Preliminary Findings: Testing an Egg Farm as a Method to Increase Reproduction of Queen Conch, *Lobatus gigas*, in The Bahamas

Hallazgos Preliminares: Probando una Granja de Huevos Como Método para Incrementar la Reproducción de Caracol (*Lobatus gigas*) en Las Bahamas

Résultats Préliminaires: Test d'une Ferme d'Œufs comme Méthode pour Augmenter la Reproduction de Queen Conch, *Lobatus gigas*, aux Bahamas

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ABSTRACT

The queen conch, *Lobatus gigas,* is key to the Bahamian way of life. Recent studies suggest that commercial stocks will be depleted in The Bahamas in 10-15 yrs. To assist in restoration, an egg farm was established (5/26/19) in a historic breeding ground in Moriah Harbour Cay National Park, Exuma, Bahamas. Previously used for aquaculture, the egg farm concept was being tested as a restoration approach. Conch from two populations with lip thicknesses, 2 - 28 mm, and shell lengths, 17 - 25 cm, were bought directly from the fishermen's boats in Georgetown, Great Exuma, Bahamas. Of these conch, 67% were adults with a lip thickness of ≥ 15 mm. All 256 conch were tagged and stocked in a 0.14 ha circular enclosure at an equivalent of 1,821/ha. The egg farm was located on a back reef in a depth of 2.5 - 4.5 m; it was exposed to ocean and bank water and consisted of rubble, sand, and sparse to dense seagrass. During this project (May 26 - August 14, 2019) the egg farm was visited every 24 - 48 hours to study conch movement, burial, predation, breeding, and egg mass laying. In the first month the conch acclimated to the egg farm while recovering from their long-distance transport and shell damage. During this time 90% of the conch were aggregated in the dense seagrass area. In the second and third month the conch were found throughout the enclosure. Conch were observed actively feeding during the day and evening hours. Pairing was observed; however, no egg masses were found. The egg farm benthos was surveyed monthly inside and outside of the perimeter of the enclosure to characterize any habitat changes from the presence of conch and their grazing. It is anticipated that this partnership project will result in a path to test more egg farms and set an example of a low-tech, accessible tool that can be used by fishermen to increase egg mass production while protecting breeding populations.

KEYWORDS: Queen conch, translocation, Marine Protected Area, The Bahamas, enclosure

INTRODUCTION

The queen conch, *Lobatus gigas,* is a marine gastropod found throughout the Florida Keys, The Bahamas, and the Caribbean. As a cultural icon, important fishery species, and food staple, conch are undoubtedly an integral part of the Caribbean way of life. The conch fishery is among the most important fisheries in the Caribbean, second to spiny lobster (Brownell & Stevely 1981). Since the 1970s there have been increasing pressures put on queen conch by the fishing industry and/or from habitat degradation throughout the region. This has caused breeding population densities to decline (Stoner et al. 2019). Since conch are gregarious spawners, it is recommended that their aggregations be at a density of ≥ 100 conch/ha to be a successful breeding population (Stoner and Ray-Culp 2000). Populations with densities <56 conch/ha are less likely to be successful due to difficulty in finding a mate (Stoner et al. 2019). From 2009 - 2017, many conch breeding populations throughout The Bahamas were sampled, with the results showed that only 19.5% have large enough aggregations to have successful spawning, while 75.6% are at a tipping point (Stoner et al. 2019). Based on these findings, the headlines of The Nassau Guardian on January 10, 2019 read "Study: Conch fishery could disappear in 15 years". Therefore, actions such as new fisheries management policies, aquaculture, and restoration strategies are needed to help conserve the conch for the purpose it serves in seagrass ecosystems and to ensure sustainable fishing for the future.

As an effort to preserve current resources, many countries are setting up marine protected areas or national parks (hereafter MPA). This style of ecosystem-based management protects many species and the ecosystem as a whole. In The Bahamas, the Bahamas National Trust (BNT) has made an ongoing effort to increase the number of MPAs. BNT has established 31 protected areas, 17 of which are marine, and the oldest being Exuma Land and Sea Park (ELSP) which was founded in 1958. Not only are MPAs important for preservation of its inhabitants, but models of larval spillover and exchange between MPAs and fishing grounds around the Exuma Sound show that areas in the southeast region supply conch veligers to the northern areas of the sound, due to the current flow (Chiappone and Sullivan Sealey 2000, Kough et al. 2019). However, in the case of ELSP the queen conch population is showing aging and little recruitment from the southeast (Stoner et al. 2011). Therefore, these studies help make a case for strategically placed MPAs with high connectivity to increase productivity inside and to assist with seeding nearby fishing grounds. Another MPA was established in the southern Exumas in 2002; Moriah Harbour Cay National Park (MHCNP), Great Exuma (Figure 1). Local Bahamians have reported that large numbers of conch were fished in this area at one time, however, the remaining conch population in this MPA have not been surveyed. Without a sustainable breeding population, MHCNP will not supply conch veligers to the surrounding fishing grounds and MPAs.

