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Technical documents generated during the Queen Conch Survey Training Workshop: Document I - Report of Mock Survey & Document II – Country-specific Queen Conch Survey Plans

CRFM Secretariat
Belize 2013

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Prepared by:

SOFRECO, under contract to the ACP Fish II Project, on behalf of the Caribbean Regional Fisheries Mechanism (CRFM) Secretariat

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FOREWORD

In 2013, the EU-sponsored ACP Fish II Programme commissioned a study titled 'Training in underwater visual survey methods for evaluating the status of *Strombus gigas* queen conch stocks'. The study was executed by SOFRECO on behalf of the CRFM Secretariat, and upon completion, a Final Technical Report was submitted to the ACP Fish II Programme that contained 4 major outputs of direct interest to the CRFM: a review of underwater fisheries independent approaches to queen conch population estimation; a manual for conducting underwater visual surveys for queen conch; report of a mock survey of a sea area in the southern Grenadines of St. Vincent; and country-specific queen conch survey plans.

To make the 4 major outputs more readily identifiable as CRFM-approved, and also more easily available to the various CRFM publics, they have been extracted from the original Final Technical Report submitted to the ACP Fish II Programme, and reproduced as CRFM Technical and Advisory Documents 2013/14 (regional review), 2013/15 (manual) and 2013/16 (mock survey report and country-specific queen conch survey plans).

The CRFM Secretariat acknowledges the contribution of the EU-sponsored ACP Fish II Programme in this endeavour.

LIST OF ACRONYMS

ACP	African Caribbean Pacific
BC	Buoyancy Compensator
CARICOM	Caribbean Community
CARIFORUM	Caribbean Forum of ACP Countries
CFMC	Caribbean Fisheries Management Council
CFRAMP	CARICOM Fisheries Resource Assessment and Management Programme
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CLWG	Conch and Lobster Working Group
CODOPESCA	Dominican Council of Fisheries and Aquaculture (Consejo Dominicano de Pesca y Acuicultura)
CRFM	Caribbean Regional Fisheries Mechanism
DVR	Digital Video Recorder
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FONDOCYT	National Innovation and Scientific and Technical Development (Nacional de Innovación y Desarrollo Científico y Tecnológico)
GIS	Geographical Information System
GPS	Global Positioning System
IUU	Illegal Unreported and Unregulated
JICA	Japan International Cooperation Agency
LAPE	Lesser Antilles Pelagic Ecosystem
MARSIS	Grenadines Marine Resource and Space-use Information System
MPA	Marine Protected Area
MR	Marine Reserve
NDF	Non Detriment Findings
PPQ	Plant Protection and Quarantine
QGIS	Quantum Geographical Information System
ROV	Remotely-Operated Vehicle
SIOBMPA	Sandy Islands Oyster Bed Marine Protected Area
SL	Shell Length
SPAW	Specially Protected Areas and Wildlife of the Cartagena Convention
SVG	St. Vincent and the Grenadines
TAC	Total Allowable Catch
TCMP	Tobago Cays Marine Park
UASD	Autonomic University of Santo Domingo
USA	United States of America
USD	United States Dollar

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Introduction

Queen conch, *Strombus gigas*, is one of the most important fisheries in the Caribbean region. Populations of conch can be found throughout the Caribbean from the northern coast of South America, northwards through the Lesser Antilles and Central America, and northwest as far as Bermuda. Queen conch is commercially exploited in at least 22 countries throughout the region, with an estimated landing of about 60 million USD. The fishery represents a significant source of income to fishers and creates jobs for the processing and marketing, ornamental, tourist, and restaurant industries in the region. Annual regional harvests for conch meat range from 4,000 MT to 10,200 MT. Significant numbers of conch shells have been exported from the region, with much of the activities originating from Haiti, The Bahamas and the Turks and Caicos Islands (FAO 1999).

In the last 30 years the overall harvest of conch has increased substantially, largely driven by international market demand, as well as growing resident populations, increasing tourism in the Caribbean region, and the expansion of the fishery into previously unexploited deeper waters. These factors have been the main contributors leading to a dramatic decline in conch population densities in several Caribbean countries. This led to the inclusion of queen conch on Appendix II of the Convention on International Trade in Endangered Species of Fauna and Flora (CITES) in 1992. Since then, CITES has progressively increased pressure on states to adopt resource management and trade related measures to protect and conserve the stocks and to ensure sustainable utilization and trade in the species, including issuance of a CITES export permit for all international trade (Theile 2001).

There are a number of regional and international treaties and agreements to ensure the sustainable use and trade of queen conch. At the international level are the CITES and the Protocol concerning Specially Protected Areas and Wildlife of the Cartagena Convention (SPAW Protocol). At the regional level, several organizations are promoting regional management of the queen conch resources; namely, the Caribbean Regional Fisheries Mechanism Secretariat (CRFM), Caribbean Fisheries Management Council (CFMC), FAO, and several universities and scientific institutions.

According to data obtained directly from countries involved in the training, the annual harvest of conch ranged from 2,127 to 5,841 MT during the 1990s, while correspondingly higher harvest amounts had been reported to FAO (Tewfik 2002). The data from countries are not believed to reflect the harvest of conch by subsistence fisheries and illegal harvests. Jamaica and the Dominican Republic are the largest producers of queen conch meat with each country reporting annual landings of about 1,000 MT, followed by Turks and Caicos Islands (737 - 965 MT per year) and the Bahamas (453 - 680 MT), and finally Belize with an annual harvest fluctuating between 138 - 257 MT / year. The queen conch fishery in CARIFORUM countries is predominantly artisanal. In St. Lucia and St. Vincent and the Grenadines conch is targeted by a limited group of divers. In The Bahamas, Antigua and Barbuda, and St. Vincent and the Grenadines, fishers target conch primarily during the closed season for spiny lobster. On the other hand, in Dominica and Barbados, conch is fished opportunistically. In Jamaica, Belize, Dominican Republic, and Turks and Caicos Islands, conch is a major target species for artisanal and industrial vessels the production of which is supported by a developed processing sector that is export oriented. The main fishing gears are SCUBA and compressor (Hookah) diving techniques, except in Belize where these gears are prohibited. In areas where the fishery is more artisanal, harvesting is done by free diving (Theile 2001).

The status of the queen conch fishery in CARIFORUM counties varies from stocks that appear to be over-exploited to stocks that are considered to be stable. In an effort to manage the fishery, CARIFORUM countries implemented various regulations, including: minimum size restrictions, seasonal closures, gear and vessel restrictions, quotas, and limited entry (Appeldoorn 1997). Although these regulations are in place, there are still a number of concerns: poachers / illegal fishing; lack of enforcement of existing regulations; inadequate legislation to support implementation of CITES recommendations; the use of modern diving technology, allowing fishers to access the deepest areas (> 30 m) of adult conch habitat which were once spawning stock refuge; and unsafe diving practices as a direct result of no formal dive training, deeper and prolonged diving, poorly maintained equipment, limited understanding of diving techniques, etc.; and overfishing to supply international demand for conch meat.

CRFM Member States have identified the need for a common regional approach to manage their queen conch fishery, with main issues being: Illegal, Unreported and Unregulated fishing activities, including poaching and illegal trade; monitoring of the conch natural populations and level of fishing and trade, control and surveillance; enforcement; the nature and extent of resource sharing of larval stages; and regional cooperation in management, including the harmonization of management regulations such as a closed season which could help to reduce illegal fishing. These issues could be addressed and effectively reduced at the regional level with the cooperation and commitment of Member States, and to support this decision, the CRFM Secretariat has taken on the task of coordinating conch management in the region. The overall objectives of queen conch management, as identified by Member States, are conservation of the species, sustainable harvest, and re-building of stocks, where depleted. In order to achieve these objectives, the CRFM Secretariat established the annual scientific meetings to examine information and data from important commercial species to determine their status, and if management objectives are being met. The findings and recommendations of these meetings guide fisheries management and decision-making. The Conch and Lobster Resource Working Group (CLWG) is one of five working groups that conduct fisheries assessments, and it currently strives to provide advice on conch stock / population status and to facilitate the development of appropriate management strategies.

As mentioned above, to improve the management of queen conch in the region, Member States need to increase their effort to develop or improve existing data collection systems that will enable better assessment of queen conch impact and population status (CFRAMP 1999). Although many countries have production information data systems, gaps still exist and very little information on spatial distribution and abundance is currently available. The importance of developing strategies to improve catch-effort data systems (i.e., vessel logs, fisher's interview, processing plant reports, and/or direct sampling at landing sites) and other fishery biology aspects (i.e., morphometry, genetics, reproduction, disease) is well recognized. However, there is an emerging recognition that a fisheries-independent monitoring program based on data (underwater census) is also important given the biological complexities of the species and this approach is still lacking for the majority of the countries.

Visual surveys are useful in verifying the results of catch-effort analysis, providing fisheries independent details on population structure, and estimating exploitable biomass as well as levels of recruitment. Within the CARIFORUM region, queen conch visual survey assessments have been done in Antigua and Barbuda, Bahamas, Belize, Dominican Republic, Haiti, Jamaica and Saint Lucia, applying relatively similar field methodology, but differ in their data analysis. However, other countries, Grenada, St. Kitts and Nevis and St. Vincent and the Grenadines have no previous experiences in conducting these underwater visual surveys to complement the queen conch assessments. Therefore, the regional implementation of underwater visual censuses still needs to build on the experiences, methodologies, and data analysis used in the other islands.

This report presents activities and results of a mock survey completed for the project entitled "Training in Underwater Visual Survey Methods for Evaluating the Status of *Strombus gigas*, Queen Conch Stocks'

funded by the ACP Fish II Programme, European Union, as part of a regional training exercise designed to provide an opportunity to share best practices and experiences in the use of visual survey techniques. The goal of the mock survey was to determine a sustainable Total Allowable Catch or TAC for the Grenadine Islands around Union Island, Mayreau, and the Tobago Cays. Ultimately this approach will support the objective of harmonizing visual survey techniques and assessments for queen conch in the region that will be supported by the Caribbean Regional Fisheries Mechanism (CRFM).

Study Area

St. Vincent and the Grenadines is an archipelago comprised of 34 islands and islets located in the Eastern Caribbean at approximately 13° 15'N, 61°12'W. St. Vincent, the mainland, is 133 sq. miles. The Grenadine islands lie atop of the Grenada Bank which spreads forty miles to the southwest and comprise an area of approximately 17 sq. miles. The Grenadine Islands are a transboundary island chain and consist of a number of privately and state-owned islands. Bequia, Mustique, Canouan, Mayreau, Union, Palm (Prune) Islands and Petit St. Vincent are inhabited. Four other uninhabited islands make up the Tobago Cays Marine Park which is also under the jurisdiction of St. Vincent. St. Vincent and the Grenadines are flanked by Barbados 100 miles to the east, St. Lucia 24 miles to the north, and Grenada 75 miles to the south.

The mock survey was conducted in a section of the southern Grenadine Islands, covering an area of approximately 23,679ha (Figure 1.) The survey areas comprised locations immediately surrounding Union Island, Mayreau, and included the Tobago Cays Marine Park. The area was selected because this of the abundant conch stocks, it has traditionally supported an artisanal fishery, it encompasses a broad variety of benthic habitats, and there is sufficient diving infrastructure to complete surveys using SCUBA.

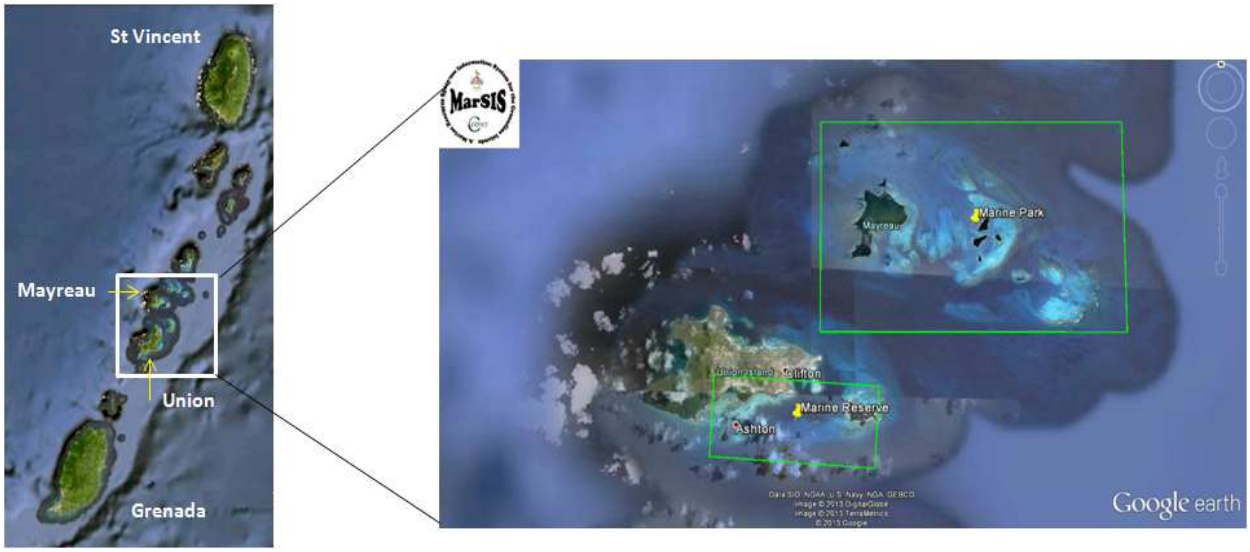

Figure 1. General location of the study area in the Eastern Caribbean. Images taken from Google Earth with MPA boundaries taken from MARSIS (http://www.grenadinesmarsis.com/)

Methods

Sampling design

The shallow water queen conch population was surveyed using SCUBA techniques and followed a stratified random sampling approach. Due to safety considerations, it was agreed that diving would take place at a maximum depth of 80 ft (24m) with sampling partitioned within strata related to the level of protection (protected or not protected) and the level of fishing (fished or un-fished). Habitat was not used as a strata for sample design because there were no maps that had habitats scaled appropriately, or habitat classes suitable, for queen conch sampling. Nevertheless, digital maps in Shape file format were essential to define the exact survey area. A total of 80 random locations pre-selected to be surveyed in this mock survey, from which at least 50 sites were expected to be censed. Digital maps were obtained from the geo-database Grenadines MARSIS (http://www.grenadinesmarsis.com/) developed by the University of the West Indies (Figure 2).

