Investigating Environmental Influences on Blue Crab Dynamics in a Changing Bay

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Introduction

The Blue Crab (Callinectes sapidus) is native to the Chesapeake Bay and represents an ecologically and economically important species. Understanding how environmental factors influence the Blue Crab population is important for future management.

The Blue Crab Survey (BCS;1968 to present) was initiated by George Abbe to investigate the effects of a nuclear power plant on the Blue Crab population. Due to the longevity of the survey direct evidence of a change in a population can be provided.

In this study, I examined water quality data: water temperature, salinity, and dissolved oxygen, to explore how these variables may affect Blue Crab population dynamics. Environmental variables are compared to the survey CPUE (Catch Per Unit Effort), a metric of relative abundance that accounts for fishing effort.

Annual and monthly environmental trends and their relationship with BCS CPUE were analyzed from 2002-2024.

Study Site

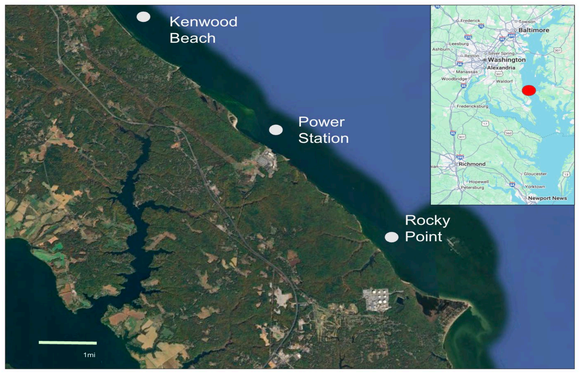


Figure 1. Map of the study area on the Western shore of southern Maryland Chesapeake Bay, showing the three sampling sites: Kenwood Beach (KB), Power Station (PS), and Rocky Point (RP). Environmental data was collected at each site to assess trends affecting blue crab populations.

Methods

Sampling Timeframe: June-November, 1968-2025
- This project used data from 2002-2024

Survey Gear: Commercial peeler crab pots with 1-inch galvanized-mesh, two entrance funnels, and no cull rings

Bait: Menhaden

Frequency: 10 pots at 3 sites (RP, PS, KB) are fished every other week in middle Chesapeake Bay

Data: Dissolved Oxygen (mg/L), Temperature (degrees Celsius), Salinity(ppt), Crab Count, Sex, Width, and Weight

CPUE: Crab Count/Number of Pots Fished

Results

In summer months there was a consistent increase in water temperature from 2002-2024 . However, in the later months, temperatures generally remain level (Figure 2).

Figure 2

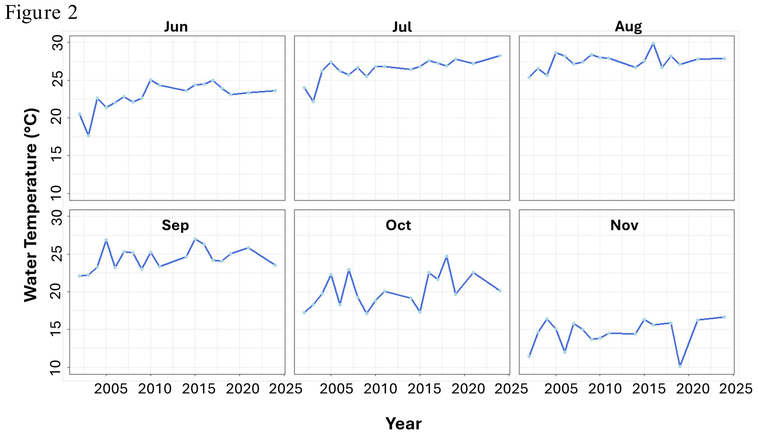


Figure 2. Monthly water temperature (°C) 2002–2024, averaged across all sampling sites and surveys.

From July to November, the dissolved oxygen levels rise by month, showing highest levels in November (Figure 3).

