

# ***SEDAR 14***

## Stock Assessment Report 3

### Caribbean Queen Conch

#### SECTION III. Assessment Workshop

SEDAR

4055 Faber Place #201

Charleston, SC 29405

# **SEDAR 14 Assessment Workshop Report**

## **SPECIES**

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# 1. Workshop Proceedings

## 1.1. Introduction

### 1.1.1. Workshop Time and Place

The SEDAR 14 Assessment Workshop was held June 4 - 8, 2007 in St. Thomas, USVI.

### 1.1.2. Terms of Reference

1. Review any changes in data following the data workshop and any analysis suggested by the data workshop. Summarize data as used in each assessment model. Provide justification for any deviations from Data Workshop recommendations.
2. Develop population assessment models that are compatible with available data and recommend which model and configuration is considered most reliable or useful for providing advice. Document all input data, assumptions, and equations.
3. Provide estimates of stock population parameters (fishing mortality, abundance, biomass, selectivity, stock-recruitment relationship, etc); include appropriate and representative measures of precision for parameter estimates.
4. Characterize uncertainty in the assessment and estimated values, considering components such as input data, modeling approach, and model configuration. Provide appropriate measures of model performance, reliability, and 'goodness of fit'.
5. Provide yield-per-recruit, spawner-per-recruit, and stock-recruitment evaluations, values, and figures.
6. Provide estimates for SFA criteria. This may include evaluating existing SFA benchmarks or estimating alternative SFA benchmarks (SFA benchmarks include  $MSY$ ,  $F_{msy}$ ,  $B_{msy}$ ,  $MSST$ , and  $MFMT$ ); recommend proxy values where necessary.
7. Provide declarations of stock status relative to SFA benchmarks.
8. Estimate an Allowable Biological Catch (ABC) range.
9. Project future stock conditions (biomass, abundance, and exploitation) and develop rebuilding schedules if warranted; include estimated generation time. Stock projections shall be developed in accordance with the following guidelines.
  - A) If stock is overfished:  
 $F=0$ ,  $F=current$ ,  $F=F_{msy}$ ,  $F_{target}$  (OY),  
 $F=F_{rebuild}$  (max that rebuild in allowed time)
  - B) If stock is overfishing:  
 $F=F_{current}$ ,  $F=F_{msy}$ ,  $F=F_{target}$  (OY)
  - C) If stock is neither overfished nor overfishing:  
 $F=F_{current}$ ,  $F=F_{msy}$ ,  $F=F_{target}$  (OY)
10. Evaluate the results of past management actions and, if appropriate, probable impacts of current management actions with emphasis on determining progress toward stated management goals.

11. Provide recommendations for future research and data collection (field and assessment); be as specific as practicable in describing sampling design and sampling intensity.
12. Complete the Assessment Workshop Report (Section III of the SEDAR Stock Assessment Report) and prepare a first draft of the Assessment Advisory Report.

1.1.3. Workshop Participants

**NAME** **Affiliation**

*Workshop Panel*

Richard Appeldoorn..... CFMC SSC/UPRM  
 Daniel Matos-Cayaballo ..... PR DNER  
 Nancie Cummings..... NMFS SEFSC  
 Guillermo Diaz..... NMFS SEFSC  
 Ron Hill..... NMFS SEFSC  
 Joe Kimmel ..... NMFS SERO  
 Andy Maldonado ..... CFMC AP  
 Kevin J. McCarthy ..... NMFS SEFSC

*Council Representative*

David Olsen ..... CFMC/VI DWF

*Staff*

John Carmichael..... SEDAR  
 Graciela Garcia-Moliner ..... CFMC  
 Patrick Gilles..... NMFS SEFSC  
 Rachael Lindsay ..... SEDAR

1.1.4. Workshop Documents

*Working Papers*

SEDAR14-AW1	An Examination of the Mutton snapper, Lutjanus analis, Commercial Catch per Unit of Effort Data in Puerto Rico from 1983-2005 Available for Use in Developing Estimates of Abundance	Cummings, N
SEDAR14-AW2	Habitat based analysis Mutton	Jeffries, C.
SEDAR14-AW3	Habitat based analysis conch	Jeffries, C.
SEDAR14-AW4	On diver catch-per-unit-effort series as measures of relative abundance of queen conch and their use in stock assessments for the islands of Puerto Rico and Saint Croix	Diaz, G.
SEDAR14-AW5	Estimation of mutton snapper total mortality rate from length observations.	Gedamke
SEDAR14-AW6	Revised queen conch (Strombus gigas) standardized catch rates for Puerto Rico and U.S. Virgin Islands commercial fisheries	McCarthy, K. J.
SEDAR14-AW7	Comments on Puerto Rico landings and biostatistical sampling	Matos, D.