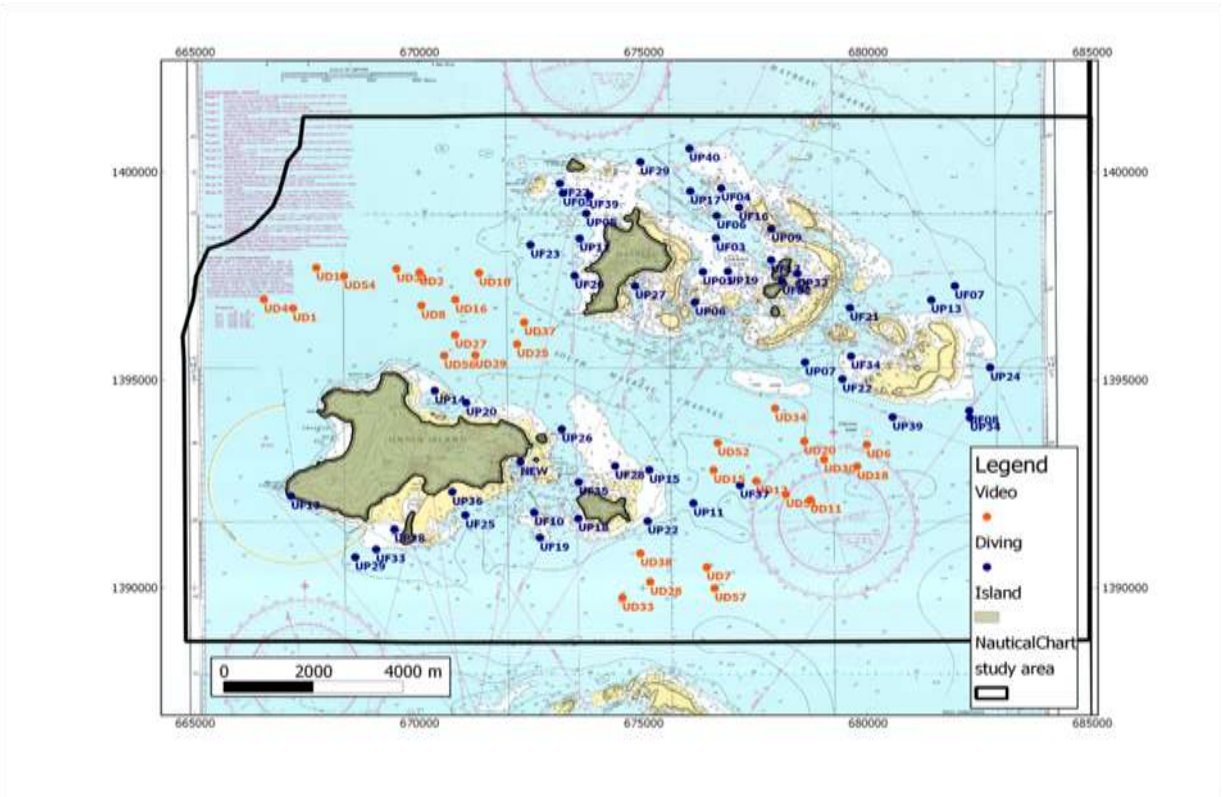

Figure 2: Locations surveyed during the mock survey in the Grenadines. 51 dive sites (blue) and 29 towed-video locations (orange) are displayed over the Central Grenadines British Nautical Chart 794P available at the MARSIS geo-database (http://www.grenadinesmarsis.com/)

The deep water queen conch population was observed from a Sea viewer towed video system rented from University of the West Indies. Additional 60 random points were preselected from the deep water and preferred locations (Figure 2).

Survey locations were selected using the open source freeware GIS program Quantum GIS (www.qgis.org) using the Random Points operation within the Research Tools. A total of 51 points were allocated based upon the strata within which they were found (Figure 1).

Underwater surveys in shallow waters using SCUBA

The underwater visual census were conducted from two vessels: a 29ft vessel with an enclosed cabin carrying three dive teams (each diving team consists in one experienced and another less experienced person) and a 23ft vessel with two dive teams. In addition to the captain, a dive master and one conch survey instructor (KE) was onboard to support the diving activities. Diving was conducted from 10 August 2013 through 17 August 2013.

We used belt-transect methods to sample queen conch. The location of each site was identified in the field using a handheld GPS with the sites preloaded. One individual familiar with the GPS unit was selected to work with the vessel captain to navigate to the starting location of each transect. When the origin of the transect was identified, a buoy was deployed from the vessel to mark the starting point of the transect. A team of 2 SCUBA divers plus a safety diver then descended to the location of the origin of the transect to begin the survey.

Each transect consisted of a maximum of four replicates (30 meters x 4 m). A 30m fibreglass tape was deployed in one direction by the first diver (Figure 3). Simultaneously, a second diver swam along the length of the tape and, using a 1-m PVC pole to measure the width of the transect, sampled all conch within a 2-m swath along the right side of the transect line (Figure 4). When the diver measuring the conch reached the end of the replicate, the same procedure was conducted on the opposite side of the 35-m tape. However, at this point, the roles of the divers were reversed; the diver who deployed the transect tape became the diver measuring conch and the diver measuring the conch rolled in the tape. Only conch that were more than halfway into the 2-m width of the swath were counted. All replicates in a transect were pooled for analyses.

Morphometric measurements consisted of two parameters: a) total siphonal or length shell using a large caliper or a hand-made conch-meter (in both centimeters or inches); and b) lip thickness using a smaller vernier caliper. Lip thickness was measured for all conch (Figure 4). Together, siphonal length and lip thickness formed the basis for determining maturity of the conch.

Upon completion of the survey, the divers ascended together back to the vessel. For dives greater than 30 ft water depth, a safety stop at 15-20 ft for 3 minutes was conducted.

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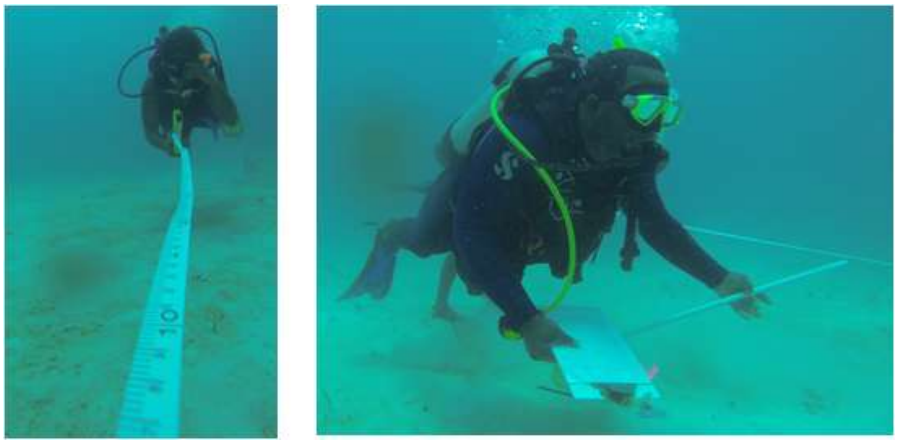

Figure 3: A diver reels in the 30-m tape (l). A second diver (r) examines a swath 2-m in width from the transect line

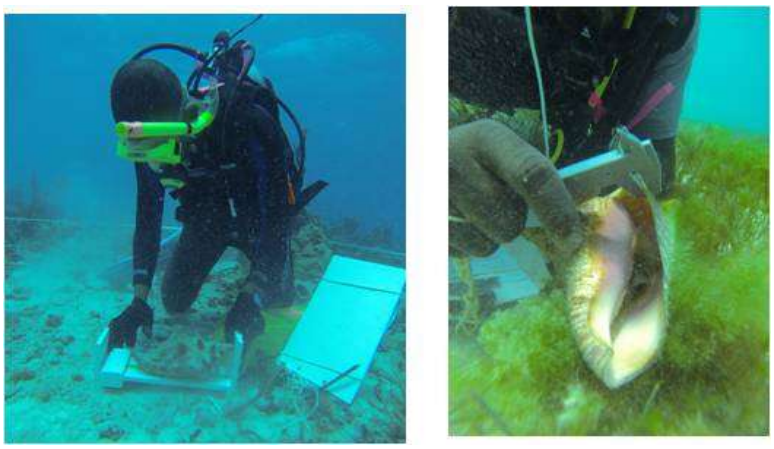

Figure 4. Measuring siphonal length of a queen conch (left) and lip-thickness (right)

Additional data on site depth profiling, bottom time, and water temperature was recorded for each location using a Reef-Net Sensus sensor (http://reefnet.ca/products/sensus/) attached to a diver Buoyancy compensator (BC). Divers made annotations on site habitat type, observations of other conch or conch outside the transects, conch reproductive activity, or any other environmental conditions.

Each night, the data was entered into an Excel spreadsheet for subsequent processing.

Observations in deeper waters

The training in the deeper waters was conducted from the 18 August through 21 August 2013 using a Sea Viewer drop-camera video system (www.seaviewer.com). Training began with a brief session conducted onshore to review the system components (Table 1), set-up the gear, and discuss and plan the deep-water video conch survey methods (Table 2).

Data collection extended over a two-day period, in which the group was divided in two teams; each team conducted surveys for ½ day in the vicinity of Union, Palm and the Tobago Cays (Figure *2*). As was the case with the SCUBA survey designs, Quantum GIS was used to select sampling locations. A random sampling design stratified by depth and by fishing preferred sites was employed. A total of 60 deep-water survey sites were identified of which 29 were surveyed.

Deep water sites were conducted aboard a 29' cabin cruiser. Each site was surveyed by a research team comprising at minimum of six persons, including a captain, navigator, DVR video operator, data recorder, and a person to deploy the drop-camera assisted by a deckhand. Participants took turns conducting each of the various roles during the surveys. Benthic habitat was observed and assessed at each site using a towed submersible SeaViewer video camera, illuminated with LED lights. Imagery was collected in real time via a 75m cable tethered to the surface. The camera equipment was rigged within a weighted PVC cradle (Figure 5) to protect it, and set mostly perpendicular to the seafloor. The camera was tilted at a slight angle (20°) in order to provide a 'landscape-view' across the substrate. Deployment of the video camera apparatus always occurred off the stern of the vessel (Figure 6) and was handled by a two person team, in order to prevent entanglement. The deployment procedure at each deep-water survey site required that the vessel was held relatively stationary.

Table 1. Video drop-camera components, accessories and materials required for the deep water conch surveys

Component	Accessories	Materials
Underwater Video Camera (with LED lights) with 75m cable	Protective cradle for camera	PVC, fishing weights, stainless steel fishing wire
SeaTrac GPS Video Overlay	GPS (2)	1 for SeaTrac; 1 for boat navigation
DVR Screen (or laptop)	Hard drive to record survey footage	
Converter	To power Video camera and DVR (Power source: 110)	Rigged with clamps to use power from the 12V boat battery

The tow speed controlled by the speed of the vessel as it drifted and, was therefore a function of the wind speed and current. The video footage was recorded and viewed in real-time on deck using a portable DVR screen (Figure 7). GPS tracking was recorded as an overlay on the video as latitude and longitude coordinates.

Real-time viewing allowed the operator to hold the camera approximately 1m off the seafloor to obtain consistent images (approximately similar landscape perspective at each site). A minimum of 3 minutes filming time was recorded at each site including the decent and ascent of the video camera in order to accurately assess the most prominent habitat type. Information recorded for each site (Figure 8) included: time, location and water depth to the nearest foot using a hand-held depth sounder; a video representation of the habitat; habitat type; and benthic coverage or density of habitat (low, medium, high). All recorded video footage was overlaid with the date, time, GPS location and vessel speed using a Sea-Track GPS Video Overlay. The video footage was subsequently downloaded and reviewed by the training team on-shore each evening. A total of 29 video surveys were completed (Table 3). The Sensus depth / temperature sensor was also attached to the camera system for better recording of the environmental data.

Table 2. Summary of the drop-camera survey methods and considerations

Methods	Considerations
Survey Team (3 person minimum)	Boat captain (GPS pre-loaded with survey sites); Data collector (DVR screen / data sheet); Deploy drop-camera
Site selection / sampling design	Random; stratified by depth, habitat type, fishing ground
Survey methods	Point / transect; drift / tow; minimum recording time at site; deployment and recording protocol
Data sheet	Field data sheet; video interpretation sheet
Converter	Video; GIS conversion; density and abundance

Figure 5. Photograph of deep water survey showing set up of submersible live-action SeaViewer underwater video camera rigged with weighted PVC cradle

Figure 6. Photograph of deep water survey showing deployment of submersible live-action SeaViewer underwater video camera off the stern of the vessel

Figure 7. Photograph of the GPS navigator and filling in of the data sheet during the conch survey

Figure 8. Photograph of the Conch survey training team conducting a deep water conch survey

