheri Pond								
	Pre Monsoon			SW Monsoon			NE Monsoon		
	PU001	PU002	PU003	PU001	PU002	PU003	PU001	PU002	PU003
	Upper	Middle	Lower	Upper	Middle	Lower	Upper	Middle	Lower
Family richness	8	8	4	4	2	2	9	2	8
Number of individuals	88	65	58	83	9	9	37	3	68
BMWP Score	22	17	5	14	3	3	20	3	11
Significance	Polluted or impacted	Polluted or impacted	Heavily polluted	Heavily polluted	Heavily polluted	Heavily polluted	Polluted or impacted	Heavily polluted	Heavily polluted

Table 8: Biological Water Quality at Putheri Pond in 2021

	Putheri Pond								
	Pre Monsoon			SW Monsoon			NE Monsoon		
	PU001	PU002	PU003	PU001	PU002	PU003	PU001	PU002	PU003
	Upper	Middle	Lower	Upper	Middle	Lower	Upper	Middle	Lower
Family richness	5	6	4	2	2	1	7	3	6
Number of individuals	73	61	43	76	8	2	37	2	53
BMWP Score	10	12	5	9	2	0	11	0	10
Significance	Heavily polluted	Heavily polluted	Heavily polluted	Heavily polluted	Heavily polluted	Heavily polluted	Heavily polluted	Heavily Polluted	Heavily polluted

According to the investigations done by Dumbrava Dodoaca and Petrovici in 2010 ,they reported that the the quality of water deteriorates in the downstream which leads to changes in the abundance of macroinvertebrate communities. Similar results were also found in the study conducted by Raescu et al. in 2011 where he experienced a progressive deterioration of water quality which is marked by the decrease in the biotic index EPT/Ch (Ephemeroptera, Plecoptera, Trichoptera/Chironomidae) value. The great concentration of organic substance in the downstream is shown by the dominance of Oligochaeta. Similar results were found in the present investigation also. In Vembanoor and Putheri Ponds the lowest strata were found to be polluted in the year 2020 and 2021 than during the other seasons.

The increase in Agricultural activities together with pesticide runoff, urbanization and other anthropogenic activities nowadays cause the reduction of macroinvertebrate taxa richness. According to the studies of Hepp et al. in 2010 ,the results showed that urban and agricultural impacts affect the water quality and aquatic diversity. The higher values of nutrients found and the lower dissolved oxygen obtained in urban streams directly affects the input of organic materials in the water which strongly influenced the community structure and composition.

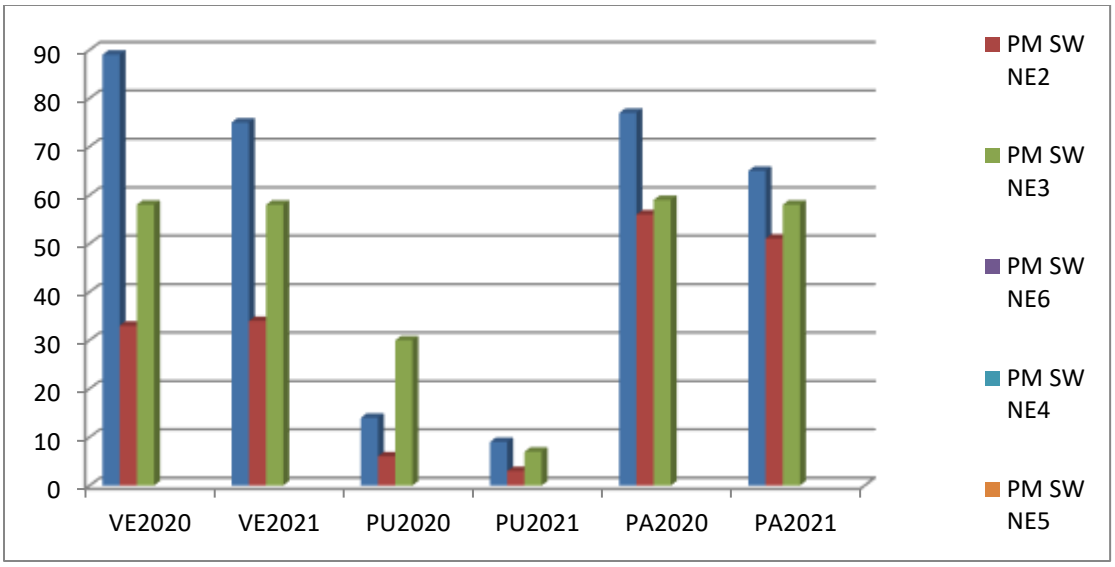

Fig 2: Overall Investigation from different ponds

CONCLUSION

In the present investigation from the BMWP results obtained ,we can come to a conclusion that the water quality is being deteriorated as years pass on ie,higher in 2021 than 2020. There is a also a seasonal variation in the quality of water . During the Premonsoon period of 2020 and 2021 a hike in the BMWP results were reported in upper and middle zones of Vembanoor in Pre Monsoon and SW Monsoon period showing a best water quality. In Parvathipuram Pond the results reported showed a good quality of water in all the zones in all seasons.The water quality in Putheri Pond is very poor comparing the other two Ponds in all the three seasons which indicated the polluted condition of the water body. Macroinverbtate abundance is also found to be lowered as the water quality deteriorates. Thus it is proved that macroinvertebrates are good bioindicators of water quality than physico chemical parameters.There may be changes in the physico chemical nature of water after each sampling,whereas macroinvertebrates do not show drastic changes likewise and prove a long term indicator of water quality.

