Would you sleep in a graveyard? Assessing the behavior of queen conch (*Strombus gigas*) to knocked shells

Charlotte Hagerty, Ellie Fredrickson, Caroline Peters, Greg Pizzurro, Renee Farquharson, Justin Allinson, Austin Halstead

Advisors: Helen Conlon and Cara Thompson

Introduction

Background

Queen conch (figure 1), *Strombus gigas*, are marine gastropods that inhabit the greater Caribbean region. Queen conch are invaluable to The Bahamas reef ecosystems as they act as grazers, maintaining the health of sea grass beds, which are a food source to a multitude of marine organisms. They are economically important, as they annually contribute seven million dollars to the Bahamian economy in exports alone, thus making it the second most important fishery in the country. Additionally they are culturally significant, as Bahamians have been eating conch for thousands of years and are a staple of the Bahamian diet.

Figure 1: A Queen Conch *Strombus* gigas

Problem

Queen conch are in rapid decline (Thomas et al. 2015). There is a both a lack of enforcement of legislation and a discrepancy between scientific data and the current legislation protecting the queen conch. Queen conch do not reach sexual maturity until they have a 15 mm flared lip, but current legislation allows sub-adults with a flared lip under 15 mm to be legally fished. Thus, sub-adults are being fished before they can contribute to their population. Due to a lack of enforcement, juveniles are being illegally fished as shown by Thomas et al. 2015. Another reason for the decline of queen conch can be attributed to overfishing (Danylchuk, 2003), as well as the fact queen conch do not have a closed season. Therefore, they do not have time to reproduce without the constant threat of fishing (figure 2).

Figure 2: A fisherman and the conch he has harvested

Graveyard Theory

Across three different islands in The Bahamas fisherman were surveyed about the greatest threats to conch decline and one in four fisherman stated that discarding knocked shells, also known as the graveyard theory, was a major threat to the conch populous (blue earth consultants, 2016). The graveyard theory states that conch have a tendency (figure 3) to move away from freshly knocked shells that are thrown in the ocean. This project assessed the behavior of conch around knocked conch shells.

Figure 3: Pile of dead conch found off Boy's Dorm Beach, Cape Eleuthera, which could be described as a graveyard

Methods

Figure 1. Trial conch being taken from reef ball (sample pool)

Figure 2. Trial set up

Figure 3. Conch movement after one hour.

Figure 4. Distance conch moved from the center of both the conch and treatment object.

1. Six random conch are taken from a pen, or a semi controlled environment in shallow water. The sample pool consisted of 87 conch: 1 adult, 10 sub-adults, and 76 juveniles.

2. Six conch are placed in a 2x2 meter quadrat around a randomly chosen treatment with their eyes facing inwards, so the treatment object is visible to the conch.

3. After one hour, the direction and distance moved by the conch is measured(in centimeters) from the middle of the conch to the middle of the treatment object. Then the shells are taken from the quadrats and carefully placed back in the pen to be used in upcoming trials.

Figure 5. Independent variable treatment object: freshly knocked shell

Figure 6. Independent variable treatment object: old knocked shell

Figure 7. Control treatment object: rock

The treatment objects consist of a freshly knocked shell for visual and olfactory cues (figure 5), an old knocked shell (figure 6) and rock (figure 7) for visual cues, and nothing to test if the conchs movement is random. There are two controls in this experiment: a rock and nothing, and the independent variables: a freshly knocked shell and old knocked shell. The conch must be measured before placing them in the quadrat.

Results

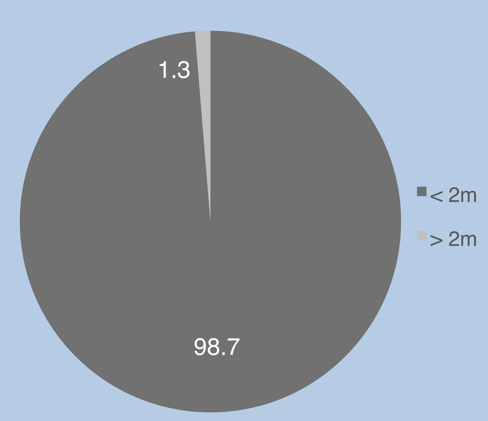

Figure 1: Percentage of queen conch (N=80) that moved out of the 2x2 meter quadrant.

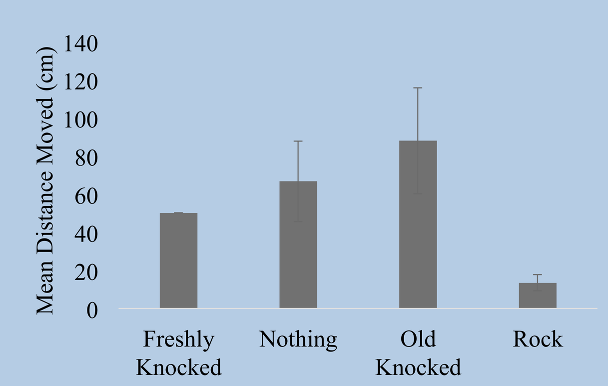

Figure 2. The mean distance queen conch moved from treatment objects: freshly knocked (n=120), nothing (n=120), old knocked shells (n=120), and rocks (n=120).

