POPULATION STRUCTURE AND SIZE DISTRIBUTION OF QUEEN CONCH IN GRAPE TREE BAY, LITTLE CAYMAN ISLAND

PAMELA M. COLLINS AND TINA HARRISON

Faculty Editor: David R. Peart

Abstract: Queen conch have been over fished throughout the Caribbean, making population studies important for informing management decisions. We surveyed the conch in a back reef lagoon and found most adult conch were dead from human fishing. Dead conch were larger than live conch. The live conch were concentrated on sandy algal turf and also found in areas of sandy mixed greens (algae and seagrass) and backreef rubble. Our information on shell size, population density, and habitat use by conch wintering at Grape Tree Bay forms the foundation for a more extensive survey currently in progress.

Key Words: fisheries, conservation, Strombus gigas

INTRODUCTION

The queen conch (*Strombus gigas*) is a large herbivorous gastropod found in coastal waters throughout the Caribbean. Though once abundant, conch have been heavily exploited by humans for decades. Local populations have declined, and conch are now protected under Appendix II of CITES (FAO 2004). Conch fisheries are important to the cultures and economies of many Caribbean nations. Since the goal of effective management is to maintain sustainable harvest levels, it is essential to understand the links between conch population structure, distribution, and patterns of human exploitation.

In summer 2006 at Grape Tree Bay, Little Cayman Island, Manfrino and Brown (2006) found low densities of conch (0.25/m^2 alive, 0.36/m^2 dead) and more dead than living individuals. They inferred a declining population, although conch fishing in the Cayman Islands has been regulated by increasingly stringent laws since 1978 (DOE 2004; Timothy Austin, *personal communication*). The study area in Grape Tree Bay falls on the border between a marine park established in 1986 and unprotected waters where harvesting is allowed from May 1 to October 31 (DOE 2004). In 2003, the Cayman Islands Department of the Environment responded to a long-term decline in conch populations by dropping daily harvest limits from 20 conch per person per day to 5 conch per person or 10 conch per boat per day, whichever is lower (Timothy Austin, *personal communication*). Poaching has been an issue around the island because

the position of marine conservation officer on Little Cayman has only recently been filled (John Bothwell, *personal communication*).

As the first part of a larger study examining conch size and distribution around Little Cayman Island (Collins 2007), we expanded on previous work done in Grape Tree Bay by measuring the sizes and age classes of dead as well as live conch and recording occurrences of conch killed by humans. Because conch are subject to size-selective fishing pressure, we predicted that dead conch would be larger and older than live conch.

We also characterized the available benthic habitats within the lagoon and the distribution of conch across those habitats. In the Bahamas, juvenile conch form large aggregations in shallow seagrass beds, while conch older than two years tend to disperse and seek deeper waters, especially in winter when seas are rough (Stoner and Sandt 1992). We therefore expected to find juvenile conch concentrated in shallow seagrass habitat and larger mature conch in deeper sandy habitat closer to the reef.

METHODS

Study organism

Juvenile conch grow by shell accretion until sexual maturity is achieved, between 3.5 and 4 years of age (Stoner and Sandt 1992). Conch then develop a broad flare on the shell lip, known as a flange. Shell length remains constant after sexual maturity, but the flange thickens (Martín-Mora, et al 1995). A combination of length and flange thickness can thus be used as a proxy for age; however, this proxy is not perfect since shell erosion offsets nacre deposition (Stoner and Sandt 1992).

Because conch are generally taken by individual fishermen with minimal technology, conch in shallow water can be heavily exploited compared to conch in deep water, which are accessible only by SCUBA. Therefore, deep water conch may provide larval recruits to heavily fished shallow habitats (Stoner and Sandt 1992).

Sampling

We surveyed the conch population of Grape Tree Bay on 25 – 27 February, 2007, in seven 4-m wide belt transects perpendicular to the shoreline, from the water's edge to the back of the fringing reef (an average distance of 104 m). The study area was a continuous 360 m-long section of shoreline, and transects were separated by 60 m. Maximum water depth was *c.* 3 m.

We counted all conch shells visible within each belt. For each shell found, we recorded distance from shore, shell length (Figure 1), lip thickness, if it was alive or dead, whether there was a chisel opening

in the apical spiral (evidence of human predation), and the habitat in which the conch was found. We observed 7 distinct habitat types distributed in bands across the study area, which we categorized qualitatively by physical substrate and by the type and abundance of vegetative growth (macroalgae and seagrasses) (Table 1). We recorded which habitats were present within each belt transect and the distance from shore where each habitat boundary occurred.

