

Variation of water quality parameters and correlation with catch per unit effort of oriental river prawn (*Macrobrachium nipponense*) in Anzali Lagoon, Iran

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ABSTRACT

Water quality in freshwater bodies is involved by multiple aspects such as physical, chemical, and biological processes and their interactions. It is vital for aquatic species' survival and growth. This study investigated to assess water quality parameters and the correlation between the water quality parameters and catch per unit effort for oriental river prawn (*Macrobrachium nipponense*). During 2015 (from January to December), we sampled water and specimens of *M. nipponense* simultaneously from the Anzali lagoon. All physicochemical parameters were sampled and determined according to standard methods. The results showed the correlations (Fig. 2) between CPUE with physicochemical variables were significant and strong. The highest positive correlations were found between CPUE and temperature ($R^2 = 89$, $P < 0.05$). The CCA results indicate the CPUE mainly was affected by water temperature and pH. The CCA results clearly separated all sites based on water quality.

INTRODUCTION

The Anzali Lagoon is located on the southern coast of the Caspian Sea in the Guilan province. Nineteen rivers enter the Anzali lagoon, connected to the Caspian Sea (Aminisarteshnizi, 2021). These rivers pass through forests, urban and rural areas, and because of that, the rivers carry a variety of organic, mineral, sedimentary materials, domestic, industrial, and agricultural effluents. Water quality has drastically deteriorated due to the constant industrial, agricultural, and domestic waste disposal in the rivers; the rivers affect Anzali lagoon ecosystems (Fallah & Zamani-Ahmadmoodi, 2017). Anzali lagoon is vital for the spawning and nursery of fish and aquatic species.

Oriental river prawn (*M. nipponense*) is natively distributed in the west of Asia, while the population of *M. nipponense* in the Anzali lagoon was recorded in 2006 (De Grave & Ghane, 2006) and later on spread in northern Iran's water basins

(Aminisarteshnizi, 2021). This species belongs to the phylum of Arthropoda (Order: Decapoda; Family: Palaemonidae (De Haan, 1849).

Catch per unit of effort (CPUE) is essential in fisheries sciences. It provides means to monitor population size trends and the relative abundance of species in different habitats and sites. It is well established that various environmental factors can influence CPUE. For example, Fuwa (1994) showed profound seasonal variation.

Effective management for incising water quality effects on increasing all aquatic species populations and consequently increased catch per unit effort can be achieved. Therefore, the study's objectives were to 1- assess the variation of selected water quality parameters and 2- determine the correlation between water quality parameters and catch per unit effort (CPUE) for *M. nipponense* in the Anzali lagoon.

MATERIALS AND METHODS

Study area

In this study, three localities were used, namely Site 1 (GPS coordinates: 37° 47' 026.42" N and 49° 34' 307.12" E) and Site 2 (GPS coordinates: 37° 41' 2998.45" N and 49° 41' 6902.1" E) Site 3 (GPS coordinates: 37° 44' 2998.45" N and 49° 44' 6902.1" E) (Figure 1).