Table 3. Video transect raw data

Site #	lat	lon	x	y	Date	WP-GPS #	Video #	Time in	Depth site (m)	Depth camera (m)	Temp °C	Habitat Class	Description	%Cover
UD1	12.630143	-61.460549	1396726	667202	8/19/2013	UD1S/UD1E	619	16:45	33.03	33.7	28.21	Gravel and sand		high
UD10	12.637595	-61.422330	1397576	671349	8/19/2013	281/282	136	0:01	27.58	25.38	28.37	Reef, sand	2 legs broke	
UD11	12.587892	-61.354661	1392122	678735	8/20/2013	285/286	6	10:31		17.81	29.89	Reef		high
UD12	12.592014	-61.365740	1392571	677528	8/20/2013	300/301	115	11:40		19.50	28.65	Macroalgae		
UD15	12.594453	-61.374454	1392835	676580	8/20/2013	304/305	136	12:02		18.86	28.56	Gravel and sand		med
UD16	12.631836	-61.427220	1396935	670822	8/19/2013	279/280	126	11:51	31.52	28.98	28.39	Reef, sand		medium
UD17	12.638965	-61.455708	1397705	667722	8/19/2013	UD17S/UD17E	557	16:22	35.76	33.09	28.14	Reef, marcoalgae		high
UD18	12.595092	-61.344994	1392925	679780	8/20/2013	287/288	17	10:42		17.10	29.28	Gravel and sand		high
UD2	12.637824	-61.434512	1397593	670026	8/19/2013	UD2S/UD2E	531	15:56	36.36	31.73	28.28	Reef, sand		medium
UD20	12.600624	-61.355815	1393530	678601	8/20/2013	294/295	43	11:08		19.90	28.84	Gravel and sand		low
UD25	12.622095	-61.414605	1395866	672199	8/19/2013	270/271		11:01	37.88	35.93	28.1	Reef, marcoalgae		
UD27	12.624141	-61.427317	1396084	670816	8/19/2013	277/278	114	11:40	30.91	30.99	28.32	Reef, sand		
UD28	12.570242	-61.387612	1390148	675167	8/20/2013	UD28S/UD28E	409	2:36	26.36	23.99	28.74	Reef, sand		low
UD29	12.619779	-61.423183	1395604	671268	8/19/2013	273/274	101	11:18	30.00	28.39	28.11	Reef, sand	saw sting rays	
UD30	12.596624	-61.351757	1393090	679044	8/20/2013	291/293	33	10:58		16.81	29.04	Gravel and sand		low
UD31	12.638618	-61.439265	1397678	669509	8/19/2013	UD31S/UD31E	540	16:04	32.42	32.37	28.3	Reef, sand		high
UD33	12.566826	-61.393333	1389766	674547	8/20/2013	UD33S/UD33E	418	2:43	24.55	20.36	28.65	Reef		high
UD34	12.607813	-61.361744	1394321	677952	8/20/2013	296/297	54	11:18		22.87	28.78	Hard bottom, macroalgae		high
UD37	12.626815	-61.413129	1396389	672356	8/19/2013	UD37S/UD37E	506	15:32	30.30	28.27	28.78	patch reef, seagrass	high density(camera angle not good, need readjusting)	high
UD38	12.576450	-61.389586	1390833	674948	8/20/2013	UD38S/UD38E	335	2:00	25.76	21.72	29.67	Reef, sand		low
UD4	12.632117	-61.466507	1396941	666554	8/19/2013	UD4S/UD4E	608	16:33	36.06	35.71	27.93	Reef, sand	omit first minute	medium
UD51	12.589125	-61.359663	1392255	678191	8/20/2013	298/299	106	11:31		19.56	28.83	Gravel and sand		
UD52	12.600354	-61.373573	1393488	676672	8/20/2013	302/303	127	11:52		26.00	21.47	Gravel and sand		
UD54	12.637055	-61.450053	1397498	668338	8/19/2013	UD54S/UD54E	549	16:14	33.33	31.38	28.19	Reef, sand		high
UD56	12.619698	-61.429587	1395591	670573	8/19/2013	275/276	102	11:28	29.09	26.57	28.22	Reef, sand		
UD57	12.568776	-61.374412	1389994	676602	8/20/2013	UD57S/UD57E	358	2:24	26.36	25.76	28.84	Gravel and sand		med
UD6	12.599843	-61.342979	1393452	679996	8/20/2013	289/290	24	10:50		16.79	28.67	Reef, sand	Saw a conch	low
	12.573359	-61.375989	1390500	676427	8/20/2013	UD75/UD7E	348	2:14	26.67	19.1	28.91	reef, medium		med
UD8	12.630612	-61.434193	1396795	670065	8/19/2013	UD8S/UD8E	519	15:46	30.30	30.14	28.33	Reef	omit first 2 1/2 minutes	med

Estimation of Total Allowable Catch (TAC)

The goal of the survey program was to determine the TAC. However, in order to make this estimation, the total biomass needed to be estimated. To estimate total biomass, we first determined the area to which the TAC was to be applied. This area was estimated within Quantum GIS using the maps downloaded from the Grenadines MARSIS webpage. The following steps were completed using Microsoft Excel except where noted and are modified from the queen conch manual:

1. The overall area to which the TAC was to be applied was determined within QGIS. The area of each strata (protected versus unprotected, and fishing vs. unfished) was also determined within the GIS.

2. We then summarized the number of conch per station, discriminating between adults and juveniles. Individuals with lip thickness less than 10mm were to be considered juveniles.

3. Estimation of total area surveyed. This was calculated at the station level by multiplying the width of the transect by the overall length of the transect determined from all replicates.

4. The density of conch per station was then determined by dividing the total number of conch by the total area surveyed. Three density values were obtained: adult, juvenile and total conch. For each case, the following formula was applied:

$$d_s = X_s / a_s$$

Where:
x_s =Total number of conch found in the station
a_s = Total surveyed area per station

5. The conch densities were grouped by sampling strata and descriptive statistics were calculated for each stratum. These parameters included mean density, variance, standard errors, confidence limits of the estimation.

6. We then extrapolated densities from sampling stations to the entire surveyed area. We also estimated the proportion of each stratum area and calculated weighted densities by applying the following formula:

$$D = \Sigma\, d_e * (A_e / A)$$

Where:
A_e = Total area by stratum
A = Total area
d_e = Density by stratum

7. We then estimated the total abundance using the sum of the weighted densities multiplied by the total area.

8. We then evaluated the fishing potential of the conch stock by comparing the calculated density estimates against pre-established density reference points, following the recommendations from the last conch CITES, CoP16, resolution "Regional Cooperation on the Queen Conch Management of and Trade" in which they adopted the recommendations from Queen Conch

Expert Workshop (May 22-24, 2012, Miami, USA). They recommended that a conch fishery was possible in cases where the mean/median adult density is 100 conch/ha or higher. Lower density values indicate significant risk that recruitment will be impaired, and therefore special management measures might be required. This reference point may change at different locations depending on the availability of data (e.g., site-specific reproduction at density), but no fishing is recommended if adult densities are less than 50 conch /ha. a threshold previously determined for successful queen conch reproduction (Stoner and Ray-Culp, 2000).

9. Because densities exceeded 50 conchs/ha, we applied the 8% rule wherein the estimated mean/ median fishable biomass was used to set a precautionary sustainable yield.

10. We then developed frequency histograms based on size classes of all conchs in all the surveys. The frequency histograms provided a quantitative method of determining the relative contribution to overall biomass from each size class.

11. We then calculated the fishable biomass by applying the following formula:

$$\text{Biomass} = \Sigma AL * WL$$

Where:
AL = abundance of conch size class (total length)
WL = Conch average weight on a given size class

However, to calculate the WL, it is necessary to apply a length-weight relationship (Weight = a*bLength or ln(Weight) = a + b*ln(Length).
We used the following values as our conversion values.

Location	**Constant (a)**	**Coefficient (b)**	**Reference**
Puerto Rico	-1.51	2.804	Appeldoorn 1988

We considered that the fishable biomass only included conch in those size-classes within which fishing is allowed. Conch in size-classes for which fishing is prohibited is not considered part of the fishable biomass. In many locations, juvenile conch are not permitted to be harvested and would therefore not be considered as part of the fishable biomass.

12. Once the total conch biomass was estimated, the 8% harvest control rule was applied. This rule follows the recommendations of the Regional Cooperation on the Queen Conch Expert Workshop. To this amount additional restrictions should be applied.

13. A meat conversion factor was then applied to the total harvest in order to calculate the TAC. The conversion factor was required because the meat is trimmed to remove the viscera and the hide is peeled We used the conversion factor presented by Aspra *et al.* (2009).

Processing grade	Conversion factor to nominal weight
Dirty	5.7
50% clean	9.5
85% clean	13.7
100%	16.3

14. To develop the final TAC, we considered additional restrictions based on several criteria. One of those was the extent of the bank. Further reductions are necessary to apply harvest and trade control rules such as: a) 8% control harvest rule over the population biomass (Medley 2008, Smikle 2010, CITES CoP 16); b) fishing recommendation only if the adult conch density threshold is met (50-100 ind/ha accordingly with CITES Queen Conch Resolution CoP 16, Stoner and Ray- Culp 2000); c) application of the conversion factors for meat trade as recommended by Aspra *et al* (2009); and d) an additional 20% discount to account for illegal fishing, a value that was set arbitrarily until a better local estimation becomes available. The use of these criteria incorporates the recommendations given at the Queen Conch Expert Workshop and later adopted by CITES on its Regional cooperation on the management of and trade in the queen conch (*Strombus gigas*) Resolution (CoP 16 Thailand, 3-14 March 2013). GIS analysis and products were obtained using Quantum GIS, and maps were downloaded from the Grenadines MARSIS webpage.

Juveniles were differentiated from adults based on the average minimum size stated in fishing regulations across the region (Table 4). This approach assumes that 50% of the population has already reproduced at least once. We were confident that this approach was appropriate because the lip thickness for the surveyed population was similar to that reported elsewhere in the region. Based on this approach, the minimum size we used to categorize adult conch was based on the average size (19.6 cm) onto which we added 1-cm to incorporate a 'precautionary' buffer.

It is important to mention that the recommendation of minimum adult conch density is still under revision at the country level, and still lacks official support from St. Vincent and the Grenadines. The adoption of a regional standard is a slow process.

Table 4. Summary of the minimum shell length stated in the current fishing regulations.

Country	Fishing Regulation	Size (cm)
Antigua and Barbuda	Fisheries Act No 14 of 1983 Fisheries Regulation No 10 of 1990 Fisheries Act No 22 of 2006	18
Belize	Fishery Regulations of 2005	18
British Virgin Islands	Fisheries Regulations of 2003 Amended in 2002; 2007	17.8
Cuba		20
Dominican Republic	Law 64-00, Decree 833-03 of 2003, Law 307 of 2004	18
Grenada	Fisheries (Amendment) Regulations	18
Honduras	Ministerial Agreement 820/ 2003, 103/2005, 391/ 2006	22
Jamaica	Fishing Industry Act of 1975; 1976	22
Martinique	Regulation 994296	22
Nicaragua	Decree DGRN-PA-No 407-05 of 2005	20
Puerto Rico	Reglamento de Pesca de Puerto Rico 2010 No 7949	22.9
St Kitts/Nevis	Fisheries Regulation No 11 of 1995	18
St Lucia	Fisheries Regulation No 67 of 1987; No 9 of 1994	18
St Vincent/Grenadines	Statutory Rules and Orders Act Part 4 Sec 18 of 1986	18
Turks and Caicos		18
US Virgin Islands		22.9
Average		19.6

Results

A total of 51 stations were surveyed during the seven days of diving and, of these, 36 stations contained conch (70%). A total of 328 conchs were counted and measured. Dive stations averaged 12.3m in depth, and ranged from 1.8 to 21.0m (6ft to 69ft). Surveys times averaged 28 minutes. On average, water temperature was 28.62°C (SD=0.21°C), with higher values in shallow waters (<10m: 28.7°C) compared to deeper sites (>15m: 28.5°C).

The majority of conch were found on various types of sandy habitats (with corals, algae, grass, gravel), followed by various types of gravel habitats (with algae, corals, grass), seagrass habitats, and to a lesser extent, in coral-dominated habitats (Figures 9 - 10).

The size distribution of sampled conch was normally-distributed with individuals ranging from 5.5 to 26.7cm in siphonal or total length (Figure 11).

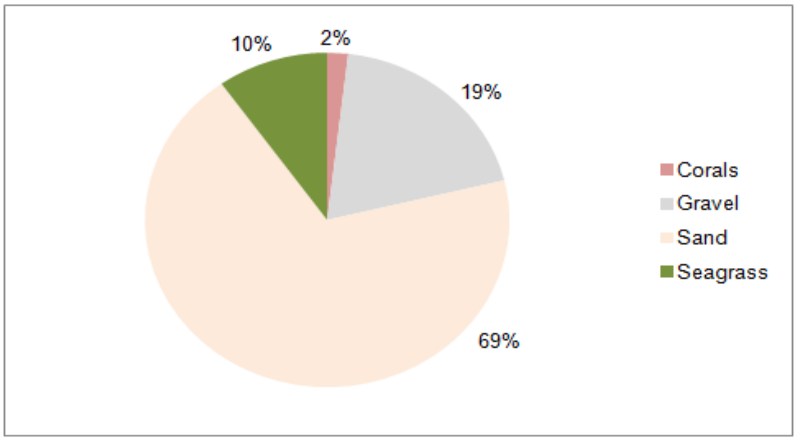

Figure 9. Habitat types associated with queen conch in the study area

Figure 10. Photographs of habitats types where queen conch were found in the Southern Grenadines

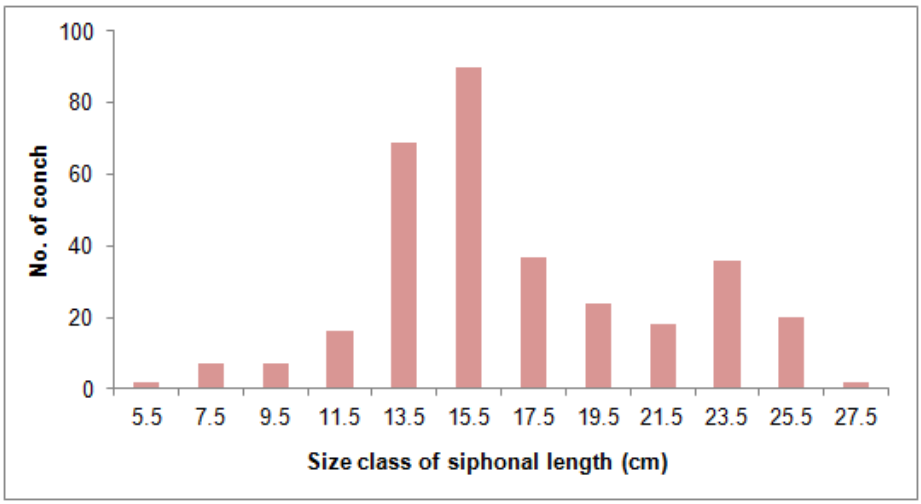

Figure 11. Size distribution of queen conch found in the study area

The largest conch densities were found in deeper surveys (12m to 20m in depth) and in sites along channels exposed to strong currents. In comparison, sites with no conch were generally found shallower (8.9m mean water depth) and on protected environments around Union Island and on the west side of Mayreau (Figure 12). Because fishermen are using SCUBA, it appears that depth is not serving as a refuge for conch, at least in the depths and areas that were surveyed (Figure 13).

Because the majority of the preferred fishing grounds were located beyond the depths selected for this survey/training (21m or 70ft), minimal information was gathered from deeper locations. However, results from the four stations conducted in these deeper areas showed high conch densities (from 100 to 2660 ind/ha) in marked contrast to other sites. The majority of these conch were adults (Figure 14). This result suggests that there are deep conch populations that are actively reproducing, and this explains the broad size classes found in these conch populations. One female laying eggs (Figure 15) was found in station UF7 (12.63418N, -61.32468W).