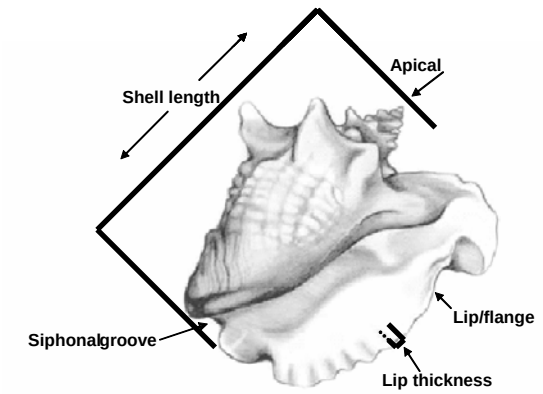

Figure 1. The shell of a mature queen conch (*Strombus gigas*), with measured dimensions and significant features labeled. (Ferren, www.sherpaguides.com).

Table 1. Habitats available to the queen conch, *Strombus gigas*, in a back reef lagoon near Little Cayman Research Center, Little Cayman Island.

Habitat	Substrate	Benthic growth	Est. depth (m)	% of total area
Turtle grass bed	Sand	Turtle grass (*Thalassia testudinum*) and some interspersed manatee grass (Cymodoceaceae) dominate (about 75% or greater cover of angiosperms)	< 1	35.9
Sandy mixed greens and calcareous algae	Sand	Similar to sandy mixed greens, but with high abundance (about 50%) of calcareous algae	< 1	6.6
Crumbly limestone	Limestone	Some calcareous macroalgae; frequent sea urchin colonies	< 1	3.6
Limestone algal turf	Limestone	Similar to sandy algal turf, but on hardpan substrate; calcareous algae often dominant	1.5 - 2	2.0
Sandy mixed greens	Sand	Sparser seagrasses mixed with macroalgae	1.5 - 3	36.3
Sandy algal turf	Sand	Open sand covered with a thin layer of algae; sparse macroalgae present.	1.5 - 3	4.0
Back reef rubble	Broken coral, shells, limestone	Some macroalgae present.	1 – 2	11.6

Statistical analysis

We tested for differences in shell size (i.e., shell length and log-transformed lip thickness) between dead and live conch, first with a MANOVA and then with two one-way ANOVAS. We used a chi-squared analysis to test if conch were randomly distributed with respect to habitat across the habitat types inhabited by conch.

RESULTS

We surveyed a total area of 2907 m^2 and found 59 conch shells, 29 of which contained live conch. Of these 59, 40 were juveniles (flange absent) and 19 were adults (flange present). Roughly two thirds of the juveniles were alive, while only one adult was alive (Table 2). Of the 18 dead adults, 14 had the chisel hole in the apical spiral indicating harvest by humans. Shell size was greater for dead than for living conch (MANOVA, $F_{2,55}$=29.27, P<0.0001) for both shell length (ANOVA, $F_{1,59}$=27.36, P<0.0001) and lip thickness (ANOVA, $F_{1,57}$=59.34, P<0.0001) (Figure 2, Table 2).

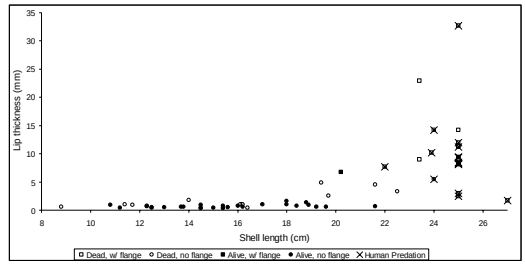

Figure 2. Shell lengths and lip thicknesses of living and dead queen conch (*Strombus gigas*) from Grape Tree Bay, Little Cayman Island. An X overlies each point representing a conch killed by human predation (bearing a chisel hole in its apical spiral).

We found live conch in only three of the seven available habitat types (sandy mixed greens, back reef rubble, and sandy algal turf; Table 1), which comprised 52% of the benthic area surveyed. Conch were distributed non-randomly across these three habitats (χ^2_2 = 171, P < 0.001), showing strong preference for sandy algal turf (Figure 3).

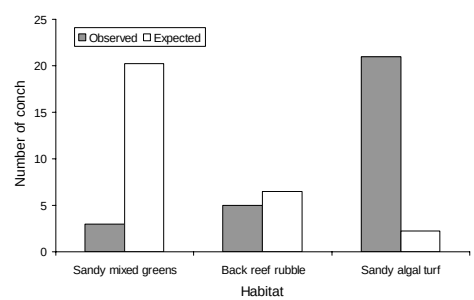

Figure 3. Queen conch were non-randomly distributed with respect to habitat across three of the seven available habitat types (Table 2) surveyed along seven shore-to-reef belt transects in Grape Tree Bay, Little Cayman Island. The three preferred habitats comprised 51.9% of the 2907 m^2 surveyed. "Expected" refers to numbers of conch expected in each habitat if conch were randomly distributed across habitats based on relative area of each habitat.

