



INTEGRATED WATERSHED RESOURCES

RESULT 2: PROTECTED AREAS MANAGED
REQUIREMENT 2.2: NATURAL RESOURCES IDENTIFIED,
CHARACTERIZED AND MADE AVAILABLE

STANDARD 2.2.1: RAPID INVENTORY OF QUEEN
CONCH (*STROMBUS GIGAS*) IN ROATAN,
MESOAMERICAN REEF



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COVER PHOTO

Mesoamerican Reef, Roatan – Queen Conch
By Stephen Dunbar

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ACRONYMS AND ABBREVIATIONS

AFE	Administración Forestal del Estado
BICA	Bay Island Conservation Association
CBM	Corredor Biológico Mesoamericano
CCAD	Comisión Centroamericana de Ambiente y Desarrollo
CITES	Convention on International Trade in Endangered Species
COHDEFOR	Corporación Hondureña de Desarrollo Forestal
CURLA	Centro Universitario Regional de Litoral Atlántico
DAPVS	Departamento de Áreas Protegidas y Vida Silvestre
DIBIO	Dirección de Biodiversidad
DIGEPESCA	Dirección General de Pesca y Agricultura
GIS	Geographical Information System
GPS	Global Positioning System
IHT	Instituto Hondureño de Turismo
PMAIB	Proyecto de Manejo Ambiental de Islas de la Bahía
SAG	Secretaría de Agricultura y Ganadería
SCUBA	Self Contained Underwater Breathing Apparatus
SERNA	Secretaría de Recursos Naturales y Ambiente
SPSS	Statistical Package for the Social Sciences
TIN	Transect Identification Number
UNAH	Universidad Nacional Autónoma de Honduras
UTH	Universidad Tecnológica de Honduras
UTM	Universal Transverse Mercator

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The principal investigators that conducted all field work, analysis and generated the report for this inventory are Veren J. Perumal and Stephen G. Dunbar from Loma Linda University, California. They were assisted by April D. Sjoboen also from Loma Linda University.

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EXECUTIVE SUMMARY

The queen conch, *Strombus gigas*, is a large gastropod mollusk which forms one of the most important fisheries in the greater Caribbean. However, increased fishing pressure and loss of habitat have reduced populations so low that the species was listed in Appendix II of the Convention on International Trade in Endangered Species (CITES) in 1992. In the Bay Islands of Honduras, there is a lack of basic information on habitat in which queen conch is found, as well as numbers of individuals (abundance). Immediate threats to conch populations in Roatan include local fishing pressures and changes in coastal and shallow reef habitat. Although a decline in numbers of *S. gigas* has generally been recognized by traditional fishers and dive operators, little effort has been made to survey specific areas for the species.

INTRODUCTION

The Queen Conch (*Strombus gigas* L.) is an herbivorous, marine gastropod that ranges throughout the Caribbean, from southern Florida to the northern coast of South America. Conchs have long been harvested for their meat as well as their shells for the curious trade. Conchs have been a staple food item in the Caribbean for many years. The use of conch meat for human dietary consumption dates as far back as 3,000 years ago (Adams, 1970; Stoner, 1997a; FMRI 2005).

Strombus gigas is actually a soft-bodied invertebrate that encases itself in a large flared shell. This species is in the Phylum Mollusca which is characterized by having a muscular foot, a visceral mass and a mantle. The Queen Conch is more specifically in the class Gastropoda which is the largest of the molluscan classes containing more than 40,000 living species of which the majority are marine (Campbell, *et al.*, 1999). Queen Conchs are among the largest marine gastropods reaching lengths of up to 30 cm and weighing up to 2.27 kg. The natural habitat of the Queen Conch is clear, warm shallow waters at depths down to 20 m, although they have been found down to depths of 170 m. Despite their slow rates of movement, Conchs may travel long distances in a season foraging on algae-encrusted rocks or detritus. They are usually found on substrates of sand plains, mixed algal plains, coral rubble, Gorgonian/sponge plains or seagrass beds (Bene and Tewfik, 2003; Danylchick, *et al.*, 2003; FMRI, 2005).

