Seasonal variation in mangrove tree crab (*Aratus pisonii*) population characteristics along a salinity gradient within the Imperial River – Estero Bay watershed

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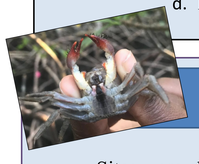
Abstract

Mangrove tree crabs are considered ecosystem engineers to mangrove forests impacting energy flow by forming links between trophic levels in mangrove food webs. Although they are common throughout southwest Florida, relatively little is known about their natural history and role in mangrove ecosystem. The effects that climate change has on mangroves are very well understood however, this cannot be said for the most common macrofauna found in the ecosystem. The aim of this study was to identify wet season variations of mangrove tree crab (*Aratus pisonii)* population characteristics throughout a salinity gradient between Imperial River and Estero Bay, Bonita Springs. Crabs were observed and captured from June 2021 to October 2021. A total of 537 individuals were captured, comprising of 226 females, 188 males and 123 egg-bearing females. In this study, salinity was the greater contributor to population variation compared to air and water temperature however this may be due to the small spatial scale of the Imperial River-Estero Bay ecosystem. No crabs were found in the freshwater river sites, and the highest number of crabs observed and captured occurred in the Site closest to the Gulf of Mexico. Salinity is significantly correlated with carapace width, number of observable crabs and number of ovigerous females found. Site 5 with close proximity to the Gulf of Mexico was the only location with a male biased population and sexual dimorphism with statistically larger females which are both uncommon. An egg-bearing female seasonality pattern was observed using the number of ovigerous females where they occur through the summer, peaked in September and drastically decreases to almost zero in October. All the results from this study indicate variations in mangrove tree crab population morphology on a relatively small spatial scale. Understanding the relationship of mangrove tree crabs and local salinities can help determine how climate-induced salinity changes could affect mangrove tree crab population and distribution.

Introduction

- *Aratus pisonii* is an arboreal grapsid (Sesarmidae) crab that commonly inhabits roots, branches and canopies of neotropical mangroves in the western Atlantic region, from Brazil to Florida and the Caribbean[1].
- Mangrove tree crabs in previous studies survive in salinities ranging from 0-36 ppt and sometimes higher[3]. They are restricted to the tropical latitudinal range of 20˚N and S, with annual temperatures ranging from 6-35˚C associated with these ranges[5].
- Varied tolerance to temperature, salinity, and oxygen explains their constrained distribution to mangroves, although new evidence suggests they are moving to other novel environments (e.g., salt marshes)[5].
- To address knowledge gaps and examine mangrove tree crab population variability to different abiotic factors (salinity, water and air temperature) in Imperial River-Estero Bay, this study investigated 4 population characteristics throughout the 2021 wet season including:
    a. Relative density (crab populations)
    b. Male-female ratio
    c. Crab carapace width (size)
    d. Number and size of ovigerous females (reproductive potential)



Methods

- Sites were chosen based on proximity to Gulf of Mexico to cover a salinity gradient with the Imperial River/Estero Bay watershed
- As the site number increases, so does the salinity from complete freshwater to saltwater (Fig. 5). Site 1 is inland on Imperial River at Riverside Park in Bonita Springs; Site 6 is in Big Hickory Preserves, behind New Pass that leads directly to the Gulf of Mexico.
- Monthly sampling at high tide in two 25m^2 plots directly next to each other adjacent to waters edge.
- Salinity, water and air temperature, and dissolved oxygen were used to measured using a YSI and T-type handheld thermometer.
- Crabs observed and captured for 30 minutes by two collectors in each plot (catch per unit effort based on 60 person minutes per plot)
- Carapace width measured with digital caliper, sexed and oviparity determined.

