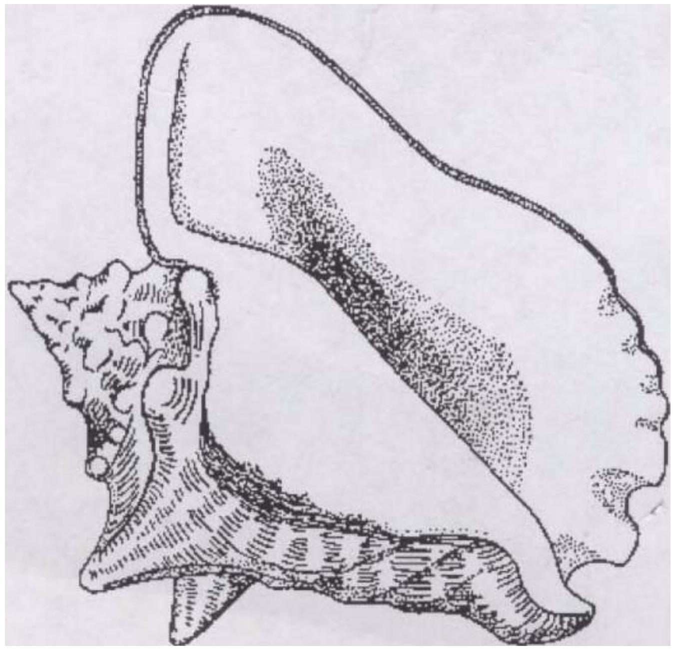
REGIONAL OVERVIEW OF QUEEN CONCH *(Strombus* gigas) RESOURCES IN CARICOM / CARIFORUM COUNTRIES



August 2002

Prepared by
Alexander Tewfik
PhD Candidate (Fisheries Ecology)
Dept. of Biology, McGill University
Montreal, Quebec, Canada

1.0 Introduction

The purpose of the following document is to provide a review of the status of Queen conch *(Strombus gigas)* resources within the territorial waters of nations participating in the CFRAMP Lobster and Conch Sub-project (WBS 430). However, some mention of regional trends that are beyond the scope of CFRAMP will be made. The Lobster and Conch Resource Assessment Unit was established and its activities initiated during the 1994 / 95 fiscal year. The goal of the sub-project is to promote the management and conservation of the lobster and conch fisheries of CARICOM / CARIFORUM countries and to permit the exploitation of these on a sustainable basis. The specific objectives of the sub-project are:

(1) to promote the gathering of basic information needed for fishery management decision-making;
(2) to develop and enhance the national and regional capability for on-going data collection and analysis; and
(3) to interpret the results from such analyses.

Nations participating in this sub-project include: Antigua and Barbuda; Belize; Grenada; Jamaica; St. Kitts and Nevis; St. Lucia and St. Vincent and the Grenadines (Fig. 1). Most recently the activities of CFRAMP's Lobster and Conch Sub-project have been extended in include the Bahamas, Dominican Republic and Haiti (Fig. 1) under the Fisheries Component of the Integrated Caribbean Regional Agriculture and Fisheries Development (ICRAFD) programme.

This review has largely been created through the integration of information prepared and presented by representatives of participating nations during the Conch and Lobster Terminal Workshop which took place during July 16 and 17, 2001 in Juan Dolio, Dominican Republic. The current document also makes use of a number of other sources including:

(1) The Lobster and Conch Subproject Specification and Training Workshop Proceedings (Kingston, JA, Oct. 1995, *CARICOM Fisheries Research. Doc.* 19);
(2) Proceedings of the International Queen Conch Conference (San Juan, PR., July 1996);
(3) Report on the Queen Conch Stock Assessment and Management Workshop (Belize City. March 1999, *CARICOM Fisheries Research Doc.);*
(4) Participant Documents Package: Second International Queen Conch Conference (Juan Dolio, Dominican Republic, July 18 - 19, 2001)
(5) Food and Agriculture Organization fisheries landings statistics (Fishstat plus, 2000)
(6) Theile, S. 2001. Queen Conch Fisheries and Management - TRAFFIC Europe. Technical report to the CITES Secretariat.
(7) A variety of unpublished country reports, research documents and published journal articles which have been cited throughout.

