ISSN NO. 2320-5407

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

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH

RESEARCH ARTICLE

The application of Phytoplankton Index of Biological Integrity (P-IBI) on the Euphrates River (Euphrates Mid-Iraq)

Dunia B. G. Al- Ghanimy[1] Hussain Y. K. Al-Rekabi[2]

1. Department of Biology, College of Education, University of Al- Qadisiyah, Al- Diwaniyah, Iraq

2. Department of Community Health, Technical Institute, Al-Nassiriah, Thi- Qar, Iraq

Manuscript Info

Manuscript History:

Received: 12 June 2015
Final Accepted: 22 July 2015
Published Online: August 2015

Key words:

Phytoplankton, Euphrates River, Iraq, P-IBI, Water Quality

Corresponding Author

duniaalghanimy@yahoo.com

Abstract

The aim of the present study was to assess the general health of Euphrates River based on Phytoplankton data that collected monthly from May 2013 to April 2014 from different sites of Euphrates. Ten metrics were selected for measuring P-IBI included relative abundance of Pennales, relative abundance of Centrales, relative abundance of Chlorophyceae, relative abundance of Cynophyceae, relative abundance of Pyrrophyceae, relative abundance of Euglenophyceae, relative abundance of Chrysophyceae, Phytoplankton density (cell $\times 10^3$/l), concentration of Chlorophyll-a (µg/l), and richness index.

Results reflected the useful of the evidence to assess the Water's Quality of this river who got the evaluation Poor-Good.

Introduction

Multi-metrics indexes such as the Index of Biological Integrity (IBI) summarize and condense information about aquatic habitat quality and are used to compare with sites over a large geographic area (Fore *et al*., 1996).

Biotic integrity has been defined as the ability of a system to generate and to maintain the adaptive biotic components through natural evolutionary process. In a lotic system, biotic integrity depends on river flow, energy input, water quality, biotic interaction and habitat structure (Karr *et al*., 1986 ,Karr, 1991). While Biological integrity can be defined as "the ability of an aquatic ecosystem, to support and maintain a balanced integrated, adaptive community of organisms having a species composition, diversity and functional organization comparable to that of the natural habitats of a region" (Karr and Dudley 1981)

The IBI is useful for many reasons: It reflects multiple, important aspects of stream biology that respond to the diverse effects of human influence and is a reliable tool for detecting biological degradation. It produces less classification errors than assessment tools using single indicator taxa or single-species toxicology tests (Nijboer *et al*., 2005).

Karr (1981) is the first devised an index to measure biological integrity in a stream, using fish as indicator species.

Karr's (1981) Index of Biological Integrity (IBI) has been modified to use benthic macroinvertebrates as indicators (Fore *et al.*, 1996) and fish (Simon, 1999).

The composition of phytoplankton can be used in bio-integration guide for being sensitive to environmental changes dramatically and when combining low cost, and samples can be saved for a long time and the survival of this sample, the results of the analysis itself if the new samples were collected. In addition to that the samples need to be saved into a little and be stored for their conservation (Al-Gahwari, 2003; Kane, 2004).

Phytoplankton is the primary source of energy driving large lake ecosystems, and the zooplankton is the central trophic link among primary producers and fish (Tatrai *et al*., 1997).