Table 2. Characteristics of 59 live and dead queen conch (*Strombus gigas*) in seven 4-m wide shore-to-reef belt transects 60 m apart in Grape Tree Bay, Little Cayman Island.

Alive	Juveniles (no flange)	Reproductive adults (with flange)
N	28	1
Mean length ± SE (cm)	15.8 ± 0.6	20
Length range (cm)	11 – 23	N/A
Mean lip thickness ± SE (mm)	0.7 ± 0.06	6.8
Lip thickness range (mm)	0.3 – 1.6	N/A

Dead	Juveniles (no flange)	Reproductive adults (with flange)
N	12	18
Mean length ± SE (cm)	16.8 ± 1.4	24.7 ± 0.4
Length range (cm)	9 - 24	18 - 27
Mean lip thickness ± SE (mm)	2.3 ± 0.5	10.9 ± 1.7
Lip thickness range (mm)	0.4 – 5.5	1.7 – 32.7

All	Juveniles (no flange)	Reproductive adults (with flange)
N	40	19
Mean length ± SE (cm)	16.1 ± 0.6	24.4 ± 0.9
Length range (cm)	10.8 – 24.0	20.2 – 27.0
Mean lip thickness ± SE (mm)	1.2 ± 0.2	10.8 ± 1.1
Lip thickness range (mm)	0.3 – 5.5	1.7 – 32.7

DISCUSSION

We characterized the size structure, habitat use, and population density of the conch at Grape Tree Bay in winter. From the high proportions of dead conch with chisel holes, we infer that fishing was the main cause of adult mortality. Further inferences are limited by our inability to determine how long ago the conch died or to account for harvested conch whose shells have been removed from the site.

We may have failed to find more living adult conch because older conch may migrate to deeper, calmer waters during the winter (Hesse 1979). All the live conch that we recorded were between the back reef wall and 60 m from shore, in the deepest part of the lagoon (2-3 m); this may be the most protected habitat for conch that do not migrate to deeper waters beyond the reef. All but one of the live conch were juveniles, but none of these juveniles was found in seagrass habitat, contradicting our prediction for habitat preference. It is possible that rough waves render the shallow seagrass beds inhospitable to young conch during winter. We found sandy algal turf mainly in the deepest part of the lagoon (*c.* 3 m); thus, conch may be selecting this habitat for its depth rather than for its benthic substrate.

If the conch in this study area were patchily distributed and we

failed to sample local aggregations, it is possible that our data may be biased to low estimates of adult conch density. We observed one such aggregation outside our belt transects, with 17 conch in a *c.* 20 m^2 area; all were alive and large, and five appeared to be adults. Future studies should account for the possibility of patchy distributions when designing sampling methods.

Collins (2007) expands on these findings by sampling additional areas around the island, including the shallow lagoon waters of the Jackson's Bay no-take zone to the west and the deeper waters beyond the fringing reef.

LITERATURE CITED

Austin, Timothy. E-mail, Feb 22, 2007.

Bothwell, John. Research Officer, Department of Environment, Cayman Islands. E-mail, March 8, 2007.

Brown, A. and C. Manfrino. 2006. First Report on the Tropical Habitats of Little Cayman Island, Data Collection, Review, and Analysis, CCMI Special Report No.1:0306 (Lamp Third Quarter Report).

Clamp, Jonathan. Manager, Little Cayman Research Center. Personal communications, March 2007.

Collins, P. 2007. Age-specific habitat preference by the queen conch, *Strombus gigas*, at Little Cayman Island. In press.

DOE (Department of Environment), Cayman Islands. 2004. Marine Park Regulations & Marine Conservation Laws.

FAO. 2004. World markets and industry of selected commercially-exploited aquatic species with an international conservation profile: Caribbean queen conch (Strombus gigas). FAO Fisheries Circulars. http://www.fao.org/docrep/006/Y5261E/y5261e07.htm, accessed 3/1/07.

Ferren, Ro. Longstreet Highroad Guide to the Florida Keys & Everglades. http://www.sherpaguides.com/florida/upper_keys/upper_keys.html, accessed 3/1/07.

Martín-Mora, E., F. C. James, and A. W. Stoner. 1995. Developmental plasticity in the shell of the Queen Conch *Strombus gigas*. Ecology 76(3), pp. 981-994.

Ray, M, and A. W. Stoner. 1995. Growth, survivorship, and habitat choice in a newly settled seagrass gastropod, *Strombus gigas*. Marine Ecology Progress Series 123:83-94.