*Reference Documents*

SEDAR14 RD09 NMFS-SEFSC-304 1992	Shallow water reef fish stock assessment for the U.S. Caribbean.	Appeldoorn, R. et al.
SEDAR14-RD10	Coral reef fisheries uses in Puerto Rico and USVI.	anon.
SEDAR14-RD11 SFD-02/03-184 2002	Standardized catch rates and preliminary assessment scenarios for queen conch ( <i>Strombus gigas</i> ) in the U.S. Caribbean	Valle-Esquivel, M.
SEDAR14-RD12 SFD-01/02-169 2002	U.S. Caribbean queen conch ( <i>Strombus gigas</i> ) data update with emphasis on the commercial landings statistics.	Valle-Esquivel, M.
SEDAR14-RD13 NMFS-Pro. Paper 5	Detecting fish aggregations from reef habitats mapped with high resolution side scan sonar imagery.	Rivera, J. A. et al.
SEDAR14-RD14 Bull Mar Sci 62(2) 1998	VARIATION IN NATURAL MORTALITY. IMPLICATIONS FOR QUEEN CONCH STOCK ENHANCEMENT	Stoner, A. & R. A. Glazer
SEDAR14-RD15 Fish Bull 96:885-899 1998	Settlement and recruitment of queen conch, <i>Strombus gigas</i> , in seagrass meadows: associations with habitat and micropredators	Stoner, A. W., M. Ray-Culp, S. M. O'Connell
SEDAR14-RD16 Mar Ecol Prog Ser 202:297-302 2000	Evidence for Allee effects in an over-harvested marine gastropod: density-dependent mating and egg production	Stoner, A. W. and M. Ray-Culp
SEDAR14-RD17 ICES Mar. Sci Symp 199:247-258 1995	Stock assessment of a large marine gastropod ( <i>Strombus gigas</i> ) using randomized and stratified towed diver censusing.	Berg, C. J. Jr., and R. A. Glazer
SEDAR14-RD18 Sociedad de Cinecias Naturales La Salle. Tomo XLVIII. Supl No. 3 1988	COMMERCIAL CATCH LENGTH-FREQUENCY DATA AS A TOOL FOR FISHERIES MANAGEMENT WITH AN APPLICATION TO THE PUERTO RICO TRAP FISHERY	Dennis, G.
SEDAR14-RD19 Mar Ecol Prog Ser 257:275-289 2003	What constitutes essential nursery habitat for a marine species? A case study of habitat form and function for queen conch	Stoner, A. W.
SEDAR14-RD20 Jou. Shellfish Res 15(2) 407-420 1996	LARVAL SUPPLY TO QUEEN CONCH NURSERIES: RELATIONSHIPS WITH RECRUITMENT PROCESS AND POPULATION SIZE IN FLORIDA AND THE BAHAMAS	Stoner, A. W., R. A. Glazer, P. J. Barile
SEDAR14-RD21 Mar Ecol Prog Ser 106:73-84 1994	High-density aggregation in queen conch <i>Strombus gigas</i> : formation, patterns, and ecological significance	Stoner, A. W. and J. Lally
SEDAR14-RD22 J. Shellfish Res. 17(4) 955-969 1998	MESOSCALE DISTRIBUTION PATTERNS OF QUEEN CONCH ( <i>STROMBUS GZGAS LINNE</i> ) IN EXUMA SOUND, BAHAMAS: LINKS IN RECRUITMENT FROM LARVAE TO FISHERY YIELDS	Stoner, A. W., N. Mehta, and M. Ray-Culp.

SEDAR14-RD23 Mar Bio 116:571-582 1993	Aggregation dynamics in juvenile queen conch ( <i>Strombus gigas</i> ) : population structure, mortality, growth, and migration	Stoner, A. W., R. Ray
SEDAR14-RD24 Fish Bull 94:551-565 1996	Queen conch, <i>Strombus gigas</i> , in fished and unfished locations of the Bahamas: effects of a marine fishery reserve on adults, juveniles, and larval production	Stoner, A. W.
SEDAR14-RD25 Fish Bull 92:171-179 1994	Queen conch, <i>Strombus gigas</i> , reproductive stocks in the central Bahamas: distribution and probable sources	Stoner, A. W., K. C. Schwarte
SEDAR14-RD26 Mar. Fish. Rev. 59(3) 1997	The status of queen conch research in the Caribbean	Stoner, A. W.
SEDAR14-RD27 TAFS 135:476-487 2006	Estimating Mortality from Mean Length Data in Nonequilibrium Situations, with Application to the Assessment of Goosefish	Gedamke, T., Hoenig, J. M.
SEDAR14-RD28 Fed-State Proj. No. NA77F0087 2000	Puerto Rico/NMFS Cooperative Fisheries Statistics Program 1997-2000	Matos, D.
SEDAR14-RD29 PR DNER 2004	Comprehensive Census of the Marine Fishery of Puerto Rico, 2002	Matos, D.
SEDAR14-RD30 CMFC Report 1984	Report on the reef fish size frequency survey July - September 1983	Morales-Santana, I.
SEDAR14-RD31 CFMC 1997	International queen conch conference proceedings, San Juan, PR, July 1996	Posada, J. M. and G. Garcia, eds.
SEDAR14-RD32 NOAA/NOS undated NA03NOS426024	Marine resource conditions for reef fishes and seagrass around St. John, USVI: Historical to present	Beets, J. and L. Muehlstein.
SEDAR14-RD33 SEFSC undated manu.	Queen conch CPUE assessment in PR & USVI's : Preliminary report.	Rivera, J. A.
SEDAR14-RD34 UPR/SEAMAP-C 2005	St. Croix and St. Thomas/St. John fisheries independent trap and line survey, 1992-2002.	Whiteman, E. A.
SEDAR14-RD35 PR Dept. of Agr., Agr. and Fish. Contr. IV(4) 1972	A report on fisheries statistics program in Puerto Rico from 1967 to 1972	Juhl, R. & J. A. Suarez Caabro
SEDAR14-RD36 PR Dept. of Agr., Agr. and Fish. Contr. III(1) 1975	La Pesca en Puerto Rico, 1970	Juhl, R. & J. A. Suarez Caabro
SEDAR14-RD37 Comm Fish. Rev. USFWS Reprint 866 1970	Puerto Rico's commercial fisheries. A statistical review.	Suarez-Caabro, J. A.
SEDAR14-RD38 PR Dept. of Agr., Agr. and Fish. Contr. II(1) 1975	Puerto Rico commercial fisheries, 1968-1969	Suarez-Caabro, J. A.