The Queen Conch fishery is the second most important fishery in the Caribbean region, next to the Spiny Lobster, *Panulirus argus* (Appeldoorn, 1996). Conchs are vulnerable to fishing because they are both long lived and slow growing (Gascoigne, 2002). Heavy exploitation of conch populations due to expanded export markets has caused significant declines in their numbers. These declines have been most notable in shallow and near-shore areas in the Caribbean where they are being collected by free-diving (Appeldoorn, 1996; Bene and Tewfik, 2003). Conch populations are now so scarce that fishermen are using SCUBA techniques to search for them in deeper waters (Tewfik, *et al.*, 1998). Recently, increased fishing pressure and loss of habitat have reduced populations so low that the species was listed in Appendix II of the Convention on International Trade in Endangered Species (CITES) in 1992. The significance of decline is extreme in light of studies that show that once conch populations collapse, they do not return for years or decades, and Gascoigne (2002) has shown that Conch reproduction fails when conch populations fall below a critical density of 50 conchs per hectare.

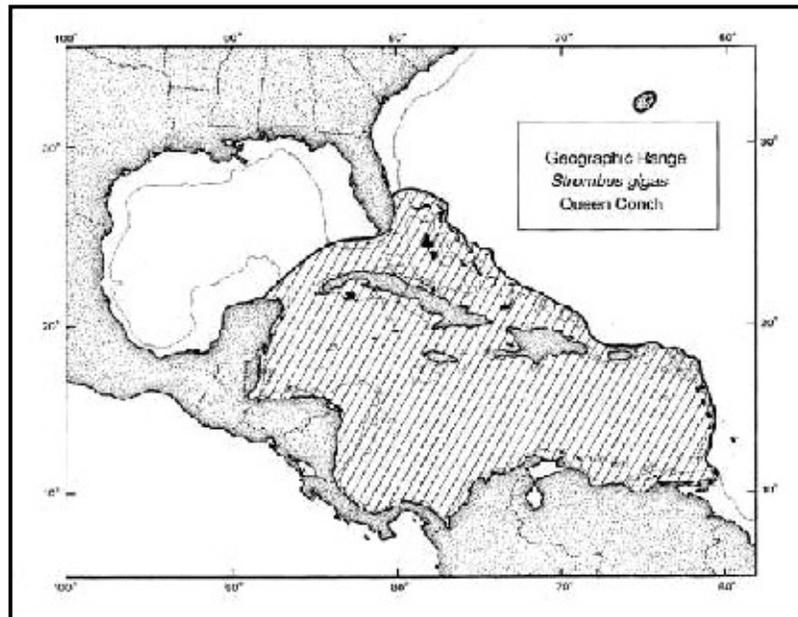
It has become clear that many factors, such as hydrography, landscape, location of larval sources and water circulation patterns all combine with basic data on substrate type to provide a broad picture of distribution and abundance of marine organisms (Irlandi, *et al.*, 1995; Minello and Rozas, 2002). In the Bay Islands of Honduras, there is a lack of basic information on habitat in which Queen Conch is found, as well as numbers of individuals (abundance). Immediate threats to Conch populations in Roatan include local fishing pressures and changes in coastal and shallow reef habitat. Although traditional fishers and dive operators have generally recognized a decline in numbers of *S. gigas*, little effort has been made to survey specific areas for the species.

The purpose of the rapid assessment inventory of Queen Conch, *Strombus gigas*, in Roatan, Bay Islands, Honduras, was to undertake a short-term, rapid assessment of Conch populations along the southern shore of the island of Roatan.

NATURAL HISTORY

There are seven species of conch in the Strombidae family in the Caribbean. These species are the queen conch (*Strombus gigas*), milk conch (*S. costatus*), goliath conch (*S. goliath*), Florida fighting conch (*S. altus*), West Indian fighting conch (*S. pugilus*), rooster tail conch (*S. gallus*), and hawk-wing conch (*S. raninus*) (See Appendix). These large marine gastropods are found in various regions from the coasts of North Carolina to Florida, to Central and South America, to Bermuda. The geographic range of the queen conch (is throughout Florida and the Caribbean region (Map 1).

