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Evaluation of the water quality of the northern part of Khor Al Zubair lagoon using Index Biological Integrity of Phytoplankton (P-IBI)

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Abstract

The assessment of the health of the aquatic environment is considered an important matter, and one of these assessments is the use of the Index Biological Integrity of Phytoplankton (P-IBI). This study used this index in the northern part of Khor Al-Zubair lagoon waters and some environmental measurements (temperature, pH, oxygen, salinity, biological oxygen demand, nitrates and phosphates). The first station located at the beginning of the lagoon was classified as poor and with polluted water, as the index values ranged from (45-34). While the index values ranged from (62.5-45) in the second station, due to the sewage flows into the lagoon from the Shatt Al-Basra Canal, while the second station was able to absorb these pollutants.

Keywords: PIBI, lagoon,phytoplankton and Khor Al-Zubair

I. Introduction

Phytoplankton communities are an essential component of ecosystems in lagoons, playing a vital role in the overall ecological balance and acting as a sensitive indicator of environmental conditions. As the base of the food chain, they respond significantly to changes in water chemistry, nutrient levels, and other abiotic factors, making them an ideal indicator of the overall health of an aquatic ecosystem and the extent of environmental pollution. They serve as the foundation of the food web and produce a significant portion of the world's oxygen. Assessing the diversity and distribution of phytoplankton communities can provide valuable insights into the overall health and resilience of these ecosystems. (Setyaningrum *et al.*, 2020)

The concept of the Biological Integrity of Phytoplankton Index, which was pioneered by Karr *et al.* (1986) in the 1980s, has been widely adopted worldwide as a robust framework for assessing the ecological integrity of various water bodies (Pont *et al.*, 2019). The phytoplankton biomass index (PIBI) is a powerful tool that increases the sensitivity of phytoplankton to environmental changes as a means of assessing the ecological status of water bodies. It shows the species composition, diversity, functional organization, and relative abundance. The phytoplankton biomass index can therefore provide a comprehensive assessment of the overall health and status of lagoon ecosystems. (Erős *et al.*, 2023)

A key advantage of PIBI is its ability to detect early signs of environmental degradation, allowing for timely interventions and management strategies. It can be applied across a wide range of aquatic systems, from lakes and rivers to estuaries and coastal waters, providing a unified framework for assessing and monitoring water quality (Newton et al., 2018).

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The development of water quality indices like the 'universal water quality index' (Boyacıoğlu, 2009) has provided a comprehensive way to evaluate water quality based on various physicochemical and biological parameters. These indices allow for the quantification of "good" and "bad" water quality, and can be used as a tool to predict potential harmful conditions. (Dao *et al.*, 2020) The P-IBI, specifically, is a powerful tool for assessing the overall health of aquatic systems by evaluating the composition and structure of phytoplankton communities(Wang *et al*., 2017).

A study (Mahu *et.al.*, 2023) in Keta Creek in Guinea, West Africa, showed that the water quality therein was poor through the safety or biological integrity index, as the diversity of phytoplankton decreased, which confirms the poor health of the studied creek.

The study site, the northern part of Khor Al Zubair lagoon, is a crucial coastal ecosystem that has faced increasing anthropogenic pressures in recent years. Understanding the water quality in this region is essential for developing effective management strategies to protect the lagoon's ecological integrity.

II. MATERIALS AND METHODS

Description of study area

Khor Al-Zubair lagoon is located in southern Iraq, west of the city of Basra, between the 50′ longitude. It is one of the important bodies of water that overlooks 29' and 23' and two latitudes 58'northwest of the Arabian Gulf, which constitutes a waterway for maritime navigation, and is a suitable environment for the presence of many living organisms. The lower approaches to the creek are situated near the Kuwaiti island of Warba, approximately 8km southeast of Umm Qasr City. The total length of the canal is 40km, with a width ranging from 1km. The navigation channel reaches a depth of about 20m during the highest tide. Khor Al-Zubair is influenced by a tidal current system, covering an area of approximately 60km² **(Al-Ramadan, 1986)**. The prevailing tides in the northwest Arabian Gulf have an average speed of 0.9 to 1.09m/s, resulting in a mixed tidal system dominated by semi-daily tides and characterized by strong flow, reaching speeds of up to 1.28m/s. Two stations were selected for the study. The first station is located at the beginning of the lagoon (30°19'21" N, 47°49'7" E), which receives water from the Shatt al-Basra Canal, known for discharging agricultural drainage and sewage. The second station is about 12 kilometers from the first, opposite the port of Khor Al-Zubair (30°19'49" N, 47°88'93" E), where it is influenced by marine water. Samples were collected during the low tide periods in autumn and winter of 2023, and spring and summer of 2024