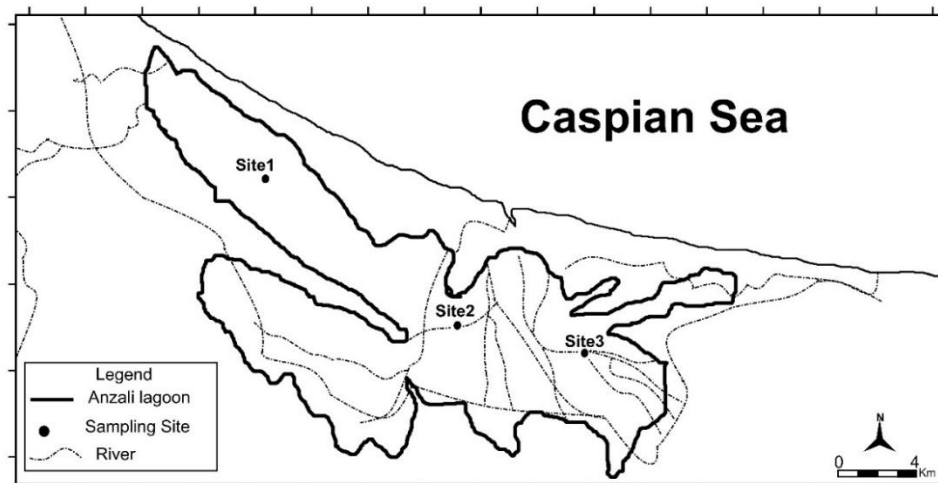


Figure 1. Sampling area for *M. nipponense* in Anzali Lagoon, Iran.

Specimens sampling

Eighteen (18) traps were randomly selected for the three sites in the Anzali lagoon. All the traps were used simultaneously to sample prawns in this study. The traps were checked every 24 hours, and the samples were collected in the morning for twenty (20) nights per month for twelve (12) months during 2015. All traps were set baited by bread.

Catch per unit effort

Collected samples were removed, placed in iceboxes, and transferred to the laboratory for further analyses. Total weight was measured on a digital scale with 0.1 g accuracy. CPUE was computed by using the following equation (**White, 1987**):

$$\text{CPUE} = \text{Total catch} / \text{Unit Effort}$$

Unit Effort = Traps \times Long-lasting trap in the water (24 h), Total catch = Total weight of the catch

Determination of Physicochemical Parameters

All the sampling trips were between 8:00 a.m. and 12:00 noon, local time. Water samples were stored and refrigerated at 4°C for later laboratory analysis. All physicochemical parameters were sampled and determined according to standard methods. Water temperature (°C), dissolved oxygen, and pH were measured in situ using the calibrated multi-parameter meter (Multiprobe, Hach HQ40d). Water samples were collected using Nalgene bottles (1000 mL). The other parameters like biochemical oxygen demand (BOD₅), total dissolved solids (TDS), total PO₄, NO₃, faecal coliform bacteria, and turbidity were analyzed in the laboratory as per the standard procedure of **APHA (1995)**.

Statistical methods

Canonical correspondence analysis (CCA) was used to analyze catch per unit effort (CPUE) for prawns across the environmental gradients measured. These multivariate ordination analyses were carried out with XLSTAT2020 software.

Correlations between ecological factors and catch per unit effort (CPUE) for prawns were tested by parametric Spearman correlation coefficient. Analyses were performed with R v2.9.0.

RESULTS

Correlations between different indices

The correlations (Fig. 2) between CPUE with physicochemical variables were significant and strong. The highest positive correlations were found between CPUE and temperature ($R^2 = 89$, $P < 0.05$). Furthermore, CPUE positively correlated with pH and DO ($P < 0.05$). The results showed that temperature increases (positive correlation) during the summer, then we increased the weight. The individual number of prawns subsequently causes an increase in CPUE.