The purpose of this study was to test a new restoration management strategy by reestablishing a conch breeding population in MHCNP. The concept was that a reestablished breeding population would lay egg masses, which would increase the veligers in the water column so that they would drift and settle in nearby conch nursery habitats. Deliberately aggregating conch to encourage spawning in an enclosed "egg farm" has been a technique used in aquaculture to ensure a reliable source of conch egg masses for the hatchery (Davis et al. 1984, Davis et al. 1987). This is not unusual, as gathering broodstock to encourage breeding and spawning is a common culture technique in many species throughout the world, such as *Rachycentron canadum, Achatina fulica,* and *Pomacea paludosa* (Gopakumar et al. 2011, Upathan et al. 1998, Posch et al. 2012, Hong and Zhang 2003).

The goal of this study was to use the conch egg farm aquaculture concept and apply it as a restoration tool to address the decline in queen conch populations in The Bahamas. This restoration study investigated the effects of translocating adult conch into an enclosure within a historic conch habitat in a MPA through these objectives:

i) To characterize the morphology and behavior of the conch from the two translocated breeding populations that were used in the egg farm enclosure,
ii) To determine how the translocated conch acclimated to the habitats in the enclosure, and
iii) To determine if the translocated conch changed the habitats in the enclosure.

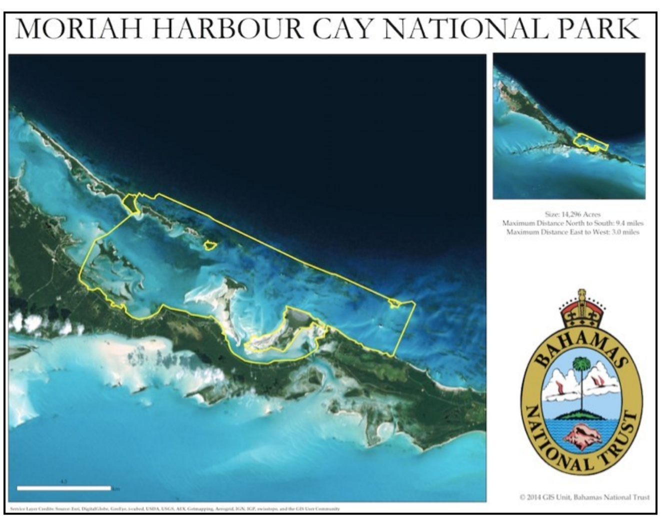

Figure 1. A map showing the boundaries of Moriah Harbour Cay National Park. The Park is 15.1 km long and 4.8 km wide at the largest points and has a total area of 57,740.5 m^2.

METHODS

A preliminary visit to Great Exuma, Bahamas to select the egg farm study site occurred March 29 – April 3, 2019. The study site selected inside the MHCNP was in the cut between Elizabeth Cay and Guana Cay (Figure 2) approximately 5.4 km from Georgetown, Great Exuma. This site traditionally had conch in the area, however, they are not as abundant as they previously were. In the summer of 2017, a range of sizes from juveniles to adult conch were found in this location and one female was seen laying eggs. This site showed the characteristics that make it ideal as a conch breeding location:

i) Located on the back reef with a 1-knot flow of tidal ocean water and bank water,
ii) Substrate contained calcareous sand and coral rubble,
iii) eagrass beds were present for grazing, and
iv) The depth was < 8 m.