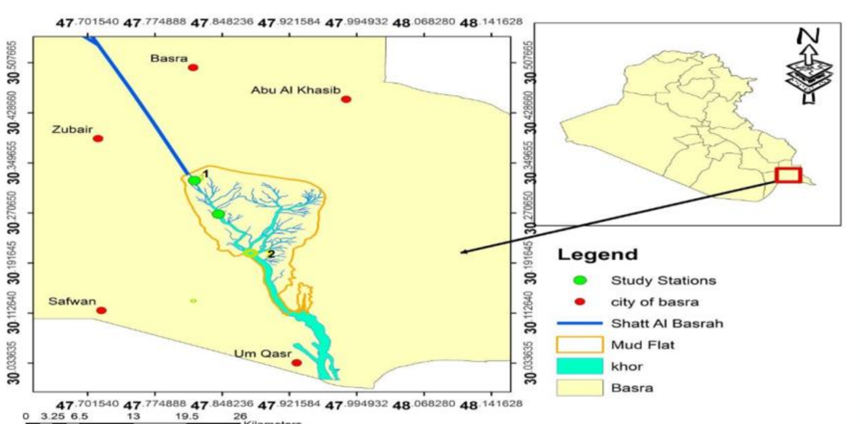

Fig. 1. Map of the study area showing the stations in Khor Al-Zubair lagoon

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Ecological measurements

Some environmental factors were measured, including water temperature, transparency (m), salinity (ppt), pH, PO4(mg/L), NO3(mg/L)and BOD5(mg/L) (APHA, 2005).

The sum of seasonal densities of each species was calculated to obtain the total density of species. Then species were arranged according to proper metrics. The phytoplankton metrics used for P-IBI included: phytoplankton density (cell/L3), phytoplankton biomass, richness index and the relative abundance (RA) of Bacillariophyceae, Chlorophyceae, Cyanophyceae, Euglenaphyceae

P-IBI calculation

Metric raw data were converted into metric scores after being submitted to a scale of thresholds of 3, 5 and 10 (Table1). The development of these thresholds was carried out according to(McCormick, Frank H., *et al*.2001) based on the historical data and professional judgment as recommended in EPA (Maulood,., *et al* 2011).. Threshold of high score 10 was given for metrics that have values equal or near to reference condition, 5 was given to those of medium or moderate conditions, while 3 was-given to those of worst or unhealthy conditions. Astin (2007) refer to these values as a good reflection of trophic status from the traditional measures. The sums of these metric scores for each studied Station were calculated monthly as the P-IBI.

Final index scores were grouped into four rating categories of "Excellent", "Good", "Fair", "Poor" and "Very Poor" as in Table 2 A value of rating categories close to 82 indicates that streams biology is healthy and equivalent to what would be found in a natural system condition, a value close to 56 reflect a poor biological status within the aquatic ecosystem. Table 3 illustrates the cutoff values for the final P-IBI scores and qualitative interpretation

The minimal and maximal cutoff values for each class represent the outcome of multiplying the minimal values (i.e., 3) and the maximal values (i.e., 10) scoring criteria. It collected the values of the metric scores and hit in ten then divided by the number of metric scores to ensure that the resulting number does not skip number 100 in any case.

$$\text{P-IBI}=\sum_j s\,\frac{1}{M}(\boldsymbol{EA}+\boldsymbol{CB}+\boldsymbol{RJ}+\boldsymbol{LM}+\boldsymbol{RA}+\ \boldsymbol{1ZB})*\boldsymbol{10}$$

M= number of metrics

EA= Phytoplankton Density metric score .

CB= R.A. of Cyanophyceae metric score .

RJ = R.A. of Bacillariophyceae metric score.

LM= R.A. of Chlorophyceae metric score .

RA= R.A. of Euglenaphyceae metric score .