Figure 3

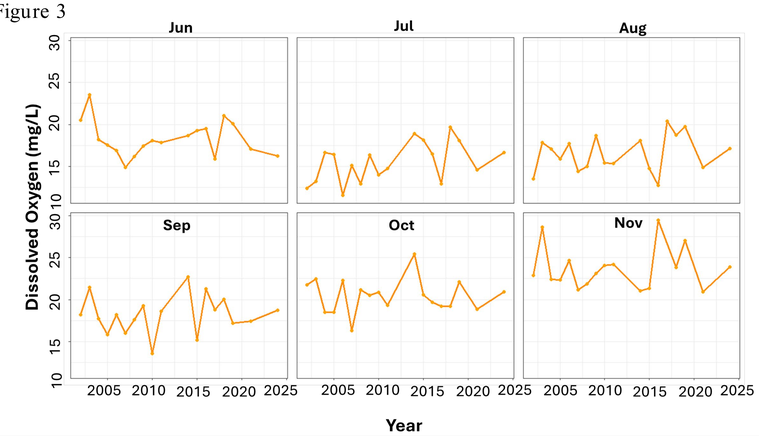


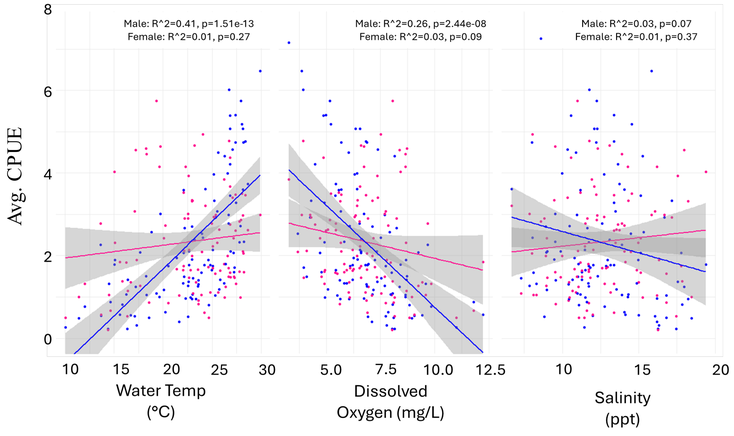
Figure 3. Monthly dissolved oxygen (mg/L) 2002-2024, averaged across all sampling sites and surveys.

Male CPUE showed a strong positive correlation with water temperature and a significant negative correlation with dissolved oxygen (D.O.). Female CPUE had weak positive correlations with temperature and salinity, and a weak negative correlation with D.O. (Figure 4).

Figure 4. Monthly average male (blue) and female (pink) CPUE plotted against salinity, dissolved oxygen, and water temperature. Lines represent linear regressions with 95% confidence intervals shown in gray shading.
Figure 5a and 5b. Monthly faceted scatterplots of male and female CPUE against dissolved oxygen and water temperature, highlighting seasonal patterns and differences in environmental associations between sexes

Male ------- Female -------

Figure 4



The strongest temperature-CPUE correlations occur in July and August. Female trends shifted from positive in August to negative in September (Figure 5a). Male and female responses to D.O. were generally similar, with exceptions in June and October (Figure 5b).

Figure 5a

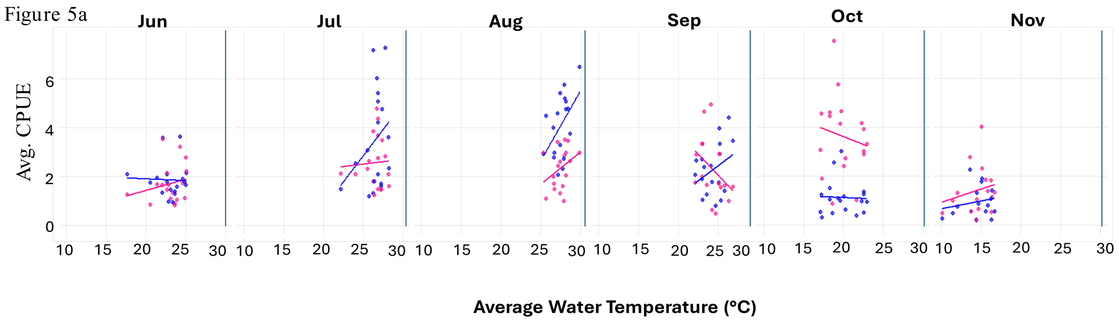
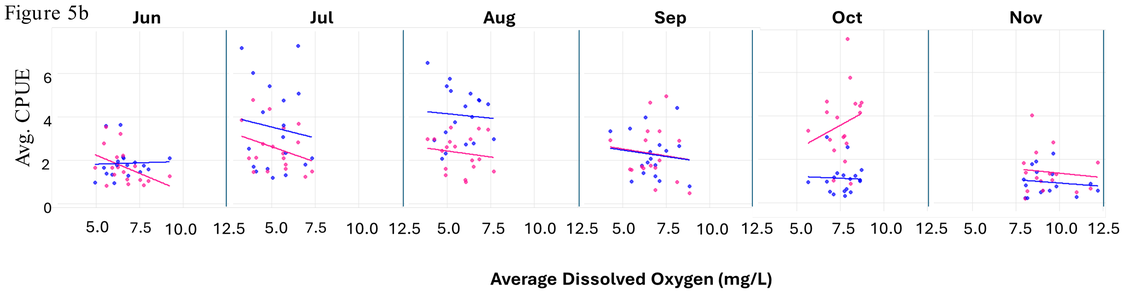


Figure 5b



Summary

- Overall, males show stronger trends in CPUE over time compared to females (Figure 5a, Figure 5b) suggesting that males are more vulnerable to environmental influences
- Both environmental plots highlight seasonal patterns and potential long-term environmental changes in Chesapeake Bay tributaries (Figure 2, Figure 3)
- Trends in Figure 4 indicate males may have greater overall sensitivity to environmental variation compared to females – thus, males may serve as a better indicator species for short-term environmental changes

Next Steps

Next Steps: Future analyses exploring the influence environmental factors have on male and female CPUE could include applying new statistical approaches and interpreting the ecological implications of these findings. Multivariate models can investigate whether combined environmental factors affect Blue Crab abundance. Additional analyses of sex-specific responses may suggest differing vulnerabilities that could help with more accurately targeted management.

References

Mistiaen, J. A., Strand, I. E., & Lipton, D. (2003). Effects of environmental stress on blue crab (Callinectes sapidus) harvests in Chesapeake Bay tributaries. Estuaries, 26(2), 316–322.

Acknowledgements

This work was supported by the 2023 Congressionally Directed Spending through Morgan State University's PEARL Lab.