Results

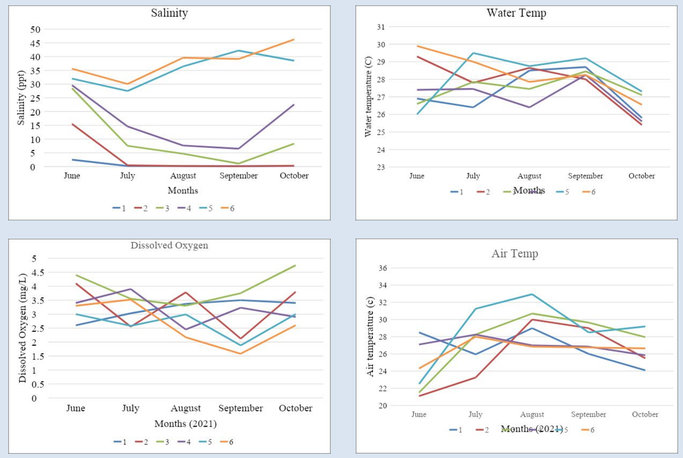


Figure 1: Measurements of abiotic factors during sample period

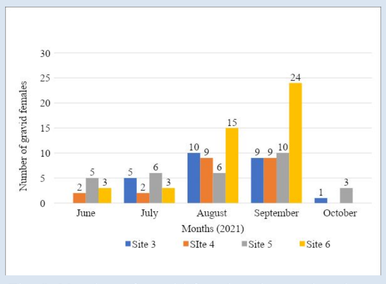


Fig. 2. Number of gravid females observed each month at each site during the wet season. ANOVA and Tukey HSD test showed total gravid females in October are significantly lower than September ($p>0.0453$)

- Peak breeding season was Aug.-Sept.
- Linear regression showed significant positive correlation between salinity and total gravid females
- Dissolved oxygen showed negative correlation to total females and gravid females

Table 1. Sex ratio for each site during sample period

Site #	N	Female	Male	Total
	3	67	46	113 (1.46:1)
	4	65	39	104 (1.67:1)
	5	60	88	148 (1:1.47)
	6	119	53	172 (2.25:1)
	Total	311	226	537

- Sex ratio is significantly influenced by sites they are found (Chi square ($p<0.0001$)).
- Female bias is common. Reason for large male bias population at site 5 is unknown.
- Positive correlation between salinity and number of females and males ($p<0.001$)

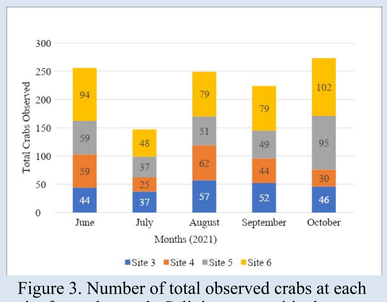


Figure 3. Number of total observed crabs at each site for each month. Salinity was positively correlated with total observed crabs ($p<0.0001$)

- Hurricane Elsa (Cat. 1) passed 5 days before sampling in July when totals declined.
- No statistical difference between months ($p>0.8433$)

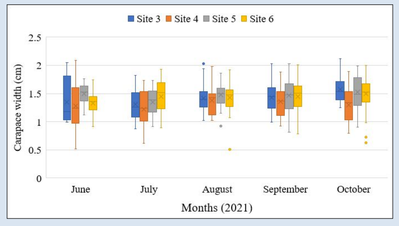


Figure 4. Carapace width variation for each site throughout sample months. Average carapace width in June and July significantly lower than October ($p<0.009$).

- Slight significant positive correlation between salinity and carapace width ($p=0.0346$)
- Increase in mean carapace width each month may indicate carapace width growth overtime

Study Site

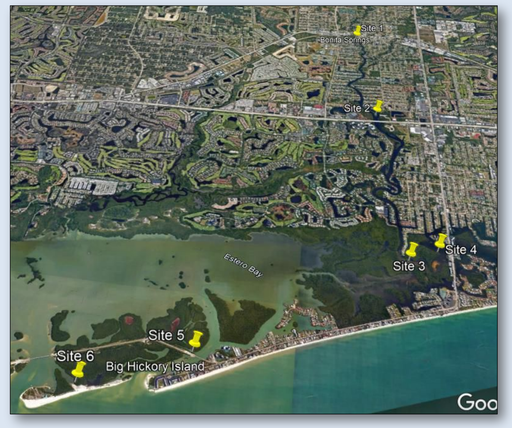


Figure 5. Map of sample sites in Imperial River-Estero Bay watershed.

Note site 4 is receiving directly from Imperial River and Little Hickory Bay but is still part of southern Estero Bay

Discussion and Future Implications

- Salinity plays a key role in mangrove tree crab population dynamics and abundance. Areas with higher salinity had larger number of overall crabs and gravid females
- Summer peak breeding identified, similar other Florida population studies
- Female and gravid female crabs showed higher abundance in low dissolved oxygen areas. The mechanism of this observation requires additional research
- Female bias populations are more common in Imperial River-Estero Bay watershed
- No crabs were found in the Imperial River sites, this suggests that continuous freshwater conditions hinder range expansion.
- Crab populations exposed to high salinity variability may be adapted to the impact of future climate change.
- Higher salinities from increased evaporation, more variable precipitation and sea level rise may lead to range expansion of mangrove tree crabs inland.
- Understanding how mangrove tree crabs adapt to different salinities in their environment will give accurate predictions of how they are affected by human induced hydrological changes

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