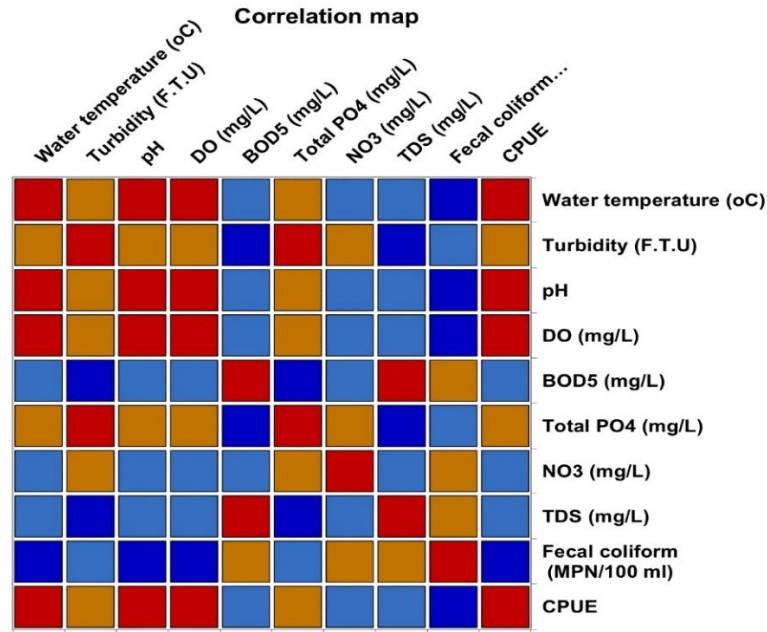


Figure 2. Correlation map of the different water quality factor and CPUE parameter for *M. nipponense* in Anzali lagoon.

CCA analysis

The CCA results indicate that our set of variables explained 100% of the variability with the first two axes (Fig. 4). The first principal component (F1) explained 55.56% of the total variance and was positively correlated to faecal coliform bacteria, BOD and TDS, negatively correlated with pH, water temperature, and turbidity. The F2 was positively correlated to NO₃ and negatively correlated with DO. At the same time, F2 explains 40.38% of the variance (Fig. 3). The CPUE was mostly affected by pH and water temperature. The CCA results showed a clear separation among all sites. Site 1 was mostly affected by DO, site 2 turbidity, and site 3 NO₃.

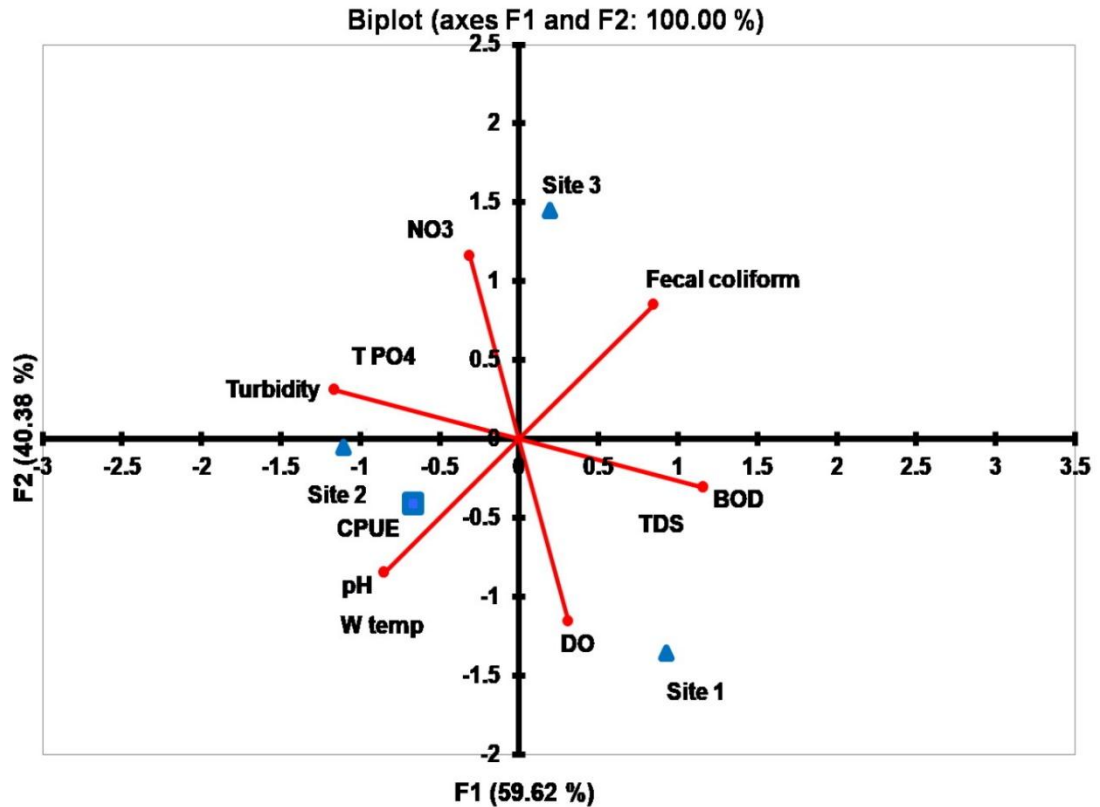


Figure 3. Canonical correspondence analysis of *M. nipponense* in Anzali lagoon. The environmental variables are indicated with arrows, sites are marked with triangle symbols, and CPUE is marked with square symbols. W Temp = Water temperature, DO = dissolved oxygen, BOD = Biochemical Oxygen Demand, T PO₄ = Total PO₄, TDS = Total Dissolved Solids, NO₃ = Nitrate.