The abundance of phytoplankton distribution and species composition and diversity are the most important evidence of the state of water (Townsend *et al.,* 2000). The phytoplankton reflects the nutrients status in the environment and for being with limited movement used frequently to evidence of the state of water systems (Barnes, 1980).
There are plenty of studies conducted in the world using the phytoplankton as vital evidence such as (Wu, 1984; Cox-Lillis, 2000; Olding, 2000; Bittencourt and Nascimento, 2001; Fore and Grafe, 2002; Ramakrishnan, 2003; Blinn and Herbst, 2003; Bate *et al*., 2004, Lacouture *et al*., 2006; Shehata, *et al*., 2009; Chaib and Tison - Rosebery, 2012; Khongsang and Wongsia, 2012; Hosmani and Mruthunjaya, 2013)
In recent times, Local studies that evidenced of the vital subject by using phytoplankton Such as Al-Janabi (2011) use phytoplankton in Biotic Integrity on the Tigris River was obtained (good– acceptable) evaluating. Phytoplankton also used to evaluate the general health of southern marshes of Iraq in the study of (Maulood *et al*., 2011) the P-IBI Scores showed better condition in Al Hawizeh marsh as compared with the Central, West and East Al Hammar marshes.
The Index of Biotic Integrity IBI also use in evaluating the aquatic environment health to Chebaish Marsh- southern Iraq- by using phytoplankton, the results evidence increase the Value of Index in winter (Al-Saboonchi *et al*., 2012)
The aim of this study is to apply a metric index of biological integrity for phytoplankton to evaluate the health of Euphrates River.

Materials and Methods

The Euphrates is the longest river in western Asia. It's one of two major rivers flowing through Iraq. It originates in Turkey, runs through Syria entering Iraq from the western border and discharge in Shat Al-Arab. The present study selected four sites along the main river basin (**Figure 1**). Monthly sampling was taken for the study period of May 2013- April 2014.

Phytoplankton samples were collected monthly from four locations in Euphrates River. These samples were taken by a 20 µ mesh size net and Identification of species by using light Microscope and following reference (Prescott, 1973; Germain, 1981; Wehr and Sheath, 2003; Lavoie *et al.,* 2008) quantitative study depend up on Hadi (1981) method.

Phytoplankton metrics used for this analysis included relative abundance (R.A.) of Pennales, relative abundance of Centrales, relative abundance of Chlorophyceae, relative abundance of Cynophyceae, relative abundance of Pyrrophyceae, relative abundance of Euglenophyceae, relative abundance of Chrysophyceae, Phytoplankton density (cell $\times 10^3$/L), concentration of Chlorophyll- a (µg/l) and richness index.

The P-IBI calculated based on historical data for the study of each of (Al- Lami *et al*., 1998) and (Al- Saadi *et al*., 2000) by converted metric raw data into metric scores after being subjected to a scale of thresholds of 3, 5 and 10 (Karr, 1981) (**Table 1**) Thus, a threshold of (3) was given for metrics that have value exceed the permissible condition and a thresholds (5) was given to those of medium condition and (10) was given to that has value equal or near to natural condition. According to (McCromick *et al*., 2001) these values reflect those more traditional measurements of trophic status as following: The IBI scores exceeding the 75th percentile for reference sites (IBI.82) were classified as having "excellent" biotic integrity and scores between the 75th and 25th percentiles ($72 < IBI \leq 82$) were identified as having "good" biotic integrity. Scores between the 5th and 25th percentile for reference sites (IBI=56–72) were identified as being in "fair" condition, and scores below the 5th percentile for reference sites ($IBI<56$) were defined as in "poor" condition. To calculate the value of P-IBI compiled unit values and hit 10 and then divided by the number of units (10) to ensure that resulting number does not skipped (100) in any case. Nevertheless the highest value of P-IBI in this study should be 100 that are a result of multiplying the number of metric (10) by the highest score can be obtained by each metric (10).

