Return of the Queen: A Queen Conch Repopulation Study in The Bahamas

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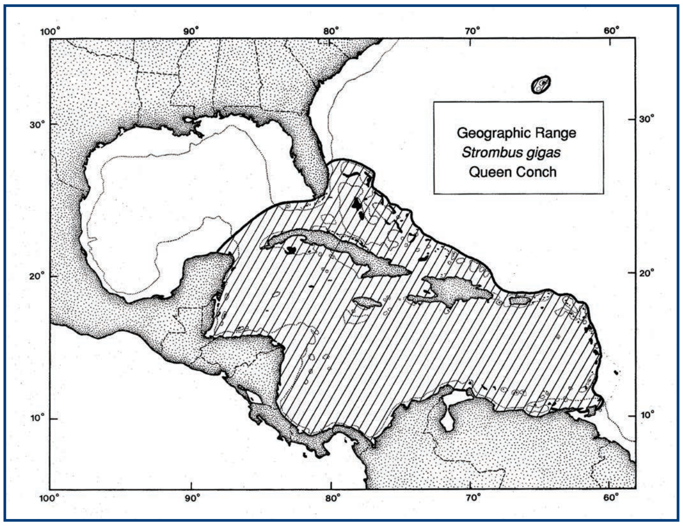

FIGURE 1. *Native geographic range of queen conch (Illustration: Bonnie Bower Dennis).*

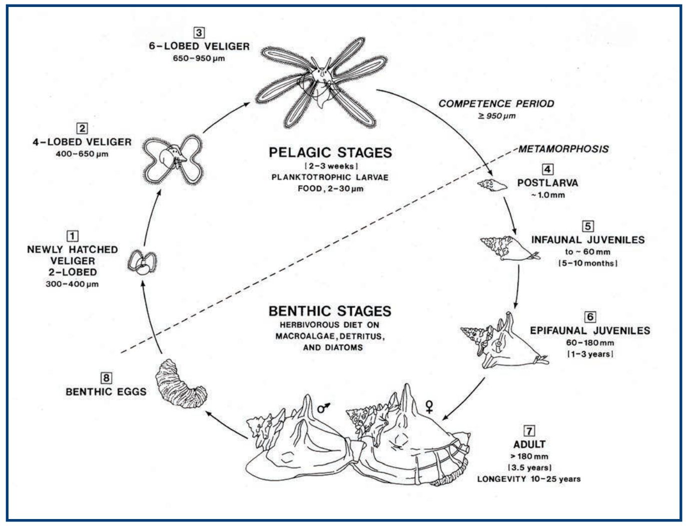

FIGURE 2. *Queen conch life cycle (Illustration: Bonnie Bower Dennis).*

Background

In the crystal blue waters of Florida, The Bahamas and the Caribbean lives a keystone herbivore species in need of saving: the queen conch *Aliger gigas* (formerly *Strombus gigas*) (Fig. 1). These iconic gastropods spend their days grazing in shallow seagrass beds and sand flats, helping to keep the ecosystem clean and in balance. They are economically valuable throughout the Caribbean for culinary delicacies such as conch salad, chowder and fritters, and for their beautiful pink-lipped shell and rare pearls.

Conch have been heavily fished for decades, leading to a Florida conch fishing moratorium in 1985 and a number of other regulations throughout the Caribbean. In 1992, the species became a managed fishery as part of the Convention of International Trade in Endangered Species of Flora and Fauna (CITES) Appendix II. However, this listing, along with local regulations, have not been enough to slow the decline of the species. In a recent study, researchers found that, without changes in fishery practices, commercial conch stocks in The Bahamas may be depleted in 10-15 years (Stoner *et al*. 2019). The citizens of The Bahamas and the Caribbean are concerned about access to this cultural food staple but the decline is most alarming for fishermen, whose traditional livelihoods are at stake, and for ecological balance in seagrass beds.