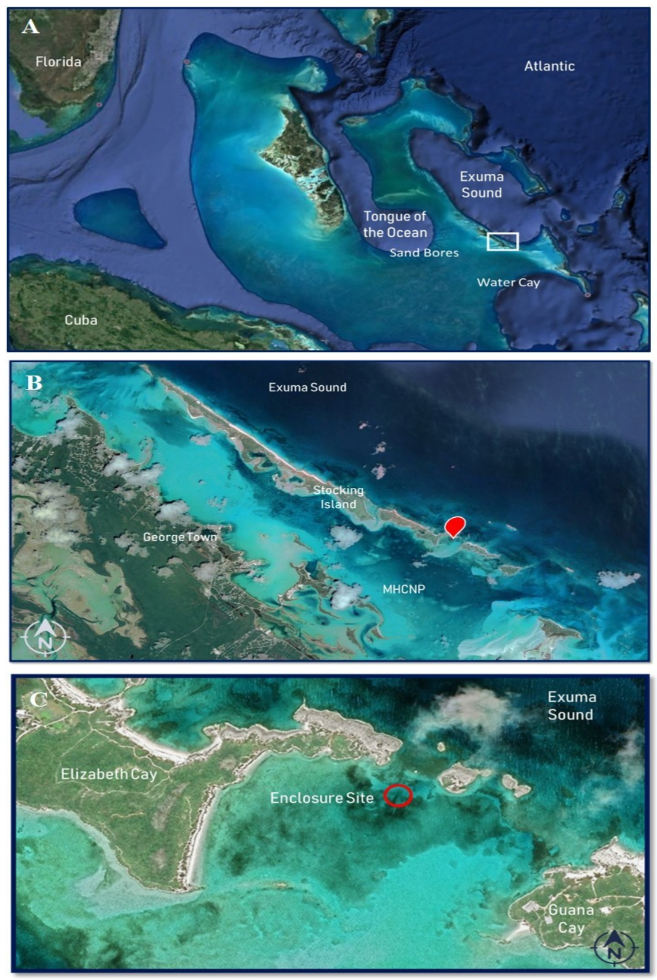

Figure 2. The study site was near George Town, Great Exuma, Bahamas, which is 513 km from Miami, Florida (a). The two conch collection sites, were Sand Bores (111 km from study site) and Water Cay (101 km from study site) (a). The study site was located in the cut between Elizabeth Cay and Guana Cay inside the MHCNP (b, c). The red circle shows the size (0.14 ha) and location of the egg farm enclosure at the study site (c).

The 12-week study was conducted from May 26 to August 16, 2019. A circular enclosure with a center partition was built underwater at the site using vinyl coated 11-gauge wire with a mesh size of 7.62 cm x 7.62 cm. The circular enclosure was 1400 m^2 (0.14 ha) with a height of 76.2 cm and diameter of 42 m. Steel rebar rod (1.2 m length x 1.6 cm dia) spaced 2.4 m apart was used to support the enclosure wall. The wire mesh was attached to each rebar with heavy duty zip ties. For additional stability, steel Duck anchors were used to secure areas of the enclosure in higher energy zones. Several sand bags were used in areas where there were gaps between the substrate and the bottom of the enclosure. To aid in navigation and observations 24, 15 cm white numbered buoys (1- 24) were attached evenly around the enclosure. Six additional buoys were attached evenly down the center partition. A nylon rope was tied to the enclosure intersecting at the center rebar to divide the enclosure into four quadrants. This also aided in navigation and observations. Signs were attached to the enclosure to inform snorkelers that this was a research project and not to disturb the conch.

Initially an effort was made to locate conch local to the Great Exuma area for stocking the enclosure. However, since only a few were found it was determined that conch translocated from nearby fishing grounds would be used to stock the enclosure. The enclosure was stocked with adult conch purchased ($3.00 ea) directly from local fishermen. The conch were from Water Cay (WC) (n = 50) approximately 101 km from the study site and the Sand Bores (SB) (n = 200) approximately 111 km from the study site. The majority of the conch (86%) had small holes knocked in the front lip of their shell. Fishermen use these holes to string five conch together for easy transport and to keep them from crawling away in the water before they were sold. In addition, a local Bahamian provided three Exuma conch to the project and three adult conch were found at the study site. There was a total of 256 conch stocked in the enclosure. The translocated conch had a high survival rate of 98% during the study. Four died within two weeks of the start of the study, most likely from handling disturbance. Another conch died from predation by an octopus. Therefore, there were a total of 251 conch during the majority of the study period, which was an equivalent density of 1,793 conch/ha.