SEDAR14-RD39 PR Dept. of Agr., Agr. and Fish. Contr. IV(1) 1972	Status of fisheries in Puerto Rico, 1971.	Juhl, R. & J. A. Suarez Caabro
SEDAR14-RD40 PR Dept. of Agr., Agr. and Fish. Contr. V(3) 1973	Status of fisheries in Puerto Rico, 1972.	Suarez-Caabro, J. A.
SEDAR14-RD41 PR Dept. Nat. Res; Fish. Res. Lab. Tech. Rpt. 1(1) 1986.	Overview of Puerto Rico's small scale fisheries statistics, 1972 - 1978	Weller, D. & J. A Suarez-Caabro.
SEDAR14-RD42 PR Dept. of Agr., Agr. and Fish. Contr. VII(1) 1975	Status of fisheries in Puerto Rico, 1974.	Rolon, M.
SEDAR14-RD43 PR Dept. of Agr., Agr. and Fish. Contr. VIII(4) 1976	Status of fisheries in Puerto Rico, 1975.	Suarez-Caabro, J. A. & M.A. Abreu Volmar
SEDAR14-RD44 PR Dept. of Agr., Agr. and Fish. Contr. IX(1) 1978	Status of fisheries in Puerto Rico, 1976.	Abreu Volmar, M. A.
SEDAR14-RD45 CODREMAR, Fish. Res. Lab. Tech. Rpt. 1(2) 1987-1988	Status of fisheries in Puerto Rico, 1979-1982	Collazo, J. & J. A. Calderon
SEDAR14-RD46 NMFS/SERO State-Fed Proj. SF23 1986	CODREMAR/NMFS Cooperative statistics program. Completion report.	Garcia-Moliner, G. & J. Kimmel
SEDAR14-RD47 Comm. Fish. Res. and Dev. Act Pgm. 2-395-R 1986	Puerto Rico commercial fisheries statistics for 1983 - 1986.	Garcia-Moliner, G. & J. Kimmel
SEDAR14-RD48 PR Dept. Nat. Res; Fish. Res. Lab. Tech. Rpt. 1(1) 1994	Overview of Puerto Rico's small scale fisheries statistics, 1983 - 1987	Matos, D. and C. R. Alvarez

## 2. Panel Recommendations and Comment

### 2.1. Discussion and Critique of Each Model Considered

Preliminary production model (ASPIC) runs were completed for Puerto Rico and St. Croix queen conch, however those analyses were not continued because the available data were inadequate and conclusions resulting from analyses based upon those data would likely be erroneous. This decision was based upon the arguments in SEDAR 14-AW-04, summarized here.

Surplus production models, as have been previously used in queen conch assessments in the US Caribbean (Anon. 1999, Valle 2002), require at least one series of yield and one index of stock abundance or effort as input. Incremental changes in effort should result in proportional changes in catch. Standardized catch-per-unit-effort (CPUE) series from the commercial fisheries were the only available stock abundance measures available prior to the assessment workshop (Table 1). As discussed in at the workshop (summarized in section 2.1.1), the diver-based CPUE data available for the queen conch assessment do not vary even when landings have an 8-fold increase (Figure 1, years 1992-2006) or a marked decrease (Figure 2, for the years 1989-1992). The only available CPUE series does not meet the assumption of a production model that changes in catch are reflected by incremental changes in effort.

Uncertainties are also associated with the landings estimates. On many occasions some fishers did not submit landing reports, therefore, expansion factors were used to raise the reported landings to account for incomplete reporting. Also, in Puerto Rico there were instances when the landings reported by individual fishers differed from what was actually landed (Matos-Caraballo, 2004). In both Puerto Rico and St. Croix there were no current estimates of recreational harvest. The single estimate of recreational harvest available was from Puerto Rico in 1986 where recreational harvest was estimated to be 35% of the commercial landings, suggesting that queen conch harvest by the recreational sector is potentially important. With such uncertain and inadequate available data, the decision was made to not continue an assessment of queen conch stocks in Puerto Rico or St. Croix using production models dependent upon diver-based CPUE series.

#### 2.1.1 Catch per Unit Effort

Discussion on catch per unit effort (CPUE) for conch revolved around two points. The first concerned what constituted a directed conch trip, given that conch fishers routinely target other species, particularly spiny lobster, while fishing conch. The second point regarded what zero-caught-conch trips should not be counted toward estimating CPUE. Specifically, identify and use only data from those areas where vessels in the conch fishery operate (e.g., excluding north coast dives) and excluding trips where lobsters were

caught but no conch were caught. These guidelines were accepted based on both the knowledge of local scientists and commercial fishers and the behavior of subsequent standardized CPUE.

The resulting CPUE trends showed a distinct flat trend despite evidence from resource surveys that densities have increased and in the face of an 8-fold increase in catch from St. Croix over the past decade (a trend that has accelerated over the last three years). There was also a significant reduction of conch landings in Puerto Rico during the period 1988-1992 that, according to local commercial fishers, was the result of low conch densities. The estimated standardized CPUE for that period, however, did not show any declining trend. The regulatory catch quota (150 conch/commercial fisher/day) that was introduced during the CPUE time series introduces a confounding effect. Commercial fishers stated they have been able to catch the daily quota despite any changes in stock abundance.