Map 1: Range of queen conch (Drawing by Bonnie Bower-Dennis)



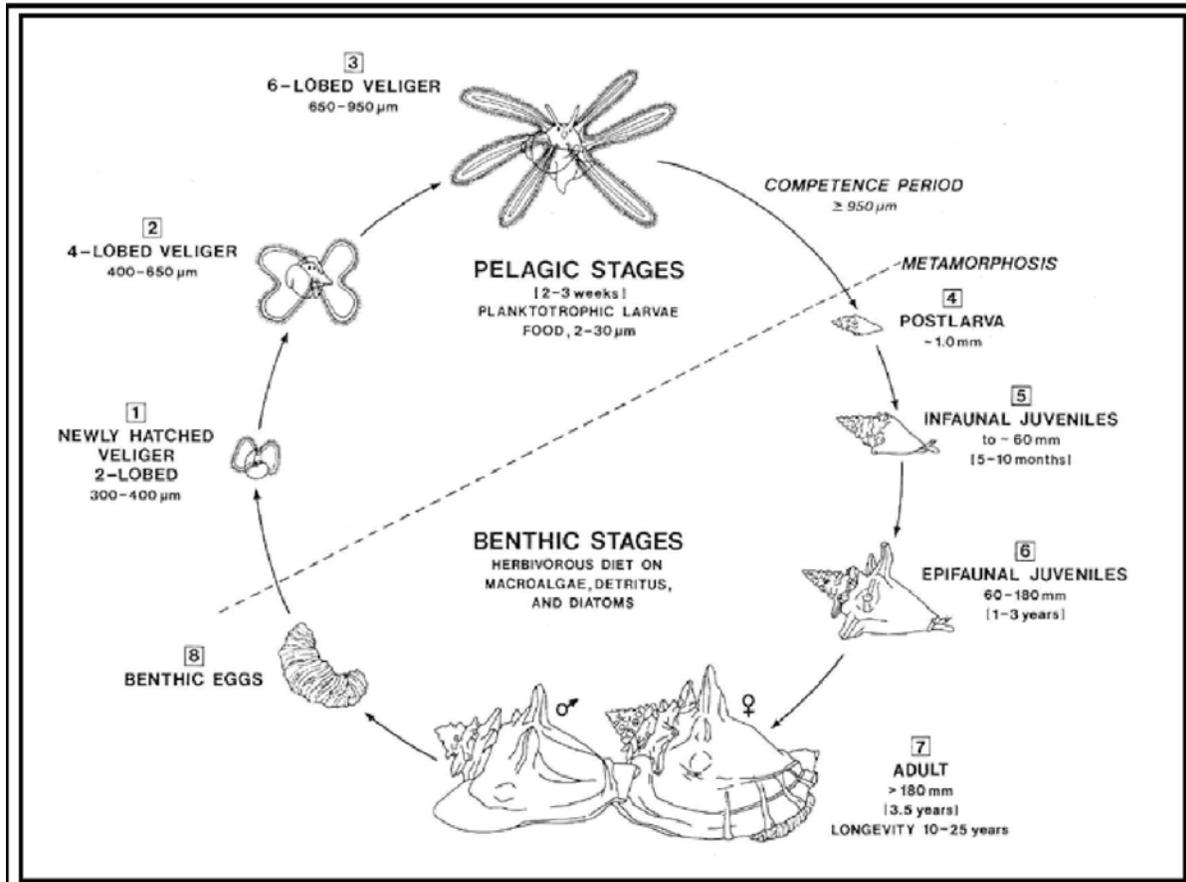
Adult and juvenile conch live in shallow seagrass beds and sand flats. They feed on epiphytic algae and diatoms located on the seagrass blades and sand grains. Adult conch migrate to deeper water (15m) in the winter months and then return to shallow waters (3m) in the summer to spawn. Juvenile queen conch will remain buried in the sand for the first year of their life. After this time, they will emerge from their nursery habitat and migrate towards deeper waters in search of food. Sometimes they migrate in very large groups called a “conch wave”. This rare occasion is thought to be a predator avoidance tactic: “safety in numbers”.

