Diverging Weight-Width Trajectories Among Male Blue Crabs Reveal Sex and Class Specific Trends in the Chesapeake Bay

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Introduction

The Blue Crab (*Callinectes sapidus*) is a Chesapeake Bay native that is highly valued in the seafood market. The PEARL Blue Crab Survey (BCS) began in 1968 to identify any negative effects of waste heat discharge from the nuclear power plant in Calvert County, Maryland. The study has since evolved into a long-term monitoring project focused on Blue Crab population dynamics. The survey methods have remained consistent and the BCS is the longest-running fishery-independent survey of the Blue Crab population on the East Coast of the United States. Since 2002, a subsample of individually weighed and measured crabs has provided data on carapace width and total weight.

In crustacean studies, the carapace width to weight relationship is a condition factor that is used to assess crab growth and health (de Carvalho-Souza et al. 2023). This study analyzed the width-weight relationship for Blue Crab using the long-term BCS subsample dataset.

Study Site

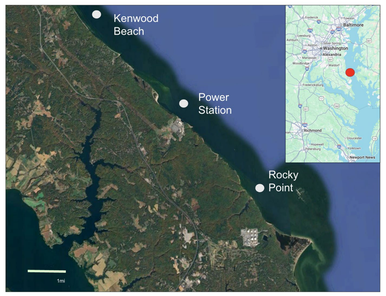

Figure 1. A map of the survey locations on the Western shore of the Chesapeake Bay in Southern Maryland. Circles represent sampling sites.

Methods

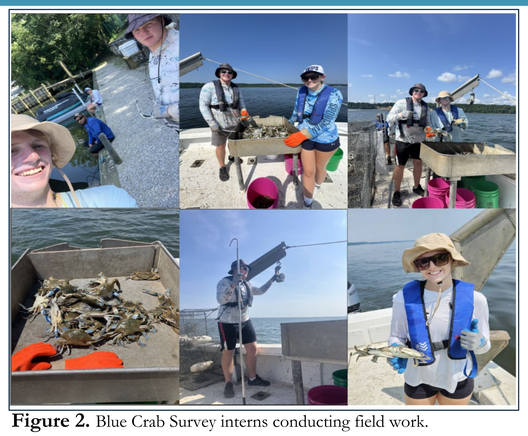

Figure 2. Blue Crab Survey interns conducting field work.

- **Sampling:** Biweekly sampling from June-November
- **Bait:** Menhaden
- **Gear:** Historical commercial peeler pots with 1-inch galvanized hexagonal mesh, two entrances, no cull rings
- **Frequency:** Two, full-day samples are performed over the span of 3 days (weather-dependent) using 10 pots per station
- **Data:** Crabs are sexed, measured to the nearest 1/8th inch, and weighed in aggregate by sex; total counts recorded by sex
- **Subsample:** Subsamples of 10 males and 10 females (smallest, largest, and representative sizes) are individually weighed and measured for each site

Results

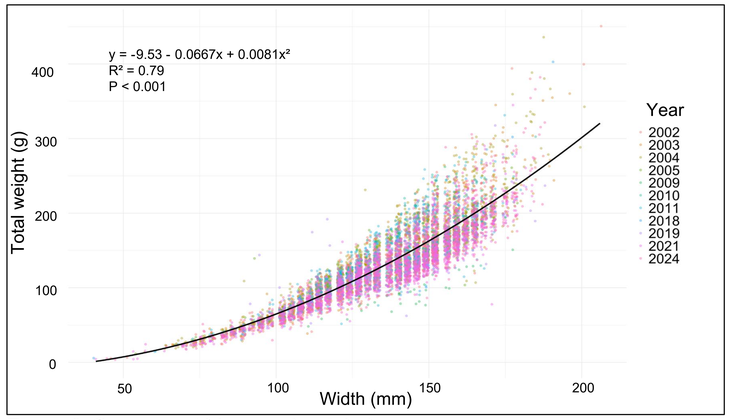

Figure 3. Carapace width vs total weight by year. Total weight increases with carapace width, and this relationship is used to calculate weight per width (g/mm). A quadratic model was used to better capture this relationship. Individual measurements are jittered along the x-axis to show masked points due to overlap.

