Investigating the population dynamics of the spider crab *Mithrax spinosissimus* in southern Eleuthera

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Introduction

Aquaculture is the farming of seafood. Multi-trophic aquaculture is the use of species from various trophic levels to create a mini-ecosystem (Figure 1). This system has an input of food for the main species in the culture, commonly a fish such as salmon, tuna, or cobia – a local example. Surrounding the cages or nets, a series of buoys hold up lines which allow filter feeding organisms, such as mussels, to grow. These filter out the wastes out of the water from the fish, such as excess food and excreted wastes and are then utilized for mussel growth. Following the mussels lines, seaweed filters dissolved nutrients such as ammonias and nitrates from the water.
This method of farming reduces nutrient loads on the surrounding environment and the excess nutrients are utilized for the growth of the surrounding species. Overall, with one food input three or more potentially economically beneficial species can be grown. However, there are still limitations with the method, similar to traditional aquaculture, with issues such as water flow and biofouling.

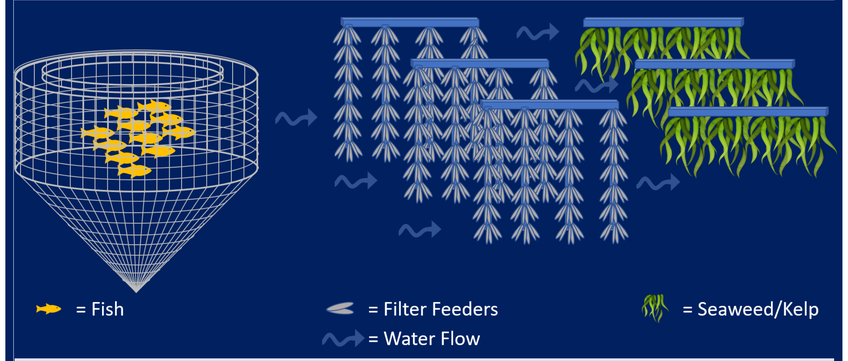

Figure 1: A graphic representation of multitrophic aquaculture (IMTA)

Biofouling can be found on aquaculture cages and is when algae and other settling organisms cover an underwater structure. Some issues include reduced water flow, harboring pathogens, extra competition for food and overall reduced health.

The Caribbean Spider Crab

The Spider Crab *Mithrax spinosissimus* (Figure 2) was chosen for use in biofouling because it is:

- Herbivorous
- Nocturnal
- Short Larval period (Baeza et. al, 2012)
- Continuous reproduction (Baeza et. al, 2012)

It has the potential to be very marketable as a food as it is the largest crab in the Caribbean and it supposedly tastes like Alaskan King Crab. However, it has not yet been marketed because it is difficult to catch - it hides in cracks and crevices and cannot be caught in traps.

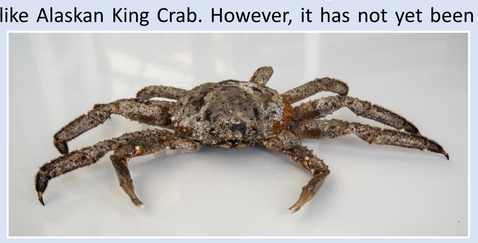

Figure 2: Female Caribbean Spider Crab, *Mithrax spinossisimus*

Research Objectives

Determine:

- The size range and population numbers of the spider crab around Eleuthera (Figure 3) in the three locations
- The size at sexual maturity of male and female spider crabs
- If over the course of a month, crabs will repopulate an area

Currently there are no fisheries regulations for the harvest of spider crabs in the Bahamas. Size is generally used to determine take limits for commercial species. There is a need for regulations so that these crabs can reach sexual maturity and reproduce in the wild before they are harvested.