The conch were purchased from the fishermen's boats and transported by dive boat to the egg farm enclosure. Wet burlap was laid over the conch to keep them moist and cool. Buckets of saltwater were poured over the burlap to keep the conch wet during transport and tagging. Before the conch were released into the enclosure, their shell morphometrics were recorded. Calipers were used to measure lip thickness (LT) following the guidelines of Appledoorn (1988) and an osteometric board was used to measure shell length (SL) from apex to siphonal canal (Figure 3a, b). Each conch was tagged with two tags to ensure that the conch could be identified if one of the tags was lost. A numbered cattle tag was attached with a small zip tie to Monel wire that was wrapped around the spire of the conch's shell behind a row of pronounced spines (Figure 4). If a conch did not have well pronounced spines, a triangle file was used to make notches in the spire shell for the wire to sit in. In addition, a small plastic numbered tag (2.5 cm x 1.3 cm) was attached to the conch with two-part underwater epoxy. Conch were divided into two groups and placed on either side of the center partition. Conch on the NW side of the enclosure were referred to as "green conch" because their tags were green. Conch on the SE side of the enclosure were referred to as "yellow conch" because their tags were yellow. As conch morphometrics were being processed, an effort was made to evenly distribute conch on each side with similar LT ranges. The majority of the SB conch were thick lipped, therefore, fishermen were requested to collect thinner lipped conch from WC to provide a range of lip thicknesses for this study. The conch in the enclosure had a range of lip thicknesses (LT), from < 15 mm to > 15 mm, to provide an opportunity to observe behavior at the various levels of maturation. Of these conch, 67% were adults with a lip thickness of $\geq$ 15 mm. The current recommendation is that conch that have a LT of $\geq$ 15mm are 50% likely to be functionally mature (Stoner et al. 2019).

The sub-habitats inside the enclosure were described by recording visual observations on a snorkeler's slate. This was repeated multiple times by various snorkelers for accuracy. The enclosure was located in the back-reef area and encompassed eight sub-habitats (Table 1). The most prevalent sub-habitat was thick seagrass (namely *Thalassia testudium*). In this study, the term sparse seagrass refers to a density $\leq$ 320 shoots/m^2, medium refers to 321 - 624 shoots/m^2, and thick refers to 625 - 1,000 shoots/m^2. The depth was recorded in 58 locations inside the enclosure, and the distance from the enclosure to the nearby reef was also measured. The depth of the enclosure ranged from 2.5 m to 4.5 m, with the southern end of the enclosure being the shallowest area and the sandy area near the reef being the deepest. At the nearest point, the enclosure was 2 m from the reef.

The conch enclosure was monitored every 24 - 48 hrs during the study. Observational data of the conch included conch movement, burial, predation, breeding, and egg mass laying. During each visit the position of each conch was recorded by snorkeling each quadrant and writing the conch's cattle tag number on a diagram of the enclosure printed on underwater paper. Each visit also included an inspection of the enclosure to ensure it was secure, repair or replacement of tags, salinity measurements with a refractometer, weather and tidal observations, and fauna observations. Maintenance also included weekly cleaning of the signs and monthly downloads of the HOBO temperature logger data. Inventory of the conch was completed every visit for the first month, then every week to ensure all conch were present.

The egg farm benthic flora was surveyed monthly (n = 3) inside and outside of the perimeter of the enclosure to characterize any habitat changes from the presence of conch and their grazing. This was accomplished by haphazardly tossing a 25 cm^2 quadrat approximately 12 times in each of the three sections of the enclosure (n = 36 - 38) (Figure 5). This was repeated around the outside of the enclosure for comparison (n = 16 - 33). The types of seagrass and macroalgae species were recorded. In each quadrat that had seagrass or macroalgae, the seagrass shoots were counted and each individual macroalgae plant was counted. The fauna that were seen within the egg farm enclosure was recorded during each visit.

During the last month of the study, many of the conch were sexed by placing them on their side underwater in the enclosure and as they flipped over the verge of the male or the egg groove of the female was noted. Additionally, at the end of the study more conch were placed in 30 g magnesium chloride/L of seawater (Acosta-Salmón and Davis 2007). This method caused relaxation of the conch in approximately one hour and the sexes can be noted. A total of 183 of the 251 conch in the egg farm conch were sexed.

At the end of the 12-week study the conch had not laid egg masses in the enclosure, therefore, a representative subsample of 75 egg farm conch were removed and sacrificed to take gonad samples. In addition, 20 newly fished conch from SB were sacrificed for gonad sampling. The samples were preserved for histology (Delgado et al. 2004), which will provide data to determine if the conch in the egg farm showed reproductive readiness. These results will be presented in future publications.

Figure 3. Lip thickness was measured with calipers. The top clamp of the caliper laid flat on the shell and triangulated with the spine ridge (a). Shell length from spire apex to the end of the siphonal canal was measured with an osteometric board (b).