Queen Conch Life Cycle

The life cycle of the queen conch starts with internal copulation during the summer breeding season (Davis 2005, Fig. 2). For this to take place, conch must be at a density of at least 100/ha to find partners (Stoner *et al*. 2019). Females can mate with multiple males before laying an egg mass. These masses are typically laid in coarse sand and reef rubble but can also be laid in seagrass beds (Fig. 3). Each conch egg mass holds close to 500,000 microscopic eggs, each smaller than a grain of sand. After eggs incubate, they hatch into pelagic veligers, drift with currents for 2-4 weeks and metamorphose into benthic snails in seagrass habitats. Areas where conch metamorphose are described as "ecologically unique" because nearby, seemingly similar areas are less suitable as conch habitat. Juvenile conch feed on epiphytes growing on seagrass blades. Conch reach sexual maturity in four years when they have a fully developed shell lip with a thickness of 15 mm or more.

Conch have many predators during their life cycle. As pelagic veligers, they are prey for planktivores. As benthic juveniles, they are prey for sharks, sea turtles, stingrays, lobsters, fish, hermit crabs and carnivorous snails. As adults, the heavy shell of the conch provides protection from most predators but they are still susceptible to predation by octopuses.

Queen Conch Repopulation Study in The Bahamas

Many researchers have suggested that using a network of Marine Protected Areas (MPAs) can serve to replenish species and provide a refuge from fishing pressure. The Bahamas National Trust has been establishing MPAs known as National Parks since 1959. Some of these Parks encompass conch breeding grounds, such as the Exuma Cays Land and Sea Park. This Park was established in 1958 and has a large population of adult queen conch that have been successfully protected. Moriah Harbour Cay National Park is a more recent MPA, established in 2002. According to local Bahamians, this Park historically had a