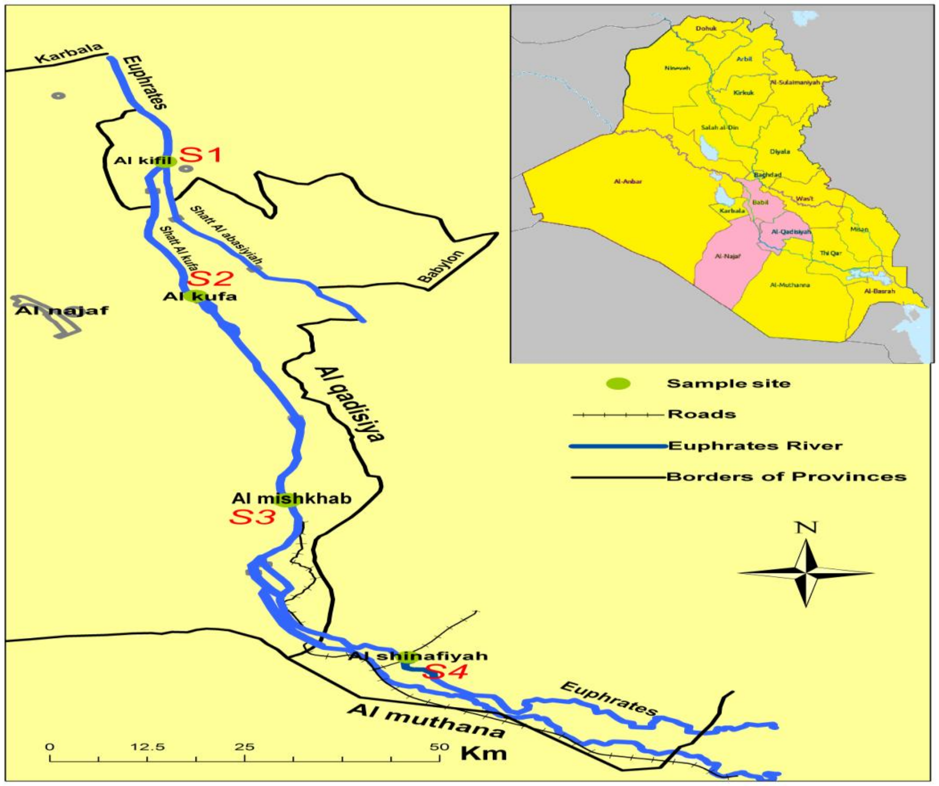

Figure (1) Map of the studies area

Table 1: Scoring criteria that use to calculated P-IBI

	Scoring Criteria		
Metrics	3	5	10
R.A. of Pennales	<12.44%	12.44% - 77.6%	>77.6%
R.A. of Centrales	>48.33%	48.33% -3.34%	<3.34%
R.A. of Chlorophyceae	<15.37%	15.37% - 81.98%	>81.98%
R.A. of Cyanophyceae	>4.31%	4.31% - 1.13%	<1.13%
R.A. of Pyrrophyceae	>0.07%	0.07% - 0.04%	<0.04%
R.A. of Euglenophyceae	>0.049%	0.049% - 0.038%	<0.038%
R.A. of Chrysophyceae	<0.01%	0.01% - 0.68%	>0.68%
Phytoplankton Density	$>275640\times10^3$	$275640\times10^3 - 338\times10^3$	$<338\times10^3$
Concentration of Chlorophyll a	>4.482	4.482 – 0.211	<0.211
Richness Index	<11.47	11.47 – 15.85	>15.85

Results and Discussion

The values of P-IBI ranged (50-81) as the lowest value recorded in the fourth site in June and August and the highest value recorded in the third and first site in March (Figure 2). The statistical analysis showed of the existence of significant differences between different months and sites.