The consensus interpretation is that CPUE was, at best, an index of aggregation density rather than overall abundance of the stock. This interpretation was supported by a review of the data that showed that the marked increase in landings in St. Croix catch was due to a concomitant increase in the number of fishing trips.

In summary, while an acceptable measure of standardized CPUE was developed, it was uninformative of stock abundance.

### 2.1.2. Resource Surveys

The assessment workshop panel strongly recommends expanding existing fishery independent surveys of queen conch populations in the US Caribbean. Available data are summarized below and in section 3.

Periodic transect surveys were available for Puerto Rico (west and east coasts), St. Thomas-St. Thomas, and St. Croix. PR surveys date back to 1986, while those in the USVI date back to 1981. In Puerto Rico and the USVI, current surveys are conducted every 5 years as part of SEAMAP-Caribbean. Additional recent data are available from limited-area benthic surveys conducted by NOS-CCMA in the protected areas of St. John and St. Croix.

The consensus was that these surveys offer much promise for developing an index of conch abundance and that they could be coupled with landings data to get an indication of relative fishing pressure. In addition, such indices may be compared to approximate target values developed or used elsewhere in the Caribbean (see below). Difficulties remain with respect to the data needed and best approach for expanding the limited survey results over some portion or the entire shelf.

Initial population estimates were made for Puerto Rico, St. John and St. Croix. Results for Puerto Rico (Table 2) had Yield/Biomass values ranging from 0.26 to 1.17. A similar calculation for recent landings in St. Croix yielded a Yield/Biomass ratio of 0.195. Calculations for St. Croix were considered more reliable due to the greater proportion of the shelf mapped and known area. For Puerto Rico there was also

considerable uncertainty in total yield, as reported landings are expanded by as much as a factor of two for some years.

Resource surveys clearly show that densities were increasing in Puerto Rico and St. Croix (adults only), the two areas that support commercial fisheries. Both had current average densities of approximately 30 conch/ha. The most recent survey in Puerto Rico also showed an increase in both the proportion of adults and a shift in the age structure to older individuals, while still showing evidence of substantial juvenile recruitment. In Puerto Rico, this most recent survey may evidence a response to the application of the full extent of management measures in both local waters and the relatively small portion of the shelf within the EEZ. Size limits, daily quotas, and closed seasons in the EEZ went into effect in 1997. The closed season was extended into local waters in 1999, while the other measures were extended 2004. The closure of the EEZ occurred in 2005. In St. Croix these measures (except the EEZ closure) went into effect in 1994. However, newly protected areas have been initiated in St. Croix, which may contribute to the density increase. Data for St. John show a sustained decline in adults since 1981, while data for St. Thomas show mixed results.

The conch FMP currently has an estimated MSST of 1,404,000 lbs and an MSY of 452,000 lbs. Density-based estimates of total stock biomass (adults only) for Puerto Rico (1,897,000 lbs) and St. Croix (668,000 lbs) sum to the approximate value of the MSST. On the other hand, the yield for these areas (723,719) is 60% greater than the recommended MSY.

The density values can also be compared to approximate target values developed or used elsewhere in the Caribbean, as illustrated in Figure 3. Here, the density levels for Puerto Rico are plotted against values obtained elsewhere in the Caribbean for surveys that can be construed as being shelf wide. The increasing trend in conch density (juveniles and adults) for Puerto Rico over the last decade is shown by the arrow. Also shown is the observed limit (50 conch/ha) found by Stoner and Ray (1996) below which reproductive activity (copulation and egg deposition) was found to decline (in proportion to density decline). Also shown is the density level used to estimate stock size at MSY on Pedro Bank, based on one-half the observed density in the 20-30m stratum, which at the time was assumed to be unfished (Appeldoorn, 1995). Observed densities for both Puerto Rico and St. Croix are still substantially below both of these levels.

Lastly, catch rates per hectare can be compared to the predicted MSY for the Turks and Caicos. This was taken as the commercial catch (87 kg/km<sup>2</sup>, Ninnes 1994) plus that for local consumption (51 kg/km<sup>2</sup>, Olsen 1985), which totals 3.04 lbs/ha. In Puerto Rico, the most recent harvest was very similar, at 3.10 lbs/ha. For St. Croix, the value was more than double, at 7.39 lbs/ha.

For St. Croix, all calculations were made assuming the whole of the shelf to be exploited. However, most, if not all, of the recent survey stations were located within the Buck Island National Coral Reef Monument or the East End Marine Park, both of which are protected areas. Thus, it is possible that the increase in density observed in recent years may reflect a sharp reduction in exploitation rate, and expansion of density values over the whole of the shelf would be inappropriate. Under this scenario, expected biomass would be lower and exploitation rates would be much higher. Unfortunately, there was

no representative from CCMA or the Virgin Islands present to address the question of exploitation/enforcement within the protected areas.

For Puerto Rico, observed densities were also expanded over the whole shelf, despite the fact that essentially no fishing occurs along the north coast and the western margin of the western shelf is within the EEZ and currently closed to fishing. Proportionally, however, the sum of these areas is still small relative to the whole shelf, so their impact on the conclusions would be low.

## 2.2. Discussion of YPR, SPR, Stock-Recruitment

**What was discussed/recommended?**

## 2.3. Recommended SFA parameters and Management Criteria

The AWP did not estimate any SFA parameters.

## 2.4. Status of Stock Declarations

The AWP did not estimate any SFA benchmarks, therefore, the status of the stock could not be evaluated.

## 2.5. Recommended ABC

The AWP did not estimate any ranges of ABC.

## 2.6. Discussion of Stock Projections

The AWP did not perform any projections to evaluate the future status of the stock.

