Surveying queen conch (*Strombus gigas*) populations off Cape Eleuthera, Bahamas: Has the density changed since 2012?

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Introduction

Importance:
Queen conch, a marine gastropod with a complex life cycle and three different life stages (Figure 1) has been important economically, culturally, and ecologically to The Bahamas for centuries (Clark, 2005). Economically, the queen conch fishery brings in $6-8 million per year in exports, with additional money circulating in local trade (Figure 2). The queen conch are important ecologically because they maintain the health of seagrass beds by eating the detritus (dead matter). Other ecosystems are maintained in turn, with a steady flow of nutrients and stabilization of the sand (Figure 3). Culturally, the queen conch is seen as a symbol of The Bahamas and is very important to the people.

Problem:
The Bahamian people's reliance on queen conch as an icon, source of income, and food staple has led to its overharvest and exploitation. In recent years, studies have suggested that the densities of conch are declining in The Bahamas (Danylchuk et al., 2005). Baseline surveys were conducted in 2012 regarding the status of queen conch off Cape Eleuthera, Bahamas. The reproduction of conch is density dependent (Stoner et al., 2000), meaning that a certain number of conch are needed per hectare for conch to reproduce. If numbers drop below a certain point, the populations may never recover.
Regulations on the queen conch fishery in South Eleuthera do not include a Marine Protected Area (MPA) nor a closed season in The Bahamas, though the use of SCUBA is banned. The harvest of juvenile conch is also prohibited, though enforcement is limited (Stoner et al., 2012). The population structure of queen conch could be altered if conch were harvested before they reached sexual maturity (Figure 4).

Purpose:
To repeat surveys from 2012 in order to compare queen conch densities and life stages to current numbers found in South Eleuthera, Bahamas.

Hypothesis:
The density of queen conch off South Eleuthera, Bahamas has changed since 2012, and it is predicted that there will be a decrease.

Figure 1. The three life stages of conch. Left: Juvenile (no flared lip, not sexually mature). Middle: Subadult (flared lip less than 15mm, not sexually mature) Right: Adult (flared lip greater than 15mm, sexually mature)

Methods

Thirty snorkel tow surveys were completed over 6000 m^2 transects off Cape Eleuthera (Figure 5). Transects were repeated from those conducted in 2012 in which conch were present. Snorkelers were towed from a boat using different hand signals to indicate each life stage of conch: juvenile, subadult, and adult (Figure 6). Signals were recorded by a researcher on the boat (Figure 7). Additionally, bottom type was recorded at the beginning and end of each tow.
Furthermore, midden surveys were completed at ten different sites on Cape Eleuthera (Figure 8). Shell siphonal length and lip thickness were measured in order to determine the life stage of the conch upon harvest (Figure 9).

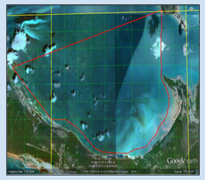

Figure 5. (Left) Map indicates transect locations along the coast of South Eleuthera.

Figure 6. (Right) This is an example of the tow survey hand signals that would convey the life stage of the conch seen to the researchers on the boat.

Figure 2. A fisherman harvests conch meat by knocking the shell.

Figure 3. Conch grazing in a seagrass bed helps to keep the seagrass healthy by allowing maximum growth. Their consumption of the detritus is extremely important to the ecosystem.

Figure 4. An example of a sexually mature, adult conch. Its lip thickness indicates old age and sexual maturity.

Results

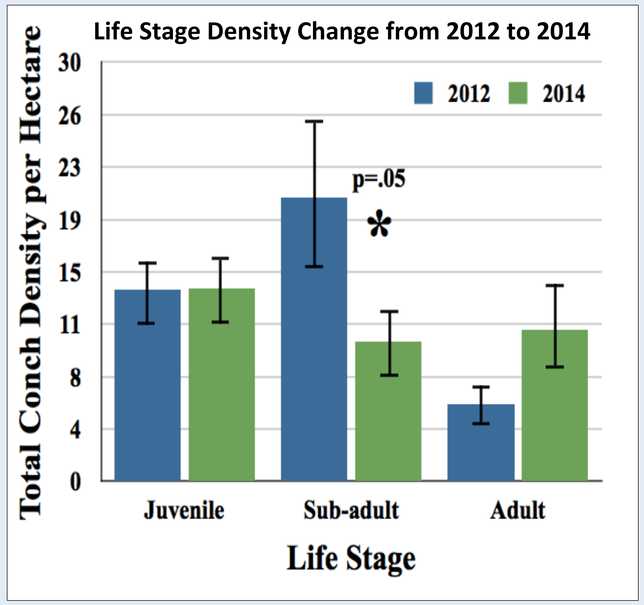

Figure 11. Bar graph showing queen conch density by life stage from 2012 to 2014. Standard error bars were placed on the data. As denoted by an asterisk, the only statistically significant change in population was a decrease in sub-adult population density with a p value of 0.05.