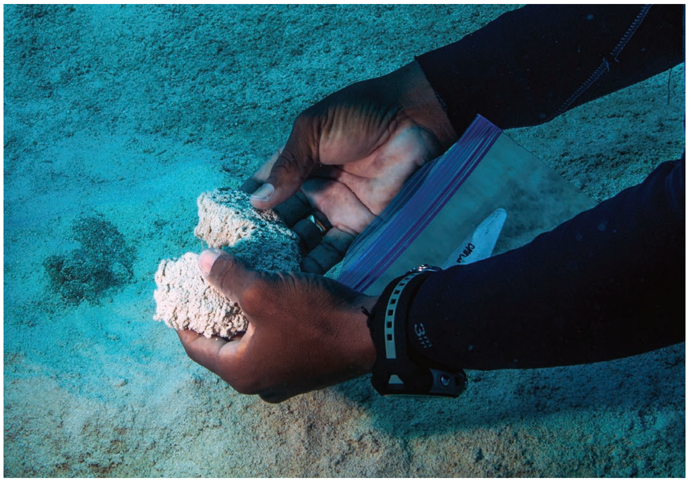

FIGURE 3. *Queen conch egg mass (Photo: H. Forrest Thomas).*

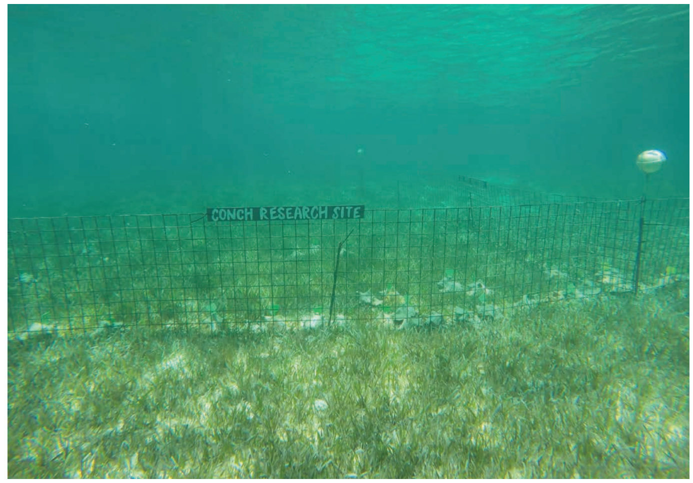

FIGURE 5. *The queen conch enclosure with signs (Photo: Megan Davis).*

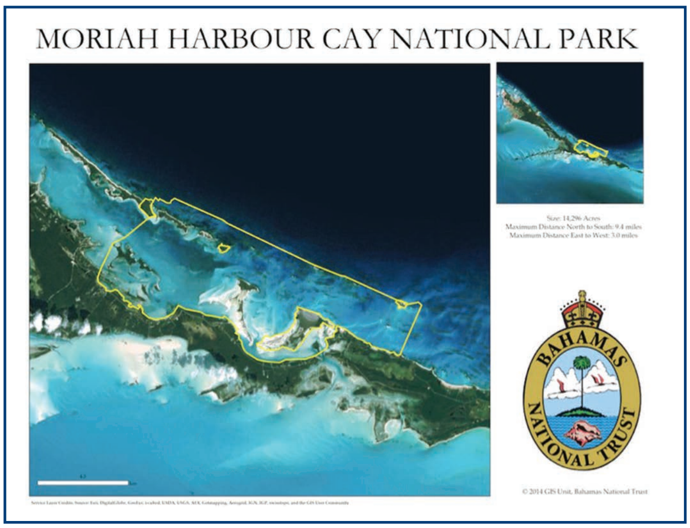

FIGURE 4. *Moriah Harbour Cay National Park study site near Great Exuma, The Bahamas (Illustration: The Bahamas National Trust).*

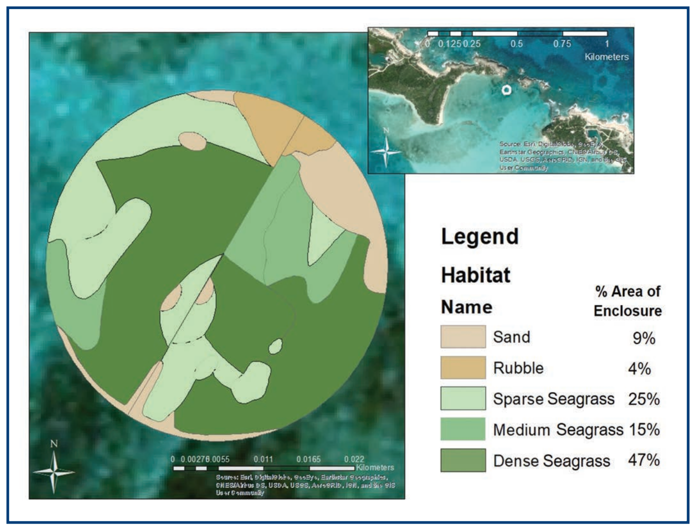

FIGURE 6. *Habitat type overview inside the 1,400-m² enclosure. The excerpt map shows the location of the study site (Illustration: Laura Issac Norton, Map: Google Earth).*

thriving conch population but now only a few conch can be found.

As a way to address the decline of queen conch, we set up a queen conch repopulation study within the MPA. The project was a partnership among Florida Atlantic University Harbor Branch Oceanographic Institute, The Exuma Foundation, The Bahamas National Trust and The Bahamas Department of Marine Resources. This project aimed to repopulate a historic conch habitat with conch translocated from spawning populations.

Study Methods

Moriah Harbour Cay National Park is located near George Town, Great Exuma, Bahamas (Fig. 4). We conducted a 12-wk study from May 26 to August 16, 2019 using a large circular enclosure 42 m in diameter and 76 cm high. It was installed by SCUBA divers in 2.5-4.5 m water depth in a backreef area. Signs were attached to the enclosure to inform snorkelers that the conch inside the enclosure were part of a research project (Fig. 5). The enclosure encompassed sand and reef rubble areas as well as large areas of thick seagrass including *Thalassia testudinum*, *Syrngodium filliforme*, and *Halodule beaudette* (Fig. 6). This mixed habitat ensured that the conch that were translocated into the enclosure would have access to sufficient food resources.