LIFE CYCLE

The life cycle of the queen conch has eight stages (Figure 1). Beginning at the adult stage, conch have separate sexes and queen conch reach sexual maturity at 3 years. At this time, the animals will mate and the female will lay an egg mass. The egg mass is a long (10 – 20m) strand that is coiled into a crescent shape and camouflaged with sand grains. A queen conch egg mass may contain up to 40,000 eggs. The baby conch are ready to hatch in 3 – 5 days. The conch “veligers” hatch with 2 lobes that supply the animals with oxygen and help it collect microscopic algae from the water column. The veligers will stay as larvae for 21 – 30 days. As they grow, they continue to add lobes until they have a total of six long lobes. After 21 – 30 days, the veligers are ready to undergo metamorphosis. They will display several physical characteristics that prepare them for life in the sand and seagrass beds: 1. Ctenidium (gills) are elongated and functional for respiration when they lose their larval lobes. 2. Buccal mass has developed into the proboscis that they will use for grazing. The

conch will settle out of the water column into nursery grounds (seagrass beds). Here they will sense a food cue that will cause them to lose their lobes and become a fully benthic (bottom-dwelling) animal. The queen conch will continue to add length to their shell they were born with until they are 3 – 4 years old. At this time, they will not grow any larger, but will instead add shell to their lip for the remainder of their life. This is when they reach sexual maturity and begin the cycle all over again.

Figure 1: Life cycle of the Queen Conch (Drawing by Bonnie Bower-Dennis)



METHODOLOGY

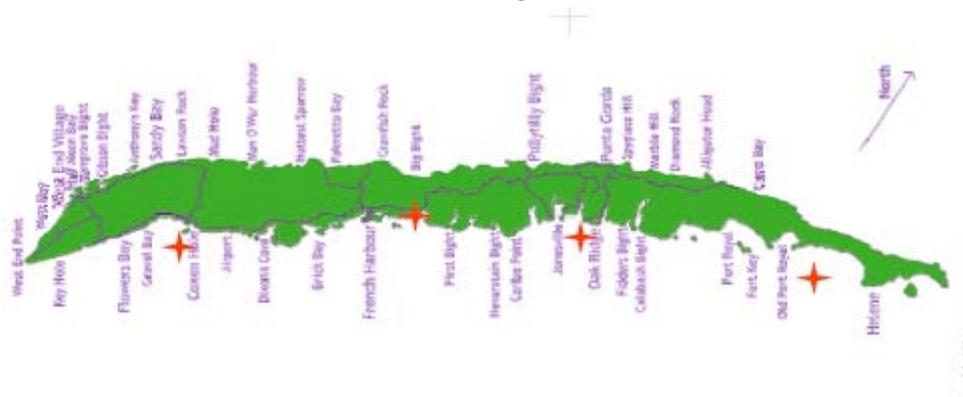
A rapid assessment of the current status of *S. gigas* around Roatan was carried out between October 25, 2005 and November 2, 2005. The surveys began with the selection of 3 Zones with 2 separate sites within each of the Zones. Transects were then done in these sites for intensive surveys along the south coast of Roatan. Study areas included a Zone to the west in the vicinity of the town and port of Coxen Hole (UTM 16Q0555241-1804877), a centrally located Zone near the town of Oak Ridge (UTM ~ 16Q0567531-1811339), and a Zone near the east end of Roatan at Rocky Point (UTM 16Q0578471-1814239). These Zones represent the range of marine habitats present along the coast and were chosen from general habitat data provided by, and in consultation with, Manejo Integrado de Recursos Ambientales (MIRA), Proyecto de Manejo Ambiental de Islas de la Bahía (PMAIB) and the Roatan Institute of Marine Sciences (RIMS). Information was also acquired from local dive operators and traditional fishers. Weather, influenced by Hurricane Wilma and Hurricane Beta, were considered in both Zone and site selection. These weather conditions restricted the areas that were able to be surveyed. The surveys conducted in these Zones were as follows:

- **Zone 1 (West)**
 - Site A – 40-Foot (1 Transect; 180 m² Surveyed)
 - Site B – Maurilio’s Bank (7 transects; 1260m² Surveyed)
- **Zone 2 (Middle)**
 - Site A – Crab Wall (8 Transects; 1440m² Surveyed)
 - Site B – Tortugas Reef (8 Transects; 1440m² Surveyed)
- **Zone 3 (East)**
 - Site A – Rocky Point (8 Transects; 1440m² Surveyed)
 - Site B – Shrimp Boat (8 Transects; 1440m² Surveyed)

A fourth Zone near First Bight was initially inspected for Conch on one occasion. This area comprises the shallow, man-made bay at Fantasy Island Resorts. The little bay is well protected by a breakwater and has a sand bottom with a small seagrass bed. A dive log provided to Stephen Dunbar by the Fantasy Island Dive operators in September, 2005, reported 40 Conch at “Fantasy Beach”. However, the turbidity of the water due to weather conditions at the time of the current study was so high that, in most cases, the 1 – 1.5 m bottom was not be visible. A cursory survey did not result in the sighting of any Conch in this area.