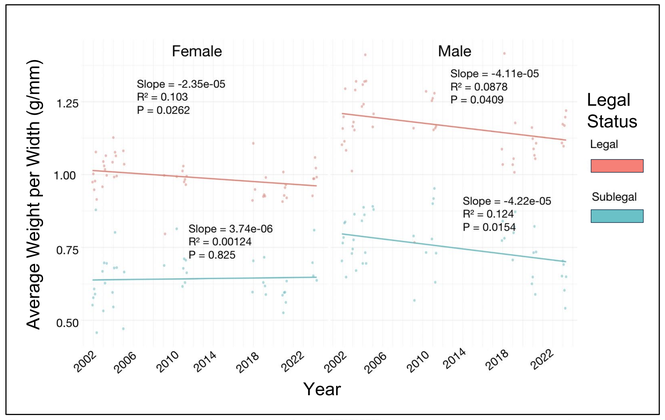

Figure 4. Average weight per width (WPW) over time by sex and size group. Legal males (*n*=2,266), legal females (*n*=3,119) and sublegal males (*n*=1,595) show a declining trend in average weight per width over time. In contrast, sublegal females (*n*=758) do not show a consistent decline. Although there is no legal size limit for females in Maryland, the legal size limit for males (5 in. or 127 mm) is applied to females for comparison.

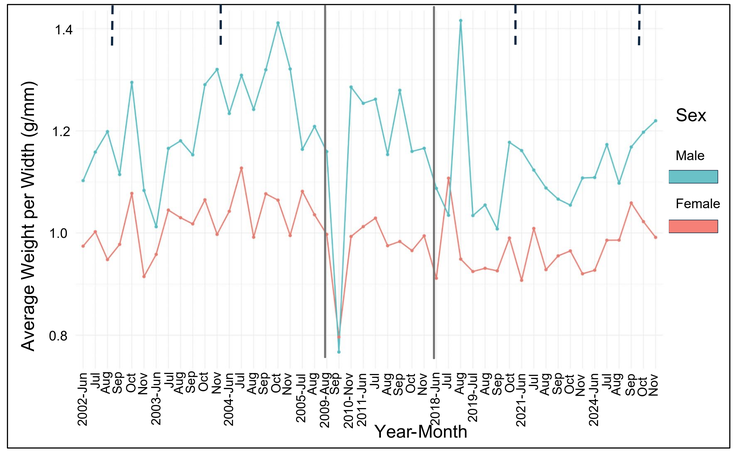

Figure 5. Average weight per width for legal sized males and females over time. The x-axis represents sampled years with irregular intervals that are marked with a gray line; spacing is not proportional to elapsed time due to intermittent sampling. The dashed vertical lines mark divergence in trends where legal sized females and males show an inverse average weight per width trend.

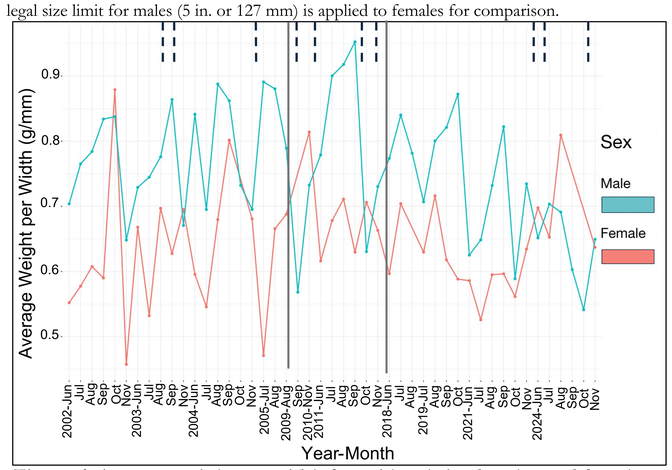

Figure 6. Average weight per width for sublegal sized males and females over time. The x-axis represents sampled years with irregular intervals that are marked with a gray line; spacing is not proportional to elapsed time due to intermittent sampling. The dashed vertical lines mark divergence in trends where sublegal sized females and males show an inverse average weight per width trend.