ZB= Richness Index metric score

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Table 1. The Scoring Criteria

	Scoring Criteria		
Metrics	**10**	**5**	**3**
Phytoplankton Density	<369.9	369.9 - 16098	>16098
Phytoplankton Biomass	<0.4214	0.4214 – 24.4983	>24.4983
R.A. of Cyanophyceae	<0.4214	0.4214 – 24.4983	>24.4983
R.A. of Bacillariophyceae	>95.3%	47.7 – 95.3 %	<47.7
R.A. of Chlorophyceae	>26.91%	2.8 – 26.91%	<2.8%
R.A. of Euglenaphyceae	<0.3%	0.3 – 7.7%	>7.7 %
Richness Index	>4.77	1.12 – 4.77	<1.12

Table 2. Cutoff Values of IBI

Ecosystem Condition	**Metric IBI Score**
Excellent	<82
Good	72-82
Fair	56-72
Poor	>56

III. Results and Discussion

The lowest water temperatures were recorded in winter, while they were high in summer, reaching (32 and 33.5) for the first and second reservoirs, respectively. The current study recorded higher values in water temperatures compared to some previous studies (Al-Handal and Al-Rekabi, 1994 ,Hussin *et al*.,2010., Al- Shaheen and Abdullah.,2022). The current study recorded pH values in the basic direction throughout the study period and for the two stations in the range (8.8-8.2), due to their influence by seawater coming from the Arabian Gulf and containing

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bicarbonate ions (Sabah 2007). The first station recorded higher values compared to the second station as a result of its direct and close influence from the discharge of the Shatt al-Basra Canal, which is affected by the discharge of sewage and agricultural drainage water, which contains high concentrations of bicarbonates, carbonates, and cleaning materials that contain many alkalis (Gatea *et al.*, 2018). The current study recorded, especially in the second station, high levels reaching 50 ppt during the summer due to high evaporation due to the increase in climate temperatures in recent years, in addition to the continuous increase in salts due to human activity and untreated sewage water (Hassan et al., 2018). Accordingly, Khor Al-Zubair has turned into a highly saline khor, which is consistent with the study of (Al-Shawi 2010). As for the decrease in salinity values during the winter and spring seasons, it is due to rainfall in them. The first station recorded lower values than the second due to its direct influence by the Shatt Al-Basra Canal, which causes a reduction in salinity. The first station recorded low values in the summer and fall seasons and dangerously, reaching low levels (2.5 mg/L) that threaten the existence of fish. The US Environmental Protection Agency confirmed the National Resources Surveys (NARS, 2024) that dissolved oxygen levels less than 5 mg/L are generally considered stressful to fish, and levels less than 3 mg/L threaten the survival of fish. Dissolved oxygen levels less than 1 mg/L are considered lifeless. The reason for the low oxygen levels was the flows coming from the Shatt al-Basra Canal affected by untreated sewage water (Heydarzadeh *et.al.*, 2022)The highest oxygen levels were achieved in the spring for both stations due to moderate temperatures and the activity of phytoplankton in this season, which recorded the highest primary productivity (Howerton, 2001)Tab 3and4.

Table 3. Seasonal changes of Temperature, salinity, pH and oxygen values at the first station

Season	Tem.°C	Oxygen mg/L	pH	Salinity ppt
Autumn 2023	23.6	4.5	8.6	45
Winter 2023-2024	15.6	6	8.2	42
Spring 2024	20.5	6.5	8.4	41
Summer 2024	32	2.5	8.8	45

Table 4. Seasonal variations of Temperature, salinity, pH and oxygen values at the second station

Season	Tem.°C	Oxygen mg/L	pH	Salinity ppt
Autumn 2023	25.7	6.5	8.2	49
Winter 2023-2024	15.1	6.5	8.3	46
Spring 2024	21.4	7.5	8.3	45
Summer2024	33.5	6	8.4	50

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The effect of the Shatt al-Basra channel flows was clear on the concentrations of nutrients nitrates and phosphates which were high especially in the first station because of these flows which contain high concentrations of nutrients. Sfriso *et.al.*,1992 explained that the creeks are exposed to a large amount of pollutants through the drainage of cultivated lands, sewage water, industrial waste and their nutrient loading, thus affecting their primary productivity and the composition of algae species through his study on Venice lagoon. The phosphate concentration reached 6.3 mg/L in the first station fig 2and3.