In Figure 2, the selected Zones are shown in relation to the southern coast of Roatan. These Zones were selected based on weather conditions, habitat and input from several sources.

Figure 2: Map of Roatan showing the 3 Zones (♦ selected for the rapid assessment inventory).



Note Zone point near First Bight (“Fantasy Beach”) where a preliminary survey was undertaken. Adapted from www.roatanet.com.

Within each site, replicate 30 m transect lines were laid out randomly along the reef surface. The line was weighted at both ends and marked with flagging tape in 1 m increments as well as numbered every 2 m. Buoy lines were attached to each of the weighted ends of the transect lines to allow location data to be recorded at the surface. Universal Transverse Mercator (UTM) codes for each transect (where possible) were recorded by a handheld Global Positioning System (GPS) unit (Garmin 72) so that as many transects as possible could be mapped in a Geographical Information System (GIS) in the future. During each survey, water and air temperatures, water salinity, tidal time and height, surface weather conditions, prevailing currents, and any fishing activity in the vicinity of the survey were recorded. Transects were surveyed by a buddy team using SCUBA and all data were recorded onto underwater paper. At the end of each day, all field data was transferred into the project database on the main laptop computer. A digital camera with underwater housing was used to photographically record habitat details for later, digital analyses and also as reference material for each site to be stored in the GIS.

DEFINED SPECIES SURVEYS

At each site, a 6×30 m belt transect was surveyed by swimming approximately 1 m above the line along its entire length with each diver sampling one side (3 m) of the transect. Survey techniques of the individual diver included swimming in a ‘ziz-zag’ pattern to cover the area surveyed. Transects were not be broken into smaller units for these surveys. For each transect, divers recorded all conch found, depth of organism, the total shell (siphonal) length, the shell lip thickness, substrate and microhabitat (See Figures 3 and 4).

Figure 3: Rapid assessment inventory team diver retrieving a specimen of *S. gigas* during one of the transect dives.



Figure 4: Rapid assessment inventory team member recording data about a specimen found during one of the transect dives.



Each animal was classified into three size/age categories as follows:

- *Juveniles*: no shell lip or shell lip < 4 mm thick.
- *Young Adult*: shell lip thickness \geq 4 mm, broad flaring shell lip, prominent spines, limited bioerosion.
- *Old adult*: shell lip thickness > 4 mm, worn, thick shell lip, worn spines, moderate to heavy bioerosion.

According to Béné and Tewfik (2003), size/age categories are important with regard to the life-history of conch. These animals have unique growth patterns, with rapid growth in shell length during the juvenile stage (0 - 4 yrs), a short period of associated growth in shell length and shell lip thickness during the young adult stage (~4 – 4.75 yrs), a halt in the growth of shell length at sexual maturity (~4.75 yrs) and finally, a period when only the shell lip thickness increases (~4.75 – 20+ yrs). This size/age system is therefore first used to be able to distinguish juveniles from adults. In the final stages of the life-history (>10 yrs) there is zero or even negative shell length growth due to bioerosion and dissolution of the outer shell. This means that young adults tend to have longer siphonal lengths than older animals in the same population and requires the use of separate categories for young adults (YA) and old adults (OA).

HABITAT SURVEYS

Buddy teams collected habitat data for the conch surveys. Each diver was responsible for recording data along one, 3 m swath of substrate next to and parallel with the 30 m transect line. For each transect, divers recorded depth and substrate/habitat information that was classified into the following 8 groups:

- *Coralline Algae*
- *Turf Algae*
- *Micro Algae*
- *Soft Coral*
- *Hard Coral Heads*: identified to species, if possible.
- *Sponges*: general life forms.
- *Sand Plain*: sand area extending >5 m on either side of the transect line.
- *Coral Rubble*: coral rubble substrates.