An effort was made to locate conch from nearby areas to stock the enclosure but insufficient numbers were found. Instead, conch were purchased from local fishermen (US$ 3.00 each) from their recent harvests. The fishermen collected these conch from fishing grounds about 100 km away from the research site. Because the conch were destined for market, the fishermen had knocked holes in their lips and strung the conch together in groups of five (Fig. 7). This practice helps fishermen to keep track of the conch during transportation and in the water prior to selling them.

Once purchased, shell length of each conch was measured and a livestock tag was attached to identify each individual (Fig. 8). A total of 251 conch (47.5 percent male, 52.5 percent female) were stocked into the enclosure at a density equivalent to 1,813 conch/ha. Shell length ranged from 17 to 25 cm and lip thickness from 2 to 28 mm (Fig. 9). We visited the study site every 24-48 hours to observe behaviors such as movement, burial, grazing and reproductive activity. Visits to the enclosure also included monitoring for predation and maintenance on the enclosure.

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FIGURE 7. *Queen conch purchased from local fishermen (Photo: Laura Issac Norton).*

FIGURE 8. *Measurement of shell length of a queen conch with a livestock tag attached to the spire of the shell (Photo: Megan Davis).*

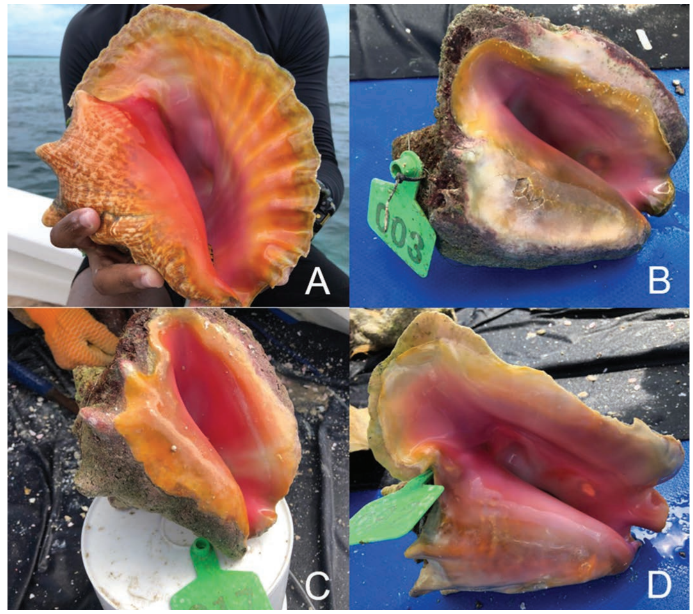

FIGURE 9. *Examples of conch from the study: the youngest conch with the thinnest lip (a), the oldest conch with the thickest lip (b), the conch with the shortest shell length (c), and the conch with the longest shell length (d) (Photos: Megan Davis).*

FIGURE 10. *An octopus preying upon one of the study conch (Photo: Laura Issac Norton).*

Observations, Outcomes and Recommendations

Before we received them from fishermen, the conch had experienced a long journey from the fishing grounds tied together in groups of five. Due to this handling stress, we were unsure about the duration of acclimation to the habitat inside the enclosure. Almost immediately after placement in the enclosure, conch were seen grazing, which was a good sign that they had acclimated quickly. By tracking conch movements over three months, we observed that conch often preferred to occupy seagrass areas of the enclosure rather than coarse sandy areas. Although conch seemingly move slowly, the maximum distance conch traveled between observation days (24-48 h) was 40 m, nearly the diameter of the enclosure (42 m). At the end of the study, 98 percent of the conch had survived. Only one conch was lost from predation by an octopus (Fig. 10) and another four died shortly after introduction to the enclosure.