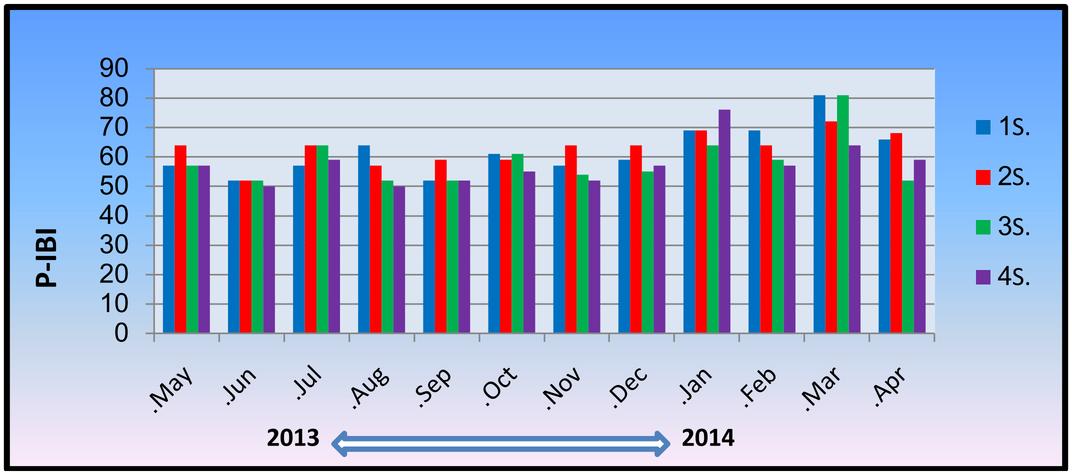

Figure (2) monthly and in situ changes to the values of Phytoplankton Index of Biological Integrity

Phytoplankton is an important aquatic life and its good evidence part to determine changes in water quality because of the rapid affects by environmental changes and respond to them quickly. The phytoplankton considered product basis: it has a major role and important in feeding organism also it vital evidence of the quality of the water as it is used repeatedly in pollution studies (Kumar *et al*., 2012) because of the high sensitivity of phytoplankton so the negative changes affecting the plankton composition effect on the other organism because of the unique location of algae in general and plankton in the food chain especially (Ersanli and Gönülol, 2003)

Richness Index is sensitivity to the number of individuals, abundance and the number of samples (Gotelli and Anne, 2013). This index is influenced by the site and type of water bodies. The increased of organic matter, result in increased the species and this will reflect positively on species richness Index (McCormick *et al*., 2001).

Maulood *et al*., (2011) pointed to the importance of biological integrity as evidence directly and valuable tool in determining the health of the water system, While the use of phytoplankton biological Integrity as evidence of reflects the abundance of nutrients and environmental conditions in the optical system through the response made by phytoplankton towards these changes (Lacouture *et al*., 2006).

The results of the current study showed that the Phytoplankton Index of biological Integrity values rang between (50-81) that is fall within the Rating (Poor-Good), which gives a good indication of the change in environmental and effectiveness of phytoplankton in the estimation of these change's circumstances as this guide brings together a number of units which have a different reaction to the changes in the water quality changes and put them in a mathematical model, making it more reflective of the environmental situation (Lacouture *et al*., 2006) this study confirm the effectiveness of phytoplankton in the estimation of the environment changes and agreed the results of it with the study of each of (Maulood *et al*., 2011) and (al-Janabi, 2011) and (Al-Saboonchi *et al*., 2012)

References

- ✓ Al - Gahwari, Y. A. (2003) Use of Phytoplankton abundance and species diversity for monitoring Coastal Water quality. MSc. Thesis, University Sains Malaysia.
- ✓ Al- Saadi, H.A.; Kassim, T.I.; Al-Lami, A.A.; and Salman, S.K. (2000) Spatial and Seasonal Variations of Phytoplankton Populations in the Upper Region of the Euphrates River, Iraq. Limnologica, 30: 83-90.
- ✓ Al-Janabi, Z.Z. (2011) Indices Application of Water Quality and Biological Integrity for Tigris River with in Baghdad City. Thesis in Ecology, University of Baghdad College of Science for Women.
- ✓ Al–Lami, A.A.; Al –Saadi, H.A.; Kassim, T.I. and Al – Aubaidi, K.H. (1998) On The Limnological Features of Euphrates River, Iraq. J. Edu. Sci. 29: 38–50.
- ✓ Al-Saboonchi,A.; Abid, H.S.; Alobaidy, A.M.J. and Maulood, B.K.(2012) Assessment of Environmental Changes in the Iraqi Marshes by Index of Biological Integrity. Journal of Environmental Protection, 3: 681-688.