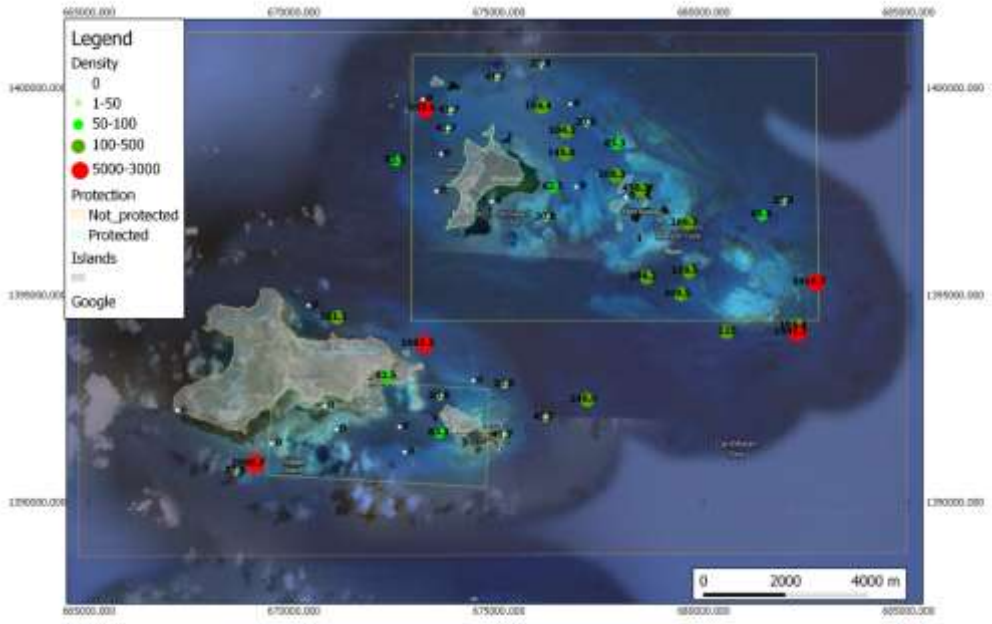

Figure 12: Spatial distribution of queen conch densities with respect to protection status in the study area

Existing marine protected areas are presented by the areas within the rectangles. Source of information about protected areas boundaries: http://www.grenadinesmarsis.com/.

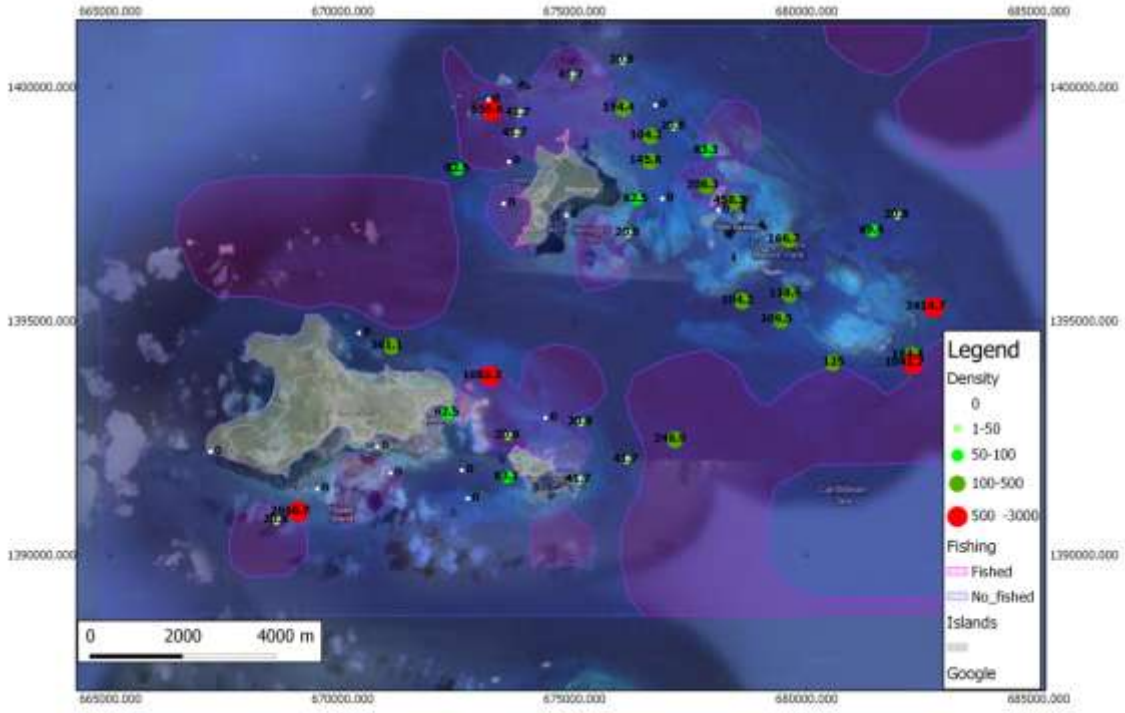

Figure 13. Spatial distribution of queen conch densities with respect to fishermen preferences in the study area. Information about preferred fishing grounds from: http://www.grenadinesmarsis.com/

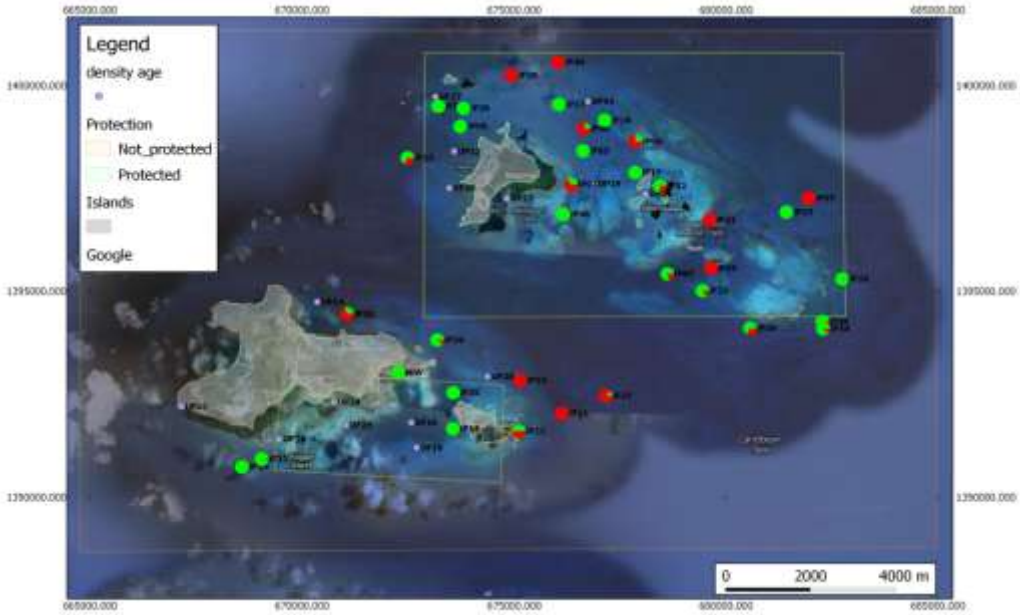

Figure 14. Spatial distribution of queen conch juvenile (green) and adult (red) densities with respect to protection status (protected or unprotected). Information about protected areas was from: http://www.grenadinesmarsis.com/

Figure 15. Female laying eggs found in site UF7 in 17m of water depth

Towed-video observations from the 29 deeper locations were conducted at depths between 16.69 to 35.93m. Habitats there were found to be comprised of reef or hard bottom with sand pockets. These were areas where conch were expected to occur (Table 5). Unfortunately these initial tests did not have high quality video imagery due to difficulties in adjustments of the correct camera angle and the strong currents. The resolution of the camera and the interference with the electric system also played a role in reducing the quality of the imagery.

It was clear from these surveys that approaches need to be developed to address these issues. These include developing protocols for the best conditions within which these surveys should be conducted. For example, we conducted these surveys in windy conditions and in highly rugose reef type environments. The surge created by the sea conditions coupled to the complexity of the environment resulted in collisions with the reef and damage to the cameral structural support trusses. In better sea conditions, the vertical surge would likely be reduced thus resulting in decreased damage to the camera rig.

Furthermore, the analog nature of the video signals resulted in video captures with lower than optimal resolutions. There are systems that incorporate high definition signals; however, these systems require a much greater monetary investment in equipment including cameras, cables, data storage, computing power, It is not clear that the images would be much better, either. In any case, we felt that the system as used needed some more modifications to maximize efficiency and to be more useful for deepwater surveys. Additionally, selection of the most appropriate equipment should be dependent on the resources available and the nature of the local conditions.

Nevertheless, we observed at least 4 conchs, although it might be possible that the number of conch was higher (Table 5). Therefore, it was not possible to estimate the density from these areas which accounted for the majority of the study area. As a consequence, calculations of the total allowable catch (TAC) were made exclusively on the shallow water conch stock and these estimations may underestimate the true abundance and densities.

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Table 5. Characteristics of deep water sites explored with the Seaview towed video system. Temperature and depth was obtained from Reef-Net Sensus sensor

Habitat class	No. sites	Depth (m)	Temperature (°C)	No. conch
Gravel and sand	8	22.2	27.88	1
Hard bottom, macroalgae	1	22.9	28.78	
Macroalgae	1	19.5	28.65	
Patch reef, seagrass	1	28.3	28.78	
Reef	3	22.8	28.96	
Reef, marcoalgae	2	34.5	28.12	
Reef, sand	13	27.8	28.43	3
Total	29	25.5	28.36	4

When the protection status was used as the strata for analysis, the overall density was estimated at 306 ind/ha (weighted). Higher values were found within non-protected zones with 260 ind/ha versus only 47 ind/ha found within the protected zones. However, the majority of the individuals observed were juveniles (overall density = 254 juveniles/ha) compared with only 52 adult conch/ha (Table 6). On average, the sites within the two protected areas had lower conch densities.

Similar results were found when the estimations of density considered the intensity of the fishing as the stratum. In this case, total density was estimated again at 227 ind/ha, with juveniles having on average 189 ind/ha; adults accounted for 37 ind/ha. Sites within less fished locations had higher conch densities, and relative adult densities were slightly higher there (Table 6).

Table 6. Summary of the weighted queen conch densities (ind/ha) in the southern Grenadines, accordingly with two strata
Extension of each strata was calculated from available maps in the MarSIS at (http://www.grenadinesmarsis.com/).

Stratum	Total	Juvenile	Adults
Protected	46.61	39.5	7.1
Not protected	259.84	214.9	44.9
Total	**306.4**	**254.4**	**52.0**
Population size	**7,256,446**	**6,023,503**	**1,231,373**

Stratum	Total	Juvenile	Adults
Preferred fishing grounds	44.2	38.3	5.9
Not preferred fishing grounds	182.0	150.8	31.2
Total	**226.2**	**189.1**	**37.1**
Population size	**5,288,361**	**4,420,642**	**867,719**

Once total conch density was calculated, it was possible to estimate the population size for the selected area (23,679 ha). When the status of protection was applied, the queen conch population size was approximately 7.27 million individuals. Juveniles accounted for up to 83% of the estimate. When the fishing intensity was the stratum, the population size was estimated at 5.29 millions, with juveniles comprising 84% of the estimate.

Combining the size frequency distribution with the queen conch population size, total conch biomass was then estimated to be 1,605,219 pounds using the protection stratum, or 1,169,854 pounds for the fishing intensity stratum.

The recommendation of minimum adult conch density was found to be at the lower side, with 52-37 adults/ha, thus, applying the 50 conch/ha rule, a queen conch fishery can be recommended with caution. This recommendation is based on the expected higher densities of conch in deeper sites, where diving was not conducted. As a consequence, a better estimation of the overall adult density still needs to be produced.

The application of the 8% harvest control rule estimated the maximum exploitable biomass to be around 128,418 to 93,588 pounds depending on the strata. This amount is further reduced to 107,485 to 78,333 pounds for 100% clean meat conversion factor (16.3% recommended by Aspra *et al.* 2009). The 100% clean meat is achieved when only white meat remains, and it is the most common export product. Further reductions to account for illegal fishing (arbitrarily assumed to be 20%) resulted in a final recommendation of 85,988 to 62,667 pounds (31.3 to 28.5 mt) for the overall total allowable catch.

The data from the surveys is included in Annex 1 to this report for future reference and use.

The dataset on water temperature and depth gathered from the Sensus sensor demonstrated that in general shallower waters were warmer. Waters from 5-20m in depth averaged 28.66°C whereas those in sites from 20-35.93m averaged 28.14°C. The tendency towards declining water temperatures at depth was most pronounced for data collected at deeper sites over the course of individual dives (Figure 16).

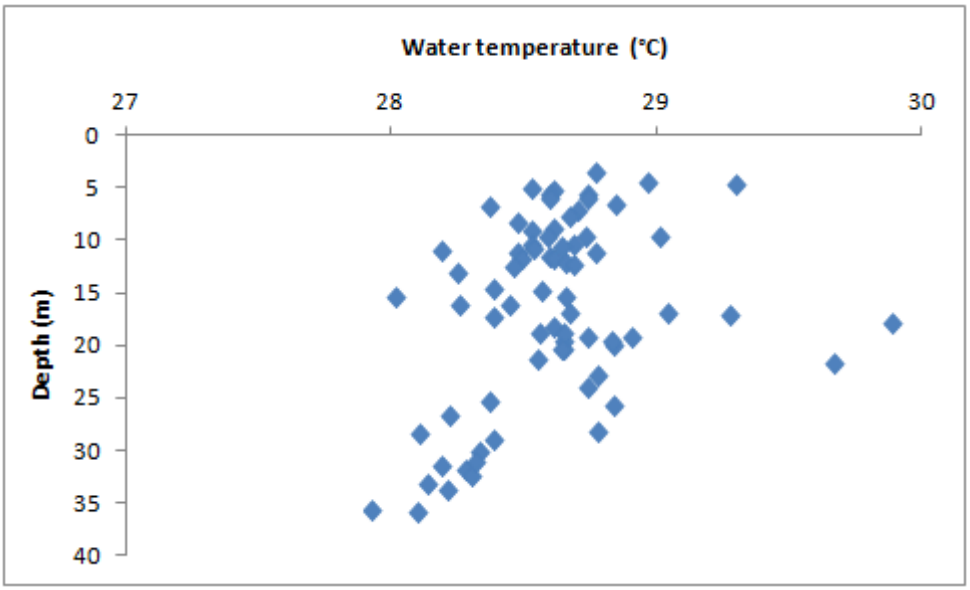

Figure 16. Scatter plot of the water temperature and depth obtained from the Sensus sensor utilized at all visited sites

Discussion

Results found in the 2013 southern Grenadines survey indicated that the queen conch population was dominated by juveniles in the relatively shallow areas (up to 21m in depth), and by adults in the deeper, exposed areas. Unfortunately, very little information was collected at these sites. The abundance of the queen conch in this section of the Grenada bank was recognized more than four decades ago, when Adams (1970) stated that richest conch grounds are found at the central and southern banks, and described the conch populations in the northern Grenadines around Bequia, and Mustique to be much lower.