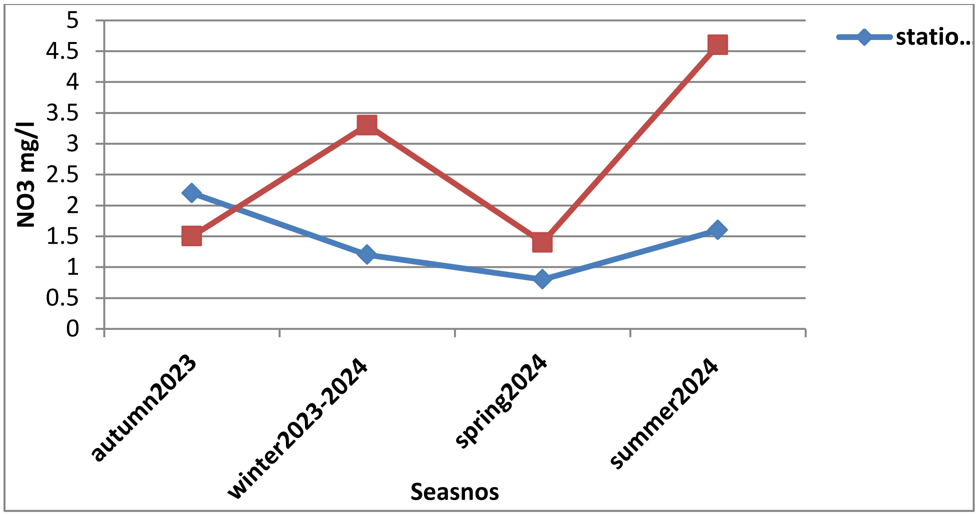

Fig.3. Seasonal variations of nitrate concentrations at the two study stations.

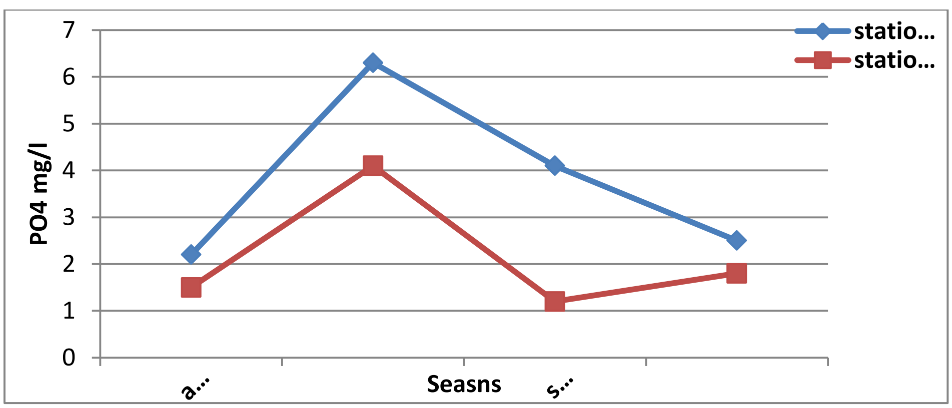

Fig. 5. Seasonal variations of phosphate concentrations at the two study stations

Biological oxygen demand (BOD5) is basically an approximate measure of the concentration of biologically active organic matter as a factor in water pollution and is considered an indicator of the level of pollution of water bodies and their quality (Rudaru *et al.*, 2022). The first station is considered severely polluted with sewage water, as it reached 18.5 mg/L in the summer, while the second station is moderately polluted with sewage water as a result of their being affected by the Basra Canal water agreements based on the division (Paquin, and Cosgrove 2016).

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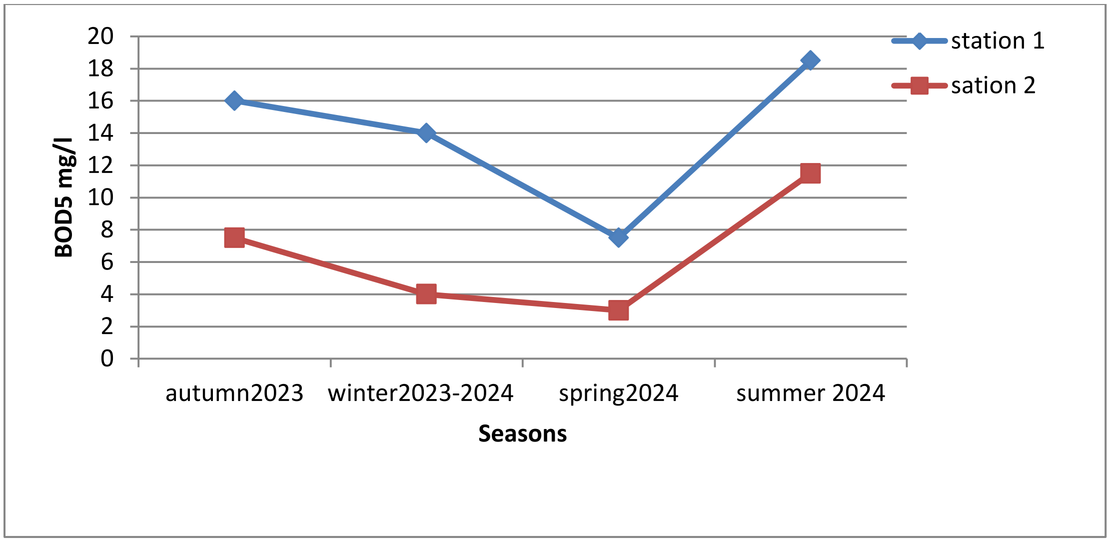