- ✓ Barnes, R.S.K. (1980) Coastal Lagoons. 2nd Edn., Cambridge University Press, London, U.K. 106 pp.
- ✓ Bate, G.; Smailes, P. and Adams, J. (2004) A water quality index for use with diatoms in the assessment of rivers. Water SA 30 (4): 493 – 498.
- ✓ Bittencourt – Oliveira M. D. C. and Nascimento, M.A. D. (2001) Influence of abiotic variables and polluting source in the structure of the phytoplankton community in the Tibagi river Parana state, South Brazil. Algological studies 101 = Archive Hydrobiologie Supplement (Arch. Hydrobiol. Suppl.), 137: 75 – 95.
- ✓ Blinn, D.W. and Herbst, D. (2003) Use of Diatoms and Softalgae as Indicators of Stream Abiotic Determinants in the Lahontan Basin. Final report to the California Regional water Quality control Board,Lahontan region and the California state water Resource control Board: 1- 10
- ✓ Chaib, N. and Tison – Rosebery, J. (2012) Water quality assessment and application of the biological diatom index in the Kebir – East Wadi, Algeria. African Journal of Aquatic Science, 37 (1): 59 – 69.
- ✓ Cox-Lillis, J.R. (2000) Evaluation of Biological Data, Guanella Pass Area, Clear Creek and Park Counties, Colorado, Water Years 1995–97. U.S. Geological Survey, USGS Open-File Report 00–54,Prepared in cooperation with the Federal Highway Administration, Denver, Colorado, 38. http://pubs.water.usgs.gov/ofr00054.
- ✓ Ersanlı, E.and Gönülol, A. (2003) Study on the Phytoplankton and Seasonal Variation of Lake Simenit (Terme – Samsun, Turkey). Turkish Journal of Fisheries and Aquatic Sciences, 3: 29-39.
- ✓ Fore, L. S.; Karr, J. R. and Wisseman, R. W. (1996) Assessing invertebrate responses to human activities: evaluating alternative approaches. Journal of the North American Benthological Society, 15: 212-231.
- ✓ Fore, L.S. and Grafe, C. (2002) Using diatoms to assess the biological condition of large river in Idoho (U.S.A.) Freshwater Biology. 47 (10): 2015 – 2037.
- ✓ Germain, H. (1981) Flora des Diatomees Diatom phyees eau deuces et summates dumassif Americiom et des contreesvoisines d Europe occidental. Societe nouvelle des Edition Boubee, paris. 443 pp
- ✓ Gotelli N. J. and Anne, C. (2013) Measuring and Estimating Species Richness, Species Diversity, and Biotic Similarity from Sampling Data. In: Levin S.A. (ed.) Encyclopedia of Biodiversity, second edition, Waltham, MA: Academic Press, 5:195-211.
- ✓ Hadi, R. A. M. (1981) Algal studies on the river usk. ph.D. thesis, univ. college Cardiff U.K.
- ✓ Hosmani, S.P.and Mruthunjaya, T.B. (2013) Impact of Plankton diversity on the Water Quality Index in a Lake at Thirumakudal Narasipura Mysore District. International Journal of Innovative Research in Science, Engineering and Technology, 2 (5): 1434 – 1441.
- ✓ Kane, D. D. (2004) The Development of Planktonic Index of Biotic Integrity for Lake Erie. Ph.D. Thesis, The Ohio State University, Columbus. 299 pp.
- ✓ Karr, J. R. (1981) Assessment of biotic integrity using fish communities. Fisheries, 6: 21-27.
- ✓ Karr, J. R. and Dudley, D. R. (1981) Ecological perspective on water quality goals. Environmental Management, 5: 55-68.
- ✓ Karr, J. R.; Fausch, K. D.; Angermeier, P. L.; Yant, P.R. and Schlosser, I. J. (1986) Assessing biological integrity in running waters: a method and its rationale. Illinois Natural History Survey Special Publication, 5: 1-28.
- ✓ Karr, J. R. (1991) Biological integrity: a long neglected aspect of water resource management. Ecological Appications, 1: 66-84.
- ✓ Khongsang, A. and Wongsia, S. (2012) Phytoplankton Indicators in the Ban Thai Reservoir, Phuketprovince, Thailand.
- ✓ Kumar, P.; Wanganeo, A.; Sonaullah, F. and Wanganeo, R. (2012) Limnological Study on two high Altitude Himalayan ponds, Badrinath, Uttarakhad. International Journal of Ecosystem, 2 (5): 103 – 111.
- ✓ Lacouture, R.V.; Johnson, J.M.; Buchanan, C. and Marshall, H.G. (2006) Phytoplankton index of biotic integrity for Chesapeake Bay and its tidal tributaries. Estuaries Int. press, 29 (4): 598 – 616.
- ✓ Lavoie, I.; Hamilton, P.B.; Campeau, S.; Grenier, M. and Dillon, P. J. (2008) diatomées, Guide d'identificationdes rivières de l'Est du Canada. Presses de l'Université du Québec, Canada. 244 pp.
- ✓ Maulood, B.K.; Alobaidy, A.H.M.J.; Alsaboonchi, A.; Abid, H.S. and Alobaidy, G.S. (2011) Phytoplankton Index of Biological Integrity (P-IBI) in Several Marshes, Southern IRAQ. Journal of Environmental Protection, 2: 387-394.
- ✓ McCormick, F.H.; Hughes, R.M.; Kaufmann, P.R.; Peck, D.V.; Stoddard, J.L. and Herlihy, A.T. (2001) Development of an Index of Biotic Integrity for the Mid-Atlantic Highlands Region. Transactions of the American Fisheries Society, 130: 857–877.