At that time, queen conch were generally found inshore around the main islands, and between the islands and fringing reefs in water depths primarily over nine fathoms (16m approximately). In particular, conch were found on the extensive sand and coral bottoms from Canouan to the south, including leeward of Union Island, the Tobago Cays, Petit St. Vincent, and northern Carriacou. Even then, there were signs that conch were being depleted because fishermen were forced to dive deeper; for the most part, they have already reached the maximum depths for free-diving. He mentioned that by 1966, fishermen often had difficulty in locating large-sized conch in about five to seven fathoms because they relied solely on their lung capacity and physical endurance to harvest individuals. According to Isaacs (2012), all conch fishermen now use SCUBA and fish mostly during the closed season for lobster (1 May to 31 August), a fishery which is virtually unregulated. A minimum size of 18cm of shell length and the presence of a flared lip for harvest are the only fishing regulations, and both are poorly observed and enforced.

The conch fishery in the southern Grenadines is artisanal in nature. When the fishery was first developing, conch harvest was conducted daily throughout the year, except Sundays, holidays, and at market time. In addition, fishing was more restricted by unfavorable weather conditions (about two or more days each week). These conditions were a consequence of high wind speeds associated with seasonal changes. As a consequence, only the leeward side of islands and reefs were frequently fished for conch. Currently, conch is fished at deeper sites by relatively few fishermen (less than 20, Kris Isaacs and Albert Hanson, personal communication) mainly during the closure of the lobster fishery.

There have been few comprehensive studies in the region that estimated the overall conch density to which we can compare our results from southern Grenadines where conch still appear to be relatively abundant in shallow waters (168 ind/ha). In St Lucia, it is believed that conch abundance in shallow-water areas is very low or non-existent (King-Joseph *et al.* 2008). Because of that, researchers searched only for deep-water stocks in two areas (north and south) and estimated conch densities at 229.5 ind/ha in depths between 18.3 and 39.6m or 60 to 130ft. Unfortunately, no indication of the proportion of adults to juveniles was provided. In St. Lucia the conch fishery is also artisanal and conducted by only 40 fishermen with 20 boats. Predominantly large and mature conchs are harvested (FAO 2007).

In the case of Barbados, conch density was much lower with an overall mean density of 12.93 conch/ ha; juveniles comprised 87-79% of the surveyed population (Oxenford *et al.* 2008, Oxenford *et al.* 2010). Adults had critically low densities (0.68 - 1.39 conch/ha) for the population between 3 to 15 m in depth, with no indication of higher densities from preliminary surveys of deep-water habitats (15-30 m depth). They also reported patchy conch distribution and concluded that given the rarity of mature adults, there is a significant concern for the sustainability of this unmanaged fishery. Indeed, population size estimations were two orders of magnitude lower (34,167 queen conch) when compared to estimations in the southern Grenadines (this report).

Conch density in the southern Grenadines was also higher than densities in St. Eustatius where conch densities in shallow waters were estimated to be 167 ind/ha from 12 transects (Davis 2003), 88 ind/ha

(White 2005), and 121 ind/ha from only 8 transects (van Rijn 2012). There were no statistically significant differences among them.

The normal size distribution of the local stocks, the relatively high juvenile conch density, and the expected presence of reproductive individuals at deeper sites all suggest that the population may be recovering perhaps due to a reduction in the fishing pressure. This reduction may be related to the recent implementation of the Tobago Cays Marine Park in 2006, especially at sites between the eastern side of Mayreau, and the western side of the Tobago Cays including Horseshoe Reef. These locations are inside the protected area and had relatively high juvenile densities. This stands in contrast to lower juvenile densities observed in surveys around Union Island, where a Marine Conservation Area was established in 1998, but is not yet actively managed. The Tobago Cays Marine Park was established in 1997, but it was only in 2006 that personnel and management were put in place. If this recovery is indeed occurring, more efforts are needed to ensure good enforcement and surveillance thereby allowing those juveniles to mature and reproduce. This could compensate for the fishing pressure targeting the deep-water stocks. The overall conch density within the MPA is still low compared with the non-protected areas.

Annual conch landings available from the Fisheries Division in St. Vincent (Table 7) are highly variable. This is likely the result of an incomplete dataset the result of which is making it impossible to determine with certainty the current levels of conch production. Additionally, it was not possible to estimate the current levels of illegal fishing taking place within the Tobago Cays Marine Park and The Marine Conservation Union-Palm Island area.

It is likely that a great deal of illegal fishing originates from fishermen from neighboring countries. For example, rangers from the Tobago Cays Marine Park report that illegal fishing often is the result of fishers from the French-speaking islands (e.g., Martinique) where their stocks are already severely depleted. EU Sanitary Food Regulations restricted the import of queen conch in 1997 to the European Union (Theile 2001), but Martinique was still importing conch illegally from the neighboring islands (CITES 2003). Furthermore, Grenada has been under CITES trade suspension since May 2006 due to lack of response to CITES, (CITES 2012), thus facilitating the illegal conch trade with the Southern Grenadines.

Table 7. Annual queen conch landings and exports

Year	Landings (lbs)	Exports (lbs)	Year	Landings (lbs)	Exports (lbs)
1990	5,545	10,945	2001	84,238	78,816
1991	3,240	84	2002	79,048	75,238
1992	4,225	21	2003	19,601	14,707
1993	62,140	72,477	2004	37,950	30,698
1994	33,422	19,586	2005	14,221	8,646
1995	17,024	13,537	2006	7,907	5,354
1996	27,404	18,160	2007	23,668	19,441
1997	18,040		2008	9,144	1,790
1998	45,774	1,100	2009	38,597	25,373
1999	15,040	5,010	2010	86,223	62,610
2000	15,212	10,239	2011	22,991	13,433

Data provided by Kris Isaacs from the St Vincent and the Grenadines Fisheries Department.

The estimation of a TAC resulted in around 30mt of clean meat. However, this amount is far smaller than the export quota enacted in 2002 which was set at 70mt. This quota was arbitrarily set and was not based on any scientific information. The fact that conch were found to be smaller, deeper and fewer than previously reported (CITES 2012) was not considered in developing the 70mt quota.

In order to effectively determine the level of harvest that would ensure sustainability, there is a critical need to improve the monitoring of landings. There is also a need to improve fisheries management cooperation with Grenada and other neighboring countries. Improved inter-island communication will have the effect of counteracting illegal fishing and would have the added benefit of providing more comprehensive understanding of conch production and harvest.

With regards to the underwater video system the initial testing of the equipment could easily identify habitat, but identification of individual queen conch was more challenging. Similarly, it was clear that the technique using this gear is not yet perfected; however, ongoing efforts in other countries should provide systems and approaches that are more workable.

Van Rijn (2012), using towed video systems, showed a direct link between rubble/algae habitat and queen conch densities; the densities on rubble/algae had higher density than predominantly sandy transects. His results suggest that conch densities estimates resulting from a towed-video system are likely to be lower; and the difference between live queen conch, dead queen conch and milk conch were impossible to distinguish. He also recommended determining the length of the transect using the GPS track rather than the straight line between two waypoints.

Recommendations

- The queen conch stocks in the Southern Grenadines have a relatively high density; nevertheless, very few adults were found. The recent implementation of the Tobago Cays Marine Park appears to be a reason why these juveniles were seen in relative shallow and protected sites. Therefore it is recommended to keep and extend the MPA enforcement and surveillance, in order to allow these juveniles to mature and reproduce. This recommendation also applies to the Union-Palm Island Marine Conservation Zone to promote conch recruitment and therefore begin the population recovery.

- Higher adult conch densities were found only in locations influenced by extreme environmental conditions (e.g., strong currents, high swells, deeper sites); therefore, it is recommended that more fishing regulations should be developed such as a closed season and restrictions from fishing inside protected areas to reduce the targeting of the fishing on the conch reproductive stocks.

- There is a need to conduct more work in the quantification of deep-water queen conch stocks. The underwater video system needs some calibration and improvement in the imagery quality and deployment, but the tests proved this is a promising technology. Interpreters of the video-imagery need more training and the collaboration of fishermen who can recognize conch at a distance or in cryptic environments should be included as part of the image analysis. In other studies, it was determined that some observers had a tendency to be more uncertain and mischaracterize milk conch as queen conch (van Rijn 2012).

- Because the current level of conch fishing is not completely known, it is recommended that a program should be developed to monitor conch landings across the entire southern Grenadines. This survey should last at least one year, thus facilitating the estimation of total catch and also IUU fishing. This will help estimate sustainability vis-à-vis the recommended TAC. The collection of better landing data should include efforts to better estimate illegal fishing. Any reduction of illegal fishing will benefit the local fishers.

- In order to protect the reproductive stocks or sites with high conch recruitment, it is recommended to develop a strategy for focused enforcement. For instance, a program to approach yachts visiting the area from neighboring countries should be a priority. Integration of the fisheries and MPA personnel is highly desirable for higher efficiency and reduction of associated costs. In this respect, it is also recommended that special zones for conch recovery should be established within the existing protected areas.

- There is a need to develop more collaborative work between fisheries managers and tourism officials in order to define non-conflicting policies, particularly with respect to the extractive potential of marine resources, including the queen conch. These policies should extend to better educational practices and information targeted at tourists and fishermen.

- There should be an effort to develop for example length-weight relationships specifically for the Grenadines which can be used to better calibrate equations necessary to estimate total allowable catch.

- The current study was possible because of the integration of personnel from different sites, with different experiences and skills, demonstrating how the strategy was effective for conducting underwater queen conch surveys. It is recommended to continue conducting these censuses and

to update the survey results every three to four years. The survey intervals should take into account the queen conch life cycle to ensure that no detrimental event occurs.

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ANNEX 1. Summary of Survey data

SITE	LAT	LON	Y	X	Total	Juv	Adult	Area_m2	Area_ha	Adu_den	Juv_den	Total_den	Protection	Fishing	Depth
NEW	12.59649	-61.4438	1390928.87	669058.51	3	3	0	480	0.048	0.00	62.50	62.50	Not_protected	No_fished	6.3
UF02	12.63541	-61.3176	1395303.18	682744.11	0	0	0	480	0.048	0.00	0.00	0.00	Protected	No_fished	3.1
UF03	12.64489	-61.4056	1393821.65	673194.38	7	7	0	480	0.048	0.00	145.83	145.83	Not_protected	Fished	10.3
UF04	12.65572	-61.3218	1394093.01	682294.89	0	0	0	480	0.048	0.00	0.00	0.00	Not_protected	No_fished	4.5
UF05	12.65487	-61.405	1399498.40	673223.33	20	20	0	360	0.036	0.00	416.67	416.67	Protected	Fished	13.7
UF06	12.64976	-61.357	1397562.39	678447.64	5	1	4	480	0.048	83.33	20.83	104.17	Protected	No_fished	11.1
UF07	12.63419	-61.4251	1394458.88	671064.29	1	0	1	480	0.048	20.83	0.00	20.83	Not_protected	No_fished	16.8
UF08	12.60708	-61.3479	1395022.81	679451.06	7	4	3	360	0.036	62.50	83.33	145.83	Protected	No_fished	18.9
UF10	12.58546	-61.369	1392468.43	677169.74	0	0	0	480	0.048	0.00	0.00	0.00	Not_protected	Fished	10.5
UF13	12.58931	-61.4612	1392208.88	667159.71	0	0	0	480	0.048	0.00	0.00	0.00	Not_protected	Fished	13.6
UF16	12.65155	-61.3624	1397889.95	677861.88	1	1	0	480	0.048	0.00	20.83	20.83	Protected	Fished	5.5
UF17	12.64008	-61.3219	1394267.84	682280.17	10	10	0	480	0.048	0.00	208.33	208.33	Not_protected	No_fished	11.0
UF19	12.57997	-61.3789	1399544.34	676060.04	0	0	0	480	0.048	0.00	0.00	0.00	Protected	Fished	10.0
UF20	12.6369	-61.3463	1396737.80	679618.68	0	0	0	360	0.036	0.00	0.00	0.00	Protected	No_fished	11.0
UF21	12.62956	-61.3737	1398414.84	676630.93	2	0	2	120	0.012	41.67	0.00	41.67	Protected	No_fished	19.6
UF22	12.61407	-61.3461	1395572.50	679644.63	13	11	2	420	0.042	41.67	229.17	270.83	Protected	No_fished	10.7
UF23	12.64362	-61.3376	1394110.25	680571.29	3	2	1	362	0.0362	20.83	41.67	62.50	Not_protected	No_fished	15.3
UF25	12.58499	-61.3735	1398954.05	676648.30	0	0	0	480	0.048	0.00	0.00	0.00	Protected	No_fished	16.8
UF27	12.65696	-61.3555	1395430.02	678618.28	0	0	0	480	0.048	0.00	0.00	0.00	Protected	No_fished	11.0
UF28	12.59548	-61.3623	1398639.38	677865.41	0	0	0	480	0.048	0.00	0.00	0.00	Protected	Fished	7.0
UF29	12.66156	-61.4023	1391670.89	673565.30	2	0	2	480	0.048	41.67	0.00	41.67	Protected	No_fished	13.4
UF33	12.57764	-61.4117	1398249.50	672498.31	32	31	1	120	0.012	20.83	645.83	666.67	Not_protected	No_fished	11.8
UF34	12.61903	-61.3296	1396930.65	681432.83	2	0	2	144	0.0144	41.67	0.00	41.67	Protected	No_fished	7.7
UF35	12.59202	-61.4141	1393033.36	672271.78	1	1	0	480	0.048	0.00	20.83	20.83	Not_protected	No_fished	17.8
UF37	12.59111	-61.3764	1397604.06	676342.86	8	1	7	324	0.0324	145.83	20.83	166.67	Protected	No_fished	21.0
UF39	12.6544	-61.3891	1400248.57	674946.71	2	2	0	480	0.048	0.00	41.67	41.67	Protected	Fished	10.7
UP03	12.63758	-61.3995	1399449.15	673813.28	3	1	2	480	0.048	41.67	20.83	62.50	Protected	Fished	9.6
UP05	12.65042	-61.4002	1399008.82	673740.08	2	2	0	480	0.048	0.00	41.67	41.67	Protected	Fished	12.5