Study Sites

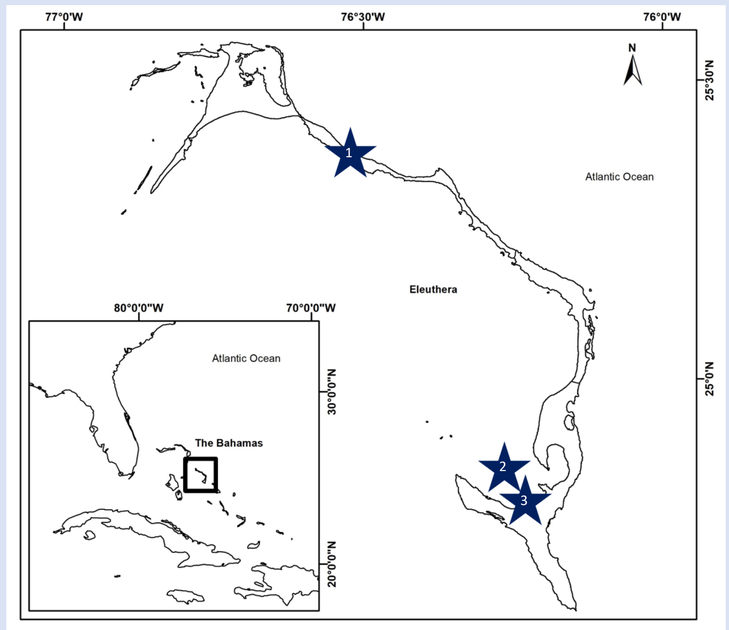

Figure 3: The various habitats and their locations used in this study. 1, Sweetings Pond; 2, Coral patch reefs; 3, Greencastle blue holes

Fisheries Implications

Lobster, conch and stone crabs are three commercially harvested species in the Bahamas. If in the future these species become overexploited, spider crabs have the potential to fill the market gap.

- In order to prevent overharvesting, regulations must be put into place
- Currently there is limited knowledge as to the size at which a spider crab reaches sexual maturity as well as reproductive capacities

Knowing the size at which a species reaches sexual maturity can be useful in informing fisheries regulations as these individuals have contributed to the population before they are harvested.

Methodology

At each of the aforementioned sites we collected at least 100 crabs. At Sweetings Pond we collected during the day and completed the measurements on site. At the Patch Reefs and Greencastle Blue Holes we collected at night and brought the crabs back to the Cape Eleuthera Institute wet lab in coolers to measure them.

Morphological Measurements:

These measurements (Figure 4A-4D) were used to determine sexual maturity. Measurements were taken using calipers (Figure 5) to the nearest 1 mm and based on measurements from González-Pisani et. al, (2017).

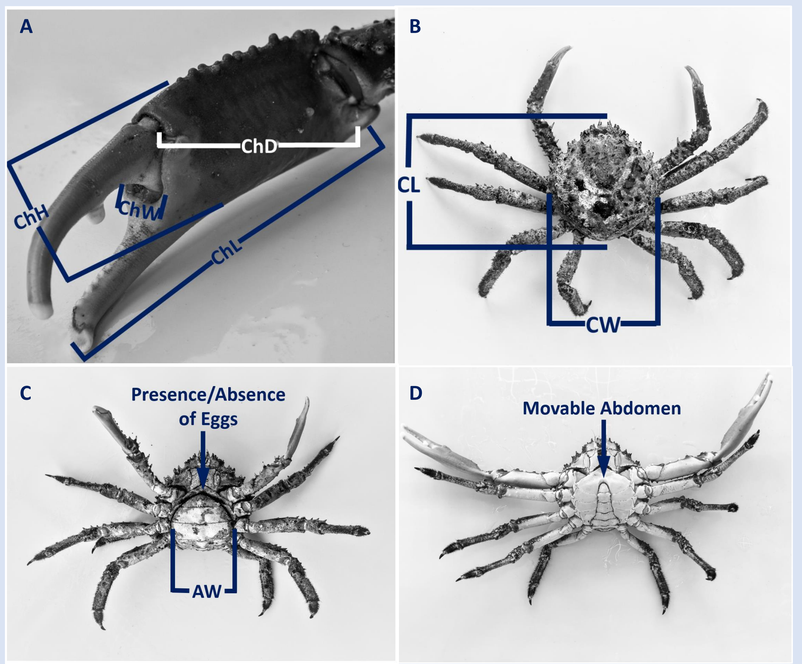

Figure 4: (A) Dimensions of the right chela. ChL, Chela Length; ChD, chela diagonal; ChH, chela height; ChW, chela width. (B) Dorsal view of the spider crab. *Mithrax spinosissimus* with carapace measurements. CL, carapace length; CW, carapace width. (C) Ventral view of a female spider crab. Note the wider abdomen width, used as an indication of a female. Abdomen checked for presence or absence of eggs. AW, abdomen width. (D) Ventral view of a male spider crab. Note the smaller abdomen width, used as an indication of a male. Abdomen checked for movement to indicate behavioural maturity.