Figure 4. Each egg farm conch was tagged with a cattle ear tag that was attached with a zip tie to Monel wire that was wrapped around the spire of the conch

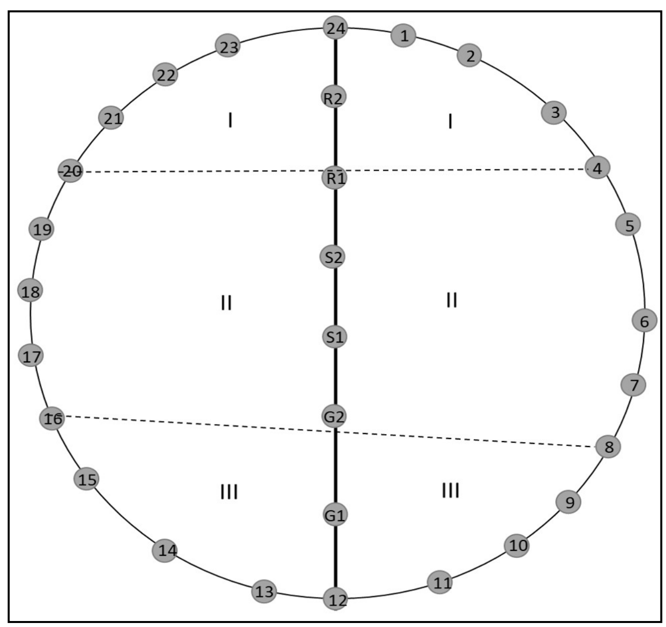

Figure 5. A diagram of the 0.14 ha egg farm enclosure, divided into three sections for the monthly benthic surveys.

Table 1. Description and percent area of the sub-habitats inside the 1400 m^2 (0.14 ha) egg farm enclosure

Sub-Habitat Types	*Area (m^2)*	*% of Enclosure*
Sand	62.23	4.4%
Sand and back reef rubble	18.69	1.3%
Sand, back reef rubble, and calcareous algae	130.55	9.3%
Thick Seagrass	655.17	46.8%
Medium Seagrass	184.31	13.2%
Sparse Seagrass	350.10	25.0%

RESULTS

The environmental conditions that were monitored at the egg farm showed that the salinity ranged from 35-39 ppt depending on tidal currents coming from the bank and ocean water. After occasions of heavy rainfall salinity was 27 ppt in the surface water. Water temperature ranged from 27.4 - 32.6˚C during the study period. At the beginning of the study, the end of May, the winds were approximately 18 knots or higher, which caused the water to be turbid. By early June through July the winds ranged from approximately 8 - 16 knots and water visibility was favorable for observations. In most cases the visibility was 20 m horizontal with some days as clear as 42 m, which was the diameter of the enclosure. In late July a tropical disturbance passed through the area, causing winds of 20 - 30 knots. The weather became increasingly calmer through August and there were many days where there was little wind to no wind. The tidal currents at the egg farm were minimal (1 knot), which aided with the snorkeling observations.

Morphology of the conch from the two distant collection sites were characterized by SL and LT with a mean ± SD calculated. Conch translocated from the SB site were 19.9 ± 1.34 cm SL and 17.5 ± 3.06 cm LT (n = 200). Conch from WC were 21.7 ± 1.15 cm SL and 10.4 ± 3.59 mm LT (n = 50) (Figure 6). The morphology of the conch on the green side of the enclosure were 20.5 ± 1.55 cm SL and 15.9 ± 4.41 mm LT. The conch on the yellow side were 20.2 ± 1.52 cm SL and 15.9 ± 4.41 mm LT. Of the 256 conch, 67% were adults with a lip thickness of $\geq$ 15 mm. Based on the conch that were sexed 58% of the conch were female and 42% were male. Of the 256 conch in the study, the 220 that had a hole in their lip started to repair their hole after being placed in the enclosure. After about one month it appeared that the majority of the conch had healed their hole. By the end of the 12-week study 99% of the conch had healed their hole completely.