UP06	12.631	-61.3786	1392039.99	676129.05	1	1	0	480	0.048	0.00	20.83	20.83	Not_protected	No_fished	4.1
UP07	12.6178	-61.388	1391608.33	675112.11	5	4	1	480	0.048	20.83	83.33	104.17	Not_protected	No_fished	18.2
UP09	12.64685	-61.3247	1397264.19	681959.34	4	1	3	480	0.048	62.50	20.83	83.33	Protected	No_fished	10.6
UP11	12.58729	-61.3689	1399155.02	677145.39	2	0	2	480	0.048	41.67	0.00	41.67	Protected	No_fished	16.7
UP12	12.64498	-61.4021	1392547.70	673574.27	0	0	0	480	0.048	0.00	0.00	0.00	Protected	Fished	12.4
UP13	12.6312	-61.378	1396874.81	676165.94	3	3	0	432	0.0432	0.00	62.50	62.50	Protected	No_fished	12.2
UP14	12.61208	-61.3876	1392840.40	675147.53	0	0	0	480	0.048	0.00	0.00	0.00	Not_protected	No_fished	3.7
UP15	12.59458	-61.4481	1390740.79	668592.14	1	0	1	480	0.048	20.83	0.00	20.83	Not_protected	Fished	12.2
UP17	12.65513	-61.379	1400569.47	676040.10	7	7	0	360	0.036	0.00	145.83	145.83	Protected	No_fished	9.0
UP18	12.5841	-61.3602	1397375.69	678104.73	4	4	0	480	0.048	0.00	83.33	83.33	Protected	No_fished	6.1
UP19	12.63767	-61.3725	1399614.24	676750.17	0	0	0	480	0.048	0.00	0.00	0.00	Protected	No_fished	8.0
UP20	12.60944	-61.4113	1391815.08	672582.09	13	4	9	360	0.036	187.50	83.33	270.83	Protected	No_fished	9.0
UP22	12.58345	-61.4612	1392208.88	667159.71	2	1	1	480	0.048	20.83	20.83	41.67	Not_protected	Fished	13.3
UP24	12.61641	-61.4102	1391208.66	672708.01	58	57	1	240	0.024	20.83	1187.50	1208.33	Protected	No_fished	15.5
UP26	12.60356	-61.4027	1397511.38	673481.71	52	46	6	480	0.048	125.00	958.33	1083.33	Protected	Fished	11.5
UP27	12.63459	-61.4255	1391754.45	671044.99	0	0	0	480	0.048	0.00	0.00	0.00	Protected	Fished	10.7
UP28	12.582	-61.4056	1399728.64	673154.21	0	0	0	480	0.048	0.00	0.00	0.00	Protected	Fished	9.5
UP29	12.57596	-61.3947	1392934.49	674383.31	1	1	0	480	0.048	0.00	20.83	20.83	Not_protected	Fished	20.0
UP32	12.63708	-61.4016	1398406.31	673595.58	22	16	6	480	0.048	125.00	333.33	458.33	Protected	Fished	4.6
UP34	12.6055	-61.4315	1394747.52	670364.78	25	22	3	240	0.024	62.50	458.33	520.83	Not_protected	No_fished	19.8
UP36	12.59005	-61.3713	1397617.23	676897.89	0	0	0	480	0.048	0.00	0.00	0.00	Protected	No_fished	1.8
UP39	12.60576	-61.3903	1397263.88	674831.94	3	2	1	240	0.024	20.83	41.67	62.50	Protected	No_fished	14.5
UP40	12.6644	-61.44	1391414.00	669466.00	1	0	1	480	0.048	20.83	0.00	20.83	Protected	No_fished	13.1

Document II - Country-Specific Queen Conch Survey Plans

This document is a compilation of country-specific queen conch survey plans, completed for the project entitled "Training in Underwater Visual Survey Methods for Evaluating the Status of *Strombus gigas*, Queen Conch Stocks' funded by the ACP Fish II Programme, European Union. A major activity of this project was a regional training workshop that was designed to provide an opportunity to share best practices and experiences in the use of visual survey techniques. Annex 1 provides a list of the fisheries researchers and officers who participated in the training sessions and who worked together to develop the country-specific plans presented here.

Country: Jamaica

Proposal: Assessment of Jamaican Queen Conch (*Strombus gigas*) deep (below 30 metres) stocks on the Pedro Bank
Prepared by: Ricardo A. Morris, Fisheries Officer
Institution: Fisheries Division, Ministry of Agriculture and Fisheries, P.O. Box 470, Marcus Garvey Drive, Kingston 13, Jamaica.

Background

The Queen Conch (*Strombus gigas*) is Jamaica's most important fishery resource providing over US$4 million in gross export revenue annually from supplying primarily the EU (European Union) market with an average 500 MT of meat over the last decade. Its importance extends also to the provision of jobs at various levels from fishing, harvesting, processing to the exportation of the product. Sustainability and continued development of the resource is therefore the most important strategic objective of Jamaican fisheries managers.

Project Rationale / Problem Statement

Since 1994 Jamaica has put in place a programme of conducting conch abundance surveys on the Pedro Bank every three (3) to five (5) years to (i) assess the stocks there for the industrial fishery and (ii) as partial fulfillment of Jamaica's obligation under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) to present non-detrimental findings (NDF) and (iii) to assess the state of the conch habitat. These are important facets of our management regime aimed at sustainable development of this our most valued fishery resource.

To date we have completed five (5) such surveys on the bank down to 30 metres however it has long been reported anecdotally and otherwise that there may be large protected spawning aggregations of conch below this depth particularly on the north-eastern and north-western reaches of the bank. We believe that confirmation and ultimately a strategic assessment plan for this deeper area will allow for a more wholesome picture of the state and extent of queen conch on the Pedro Bank allowing for even more informed management measures to be implemented.

We have been unable thus far to assess these deeper stocks due main to (i) diver safety concerns, (ii) the availability of digital bathymetry information on the bank to assist with planning and

carrying out of such assessments, (iii) lack of an accessible and cost-effective method of assessment, and (iv) and a general lack of human, technical and financial resources.

Goal

Assess the deep-water (>30 metres) Queen Conch (*Strombus gigas*) stocks on the Pedro Bank using appropriate assessment methods.

Objectives

1. Confirm the existence of deep-water aggregations of conch in deep-water zones of the Pedro Bank

2. Determine a baseline for the size, distribution and structure of deep-water aggregations on the Pedro Bank

3. Explore, assess and compare the effectiveness of using underwater cameras for deep-water survey of conch on the Pedro Bank

Availability of Resources

Data

There is fairly good quality data on the current state of Jamaica's conch fishery especially since 1994 however this information represents catch and effort from fishing in areas below 30 metres. Fishing does not occur in areas greater than 30m depth. Apart from depth and basic habitat information available from nautical charts there is very little information on the deeper areas of the bank.

Marine personnel and Equipment

If required the Fisheries Division does have a cadre of persons who are able to be at sea. There are 2 persons with boat-handling competence and at least 6 persons on staff who are certified divers, however since the focus of the assessment will be on using cameras to assess depths below 30 metres we would not expect divers to play a big role. Their importance may be in, for example, the analysis of underwater pictures and videos.

In terms of equipment we have available one **27 foot Boston Whaler** that may be used to transport persons and equipment, one **21 foot inflatable boat** with less capacity but can provide support, as well as **dive gear** and **30 tanks for 6 persons** (if required). Additionally we have 2 Trimble Explorer GPS units however lacking a reliable operating software.

Proposed Survey Area

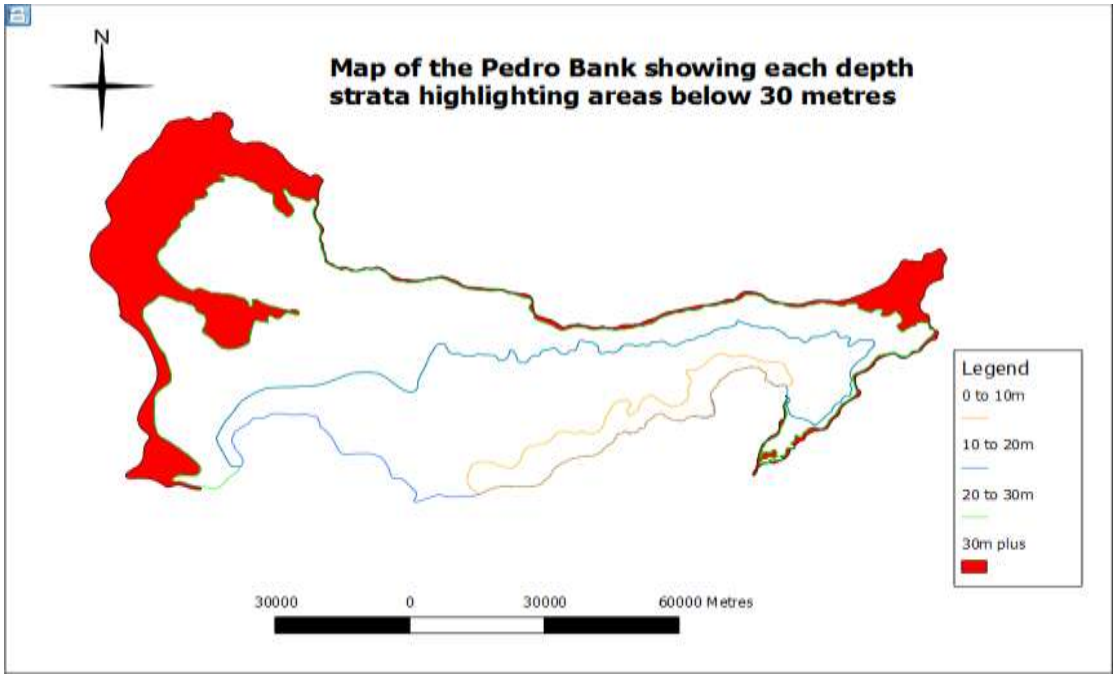


Figure 1. Pedro Bank depth strata highlighting the deep-water zone (below 30 m).

The programme of surveys since 1994 has been focused on areas of depths down to 30 metres. The proposed assessment would be conducted at the north-western and north-eastern reaches of the bank depths below 30 metres where it is believed there may be protected deep spawning populations. This zone covers an area approximately **1,617.21 km²** and has mixed depths down to about 60 metres.

Proposed Method

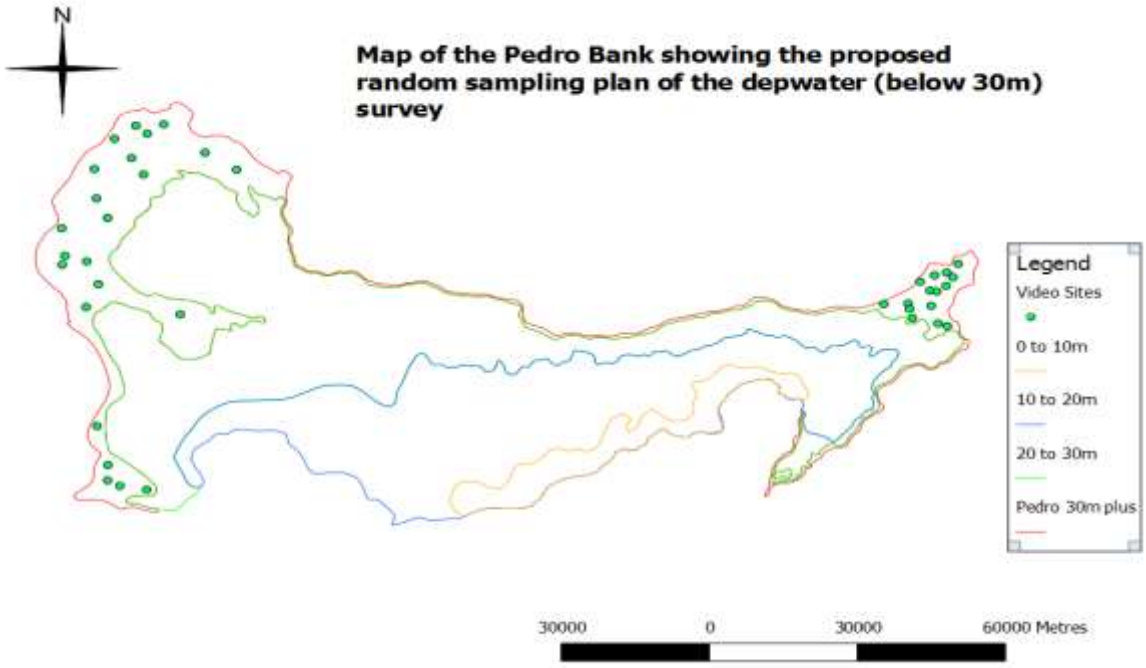


Figure 2. Map shows the proposed sampling plan 38 sampling stations for both video transects and enriched for surveying the deep-water areas of the Pedro Bank.

The survey plan includes the completion of thirty-eight (38) 5 to 10 minute video transects across the deep zone using a SEAVIEWER underwater video camera or an appropriate alternative to ascertain the location, distribution, size, population structure, and the associated habitat of conch in the deep zone. Video recordings as well as written notes on habitat type, habitat condition, temperature, depth, and additional comments will be recorded and stored on a field rugged laptop and backed-up on and external hard drive for analysis back on the mainland.

The survey would be conducted using the 2 available vessels operating from the Pedro Cays for roughly 5 survey days with 2 additional days for travelling to and from the mainland. Bearing in mind that the Pedro Bank lay some 70km south of the mainland it would not be practical to do daily trips from the mainland and so an additional support vessel may be required to transport equipment and supplies to the cays.

On the collection of all transect data and return to the mainland analysis will be conducted over an approximate period of 10 days by fisheries biologists and fishers who will visually analyse the video content and generate a final report.