## 2.7. Management Evaluation

The Caribbean Fishery Management Council is charged with developing Annual Catch Limits for queen conch. Management benchmarks (e.g. FMSY, BMSY) could not be estimated, therefore it was not possible to perform an evaluation of current management regulations. The workshop panel recommends expansion of fishery independent surveys of queen conch populations, however, it is unclear how density surveys can be used to set Annual Catch Limits. It is also unclear how density surveys can be used to assess (and hence open) the closed areas on the Puerto Rico and St. Thomas/St- John EEZ.

## 2.8. Research Recommendations

1. The efforts to analyze the available data were greatly enhanced by the presence of local fishers and agency representatives. However, there was no local representative from the USVI Division of Fish and Wildlife assigned to the

- meeting, while the Puerto Rico representative could not attend the full term of the meeting. There must be greater buy-in from the local agencies such that knowledgeable representatives are present for the full term of the meeting. Greater efforts should be made to attract the participation of local fishers.
2. Data from past density surveys should be re-analyzed so that values can be expanded on the basis of both habitat and depth, including confidence limits. Habitats should be matched to those available for existing/planned habitat maps. As a subportion of this, the data for the Puerto Rico 1986 survey should be entered into electronic and GIS formats. This could be done using NOAA's Data Rescue funds.
  3. Expansion factors for both Puerto Rico and the USVI should be calculated for conch fishers only.
  4. Assessment of the spatial and temporal variations and dynamics of the resource, fishery, habitat and species interactions would be greatly enhanced if traditional ecological knowledge were obtained from fishers. Efforts should be made to incorporate fishers into the process, particularly using NOAA's CRP funds.
  5. The impact of the recreational fishery is unknown and must be quantified.
  6. Considering the established and potential value of resource surveys, mechanisms should be identified to increase their aerial coverage.
  7. More detailed spatial expansions of survey densities should be planned in preparation of the 2010 Conch Update. For this, significant improvements in available data and analyses are required, including but not limited to the following:
    - A. Detailed bathymetry data for PR and USVI
    - B. Analysis of the impact of closed areas
    - C. Inclusion of more detailed habitat maps for the PR western platform currently in progress
    - D. Quantified size/age structure of the exploitable stock.
  8. The only estimate to date of fishing mortality came from a tagging study in the 1980's. New tagging studies should be initiated to quantify rates of exploitation. This would allow existing SPR models for conch to be used in assessments.

9. Another issue remaining is to investigate the potential impact of very old conch in deep refuges, especially with respect to reproduction, coupled with studies to age very old conch. Such refuges may be substation off St. Thomas/St. John, in patches in Puerto Rico and potentially in protected areas on all three platforms.
10. Intersessional data evaluation workshops for CFMC managed species or species-complexes should be conducted by the Council so that SEDAR level analyses are limited to those where data are sufficient to warrant such an analysis.
11. There needs to be a complete review of the potential data collection programs, including commercial and recreational catch, biostatistical sampling and fishery-independent surveys for Puerto Rico and US Virgin Islands with the purpose of identifying what relevant information could be obtained and modifying sampling procedures accordingly, including the identification of key economic and ecological indicator species.

### **3. Data Review and Update**

#### **Estimation of queen conch populations for the US Caribbean**

During the SEDAR 14 Assessment Workshop (4-8 June 2007) various techniques were evaluated to assess the current stock status of queen conch (*Strombus gigas*). Of those investigated, the most promising approach was comparison of changes in habitat-based densities throughout the years where comparable surveys have been conducted. Considering each island separately, data from those surveys were expressed as densities per unit area and then extrapolated to island-wide population estimates based on available bathymetry and benthic habitat maps. Population sizes were compared to reported landings to see if predicted populations could reasonably support the catch.

#### **Methods**

Queen conch populations have been surveyed in Puerto Rico and the Virgin Islands since about 1981. In the Virgin Islands, beginning in 1981, 22 transects around the islands of St. Thomas and St. John (considered as a unit; St. Thomas=10 transects, St. John=12 transects) and 22 transects around St. Croix were surveyed, documenting density and size distribution by transect, depth and habitat (Wood and Olsen 1983). This initial effort was followed by repeated surveys under the SEAMAP-C program and resource evaluations by the Virgin Islands National Park: 1985 (St. John only, Boulon 1987); 1990 (all USVI, Friedlander et al. 1994); 1996 (St. Thomas and St. John only, Friedlander 1997); and 2001 (all USVI, Gordon 2002, Valle-Esquivel 2006). An additional site (Saba Island) was added for the St. Thomas surveys in 2001 following observations by DFW staff of abundant juvenile conch. For 2001, a total of 11 sites were surveyed in St. Thomas and 12 sites were surveyed in St. John. Of the 22 original transects surveyed in

1981 around St. Croix only 16 were resurveyed in 2001 because of limited study time. The experimental design for these surveys has generally been focused on examining the long-term trends in queen conch stocks based on repeated surveys through time. For this analysis, we are comparing each island separately, with St. Thomas/St. John lumped together when necessary. The current SEAMAP-C conch survey is planned for 2007/8.