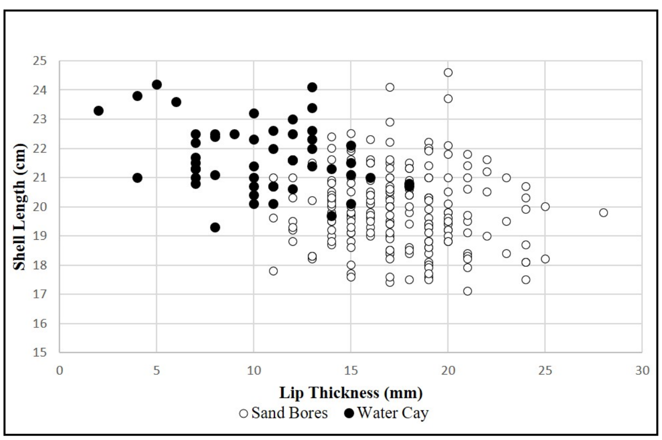

Figure 6. Shell length and lip thickness for the translocated conch from the two collection sites (Sand Bores and Water Cay).

The conch appeared to acclimate to the enclosure immediately based active grazing observed on the epiphytes in the seagrass and sand habitats. On one night snorkel, conch were also seen actively grazing. Over the 12-week study the enclosure site was visited 42 times. Behavioral observations during each visit showed that up to 21% of the conch were seen actively moving and up to 7% were buried. Although no mating or egg laying was observed during this study, there were 14 pairings. Also on seven occasions conch were seen following another conch via their trail.

The position of the conch in the enclosure was recorded during each visit to aid in understanding the spatial and temporal movement of the conch. Three of these observations were selected to demonstrate that the conch were found in different locations in the enclosure over the 12-week study period (Figure 7). In June the majority of conch were concentrated at the southwest side of the enclosure in thick seagrass (Figure 7a); this high traffic led to the seagrass near the southwestern edge of the enclosure being worn down. In July, conch started to migrate away from the southwestern edge and towards sub-habitats of the enclosure that were a mixture of sand and less dense seagrass (Figure 7b). In August and July, conch were observed utilizing the majority of the enclosure (Figure 7b, c).

The sub habitats inside the enclosures were mainly dominated by sparse to thick seagrass (85%) and the rest of the sub habitats were comprised of sand, rubble and calcareous algae (Table 1, Figure 8). Based on the monthly benthic surveys inside the enclosure there were eight types of flora species found in the sub habitats (seagrasses and macroalgae) (Table 2). The frequency at which each species was sighted was calculated as the number of times each species was encountered in the benthic quadrat divided by the number of benthic quadrats tossed during that monthly survey (Table 2). In July, the most abundant species was *Thalassia testudinum*, which was observed 66.3% of the times a quadrat was thrown, and the least abundant was *Laurencia sp.,* which was observed 4.9% of the times a quadrat was thrown.

Although the density of the conch was high (1,793/ha), the shoot density of *T. testudinum* inside and outside the enclosure in June and August showed that there were no significance difference found except in area I in June, using a single-factor ANOVA and Tukey HSD/Kramer test (Figure 9). In June, more *T. testudinum* was found inside the enclosure versus outside the enclosure. The fauna observed and recorded inside the enclosure during each visit showed that there were 50 different species. The most commonly observed species were mojarra, sea biscuit, bar jack, porgy, and Nassau grouper.