Resources and Draft Budget

ITEM	QUANTITY	PURPOSE	ESTIMATED COST ($US)
Sea Viewer underwater camera with fixtures for operating down to 70m	2	Underwater visual survey	14,000
GPS Mapping software for Thrimble GPS – geoexplorer 2008 Series	1	Planning and Mapping	1,500
Field rugged laptop computer and external hard drive	1	Storage and analysis of data before during and after survey	3,500
Training in the use of Nitrox mixes for scuba diving	6	Deep-water diver surveys	20,000
Nitro scuba tanks and dive computers	6	Supply and regulate nitrox levels	
Full-face mask with seafloor-surface communication unit	4	Communication between diver and boat	3,000
Picture analysing software	1	Analysis of picture and video images	2,500

Timeline

Given the objectives listed above the entire survey including planning, mobilization of personnel and equipment to the base on the Pedro Cays, collection of underwater video data, collection of data, through to analyses and final report should take roughly **20 days** to complete barring any undue delay.

Country: Belize

Proposal: Deep water conch (*Strombus gigas*) habitat and potential reproductive grounds
Prepared by: Marsha Vargas, Assistant Fisheries Officer
Institution: Belize Fisheries Department, Princess Margaret Drive, P.O. Box 48, Belize City.

Background

In the last ten years the Belizean Queen Conch fishery has remained more or less stable with the recommendations made through the National surveys and analysis of those surveys. Sustainable quotas have been established each year and the cooperation of the fishers, cooperatives and other stakeholders also add to this success.

With the Queen Conch being on the CITES Appendix II since 1992 and The Belize Fisheries Department conducting National abundance surveys since 2003; the next step to a more productive and sustainable Conch Fishery would be assessing the reproductive stocks.

Objectives

To conduct survey to determine deep water queen conch replenishment stocks in Belize.

Specific objectives:

- To assess the abundance of deep water Queen Conch stocks in Belize.
- To identify deep areas with high Queen Conch aggregations.
- To collect data identifying deep conch stocks such as: shell length, lip thickness, depth found, habitat and whether or not mating and or egg laying is occurring.
- To assess the maturity levels of the deep conch stocks.

Methods

Surveys will be conducted at the fore-reef of each marine reserve. These sites will be surveyed using the line transect method. These transects will be 30 meters long by 4 meters wide and 30 meters apart. The same strategy will be used within channels and deeper general use areas.

Morphometric data collection:

1. Shell length (SL) (tip of the spire to the siphonal canal) will be measured to the nearest millimeter using a measuring board/ruler.

2. The shell lip thickness (LT) (mid-lateral region on the lip flared side of the shell / the flared area in line with the larger shell spike) will be measured to the nearest 0.1 mm using sliding vernier calipers.

3. Life stage of conch will also be Identified

4. Data will be digitized by individual data collectors in a coordinated method.

Example of field data sheet for queen conch data collection:

Date:	Transect No:	GPS		Depth (ft)	Habitat Type	No. conch	SL (mm)	LT (mm)	Conch aggregations	
Comments										

The survey is proposed to explore:

Northern Belize: Bachalar Chico, Hol Chan and Caye Caulker Marine Reserves.

Central Belize: Turneffe MR and Half Moon Caye MR

Southern Belize: Glovers Reef MR, South Water Caye MR, Sapodilla Caye MR, Port Honduras MR and Gladden Spit area.

The deep areas reaching 70 - 90 feet outside the atolls of these reserves, within the channel areas and other deep water areas should be focused on.

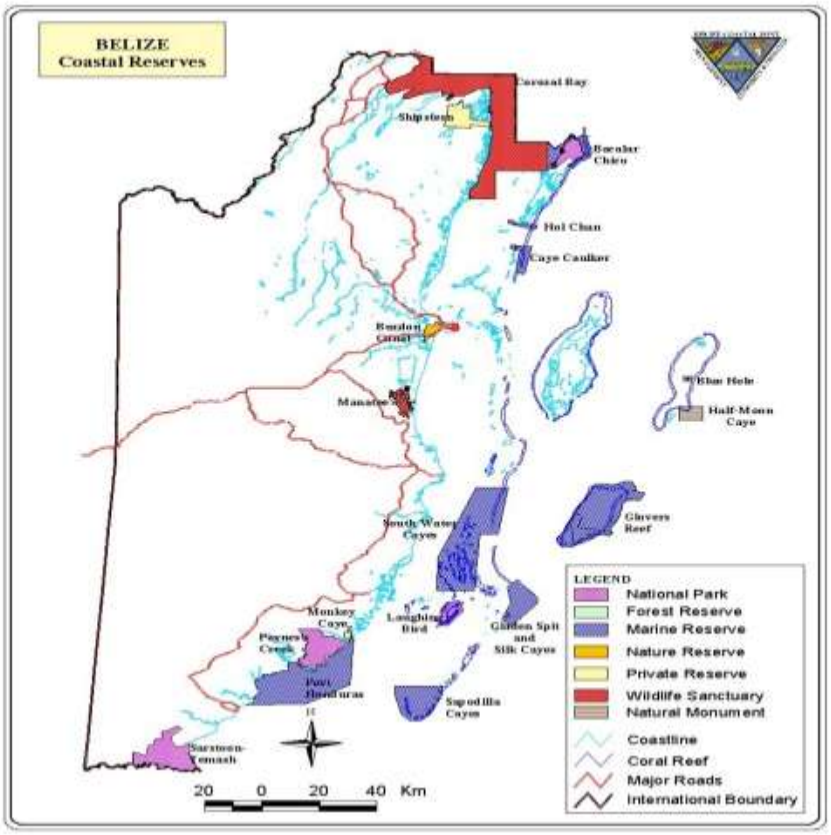
The number of sites to be surveyed is not absolute but estimated to be at least 35 sites nationally.

Team members:

Northern Teams	**Central Teams**	**Southern Teams**
2 divers Bachalar Chico	Joel Cruz	2 divers Glovers Reef
4 divers Hol Chan	Dwayne Garcia	2 divers Port Honduras
2 divers Caye Caulker	Mark Gentle	2 divers Sapadilla cayes
	Eli Montejo	
	Sherwin Pererra	
	Michael Sabal	

	Marsha Vargas	
Additional divers may be taken from the central team to assist some of the northern sites.	Dive Masters from the Northern team's Hol Chan may be assisting the Central and Southern teams.	Additional divers from the Central Team and Dive masters from Hol Chan may assist the Southern Teams

Equipment and materials: in addition to the equipments and materials needed at least 8 Fisheries department vessels will be utilized.



Estimated budget (in Belize dollars)

ITEM	Cost	# of Items	Total cost
Dive equipment	$ 400.00	6	$3200
slates	$200.00	N/A	$200
100 m tape	$50	6	$300
calipers	$5	20	$100.
Calibrated rulers	$20	10	$200
Data sheets	$10	3	$30
Tape	$15	2	$30
pencils	$5	6	$30

rope	$3	2000 ft	$5000
Fuel	$12	4000 gal	$48,000
Oxygen refill	$5	35 dives	$ 175
First aid kits	$250	6	$1500
Advisors	$5000	1	$5000
TOTAL			**$63,840**

Sources of funding:

1. Government

2. NGO

3. Cooperatives

4. Other interested stakeholders

Funding needed for equipment, fuel, subsistence, other incidental costs and funding needed for outside professional input / advisor.

Time table (Scheduled 2013 – 2014)

Duties	October	November	December	January	February	March	April	May	June
PR	X	X						X	X
Staff	X	X							
Funding	X	X	X	X	X			X	X
N. survey			X	X	X				
C. Survey			X	X	X				
S. Survey			X	X	X				
Data compilation						X	X		
Data analysis and results								X	X

Recommendations:

- In order to find possible aggregations without sending divers into the water each time, the use of an underwater video camera may be utilized. By towing the video camera linked to a cord, screen and apparatus along the water column observers can perhaps spot conch.

- The whole DVR set up, underwater camera, screen, cords, PVC set up, GPS, GPS USB connecting cable, 'modem' to link underwater cam and screen and GPS would cost around $6000. US dollars. The set back would be need for training for proper use and set up the equipment.

- Conch stocks around the Caribbean are believed to be interrelated and so it could be an advantage to invite other regional countries to observe and participate in the deepwater data collection. National Plan of action with regional support.

Country: Dominican Republic

Proposal: Queen conch (*Strombus gigas*) survey in Dominican Republic
Prepared by: Elodie Fernandez, Research Assistant
Institution: Dominican Council for Fisheries and Aquaculture, Urb. Jardine del Norte Km. 6½ Autopista Duarte, Santo Domingo

Problem statement

Several Queen Conch abundance studies have been carried out in the Dominican Republic, however, there is not still enough information to determine a fishing quota to allow exportation, which was banned in 2003 by CITES recommendation. Deeper areas (below 20m) are the least known related to Queen Conch density due to limiting bottom time from scuba diving with normal air. In addition, there are still some marine protected areas where Queen Conch fishing occurs but a distribution or population size study has never been carried out. This is the case of the North coast of Samaná Peninsula.

Objectives

The main objective of this study would be to cover the areas not included in the new Conch Survey funded by FONDOCYT and managed by the Autonomic University of Santo Domingo (UASD), based on the Assessment of Queen Conch population in two protected areas in the Dominican Republic: Parque nacional Jaragua and Parque Nacional Montecristi. This study objective would be to assess the Queen Conch population size also in the marine protected area in the North coast of Samaná Peninsula. The combination of results could mainly help to establish the first and more precise sustainable quota system to finally lift the exportation ban and allow the country to profit at the maximum its resources, while maintaining the sustainability. In addition, this study could bring the possibility of developing deepwater surveys using new methodologies, like underwater visual camera. Finally, it would be very important to try to establish a national data collection program at least in the most important fishing areas.

Availability of resources

(a) Data about the fishery in terms of captures and fishing effort (current and historical).
In the last 30 years, Queen Conch production has increased substantially due to an increase in the export market demand, an increase in the national population and an increase in tourism. Studies undertaken in the country for the moment suggest that national Queen Conch populations have not been permanently impacted due to overfishing. However, some recent studies (not published yet) indicate a density of 11.5 individuals/ha in PNJ, a main fishing area, when 56 individuals/h are needed for reproduction to take place. More studies are needed nationally about population status and commercialization.

(b) Dive support, certified divers, diving gears, boats, etc.

Samaná is characterized by a large number of free and scuba divers. However, this does not mean that all scuba divers are correctly certified. The availability of boats for renting should not cause a major problem in the Peninsula. Diving gears are available in several diving center in Samaná.

Proposed methods / sampling plan

Before initiating any field work, all types of images available will be obtained and studied for the study area, from maps to aerial photographs and GIS data. Using this material, the survey area will be determined and delimited. No study has ever been done before in this area, therefore, no comparison or baseline is available about specific areas to be sampled. Some maps of habitat zones were recently made for Samaná Peninsula, which could help to first determine the habitats where conchs are more prone to be found. Once areas and stations are randomly selected, the locations' coordinates will be introduced in the GPS available for the study.

The protected marine area in the surrounding almost all of Samaná Peninsula is known as the Sanctuary of marine mammals Silver Bank and Navidad Bank, which covers an area of 25,240km^2. This is an extremely large area, so only the closest shelf to the North coast of Samaná will be considered. To specify the distance from the coast where the sampling will take place, available data on bathymetry of the area will also be used. Equal or less than 20m depth will be considered as shallow areas, which will be surveyed with scuba diving. For deeper waters, maybe down to 45m as the deepest, underwater visual camera could be utilized. This is a fairly new methodology, so results could be unexpected and the method itself not considered a precise tool to estimate Queen Conch abundance in deeper waters. In addition, this differentiation in depth also correlates to more exploited areas (shallow waters, which fisherman can reach using compressors or snorkeling, mainly) or least exploited areas (deep waters, maybe reached only using compressors, although death risk is much higher).

Following the same methodology then the assessment on Queen Conch to be undertaken in PNJ and PNM, once determined the exact boundaries of the study area, two trips will be done yearly for two consecutive years. These will be 10 days long, one during the close season (from July 1st to October 31st) and the second during the open season (the rest of the year). This will allow for comparison of abundances during supposed presence or absence of fishing pressure within and between the three protected areas (PNJ, PNM and Samaná Peninsula). The exact number of stations would be determined later after the analysis of the maps; however, the total sampled area should cover 30% of the total study area determined for the assessment for it to be statistically relevant.

The preferred methodology for "shallow" waters and probably best known one in the country is the Belt Transects. In this case, transects would be 100m long, 5m wide and perpendicular to the coast (method already used in past assessments in the country, in PN del Este) to be sure that depth ranges will allow this. This will be done using scuba diving gear. While one diver runs the tape, the other two run at both sides of it covering 2.5m each. Lip thickness and siphonal length will be measured from each conch encountered. In addition, the habitat surrounding the conch will be described, any particular observation or whether any type of reproduction was observed.

The rest of the shallow water methodology will be the same as for the Queen Conch assessment carried out by the UASD.

As already mentioned earlier, deeper waters (approx. 20m to 45m) could be surveyed using underwater visual camera. Already randomly determined 500m long transects, also perpendicular to the coast, will be used.

The basic analysis of the data will include the calculation of Queen Conch density per square hectare and the fishing quota for the country.

During both field work and data analysis, fishermen participation and advice will be always included and considered extremely valuable.

Draft budget

This study would be very similar to the assessment to be done by the UASD. Therefore, the budget used to undertake such assessment should be similar for this study.

The common and main activities to be covered are the salaries for the coordinator and field assistants. In addition, to pay for the field trips, the equipment needed for underwater activities (calipers, tapes, underwater photographic cameras, buoys, rope, water resistant paper, etc.), the equipment for boat activities (GPS, computer, printed maps, etc.), renting of boats and diving gear, etc.

Therefore, since we are considering only one study area in this proposed survey, the budget should be about RD$4,000,000 (about US$95,000).

Country: St. Lucia

Proposal: Assessment of Conch population in Saint Lucia
Prepared by: Sarita Williams-Peter, Fisheries Biologist III
Institution: Ministry of Agriculture, Food Production, Fisheries and Rural Development, Sans Souci, Castries.

Problem statement

The catch per unit effort abundance index for the conch fishery in Saint Lucia shows an annual continuous decline (CRFM, 2009) and fishers have been progressively fishing deeper due to the decline in availability of nearshore stocks (King-Joseph *et al*., 2006). There are two main concerns that have been hypothesized for the decline in nearshore conch stocks – decline in suitable conch habitat and overharvesting. Currently, there is no information on island-wide conch aggregation distribution, reproductive status or habitats in Saint Lucia that will assist in the sustainable management and use of the species, extend management of the conch fishery to an ecosystem approach and strengthen the reliability of fishery dependent assessments.