Fig.6. Seasonal variations Biological oxygen demand (BOD5) **at the two study stations**

The highest numerical values of phytoplankton were in the spring and autumn blooming seasons at both stations fig.7. This is due to moderate temperatures, availability of nutrients and other environmental factors(Soong *et.al.*,218). Higher total cell counts may be attributed to the high nutrient values received as domestic disposal that discharge in these stations (Hassan.1993)

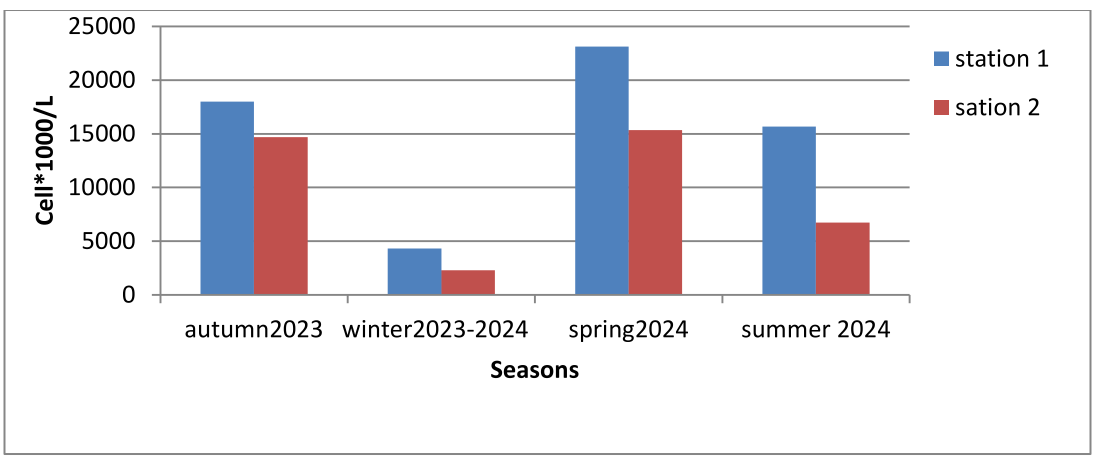

Figure 7. Seasonal variation of the total number of phytoplankton (Cell*103/L) for all stations.

The total biomass of phytoplankton, determined by factors such as nutrient availability, light exposure, and grazing pressure, exerts a profound influence on the overall structure and function of aquatic trophic networks. (Liu *et al.*, 2023) . Shallow freshwater ecosystems in the circumpolar Arctic, for example, are strongly regulated by the supply and optical properties of dissolved organic matter, which can affect bacterial diversity, productivity, and the balance

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between pelagic and benthic primary production (Rautio *et al.*, 2011). If the first station recorded higher values than the second station throughout the study period, the value of the index used would thus be reduced fig 8.