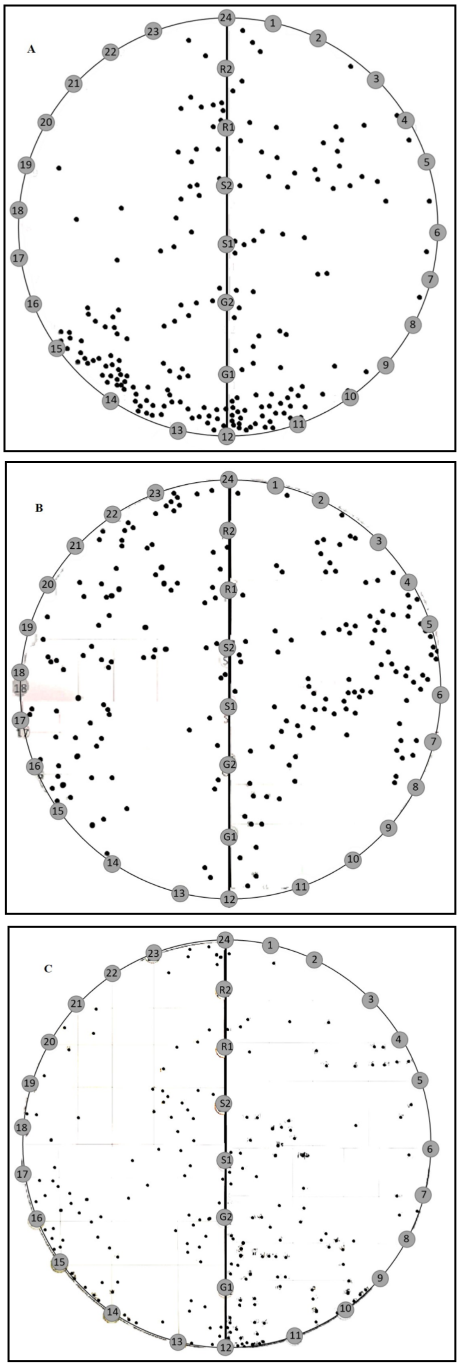

Figure 7. Diagrams showing the location of the conch in the enclosure on June 7, 2019 (a), July 8, 2019 (b), and August 3, 2019 (c).

DISCUSSION

The Moriah Harbour Cay National Park study site provided a location to investigate behavior and ecology of translocated adult (≥ 15 mm LT) and flared lipped sub-adult (<15 mm LT) conch that were moved into an overfished habitat. The expectation was that these conch would form a breeding population that would mate and lay egg masses during the study period, which was during the peak months of the breeding season. Past studies have shown that translocated conch will mate and lay eggs in field enclosures (Appeldorn 1993, Davis et al. 1984). Reproductive behavior (mating and/or spawning) for conch populations in the Exumas has been observed to be 9 - 33% of the population during surveys (Gascoigne and Lipcius 2004, Stoner and Ray-Culp 2000). Conversely in this study, no copulation was observed. However, pairing, where the conch were lined up, was observed 14 times during the study period.

Although it is not clear as to why no egg masses were laid by the translocated conch during the 12-week study, various situations could have attributed to this lack of spawning. The conch used in this study were purchased directly from the fishermen and were not specifically collected by the fishermen for this study. Therefore, handling disturbances during the long distance transport to Georgetown (SB transported ~111 km, WC transported ~101 km) along with the conch being held for an unknown period of time on ropes in the water may have caused enough stress that the conch reabsorbed their gonads (Delgado personal communication). In the Florida Keys it has been shown that conch in the nearshore waters have a lack of gonadal development due to stress from environmental conditions (Delgado et al. 2004). However, when these conch were translocated to offshore sites in the Florida Keys their reproductive tissues began to develop three months after translocation and reproductive activity

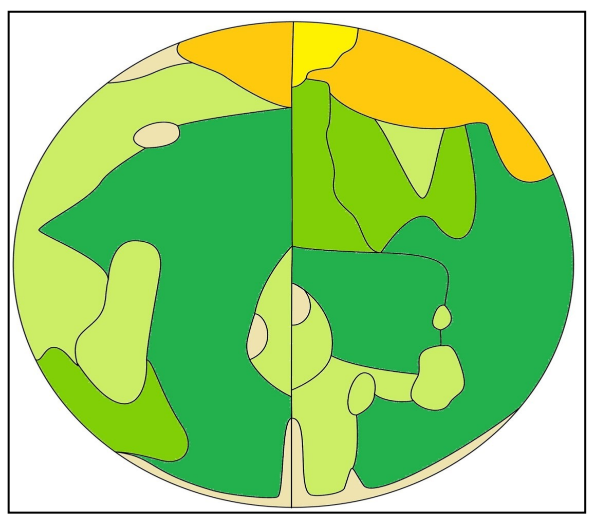

Figure 8. Habitat map of the enclosure. The colors represent the different sub-habitats: dark green is thick seagrass, the medium green is medium seagrass, the light green is sparse seagrass, the tan is sand, orange is sand and calcareous macroalgae, and yellow is sand and reef rubble (also see Table 1).

Table 2. Frequency of the eight most common algae found inside the enclosure in July 2019. Frequency was calculated by dividing the number of times the algae was counted by the total number of quadrat throws (n = 36).

Algae	Frequency Observed	Algae	Frequency Observed
Thalassia testudinum	66.3%	*Halimeda* spp.	20.6%
Sryingodium filiforme	51.6%	*Rhipocephalus phoenix*	9.8%
Halodule beaudettei	32.6%	*Udotea cyathiformis*	8.7%
Batophera oerstedii	35.9%	*Laurencia* spp.	4.9%

was observed (Delgado et al. 2004). It is possible that the translocated conch in this Bahamian study may have regained gonad maturity over the course of the 12-week study enabling them to lay eggs later in the 2019 breeding season or in the following breeding season. To determine if the gonads of the egg farm conch were reproductivity capable of laying viable egg masses after 12-weeks in the enclosure, 75 conch were sacrificed for gonad sampling. In addition, 20 newly fished wild conch from Sand Bores were also sampled at the same time. Histology results from these samples will be presented in a future publication.