DISCUSSION

Water quality indices are being developed and used worldwide due to their simplicity, adaptability, and easy-to-use nature. Due to the vulnerability of water resources, quality control of surface water is one of the key issues in environmental conservation programs. In recent years, the Anzali lagoon has been exposed to numerous threats, including environmental pollutants (Yancheshmeh *et al.*, 2014). Water quality in freshwater bodies is involved by multiple aspects such as physical, chemical, and biological processes and their interactions (Fallah *et al.*, 2018).

The temperature impressed the growing, breeding, and prawning of *M. nipponense*. *Macrobrachium* species is considered a tropical species requiring water temperatures of 26 to 31⁰ C (Sandifer & Smith, 1985). However, the optimum temperature for rapid growth rates is 25⁰C. In this study, when the temperature was 25.9 -

27.5 °C, we had the highest CPUE. Prawns can survive winter under natural conditions, but they do not grow during the low temperature (New *et al.*, 2010).

The results show that the relationship between temperature and CPUE was significant and strongly positive. In addition, temperature affects feeding, mating, spawning rates, and growth patterns (New *et al.*, 2010). Mirzajani *et al.* (2020) reported during the warm season, *M. nipponense* grows more due to the abundance of food. They indicated that 99% of *M. nipponense* had empty stomachs during the winter. Due to the abundance of food, suitable temperature, and spawning, the number of *M. nipponense* was higher in hot seasons; therefore, CPUE became high.

In the Anzali lagoon, reproduction occurs in spring and summer when males with a hard shell and females with a soft one mate together (Wakefield, 2015). New *et al.* (2010) noted the breeding season for *M. nipponense* was from May to July. They indicated during the spawning time, the prawn did not have feeding. In this study, the CPUE was low from April to July due to spawning at this time.

Moraes-Riodades *et al.* (2006) reported the minimum and maximum values of pH variables in *M. amazonicum* rearing ponds were 7.3-8.1. In this study, pH was 7.8-8.7. pH was in the range, but the salinity went up in some parts of the Anzali lagoon, which was not suitable for adults. Water plays a significant role in maintaining ecosystem health. A Survey of water physicochemical factors helps to understand the ecosystem's health and all organisms living in it (Kannel *et al.*, 2007). New *et al.* (2010) reported water quality for *M. nipponense* larvae was essential and sensitive. They showed the best water temperature ranged from 29 to 33°C, DO 4.3 to 5.1 mg/L, and pH 8.4 to 8.5. In Anzali lagoon, DO was 3.9-6.9. DO was lower than the optimum range. The result showed that depth, turbidity, and DO are more affected in the Anzali lagoon during the rainy season because of urbanization, agricultural drainage, and sediment influx (Yancheshmeh *et al.*, 2014).

CONCLUSION

In conclusion, water quality affected CPUE in *M. nipponense*. Anzali lagoon had a good ecological condition for growing, breeding, and prawning of *M. nipponense*. But the eastern part of the Anzali lagoon has a very low water quality which is not suitable for growing, breeding, and prawning. The pH was unsuitable for adults in the western part of the Anzali lagoon, especially when the salinity was high. This part is more suitable for nursery time. The central part of the Anzali lagoon was suitable for *M. nipponense*, for which we had the highest CPUE. With water management and suitable attendance of the Anzali lagoon ecosystem, *M. nipponense* can have a good population for stable CPUE in the Anzali lagoon. Besides, this prawn creates jobs and income for local fishers.

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