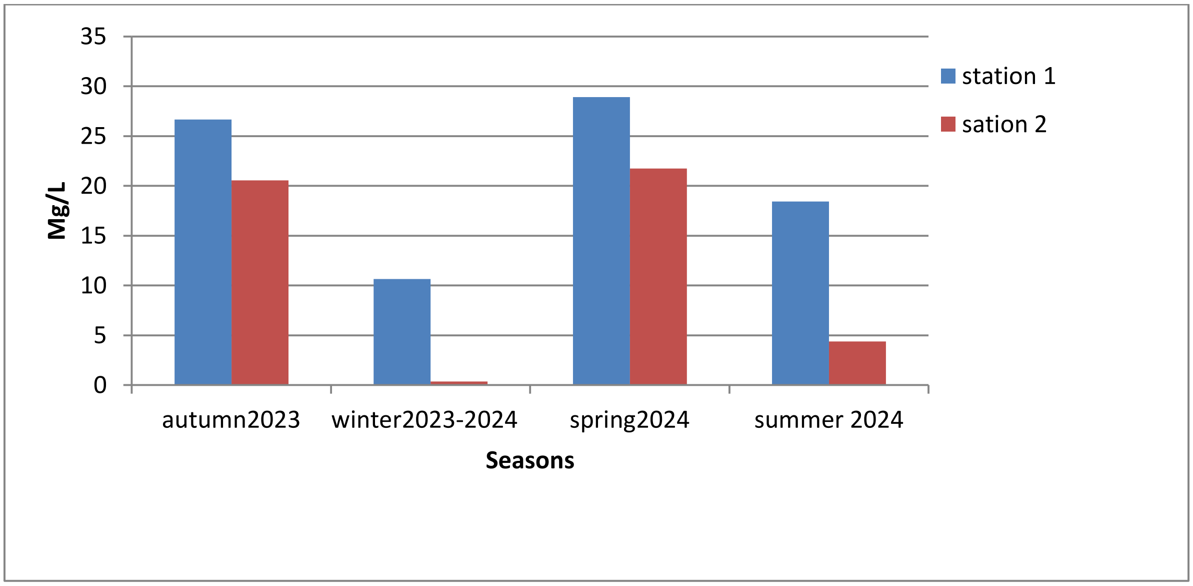

Figure 8. Seasonal variation of the total biomass of phytoplankton (mg/l) for all stations.

Higher values of the species richness index were recorded at the second station, indicating good environmental conditions favorable to the development of many species, while the first station recorded low values, indicating a disturbance in the qualitative composition of phytoplankton. Deppeler, and Davidson,(2017)fig9.

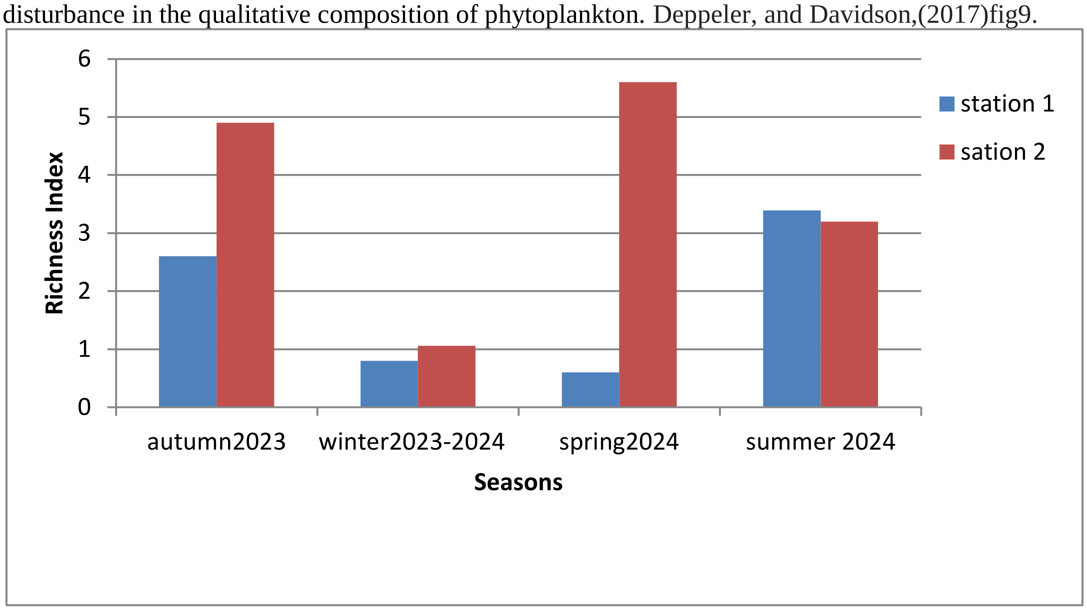

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Figure.9 Seasonal variation of the Richness Index for all stations.