The high density (1,793 conch/ha) of the conch stocked in the enclosure may have been another contributing factor to the lack of egg laying. However, high densities of adult conch (1,000 – 2,000/ha or greater) have been recorded throughout the Caribbean including The Bahamas (Gascoigne and Lipcius 2004, and see Stoner and Ray-Culp 2000). There was concern that the high density of the conch in the enclosure might deplete the food resources available, which in turn could affect reproductive behavior. Based on the benthic surveys conducted in this study the seagrass shoot density did not change from the inside and outside of the enclosure during the study period. Although about halfway through the study, there was a visual difference in detrital loads in the seagrass areas inside the enclosure versus outside. The epiphytes on the seagrass blades and diatom mats on the sand appeared to be less inside than outside the enclosure, however, they were not completely reduced inside the enclosure. Based on these observations, it appeared that there was adequate food for the conch held at high density. It is also speculated that the conch in this study may have played a beneficial role in this seagrass community. Stoner et al. (1995) noted that conch, as a herbivore, subtly help to shape the community structure in their ecosystem due to their movement and grazing.

The translocated conch acclimated immediately to their new habitat, which was evident by their behavior. As soon as the conch were placed in the enclosure they instantly began grazing both day and night. In the beginning of the study they were concentrated in the thick seagrass area of the enclosure. This may have been due to their need to graze on the epiphytes to gain energy after being fished and transported and to repair the holes in their shells. Most of the conch healed their holes in a month and it was around this time when the conch started to spread out and utilize most the enclosure area. Although there was a high concentration of conch around the southwest edge of the enclosure at the beginning, they did not pile up on top of each other, which can be a sign of the conch being discontent in their habitat (Stoner personal communication). High survival (98%), dispersal movement, and grazing were indications that this location in the MHCNP could be an ideal habitat for stocking translocated conch. Future studies that can demonstrate an increase in lip thickness, mating, and egg laying would prove that this is an ideal location for a conch egg farm.

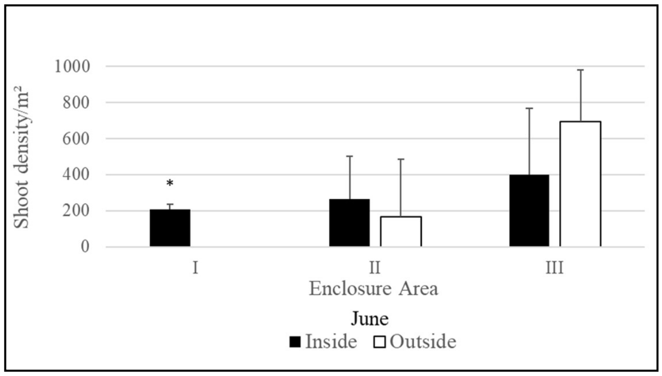

Figure 9. *Thalassia testudinum* shoot density in June in each of the three enclosure areas (see Figure 5). The only significant difference was in area I where there was more *T. testudinum* found inside than outside the enclosure.

It appeared that during the 12-week study there was an increase in the number of fauna species observed both in abundance and variety due to the presence of the conch and the enclosure. Conch predators such as turtles, southern rays, and octopuses were seen, but only one adult conch died during the study from predation by an octopus. It is speculated that these predators were feeding on the juvenile conch in the area, because pieces of crushed conch shell were seen inside and outside the enclosure. As the study period went on, there were several specific animals that were seen nearly every visit to the egg farm. These included a green turtle, a barracuda, southern rays, Nassau groupers, and rock hinds to name a few.

In conclusion, the preliminary results of this study show that conch can successfully be transported from distant conch breeding grounds to reestablish an adult population in a historic breeding habitat in the MHCNP MPA. In the future, it is recommended that conch be translocated into the area several months prior to the breeding season. Using conditions that would limit stress, such as minimal time out of the water and no holes in the shells, could increase the likelihood of mating and egg laying in an egg farm. Testing various conch densities and different sites within a MPA would also aid in building robust breeding populations that could be used to increase the supply of conch larvae to seed nearby fishing grounds. This low-tech accessible tool shows promise for fisheries management and ecosystem restoration as a way to assist in addressing the decline of queen conch populations in The Bahamas and elsewhere in the Caribbean.

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