Study site flora was comprised of seagrasses (turtle grass *Thalassia testudinum*, manatee grass *Syrngodium filliforme*, shoal grass *Halodule beaudette*) and macroalgae (*Batophera oerstedii*, *Halimeda* spp., *Rhipocephalus phoenix*, *Udotea cyathiformis*, and *Laurencia* spp.). Turtle grass was the most common plant species in the enclosure. Conch actively grazed on epiphytes of seagrass blades in the enclosure but this feeding activity did not affect seagrass shoot density over the 12-wk study. However, based on visual observations of epiphyte loads on turtle grass inside and outside the enclosure at the end of the study, conch had a positive impact on keeping blades of seagrass clean (Fig. 11). Grazing may increase photosynthesis and thereby increase seagrass biomass over time.

Faunal diversity at the study site gradually increased after conch were placed in the enclosure. Fish species such as Nassau groupers, sergeant majors, and parrotfish were attracted to the enclosure itself. Others such as southern stingrays seemed to be interested in the conch and a few (e.g. barracuda) seemed to be interested in the research divers. Because no baseline for the fauna community previously existed for this site, it is unclear if the fauna observed reflected a permanent increase or merely a temporary attraction to the enclosure. However, there was an increase in the number of

FIGURE 11. *Conch grazing on epiphytes on the enclosure mesh and seagrass blades (Photo: Laura Issac Norton).*

FIGURE 12. *A conch with a hole in its shell at the beginning of the study and a conch with a healed hole at the end of the study (Photos: Laura Issac Norton and Megan Davis).*

species over time, which included many known conch predators such as green turtles, southern stingrays and octopuses.

The enclosure and conch were placed in a historical breeding habitat during spawning season with an expectation that egg masses would be laid. This was not the case in this study despite similar temperature, conch density, depth, and food availability to other enclosure studies in the Caribbean where egg masses were laid. Handling stress from fishing and tagging may have caused the conch to resorb their gonads. A similar effect was observed in the Florida Keys, where conch in nearshore waters exposed to temperature extremes, poor food quality and anthropogenic effects had reduced gonad development. However, when those conch were translocated to offshore sites with cleaner water and cooler temperatures, reproductive tissues began to develop in just three months (Delgado *et al*. 2004).

Conch spent most of their time feeding in dense seagrass, which provided them with energy that was used to overcome handling stress and repair the holes in their shells (Fig. 12) rather than being allocated to gametogenesis. In the future, adult conch should be placed into enclosures about three months before the breeding season starts so that they can recover from stress and gametogenesis can take place. For follow-on studies in this same MPA, we plan on using similar methods to investigate topics such as how conch density affects nutrient and carbon cycling in the seagrass ecosystem and influences reproductive activities.

FIGURE 13. *Co-authors Megan Davis (left) and Laura Issac Norton (right) with tagged conch used in the study (Photo: Catherine Booker).*

With queen conch stocks in severe decline throughout the Caribbean, breeding stocks should be conserved at high densities to ensure reproductive success for the longevity of the species (Stoner *et al*. 2019). In areas that have been completely overfished, thereby increasing the difficulty of conch finding mates, we recommend repopulating MPAs with queen conch adults as a way to protect breeding populations as one solution to address the decline of this species.

Notes

Laura Issac Norton graduated with an M.S. degree in Marine Science and Oceanography from Florida Atlantic University in May 2020. Her major advisor was Megan Davis, Research Professor at Florida Atlantic University, Harbor Branch Oceanographic Institute, 5600 US 1 North, Ft. Pierce, FL 34946 USA. Catherine Booker, founder and managing director of Green Island Blue Ocean, LLC and former project manager and educator at The Exuma Foundation, lives on Great Exuma, Bahamas and was a partner on the project. Corresponding authors (Fig. 13): Laura Issac Norton (lissac@fau.edu) and Megan Davis (mdavi105@fau.edu)

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