Around Puerto Rico, similar queen conch surveys were conducted in 1986, 1995/96, 2001/02, and 2006 by both the University of Puerto Rico (for PR DNER/SEAMAP-C and the Caribbean FMC) and by PR DNER under SEAMAP-C. Surveys included stratification by conch/non-conch habitat (1995/96, 2006) as well as random (1987, 2001/02). Effort varied by survey based on resource availability: 1986 (Torres Rosado 1987, Southwest/La Parguera only); 1995/96 (Appeldoorn 1996, Mateo 1997, Mateo et al. 1998, West coast: 60 stations; East coast: 29 stations); 2001 (Appeldoorn 2002, West and Southwest coasts: 60 stations); 2006 (Jiménez, personal communication 2007, West coast: 46 stations, South coast: 13 stations, East coast: 40 stations). Sampling methods were consistent with surveys conducted in USVI. Size estimates and density data are available as density by transect, habitat and depth.

In addition to these surveys, two projects, conducted under the NOAA Coral Reef Conservation Program, are collecting data that can provide recent comparisons. NMFS SEFSC has been conducting studies of queen conch in two of the bays of St. John, using tagging and sonic tracking to look at habitat use, conch movements and migrations. Densities, by size and life stage are available by transect area, by depth, and by habitat within the bounds of the areas surveyed. NOS Biogeography Team has been surveying reef fish in St. John, parts of St. Croix and La Parguera, Puerto Rico since 2001. Since 2004 they have included records of queen conch when encountered on their surveys, recording size, maturity state, depth, and habitat. Both studies provide estimates of conch densities by area that were used for these comparisons.

## **Parameters**

Surveys are described above. Densities were calculated based on mean densities of conch per transect. For SEAMAP-C-type surveys, transect areas were estimated by the difference between starting and ending positions; widths were 4 m. Densities were taken as calculated in Valle-Esquivel 2006. For NOS reef fish surveys, transects were 100 x 4 m wide. For SEFSC tagging study transects are based on length of tracks recorded by GPS; widths were 10 m.

Area of the insular shelves for each island was calculated for all areas less than 50 m based on available bathymetry (UPR).

Conch weight conversions were taken from studies in Puerto Rico. Numbers of adult conch were converted to uncleaned meat weight using 0.80377 lbs/conch. Lacking precise sizes for juveniles, it was assumed that juvenile populations would be similar to the distribution published in Mateo et al. 1998 having two principle nodes approximately 12.5 and 17.5 cm shell length. Juvenile abundances were divided equally into these two size classes and converted into weight using the equation from Appeldoorn (1988) [as reported in Report on the Queen Conch Stock Assessment and Management Workshop, Belize City, Belize 15-22 March 1999 (CFMC and CFRAMP)] and subsequent conversion of grams (gm) to pounds (lbs.):

$$\text{Log}[\text{weight (gm)}] = -2.535 + 3.486[\text{Log (Length)}]$$

### Estimates of Population Size and Biomass

St Croix (Area: 32014 ha)						
YEAR	DENSITIES		POPULATION			BIOMASS (Adult/Juv) (UNCLEANED LBS)
	ADULT	JUVE.	ADULT	JUVE.	TOTAL	
1981	7.6	na	243,306	na	243,306	195,562/na
2001	25.5	74	816,357	2,369,036	3,185,393	656,163/213,853
2004/6	26.1	60.4	835,005	1,933,950	671,152	671,152/174,578

St Thomas (Area: 12,004 ha)						
YEAR	DENSITIES		POPULATION			BIOMASS (Adult/Juv) (UNCLEANED LBS)
	ADULT	JUVE.	ADULT	JUVE.	TOTAL	
1990	11.8	1.6	141,527	19,086	160,613	113,755/1,723
1996	32.2	31.5	386,409	377,646	764,055	310,584/34,090
2001	24.2	1.9	289,897	22568	312,464	233,010/2,037

St John (Area: 4699 ha)						
YEAR	DENSITIES		POPULATION			BIOMASS (Adult/Juv) (UNCLEANED LBS)
	ADULT	JUVE.	ADULT	JUVE.	TOTAL	
1981	52.4	na	246,296	na	246,296	197,965/na
1985	31.3	na	147,045	na	147,045	118,190/na
1990	8.08	0.7	37,971	3,102	41,073	30,520/289

<b>1996</b>	4.8	5.2	22,557	24,296	46,853	18,130/2193
<b>2001</b>	1.5	4.2	7002	19,597	26,599	5,628/1769
<b>2004/6<sup>1</sup></b>	9.7	35.4	72,832	169,838	242,670	58,540/15,331
<b>2005/7<sup>2</sup></b>	5.3	24.5	24,907	115,136	140,042	20,019/10,393
Sources: 1. NOS surveys, 2. SEFSC conch tagging						

Puerto Rico (Area: Total: 157,348 ha; West coast: 78,674; East coast: 78,674)						
YEAR	DENSITIES		POPULATION			BIOMASS (Adult/Juv) (UNCLEANED LBS)
	ADULT LT	JUVE.	ADULT	JUVE.	TOTAL	
<b>1986</b>	8.11	na	1,276,090	na	1,276,090	1,025,683/na
<b>1995 east</b>	2.5	4.7	200,461	372,285	572,746	161,125/33,606
<b>1995west</b>	2.0	3.7	156,404	290,463	446,868	125,713/26,220
<b>1995 TOT</b>			356,865	662,749	1,019,613	286,837/59,826
<b>2001</b>	4.3	10.1	675,022	1,595,506	2,270,528	542,562/144,026
<b>2006</b>	15	16.9	2,360,216	2,659,177	5,019,393	1,897,071/240,044

### Future Work Recommended

Additional estimates of population sizes could be made from available “density by habitat” and/or “density by depth” data from these same surveys. The results of combining both habitat and depth are likely to be most accurate and could be accomplished with additional manpower and time for extrapolation of survey densities to population estimates.