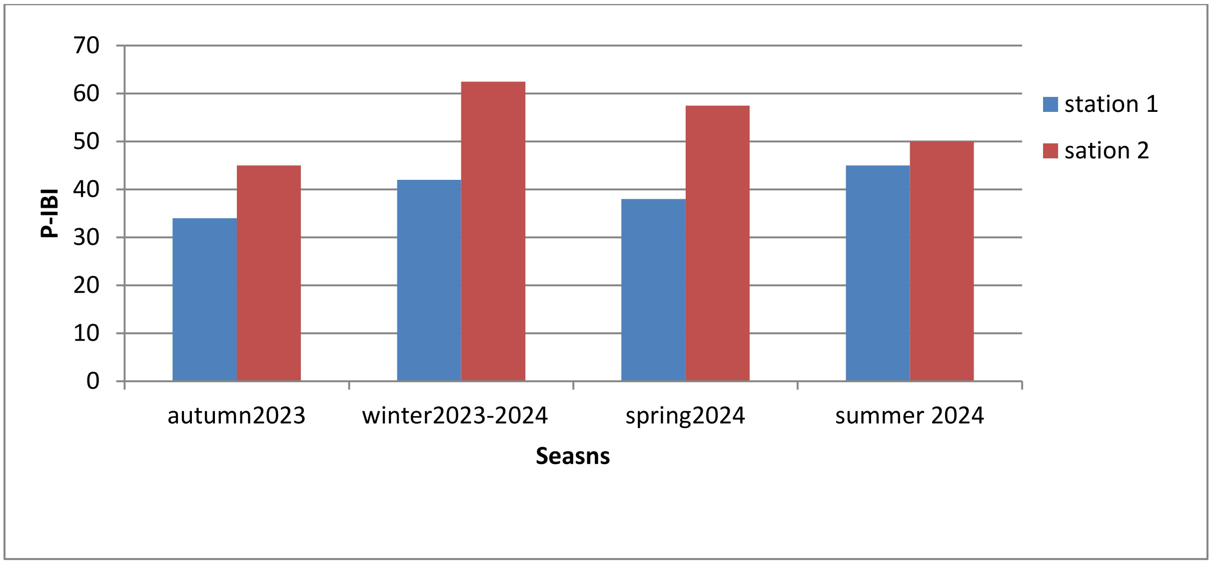

Figure 10. Seasonal P-IBI scores for the studies stations

The types of P-IBI index indicate that the health of the first station's environment is poor throughout the seasons due to the flows from the polluted Shatt al-Basra Canal and the hydrodynamic strength of the water entering from that canal. High densities of some types of blue-green algae were found that reduce the values of this index, as well as the lack of diversity of other types of green algae or euglena that can be attributed to raising the values of this index. As for the second station, its values ranged from poor to fair due to the polluted water from the canal, but it is capable of improving the health of this environment, and this was clear through the dominance of marine diatoms, i.e. coming from the Arabian Gulf fig 10.

IV. Conclusion

The first station is considered poor and the second station is between poor and fair based on the **P-IBI**. Also, the first station is considered to have a poor environment due to its high values of the Biological oxygen demand and nutrients, while the second station was able to restore the health of the environment.

V. Acknowledgment

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VI. References

Al-Handal, A. Y., & Al-Rekabi, K. M. (1994). Diatoms of Turbid Lagoon in The North-West Arabian Gulf. Riv. Idrobiol, 33(1), 2-3.

Al-Ramadan, B. (1986). Introduction to marine physics in Khor Al-Zubair. Classification of Khor Al-Zubair. Proceedings of the first symposium on the marine nature of Khor Al-Zubair: (Publications of the Marine Science Center - University of Basrah, (7): 11-20.

Al-Shaheen, M. A., & Abdullah, D. S. (2022). Occurrence of Five Diatom Species in Khor Al-Zubair Lagoon, Southern Iraq with a new record of Cyclotella litoralis Lange & Syvertsen, 1989 Basrah J. Agric. Sci. 35(2), 24-33

Al-Shawi, I. (2010). An environmental and taxonomic study of plankton in Khor Al-Zubair with an estimation of petroleum hydrocarbon levels. PhD thesis,University of Basrah, 148pp

APHA.(American public Health Association) (2005). "Standard methods for the examination of water and waste water" 21st edition. Washington, DC. 1400pp.

Astin, L. E. (2007). Developing biological indicators from diverse data: The Potomac Basin-wide Index of Benthic Integrity (B-IBI). *Ecological Indicators*, *7*(4), 895-908.

Boyacioglu, H. (2007). Development of a water quality index based on a European classification scheme. *Water Sa*, *33*(1).

Dao, V., Urban, W., & Hazra, S. B. (2020). Introducing the modification of Canadian water quality index. *Groundwater for Sustainable Development*, *11*, 100457.

Deppeler, S. L., & Davidson, A. T. (2017). Southern Ocean phytoplankton in a changing climate. *Frontiers in Marine Science*, *4*, 40.

Erős, T., Hermoso, V., & Langhans, S. D. (2023). Leading the path toward sustainable freshwater management: Reconciling challenges and opportunities in historical, hybrid, and novel ecosystem types. Wiley Interdisciplinary Reviews: Water, 10(3), e1645

Hassan, B., Chatha, S. A. S., Hussain, A. I., Zia, K. M., & Akhtar, N. (2018). Recent advances on polysaccharides, lipids and protein based edible films and coatings: A review. International journal of biological macromolecules, 109, 1095-1107.