Figure 5: Island School students take the morphological measurements of crabs at Sweeting's Pond

Results

The distribution of the carapace widths in 10 mm size increments (Figure 6) allows us to see the males reach a larger size, but females are more abundant.

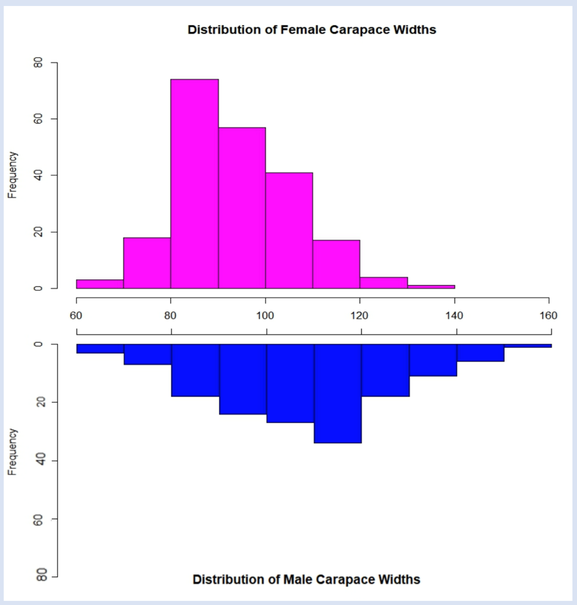

Figure 6: Distribution of carapace widths of male (n = 148) and female (n = 204) crabs

At around 97 mm carapace width (Figure 7), male chela length to carapace width ratio increases. When compared to females of a similar carapace size, males have significantly larger claws.

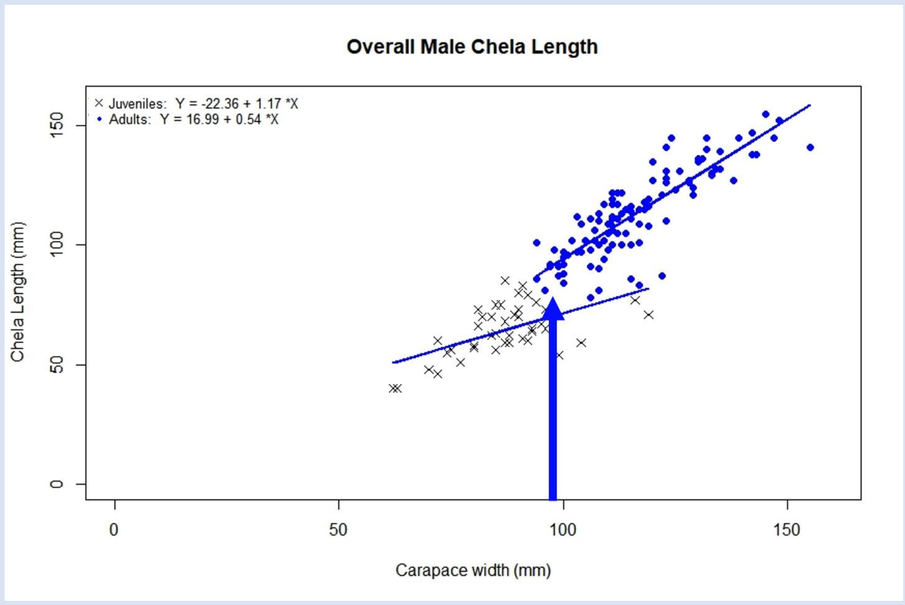

Figure 7: Ratio between chela length and carapace width in mm (n = 148) of male crabs caught in this study

At around 102 mm carapace width (Figure 8), female abdomen width to carapace width ratio decreases.