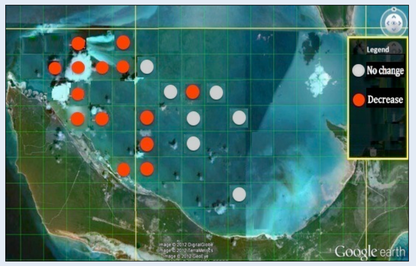

Figure 10. Map of Cape Eleuthera, Bahamas and Rock Sound where tow transects were conducted. Transects where queen conch population density decreased are denoted by red dots while transects where no change was observed are denoted by grey dots. Decreases observed tended to occur closer to shore.

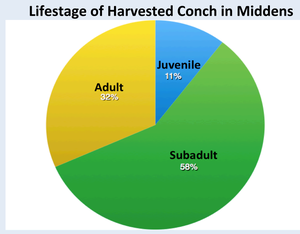

Figure 12. Pie chart showing life stage distribution of queen conch shells surveyed in middens in multiple locations on Cape Eleuthera, Bahamas. 32% of conch shells surveyed were adults, 58% of shells were subadults, and 11% were juveniles.

Figure 7. Researchers record hand signals on the boat.

Figure 8. A conch midden, a large dumping ground for empty conch shells that have been harvested by fishermen.

Figure 9. To measure the lip thickness of the conch found in surveyed middens, calipers were used. This picture displays the calipers with the conch.

Results

30 transects were conducted off Cape Eleuthera. There was not a statistically significant decrease in total conch population density from 2012 to 2014, however, decreases in conch population density did occur in some areas. Locations where conch population density decreased tended to be in areas close to shore (Figure 10). However, the decreases seen in density were not statistically significant. There was a decrease in density per hectare from 35 ± 10 conch in 2012 to 32 ± 8 conch in 2014. Also, while no total population density change was observed, there was a statistically significant decrease in the population density of subadults (Figure 11). Lastly, midden survey data showed 58% of conch harvested to be subadults, 32% to be adult, and 11% to be juvenile (Figure 12).

Discussion

Population changes by life stage:
Although we hypothesized a change in overall density since 2012 and predicted to see an overall density decrease, the results showed total change in population density was not statistically significant. We did, however, observe a statistically significant decrease in the subadult population. This decline is important in evaluating the stability of the conch populations as a whole. One potential reason for this decrease is the overharvesting of subadults, as supported by midden survey data in which more than half of the conch harvested were subadult. Another potential reason for this decrease could be the maturing of subadults into adults who may have moved to deeper water where surveys were not conducted.

Population changes by location:
When transect locations were compared to 2012 data, the majority of conch density decreases occurred closer to shore. This may be due to the fact that fishermen take cost into account and do not want to spend money on fuel, usually wading to harvest conch.

Importance of our study:
Our study was important in providing primary comparisons and determining rate of population change in an area with no previous comparative data. South Eleuthera has considered implementing an MPA, and it is important to determine if the area is still suitable. Although 2 years is not a seemingly long amount of time, our data is crucial to gathering a baseline for rate of change. If these declines have occurred in only two years, a longer amount of time could have detrimental effects for all of the communities of South Eleuthera. Furthermore, a decrease in one section of the conch population structure will create an imbalance that will lead to an unsustainable future population.

Looking forward:
- Long term monitoring of these conch populations should be established.
- Regulations on subadult fishing, which is currently legal, should be increased to protect the greater conch population in South Eleuthera.
- Other possible regulations for conch fishing include a closed season, laws against subadult fishing, and catch limits.
- More research is needed surrounding queen conch populations off Cape Eleuthera, in The Bahamas, and in the Caribbean as a whole.

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