## 4. Stock Assessment Models and Results

No assessments were performed for queen conch due to a lack of adequate data. Data deficiencies include a complete lack of recreational catch statistics, uncertainty in the commercial catch statistics (i.e. expansion factors used in the Puerto Rico landings), CPUE series that do not reflect stock abundance, and a lack of biological sampling.

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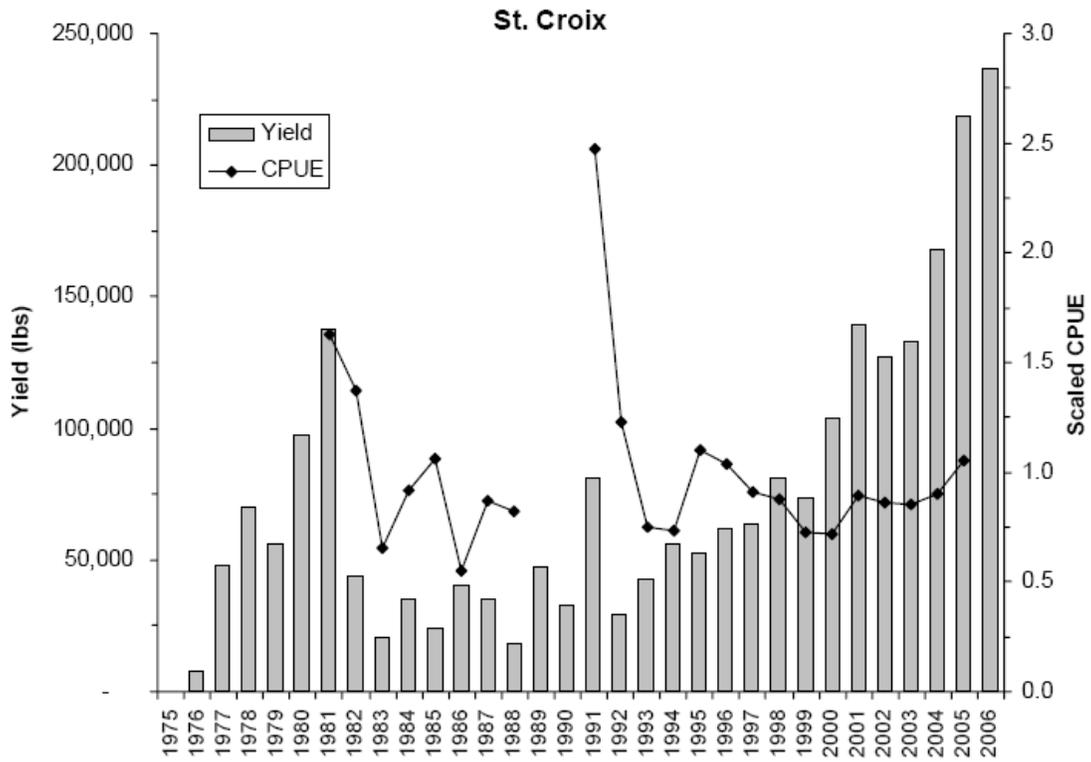
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Table 1. Data availability summary for Caribbean queen conch.

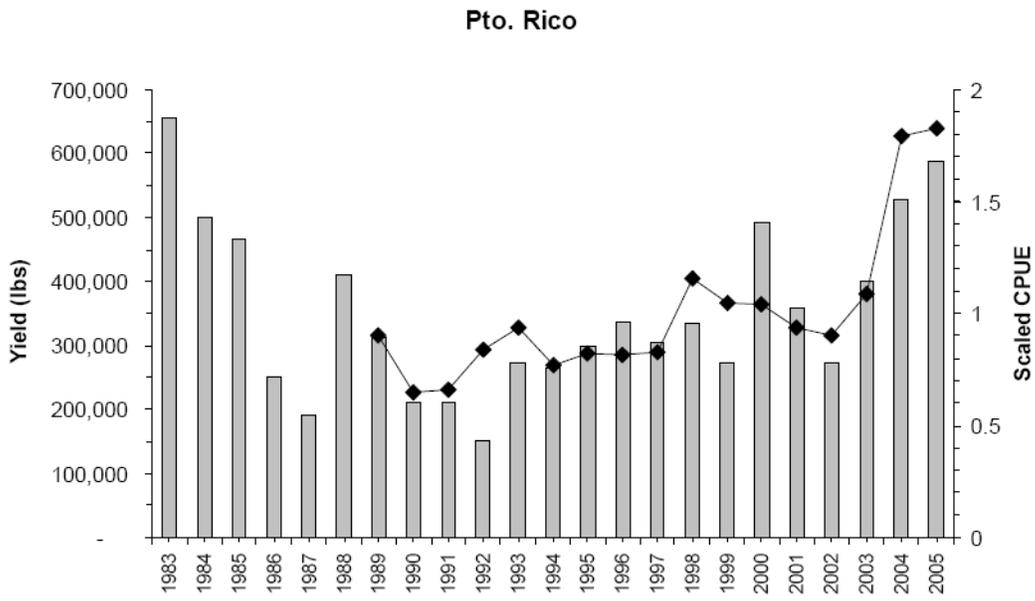
	Puerto Rico	St. Thomas, USVI	St. Croix, USVI
Commercial Landings	Since 1967 available on	Since 1974 Questions about expansion factors	Since 1975 Questions about expansion factors
Commercial Lengths	No information	No info No information	Some from late 1990s
Commercial Discard	don't exist	don't exist	don't exist
Recreational Landings	No information except one estimate from early 1980s	No information	No information
Recreational Lengths	No information	No information	No information
Recreational Discard	don't exist	don't exist	don't exist
Age Samples	Survey	none	Survey
Fishery Independent Indices and Surveys	Habitat based population estimates Seamap every 5 years	Habitat based population estimates Seamap every 5 years	Habitat based population estimates Seamap every 5 years
Fishery Dependent Indices (CPUE)	CPUE not reliable abundance measure	NO.	CPUE not reliable abundance measure
Life History	Age and growth, La Parguera Maturity by age Fecundity by length		Age and growth
Stock ID	No Information	No Information	No Information
Management Issues	Size and bag limits Closed areas and seasons	Size and bag limits Closed areas and seasons	Size and bag limits Closed areas and seasons