Although conchs appear to prefer seagrass and algal plains (Friedlander, *et al.*, 1994; Tewfik, *et al.*, 1998), habitat classification is justified by the many studies reporting the effects of habitat on conch density.

RESULTS

In all, 40 transects across the 3 different Zones were assessed along the southern end of Roatan. This area was equivalent to 7200 m². Over the area surveyed, we encountered a total of 4 living specimens of *Strombus gigas*. One additional shell was also found and recorded as non-living, yet was determined to have died of natural causes since the shell was intact. Our findings are provided in Table 1. This table shows that only four Conch were found during the current study and that all four animals were located within the same Zone (2) and within the same site (A).

Table 1: Recorded Conch data for rapid assessment inventory. See methods for lip thickness and microhabitat key.

TIN#	Quadrant #	Total Shell Length	Lip Thickness	Size/Age Category	Depth	Microhabitat
2A2	6	19 cm	2 mm	1	5.5 m	7,8
2A3	10	21 cm	2 mm	1	6.7 m	7
2A5	4	10 cm	4 mm	2	3.7 m	7
2A8	6	26 cm	5 mm	3	4.6 m	7

The number of *Strombus gigas* found in each of the 3 Zones, as well as the extrapolated density of Conch per hectare are shown in Table 2. This table shows that the calculated density of Conch in Zone 2 is 13.9 individuals per hectare.

Table 2: Final abundance and extrapolated density of *S. gigas* for rapid assessment inventory.

Zone	Numbers of Conch	Density of Conch
1	0	0/hectare
2	4	13.89/hectare
3	0	0/hectare

DISCUSSION

CONSERVATION STATUS

The rapid assessment inventory resulted in a count of 4 *S. gigas* individuals. All animals were found within Zone 2 and were located on sandy bottom substrates, with the exception of individual “2A2” (see Table 1) which was found on a mixed substrate of sand and coral rubble. Furthermore, all individuals were located at depths between 3.7 and 6.7 m. Individuals in three size classes were found, including two juvenile individuals with shell lip < 4 mm thick, one young adult with shell lip \geq 4 mm thick and one old adult with shell lip > 4 mm thick and worn spines. We recognize that densities of *S. gigas* in Zones 1 and 3 may be underestimated due to limited sampling. Still, surveys in other parts of the Caribbean have resulted in density/ha estimates which are both higher and lower than in the current study. For example, data from a rapid assessment by Fonseca, *et al.* (2004) around Barbareta Island at the east end of Roatan, reported densities of 13.9, 12.0, and 79.6 individuals/ha for 3 selected sampling sites. Surveys by Fonseca, *et al.* (2004) were conducted between depths of 1 and 15 m and the number of individuals found ranged between 1 and 10 per site surveyed. These densities correspond well with our estimation of 13.89 individuals/ha found in Zone 2, although the Fonseca, *et al.* (2004) assessment showed an overall average density of 35.14 *S. gigas*/ha around Barbareta.

Table 3 provides a comparison among densities of Queen Conch found in several locations throughout the Caribbean. While the estimated density found in Zone 2 of the rapid assessment inventory is higher than that found in Bermuda, Florida, Puerto Rico and the US Virgin Islands, it nevertheless falls below that found in the Bahamas, Jamaica, Venezuela and Barbareta (Honduras). In any case, the estimated density calculated for Southern Roatan falls well within the ranges of densities found in other areas within the region.

Table 3. Regional comparisons of Queen Conch, *Strombus gigas*, densities throughout the Caribbean (modified from Tewfik, *et al.*, 1998 in Fonseca, *et al.*, 2004).