- ✓ Nijboer, R. C.; Verdonschot, P. F. M. and van der Werf D. C. (2005) The use of indicator taxa as representatives of communities in bioassessment. Freshwater Biology, 50: 1427-1440.
- ✓ Olding, D.D. (2000) Algal Communities as a biological indicator of storm water management pond performance and function water quality Research Journal of Canada, 35 (3): 489 – 503.
- ✓ Prescott, G. W. (1973) Algae of the western Great lake Area. William. C. Brown Dubuque. 977 pp.
- ✓ Ramakrishnan, N. (2003) Bio -Monitoring Approaches for Water Quality Assessment In Two Water bodies At TiruvannamalaiTamil Nadu, India. Proceedings of the Third International Conference on Environment and Health, Chennai, India: 374 – 385.
- ✓ Shehata, S.A.; Badr, S.A.; Ali, G.H.; Ghazy M.M.; Moawad, A.K. and Wahba, S.Z. (2009) Assessment of Nile water quality via phytoplankton changes and toxicity bioassay test. Journal of Applied Sciences Research, 5 (12): 2083 – 2095.
- ✓ Simon, T.P. (1999) Introduction: biological integrity and use ecological health conceptsfor application to water resources characterization. In Assessing the Sustainability and Biological Integrity of Water Resources Using Fish Communities, Ed. T.P. Simon, CRC Press, Boca Raton, FL.
- ✓ Tatrai, I.; Olah, J.; Paulovits, G.; Matyas, K.; Kawieka, B. J.; Jozsa, V. and Pekar, F. (1997) Biomass dependent interactions in pond ecosystems: responses of lower trophic levels to fish manipulation. Hydrobiologia. 345: 117-129.
- ✓ Townsend, C.R.; Harper J.D. and Begon, M. (2000) Essentials of Ecology. 3rd Edi., Blackwell Science London, U.K.
- ✓ Wehr, J.D. and Sheath, R.G. (2003) Freshwater Algae of North America, Ecology and Classification. Academic Press, Elsevier Science (USA). 918 pp.
- ✓ Wu, J.T. (1984) Phytoplankton as Bioindicator for Water Quality in Taipei. Bot. Bull. Academic Sinica, 25: 205– 214.

.