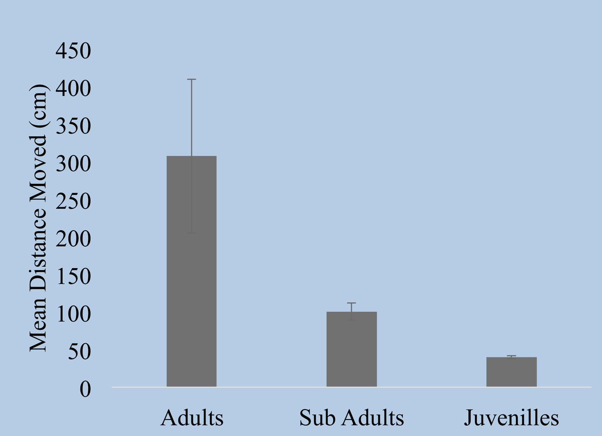

Figure 3: Mean distance ± SE (cm) travelled by conch in different life stages during trials. Adult (N=9), sub-adults (N=78), juveniles (N= 392)

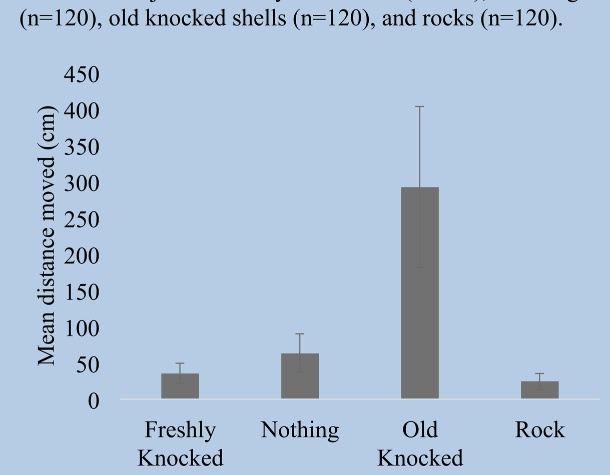

Figure 4. Mean distance ± SE (cm) moved by *Stombus gigas* with a flared lip from all treatment objects; freshly knocked (N=10), nothing (N=9), old knocked (N=30) and rock (N=38).

Figure 1 shows that 1.3% of the conch tested in the trials left the quadrat and the remaining 98.7% stayed in their respective quadrats. On average, there was less distance moved by queen conch from freshly knocked shells than from nothing and old knocked shells (Figure 2). However, this was not statistically significant (T-test, df=120, p-value>0.05). On average, there was more movement from freshly knocked shells than from rocks (Figure 2), which was statistically significant (T-test, df= 119, p-value<0.05). However, there was notably more movement from the queen conch sample population from nothing than from freshly knocked shells, which was statistically significant (t-test, p-value <0.05). Adult queen conch travelled a greater mean distance away from all treatment objects than sub-adults and juvenile conch (Figure 3), as was proven to be statistically significant (ANOVA, df=3, p-value < 0.05, T-Test, p-value< 0.05). The differences between the mean distance travelled by conch with flared lips away from freshly knocked conch shells and old knocked shells as well as the mean distance travelled away from freshly knocked conch shells and nothing were proved to be statistically significant (t-tests ,p-values < 0.05) while the difference between the mean distance travelled by conch with flared lips away from freshly knocked conch shells and rocks was not statistically significant (p-value > 0.05).

Discussion

Figure 1 shows that the 98.7% of conch did not move out of the quadrats during trials, meaning that most conch did not move away from any of the treatment objects. This could suggest that the queen conch are not threatened by the presence of treatment objects. Figure 2 suggests that conch move significantly further distances from freshly knocked shells (p-value<0.05) than from rocks, which could be because of visual or chemical cues. Future studies could investigate conspecifics alarm cues for conch in a lab setting to test this theory. Figure 3 shows that adult queen conch moved a greater distance from treatment objects than sub-adults and juveniles did, which could be because of their size and the length of their strombus leap or the fact that within lifestages adult conch move the most. However, a limitation of the study was that only one adult conch was trailed, eleven times which is not a representative sample size. In the future, we could replicate this study with a larger sample size of adult conch. Figure 4 suggests that there is not significant difference (p-value<0.05) in the distance conch with a flared-lip, which are legal to fish, moved from freshly knocked shells and from rocks. This suggests that sub adult conch, which fishermen can legally fish, and juveniles do not move away from freshly knocked shells. This finding also does not support the graveyard theory. Conch as a whole in Eleuthera have been proven to be declining (Thomas et. al), however this is the first study to test the graveyard theory. One of the contributing factors to the declining population is likely overfishing of adult and sub adult conch as well as the harvest of juvenile conch Clark et. al). This information could lead to major change in legislation by organizations such as the BNT (Bahamas National Trust), BREEF (Bahamas Reef Environment Educational Foundation), and the Nature Conservancy.

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