Objectives

1. To determine the conch abundance and density baseline in Saint Lucia founded on both habitat and depth strata.

2. To determine the abundance conch aggregations in deep water where depth and other unfavorable conditions limit fishing.

3. To establish a total allowable conch biomass that can extracted from the fishery waters of Saint Lucia.

4. To determine interrelationship between conch aggregations and identify critical aggregations for larval production and settlement.

5. To build capacity of conch fishers in assessment of conch stocks and to develop a collaborative management strategy for monitoring of the status of conch stocks and providing landing data.

Availability of resources:

(a) Data about the fishery in terms of captures and fishing effort (current and historical).

Catch per unit effort index for the conch fishery appears to be declining each year using the measure of effort as the number of compressed air tanks used (CRFM, 2009). Landings from over the past ten years (2002 -2012) have varied between 63mt to 28mt each year.

(b) Estimation of the area needed to be survey for depths less than 80ft and for areas between 80 and 140ft.

Fishing primarily takes place between 80 to 140ft using self contained underwater breathing apparatus (SCUBA). There two main fishing grounds between 80 to 140ft which are approximately 4700ha in the south and 3200ha in the north (total: 7900ha). There are some reports of conch in shallower areas; however, conch fishers have reported poor coastal habitat due to siltation as a major factor for lack of conch.

(c) *Digital or physical maps.*

The only habitat maps available, these are of the west coast area within the Soufriere Marine Management Area. These are within shallow depths as it was done using aerial photographs.

(d) Dive support, certified divers, diving gears, boats, etc.

There are five certified PADI SCUBA divers at the Department of Fisheries:

- Open water: three (3)
- Advanced: one (1)
- Rescue: one (1)

The Department can receive dive support from various registered dive operations on island and through a few conch fishers. The Department can rent the use of a vessel and dive gear.

The Department also has vernier calipers and depth gauges.

Proposed methods / sampling plan

A taskforce will be established with key representatives from the following agencies:

1) Department of Fisheries (Lead)

2) Ministry of Planning (GIS)

3) Gros Islet Fishermen's Cooperative and the Laborie Fishermen's Cooperative (Dive assistance and collaborative plan)

4) Independent Conch Fishers (Dive assistance and collaborative plan)

5) Statistical Department (assistance with Data Analysis).

A consultation with fishers and other stakeholders on the need for conch surveys and to train taskforce in conducting queen conch surveys.

GIS maps will be generated and random sampling points against various strata (depth and habitat where available) will be plotted to cover at least 30% of the sampling area. There will be two sampling teams each will comprise two dive buddy teams; a vessel, captain, dive master, chief scientist. Conch abundance and density in this area will be calculated including the collection of biological data. Total allowable catch will be determined. The marine space between 80ft to 140ft will be divided into a grid and drop camera video will be used to locate conch aggregates. Conch aggregates in both <80ft and >80ft will be mapped. Data (e.g. lip thickness, length, habitat type, reproducing) on aggregates 80ft to 140ft will be investigated using specialized human resources trained to dive using nitrox.

Source-sink dynamics of conch larvae dispersal will be investigated to determine connections between populations through the mapping if surface current patterns and through plankton tows. Plankton tows will be conducted near and around conch aggregation sites. Two tows in the vicinity of each conch aggregation will be conducted.

Host two consultations with fishers and other key stakeholders to develop a monitoring strategy and action plan based on the data results and management objectives.

Resources needed

Human resource with expertise in the following will be outsourced:

1. Mapping of surface currents

2. Habitat mapping

3. Expertise in identification of conch plankton

4. Expertise in development of closed areas

5. Nitrox divers

Payment of Honorarium for participants.

Equipment: Plankton tows (two) 202 micron plankton net with a flow-meter. Rental of SCUBA gear. Purchase of Mesh bags and large calipers for siphon length.

Draft budget (table with some details)

Activity		Item Cost (US$)	Total Cost (US$)
Rental of SCUBA gear	Wetsuit, Mask and fins	20.00 per use	30 dives per person X 8 people = 240 uses 240 x $20.00 = **$4800.00**
	Tanks (compressed AIR)	20.00 per use	120 sampling points / 4 dive teams = 30 dives per person $20.00 x 30 dives = $600.00 Total $600.00 x 8 divers = **$4800.00**
	BCD	20.00 per use	**$4800.00**
	Regulator	20.00 per use	**$4800.00**
	Tanks (Nitrox)	10.00 per use	$10.00 x 30 dives x 8 divers = **$2400.00**
Boat	Fuel and oil	$25,000.00	**$25,000.00**
	Rental fee	$5000.00	**$5000.00**
Plankton net		$200.00	200 x 2 = **$600**
Mesh Bags		$30.00	30 x 2 = **$60.00**
Stationary		$300.00	**$300.00**
Measuring tape		100.00 (incl. Shipping and handling)	$100.00 x 2 = **$200.00**
PVC rods		$20.00	**$20.00**
Fish Boards		$20.00	**$40.00**
Calipers		200.00	200x 2= **$200.00**
Honorarium for field team (fishers and external stakeholders)		$60.00 per day	$60 x 12 ppl x 30 man days = **21, 660.00**
		Sub total	**$74,680.00**
Expertises for plankton identification (Lab fees)		3000	3000
Habitat mapping (Consultant)		15,000	15,000
Surface Currents (Consultant)		10,000	10,000

Consultations		2000.00	2000.00
Drop Camera		7400.00	**7400.00**
		TOTAL	**$112,080.00**
		10% (estimation factor)	$11208.00
		PROJECT TOTAL	**$123, 288.00**

Timeline

Total: Six (6) months:

Preparation and Planning: two (2) months

Implementation of survey: two (2) months

Data Analysis and Management recommendations: one (1) month

Development of monitoring strategy and action plan: one (1) month

Country: The Bahamas

Proposal: Assessing queen conch populations the Bahamas
Prepared by: Jeremy Saunders, Fisheries Superintendent
Institution: Department of Marine Resources, P.O. Box AB 20384, Abaco, Bahamas

Background

Due to the size of The Bahamas banks, the intent is to initially survey a percentage of the banks. That percentage has not been determined, but very likely to focus primarily on fishing grounds and areas where conch has been reported to be found.

Methods

There are not enough local personnel (certified divers) and other advisor personnel, including GIS experts and survey planners.

It is being considered to use a combination of survey methods, SCUBA, scooters and underwater camera system. Specific details are currently being decided.

Budget

At this moment, it does not appear that we need financial assistance as funding for the conch stock assessment and survey project has been approved by cabinet. We should be able contract the survey experts through this project as well.

Country: Antigua and Barbuda

Proposal: Queen Conch Underwater Visual Survey Antigua & Barbuda
Prepared by: Hilroy Simon, Fisheries assistant
Institution: Fisheries Department, Morris Extension, Old Road Village, St. Mary's Parish

Background

The queen conch S*trombus gigas* has been harvested by fishers in Antigua & Barbuda for many leading back into the late 1960s. This marine species has the second highest economic value of all species harvested in the twin island state, second only to the Caribbean spiny lobster. The queen conch industry had a value of approximately 2.1 million Eastern dollars in 2009 and 2010 with landings of 758 & 764 MT (live weight) respectively. There is very little information as the true abundance of the queen conch on the island shelf of Antigua since there has been no fisheries independent survey conducted in the area since 1999. At present, all the available conch data are from fisheries dependent surveys making it very difficult to accurately calculate stock biomass in order to determine the TAC for the resource. There is very little information available with regards to the bottom type on the Antigua and Barbuda shelf, it is therefore almost impossible to create accurate habitat maps for the area.

Objectives

The main objectives of this project are:

1) To obtain the data necessary for the creation of habitat maps for the Antigua & Barbuda shelf utilizing underwater visual surveys and drop camera surveys.

2) To acquire baseline data with regards to the population density of the queen conch stocks across the shelf and across different depth and habitat strata on the same shelf.

3) To estimate queen conch biomass

4) To estimate TAC for queen conch on the Antigua & Barbuda shelf

5) To gather information on the deep water conch stocks using towed or remote underwater video camera systems

Methodology

Preliminary Survey

The survey will employ the use of electronic nautical charts to identify and separate the two main depth strata (0-25 meters and 25-40 meters) in order to determine the shallow areas to be surveyed using belt transects by SCUBA divers and the deeper sites to be surveyed using belt transects. Random points will be selected across the entire shelf and divers and drop cameras

deployed to gather habitat information. This preliminary survey will also serve as a training platform for local Fisheries Officers and other research personnel who will take part in the actual survey. During this training, the divers the belt transect protocol will be introduced to the surveyors and fine-tuned. The video survey methodology is still in its infant stage, therefore some fine-tuning of the methods and techniques for conducting the deeper water conch survey will be carried out at this stage. The information gathered from these two preliminary surveys will be used to create habitat maps for the Antigua & Barbuda shelf and be used to identify possible areas of aggregation.

Baseline surveys with the assistance of the local commercial conch divers are to be conducted to determine the fished and un-fished areas; this information also will be added to the habitat map for the shelf.

Survey

The stratified random sampling method will be used to determine the location of each sample station. These locations will be uploaded to GPS units to be used in the survey. The stations will be separated into two main categories; shallow sites (<25 meters) and deep sites (25-40 meters). A rugged all weather laptop loaded with nautical software and charts with the GPS interfaced will be used to assist in the navigation and for keeping track or the completed and outstanding stations to prevent the duplication effort.

SCUBA

Due to the extent of the Antigua and Barbuda shelf, covering in excess of 3,500 km2 (appendix 1); seeking assistance from persons already trained in the ACP Fish II "Training in Underwater Visual Survey Methods for Evaluation the Status of *Strombus Gigas*, Queen Conch Stocks" will be necessary in order to complete the survey in a timely manner. For the survey strategy, teams of two SCUBA divers along with one safety diver will survey each station using the belt transect method where four thirty meter transects with the same anchoring points running at a 90° angle to each other. Both side of each thirty meter transect line will be surveyed and the siphonal length and lip thickness measured and recorded on underwater paper for all conchs within two meters of the transect line.

Camera (option 1)

A drop camera will be released at the sampling stations with the camera set at a predetermined angle to capture live footage of the sea floor on the attached Digital Video Recorder (DVR).The DVR and GPS will be interfaced with video overlay so that the GPS coordinates are displayed on the recording in real time. The operator of the DVR will give instructions to raise or lower the drop camera to get the best height for viewing and capturing the data. The vessel will be set to drift after the camera has been deployed and the captain will make efforts to maneuver the vessel if the drift is in excess of 3 knots. The points of deployment and retrieval of the camera will be recorded along with the time and water depth.

Camera (option 2)

A ROV equipped with adjustable angle camera, depth control and compass will be deployed at the station and controlled remotely from the surface. This camera will have the ability to get closer to objects (conchs) on the seafloor to confirm their identity. The Video Ray Explorer X3 is equipped to carry out all the functions mentioned above and has a maximum cruising speed of 1.9 knots and the camera is capable of 90° horizontal and 140° diagonal viewing angles, as well as a variable tilt with an 160° vertical field of view. The maneuverability of this system also allows for close-ups where it will be possible to get a size reference for each individual conch intercepted.

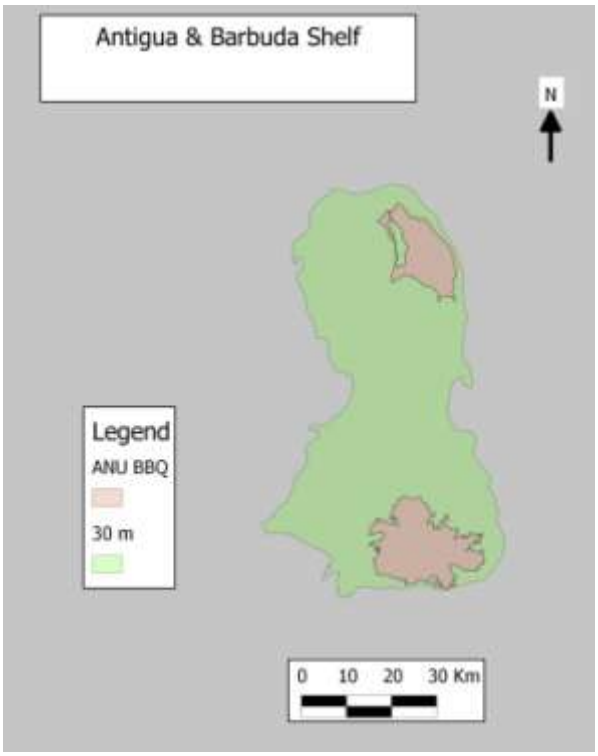
Analysis

All data collected will be uploaded in digital format using Microsoft excel at the end of every dive day using predesigned forms. At the end of the survey the data will be pooled and analysed in Microsoft Excel and the information published and some displays and publications would be made possible using GIS.

Inputs

Available Resources and numbers	**Resources to be Procured**	
	Dive insurance	
SCUBA Equipment = 6 sets	1 X digital camera with waterproof housing	
Dive platforms (Vessel) = 2	4 X Large Callipers 1mm precision	
	4 X small callipers 0.1 mm precision	
	4 X 30 meter measuring tapes	
	1 X Rugged Laptop PC (Panasonic Toughbook)	
	1X Desktop PC	
	1 X Laser Printer/copier	
	200 sheets Waterproof paper	
	2 X GPS units with PC interface	
	2 X Hand held depth sounder	
	6 X Plastic clipboards	
	(a) Video Monitoring Drop Camera	(b) Video Ray Explorer X3 ROV
	1 X Power inverter	1 X Power inverter
	1 X DVR	
	GPS overlay equipment	

Appendix 1: Antigua & Barbuda Shelf



Annex 1 - List of Fisheries Researchers and Officers who developed country-specific plans

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CRFM

The CRFM is an inter-governmental organisation whose mission is to "Promote and facilitate the responsible utilisation of the region's fisheries and other aquatic resources for the economic and social benefits of the current and future population of the region". The CRFM consists of three bodies – the Ministerial Council, the Caribbean Fisheries Forum and the CRFM Secretariat.

CRFM members are Anguilla, Antigua and Barbuda, The Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Haiti, Jamaica, Montserrat, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Suriname, Trinidad and Tobago and the Turks and Caicos Islands.