Location	Density/Hectare
Little Bahamas Bank	28.5
Great Bahamas Bank	20.8
Bermuda (1988)	0.5
Bermuda (1989)	2.9
Florida Cayes (1987-88)	2.4
Florida Cayes (1990)	1.5
Cayos Cochinos (Honduras)	14.9
Barbareta (Honduras)	35.2
South Roatan (Honduras)	13.9
St. Croix (US Virgin Islands)	7.7
St. Thomas/St. Johns (US Virgin Islands)	9.7
St. Thomas/St. Johns (US Virgin Islands)	12.2
Pedro Bank (Jamaica) – Artisanal Zone (0-10 m)	88.6
Pedro Bank (Jamaica) – Industrial Zone (10-20 m)	203.6
Pedro Bank (Jamaica) – at 20-30 m	276.6
Puerto Rico	8.1
Venezuela (Protected Area)	2130.0
Venezuela (Area under Exploitation)	900.0

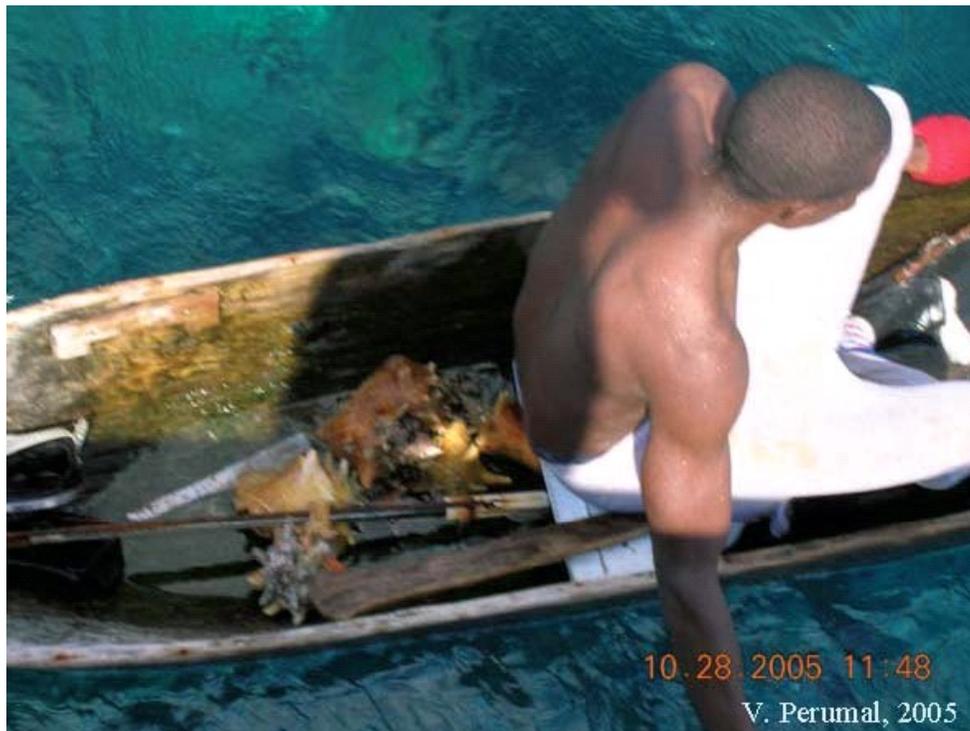
The density estimation of the current study is presented in bold type.

An interesting point to make is that we noted that in Zone 3 where we found 0 Conch per hectare, we observed a local fisherman skin diving, and during the period of a morning harvested 3-5 small conch (Figures 5 and 6).

Figure 5: Photo of a local fisherman and type of craft traditionally used to harvest conch and lobster in the waters around Roatan. *Identity concealed*



Figure 6: Several small Queen Conch that were caught by this man in one morning near Zone 3



One factor contributing to the limited data collected during the rapid assessment inventory was the fact that Roatan was in the middle of a record hurricane season. Resultant weather and currents limited the areas that were accessible for surveying. No transects were laid out on sea grass beds and few were laid in areas that were predominantly sandy bottoms. Although these are habitats that Conch can generally be found in, we

were limited in the areas that could be surveyed due to prevailing conditions. Another factor influencing data collection was the limited time in which to carry out the surveys.