Table 2. Initial calculations of conch stock biomass for Puerto Rico (adult) based on spatial expansion of survey densities. These are compared to estimates of total yield.

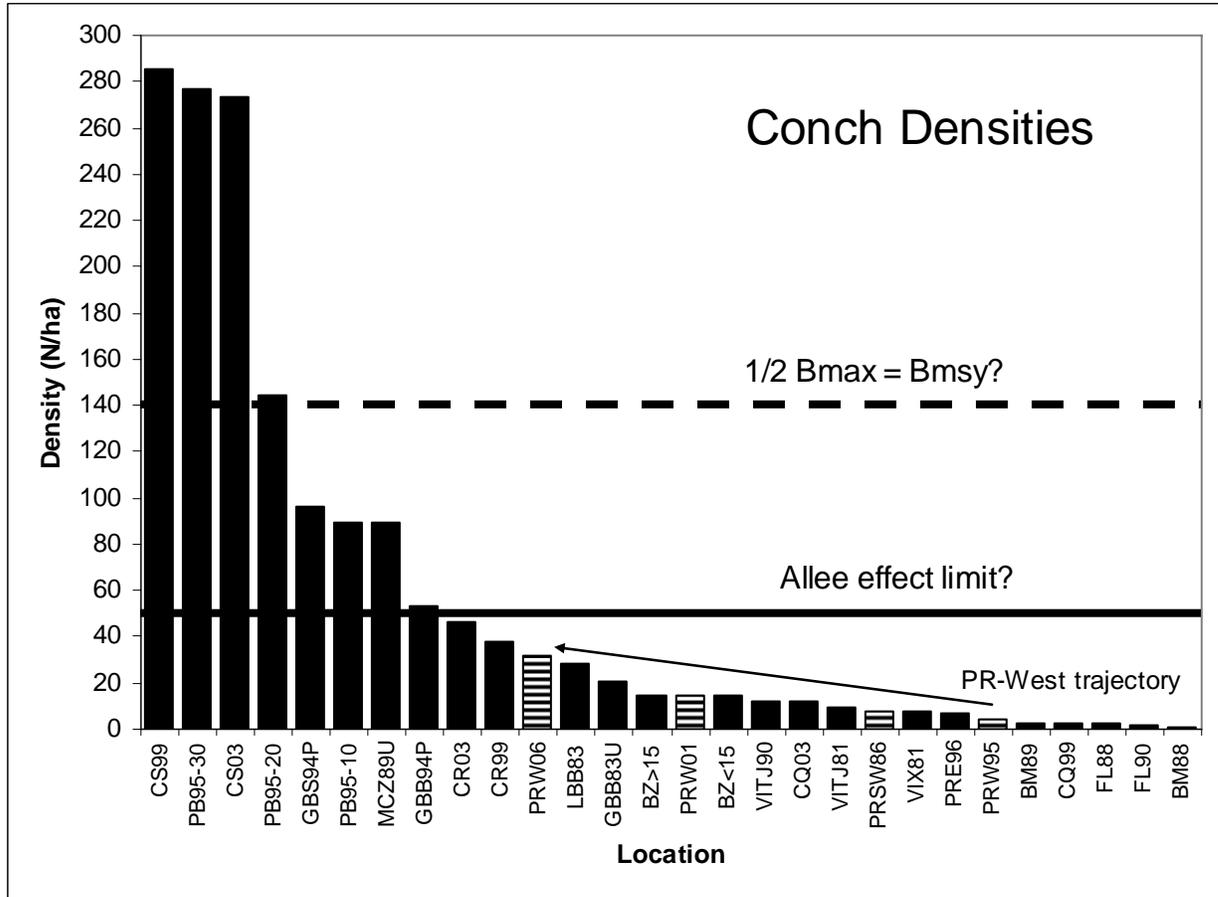
Year	Number	Biomass(lb)	Yield(lb)	Y/B
1996	1,019,613	346,663	336,000	0.97
2001	2,270,528	686,589	358,000	0.52
2006	2,360,216	1,897,071	487,000	0.26



**Figure 1.** Estimated total yield and standardized CPUE, estimated using ‘trip’ as unit-of-effort for queen conch for the island of St. Croix.



**Figure 2.** Estimated total yield and standardized CPUE, estimated using ‘trip’ as unit-of-effort, for queen conch for the island of Puerto Rico.



**Figure 3.** Conch densities for shelf wide surveys throughout the Caribbean. Densities are unadjusted for any potential differences, such as habitat distributions, proportion of juveniles, etc. Striped values are values for western Puerto Rico. Solid line represents the density below which reduced reproductive output may be expected based on studies in the Bahamas. Dashed line represents the level at which density is 1/2 the maximum density observed in the deep stratum on Pedro Bank, assumed to reflect virgin stock density there. Arrow shows the general direction of density increase off western Puerto Rico over the past 10 years.