REFERENCES

Aazami, J., Esmaili-Sari, A., Abdoli, A., Sohrabi, H., Van Den Brink, P.J., 2015. *Monitoring and assessment of water health quality in the Tajan River, Iran using physicochemical, fish and*

macroinvertebrates indices, Journal of Environmental Health Science and Engineering, 13, pp. 29.

Araúz, B., Amores, B. & Medianero, E., 2000*., Diversity of distribution of aquatic insects along the bed of the Chico River, province of Chiriquí,* Republic of Panama. Scientia, 15, pp. 27–45.

Armitage, P.D., Moss, D., Wright, J.F., Furse, M.T., 1983. *The performance of a new biological water quality score system based on macroinvertebrates over a wide range of unpolluted running-water sites.* Water Res. 17, pp. 333-347.

Biological Monitoring Working Party, 1978. *Final Report: Assessment and Presentation of Biological Quality of Rivers in Great Britain. December 1978.* Department of the Environment, Water Data Unit, pp. 37.

Bonada, N., Prat, N., Resh, V.H., Statzner, B., 2006. *Developments in aquatic insect biomonitoring: a comparative analysis of recent approaches.* Annu. Rev. Entomol. 51, pp. 495-523.

CPCB, Pollution Control Acts, Rules & Notifications Issued Thereunder, 2021*, Central Pollution Control Board.*

Deborde, D.D.D., Hernandez, M.B.M., Magbanua, F.S., 2016. *Benthic macroinvertebrate community as an indicator of stream health: the effects of land use on stream benthic macroinvertebrates.* Sci. Diliman, 28, pp. 5-6.

Del C. Guinard, J., Rivers, T. & Bernal Vega, J.A., 2013*., Diversity and abundance of aquatic macroinvertebrates and water quality of the upper and lower basins of the Gariché River, Chiriquí Province.* Panama Management and Environment, 16, pp. 61–70.

Dudgeon, D., 2019*. Multiple threats imperil freshwater biodiversity in the Anthropocene. Curr.* Biol. 29, pp. R960-R967*. https://doi.org/10.1016/j.cub.2019.08.002.*

Esakkimuthu, K., Vinod Kumar, K. P., & Ponram , P., 2015*., Assessment of water-polluting sources by multivariate statistical methods in Putheri Lake, Kanyakumari, Tamil Nadu, India* Sustain. Water Resources Management, 1, pp. 349–353.

Flecker, A.S. & Feifarek, B., 1994., *Disturbance and the temporal variability of invertebrate assemblages in two Andean streams.* Freshwater Biology, 31, pp. 131–142.

Friberg, N., 2014*. Impacts and indicators of change in lotic ecosystems*. WIREs Water 1, pp. 513-531*. https://doi.org/10.1002/wat2.1040.*

Hawkes, H.A., 1997. *Origin and development of the biological monitoring working party score system. Technical Note.* Water Res. 32, pp. 964-968*.*

Kanyakumari District*, https://en.wikipedia.org/wiki/Kanyakumari_district* dated 3 April 2020

Minae, 2007. *Regulation for the Evaluation and Classification of the Quality of Surface Water Bodies Executive Decree No. 33903-MINAE. Costa Rica.*

Mophin–Kani K& Murugesan A.G,2014 .,*Assessment of River Water Quality Using Macroinvertebrate Organisms as Pollution Indicators of Tamirabarani River Basin ,Tamil Nadu,India, International Journal of Environmental Protection,Vol.4 Iss.1PP.1-14.*

Munir, T., Hussain, M., Naseem, S., 2016. *Water pollution - a menace of freshwater biodiversity: a review.* J. Entomol. Zool. Stud. 4, pp. 578-580*.*

National Water Council, 1981. *River Quality: the 1981 Survey and Future Outlook.* National Water Council, London, UK, pp. 39.

Paisley, M. F., Trigg, D. J., & Walley, W. J., 2014*. Revision of the biologicalmonitoring working party (BMWP) score system: Derivation of present-only and abundance-related scores from field data.* RiverResearch and Applications,30, pp. 887–904*.*

Park, Y.-S., Hwang, S.-J., 2016. *Ecological monitoring, assessment, and management in freshwater systems. Water 8, pp. 324. https://doi.org/10.3390/w8080324. Pennak, R.W., 1953. Fresh-water Invertebrates of the United States.* John Wiley & Sons, New York, p. 769*.*

Parvathipuram*, http://wikimapia.org/3279054/Lotus-Pond-Parvathipuram* dated 4 April 2020

Pond*, https://en.wikipedia.org/wiki/Pond* dated 3 April 2020

Priyatharsini, P., Dhanalakshmi, B., 2016*, Water Quality Characteristics of Vembanoor Wetland, Kanniyakumari District, Tamil Nadu, India,* Int.J.Curr.Microbiol.App.Sci (2016) 5(8), pp. 852-861.

Pwd (Volume I – Part A), Public Work Department (Wro)*, Tirunelveli; Micro Level Reappraisal Study Report - Kodaiyar River Basin*

WHO, Guidelines For Drinking-Water Quality, 2011*, World Health Organization.*