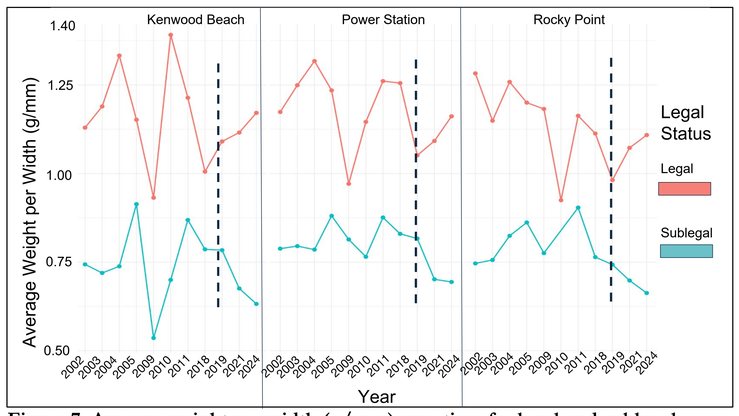

Figure 7. Average weight per width (g/mm) over time for legal and sublegal males, grouped by sampling site. Legal and sublegal males exhibit a similar relationship until 2019, where the groups diverge (indicated by the dotted line).

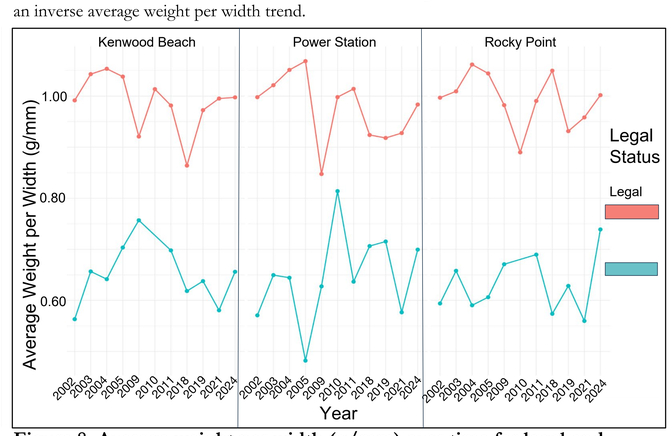

Figure 8. Average weight per width (g/mm) over time for legal and sublegal females, grouped by sampling site. Legal and sublegal females display a mix of converging and diverging trends in average weight per width over the years.

Results Cont.

- As carapace width increases, weight also increases; and this relationship has remained steady over time (Figure 3).
- Legal males, legal females, and sublegal males show similar long-term declines in average WPW; sublegal females remain stable in WPW (Figure 4).
- After mid-2024, legal males WPW increases while similar-sized females decrease (Figure 5).
- Sublegal male and females show inverse trends for WPW in multiple years (2005, 2009, 2024) (Figure 6).
- Legal and sublegal males followed similar WPW trends until 2019 when they diverge: WPW for legal males increases while sublegal males decline (Figure 7).
- WPW for legal and sublegal females exhibited mixed converging and diverging trends over the years (Figure 8).
- Sampling location had no clear effect on WPW trends (Figures 7 and 8).

Discussion

- Observed, long term declines in the WPW for legal males, legal females, and sublegal males might indicate environmental, ecological, or harvest-driven stressors could have an impact on growth (Figure 4).
- The sublegal female WPW relationship remained stable over time, suggesting this group may be less sensitive to exploitation factors influencing declines in other groups (Figure 4).
- The divergence in WPW in 2019 for legal and sublegal males may suggest a shift in growth dynamics or other environmental stressors (Figure 7).
- Inverse WPW patterns for specific years between sublegal males and females may suggest differential fishing pressure (Figure 6).

Next Steps

- Compare weight per width trends to environmental conditions
- Examine effects of fishery pressure, especially male or female selectivity
- Evaluate the relationship of inverse weight per width trends in more detail

References

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- de Carvalho-Souza GF, Medeiros DV, Silva R de A, González-Ortegón E. 2023. Width/length–weight relationships and condition factor of seven decapod crustaceans in a Brazilian tropical estuary. Regional Studies in Marine Science.

Acknowledgements

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