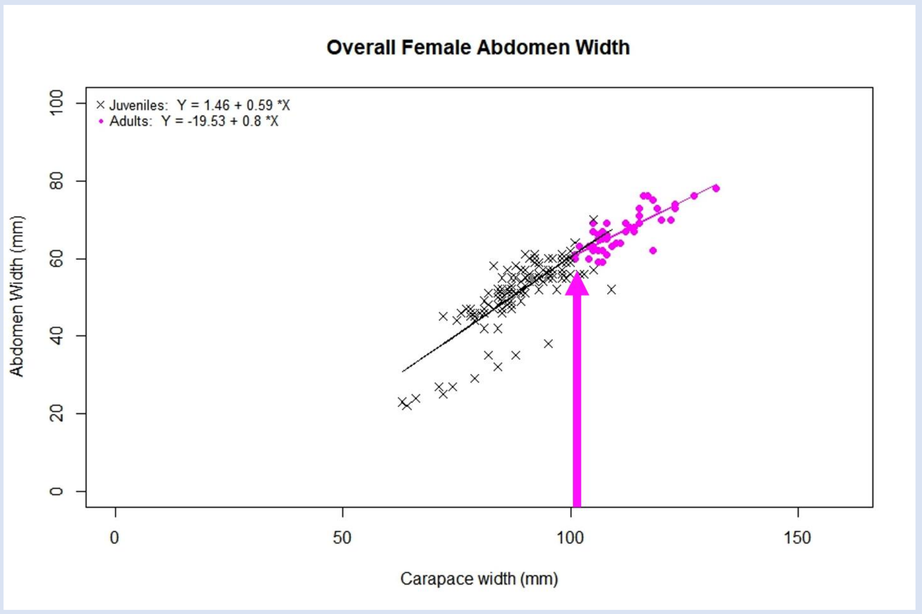

Figure 8: Ratio between abdomen width and carapace width in mm (n = 204) of female crabs caught in this study

→ Female **→ Male** **→ Immature**

Discussion

Our results show that male crabs reach sexual maturity at around 97 mm carapace width, based on the change in their claw size. The change in claw size is a display of sexual dimorphism (Figure 9A and 9B), where the two sexes of the same species show a distinct morphological difference. Males, in this case, use the claws for display purposes. It is unclear whether these are used for fighting or display only; more research is needed on this topic.
Female crabs show a slight decrease in the rate at which their abdomen grown in relation to their carapace. This may be due to the production of eggs occurring at this point, indicating energy be put into egg production rather than growth.
Overall, these crabs should only be harvested after they have reached sexual maturity or larger in order to ensure that they have had the chance to reproduce. A 5-10 mm size buffer on potential harvesting regulations would be beneficial as there is some size variation when the crabs reach sexual maturity - a size buffer would ensure most individuals would have the chance to contribute to the overall population of spider crabs. Male claws become very large, so this sex is what consumers would likely prefer. Because of this, males may need an even larger size buffer due to the smaller overall population of males.

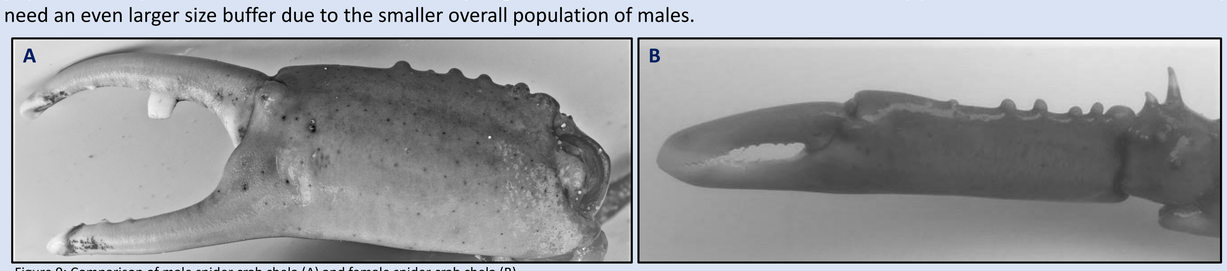

Figure 9: Comparison of male spider crab chela (A) and female spider crab chela (B)

Conclusions

Since there are currently no size regulations on spider crab harvesting, we hope that the Bahamian government will take our research information and apply regulations for the catch of spider crabs to ensure they will only be caught when they are sexually mature.
In addition, for use in biofouling removal:

- Use males for their larger overall size, likely consuming more fouling, and their more marketable meat yield
- Set up a broodstock facility for futureproofing the use of spider crabs in aquaculture

Future Recommendations

For future studies we would suggest:

- A more in depth study for better comparison between the three sites. This would require a larger sample size from each site.
- A similar study at different latitudes. These crabs are found throughout the tropics, and as temperatures varies with distance from the equator, the size at which the crabs reach sexual maturity may change.
- In addition, our study did not find crabs smaller than 62 mm carapace length. It would be interesting to find where the juveniles reside, as our numerous trips did not find any small individuals.

Figure 10: Island School students collect spider crabs on the patch reefs in Eleuthera

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Works Cited

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