EVALUATION OF THREATS AND MANAGEMENT RECOMMENDATIONS

That *S. gigas* is listed on Appendix II of CITES and populations throughout the Caribbean have been steadily declining is well recognized by the research and conservation communities (Stoner, 1997b; CHN, 2003; CITES, 2003). Yet, it is likely that there is little up-to-date knowledge on the status of Conch populations provided to local fishermen on a regular basis. *Therefore, we recommend that information on the status of Conch be made public by means of posters, radio and television announcements and newspaper advertisements on a regular (i.e. quarterly) basis.*

In 2002 Honduras was recorded to have exported 237.8 metric tons of conch to the U.S. (Cascorbi, 2004), despite the inclusion of *S. gigas* in 1992 in Appendix II of CITES which prohibited export of this organism. Most of the exported Conch are presumed to be harvested in foreign waters and brought to Honduras for landing and export (TRAFFIC, 2003). While local stocks of Conch show signs of overfishing and the current harvest consists mainly of juveniles below reproductive age, Honduras has not carried out stock assessments or placed limits on its fishing efforts (TRAFFIC, 2003). Despite these alarming statistics and the fact that Honduras has been found by a 2003 review by CITES to be one of three Caribbean nations with critically poor stock status and management, little effort has been made to reduce the local demand for conch meat and it is regularly served at many restaurants in coastal areas of Honduras and throughout the Caribbean (CHN, 2003). The current local tourist demand for conch meat may not allow for the rehabilitation of conch populations in the waters around Roatan. *Therefore, we recommend that a Seafood Watch Guide, such as that put out by the Monterey Bay Aquarium in California (Monterey Bay Aquarium, 2005)(see also: http://www.mbayaq.org/cr/cr_seafoodwatch/sfw_issues.asp) be developed and distributed among local fishermen, Tourist Guide Centers and among restaurants throughout the country. This would alert both the local population and tourists to the status of many marine organisms and which seafoods are harvested in an environmentally friendly manner.*

Despite the fact that Honduras has progressive fishing laws on the books, enforcement is poor and illegal fishing is widespread (Cascorbi, 2004). Local Conch stocks show signs of low adult densities, overfishing and the harvest of juvenile Conchs that have not yet reached reproductive age (TRAFFIC, 2003). During the rapid assessment inventory, we made personal observations of local fishermen harvesting small juvenile conch (< ~15 cm). *Therefore, we recommend that size limits for Conch caught be more strictly enforced.*

According to Cascorbi (2004), Honduras has progressive fishing laws on the books, yet enforcement is poor and illegal fishing is rampant. In addition conch fishing is intensifying with the use of SCUBA and hookah gear (Tewfik, *et al.*, 1995 in Cascorbi, 2004). There are reports of Honduran conch dealers approaching officials in other nations to “greenwash” their conch for international trade (Cascorbi, 2004). These actions will not stop unless the people doing the harvesting realize the consequences of collapsed Conch populations. In addition, enforcement should be assisted by local communities. *Therefore, we recommend that artisanal fishermen receive training that will lead to their involvement in the decision-making process for Conch population management.*

In many nations of the wider Caribbean, the nearshore habitat in which Conch are found is threatened by various levels of pollution, sedimentation and development. For example, in the Florida Keys, the Florida Fish and Wildlife Conservation Committee began studies (only recently launched in 2004) on links between levels of habitat disturbance, poor water quality and endocrine disruption and declines in fertility of Conch living in nearshore waters (CHN CIC, 2003). Investigations into the biology and ecology of Conch in Honduras and, more specifically, around the Bay Islands, have been limited. There is an urgent need for greater understanding of links between both anthropogenic and natural changes in environmental conditions and the behavioral, physiological and reproductive responses of conch populations. *Therefore, we recommend that long-term, in-depth studies be carried out on the relationships of environmental changes (temperature, salinity, sedimentation) and larval settlement, development and survival in the Bay Islands. Furthermore, we recommend that genetic studies be undertaken to investigate the relatedness of *S. gigas* populations throughout the Bay Islands.*

CONCLUSIONS

Our data suggest that the numbers of *Strombus gigas* are indeed low in the waters around Roatan and have decreased from their past population abundances. This data correlates well both with current status reports throughout the Caribbean and anecdotal evidence from locals and dive operators in the Bay Islands. To maintain or regain a healthy population in that area, much work needs to be done both in the protection of habitat, as well as limiting catches. Resources are needed for the protection and preservation of conch larval and breeding habitats, as well as the introduction and/or enforcement of regulations on catch sizes. The ban on export of conch products should continue. Education about Conch welfare must be made public, and much more scientific research is needed to increase our understanding of what measures may be taken to increase populations of *Strombus gigas* among the Bay Islands.

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