Hassan, F. M. (1997). A limnological study on Hilla river. *Al-Mustainsiria J. Sci*, *8*(1), 22-30.

Heydarzadeh, R., Tabesh, M., & Scholz, M. (2022). Dissolved oxygen determination in sewers using flow hydraulic parameters as part of a physical-biological simulation model. Journal of Hydroinformatics, 24(1), 1-15.

Howerton, R. (2001). Best management practices for Hawaiian aquaculture.

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ISSN Onlin:2708-9347, ISSN Print: 2708-9339 Volume 14, Issue 1 (2025) PP 252-263

https://doi.org/10.54174/utjagr.v13i1.323 https://iasj.rdd.edu.iq/journals/journal/view/388

Hussein, S.A.; Al-Shawi, I.J. and Abdullah, A.M. (2010). The impact of some environmental characteristics on the qualitative composition of phytoplankton and copepods community in the Khor Al-Zubair - North West Arabian Gulf. Basrah Journal of Science, 28(2): 155-177.

Karr, J. R., Fausch, K. D., Angermeier, P. L., Yant, P. R., & Schlosser, I. J. (1986). Assessing biological integrity in running waters. *A method and its rationale. Illinois Natural History Survey, Champaign, Special Publication*, *5*, 1-28.

Liu, F., Gaul, L., Giometto, A., & Wu, M. (2023). Colimitation of light and nitrogen on algal growth revealed by an array microhabitat platform. *ArXiv*.

Mahu, E., Danso, P., Edusei, M. O., & deGraft-Johnson, K. A. A. (2023). Impact of agricultural practices on ecosystem health of lagoons: a case study of the Keta Lagoon Complex in Ghana, West Africa. Environmental Monitoring and Assessment, 195(5), 622.

Maulood, B. K., Alobaidy, A. H. M. J., Alsaboonchi, A., Abid, H. S., & Alobaidy, G. S. (2011). Phytoplankton index of biological integrity (P-IBI) in several marshes, Southern Iraq. *Journal of Environmental Protection*, *2*(04), 387.

McCormick, F. H., Hughes, R. M., Kaufmann, P. R., Peck, D. V., Stoddard, J. L., & Herlihy, A. T. (2001). Development of an index of biotic integrity for the Mid-Atlantic Highlands region. *Transactions of the american Fisheries Society*, *130*(5), 857-877.

Newton, E. R., Mondrik, N., Irwin, J., Winters, J. G., & Charbonneau, D. (2018). New rotation period measurements for M dwarfs in the Southern Hemisphere: An abundance of slowly rotating, fully convective stars. The Astronomical Journal, 156(5), 217

Paquin, M., & Cosgrove, C. (2016). The United Nations World Water Development Report 2016: Water and jobs. UNESCO for UN-Water.

Pont, C., Leroy, T., Seidel, M., Tondelli, A., Duchemin, W., Armisen, D., ... & Salse, J. (2019). Tracing the ancestry of modern bread wheats. Nature genetics, 51(5), 905-911.

Rautio, M., Dufresne, F., Laurion, I., Bonilla, S., Vincent, W. F., & Christoffersen, K. S. (2011). Shallow freshwater ecosystems of the circumpolar Arctic. *Ecoscience*, *18*(3), 204-222.

Rudaru, D. G., Lucaciu, I., & Fulgheci, A. M. (2022). Correlation between BOD5 and COD– Romanian Journal of Ecology & Environmental Chemistry, 4(2),biodegradability indicator of wastewater.

Setyaningrum, W., & Yanuarita, H. A. (2020). Pengaruh covid-19 terhadap kesehatan mental masyarakat di Kota Malang. JISIP (Jurnal Ilmu Sosial Dan Pendidikan), 4(4)

Sfriso, A., Pavoni, B., Marcomini, A., & Orio, A. A. (1992). Macroalgae, nutrient cycles, and pollutants in the Lagoon of Venice. Estuaries, 15(4), 517-528.

Song, W., Xu, Q., Fu, X., Zhang, P., Pang, Y., & Song, D. (2018). Research on the relationship between water diversion and water quality of Xuanwu Lake, China. *International Journal of Environmental Research and Public Health*, *15*(6), 1262.

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https://doi.org/10.54174/utjagr.v13i1.323 https://iasj.rdd.edu.iq/journals/journal/view/388

Wang, X., Zhang, F., & Ding, J. (2017). Evaluation of water quality based on a machine learning algorithm and water quality index for the Ebinur Lake Watershed, China. *Scientific reports*, *7*(1), 12858.

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