This review will attempt to cover a variety of topics on a regional and national level including: the importance of Queen conch; landings and trade trends, catch per unit effort trends, fleet descriptions, data collection; regulations, and resource status. Recommendations have made throughout the document to establish or improve existing data collection, stock assessment and management activities.

2.0 Importance of Queen conch

Queen conch have long been valued for their meat and shell and were first harvested by native Americans (Lucayans and Arawaks) during pre-Columbian times (Brownell 1981; Berg and Olsen 1989). Local subsistence use of conch has continued from that time throughout its range. Limited commercial harvest and international trade of dried conch meat began in the mid-18th century between the Turks and Caicos Islands and Haiti (Doran 1958; Ninnes 1994). However, in the last 30 years the overall harvest of conch has increased substantially largely driven by international export as well as growing resident populations and increasing tourism in the Caribbean region (Berg and Olsen 1989; Tewfik 1997). Conch is commercially exploited in at least 26 countries throughout the region and is now consumed as a luxury food item due to its relative rarity and high market price (Mulliken 1996; Tewfik 1997).

Economically, Queen conch has become one of the most important demersal fisheries in the region. Overall annual regional harvests range from 4000 MT (Appeldoorn 1994) lo 6000 MT (Tewfik 1997) representing a significant source of income to thousands of fishers in the Caribbean. The wholesale dollar value of these landings is estimated to be about $US 60 million but may be multiplied by several times given jobs created in processing, marketing and retail (Chakalall and Cochrane 1997). At the most basic level queen conch still provides a primary source of protein in some fishing communities. These fisheries also provide an important social and cultural link to the past and both shell and meat products are sought after and well recognised in the tourist industry of all Caribbean nations.

Finally, conch serve an important role within the ecology of nearshore marine communities given their status as a major herbivore on seagrass and algal epiphytes and detritus as well as serving as competitors, commensals and a food source to a wide variety of marine organisms (Stoner and Waite 1991; Stoner et al. 1995; Tewfik 1997). The loss or substantial decrease in the numbers of this species within nearshore ecosystems could result in community changes that could negatively affect the productivity of other fisheries (e.g. spiny lobster). Therefore, the detailed understanding of conch exploitation by human fishers and subsequent management is critical to the sustainable use of this and other important subsistence, artisanal and commercial fisheries activities in the region.

3.0 Trends in Landings & Trade

Total landings of Strombid conchs for the Central Western Atlantic (Area 31) are available for a period of 50 years (1950 - 1999) and have substantially increased over the last 30 years (Fig 2). It should be noted that most of the reported landings are for Queen conch, *Strombus gigas,* but that significant landings of other stromibids (e.g. *Strombus costatus)* are likely occurring in places such as Mexico. Discrepancies may occur due to the nature of product reported (total animal, shell, various meat grades) or the absence of local consumption figures in the landings data- The top producers and traders of *Strombus gigas* in the region and within CFRAMP / CARIFORUM countries many be seen in Fig. 3 and Fig. 4 respectively. Annual catch data from country reports for the period 1990 to 1999 were incomplete (< 10 points) for all countries except Jamaica and Belize and sufficient data points to reveal trends did not exist for Grenada and Haiti (Table 1), This is in stark contrast to country data available from FAO where a complete record of annual catch data from 1990 to 1999 is available for all countries (Table 2). A comparison of the two data sets reveals significant discrepancies with the FAO data reporting overall higher landings. These discrepancies may be due to misreporting of fisheries data by other national agencies, miscalculations due to various product types and meat processing levels, or non-reporting of local consumption (non-export landings). In all cases landings are either steady or in slight decline (Fig. 5}. However, it should be noted that catch data alone is a very poor indicator of the performance or status of a fishery. Landings may be greatly affected by changing activity levels in other fisheries or economic sectors as well as the market price and demand for fisheries products on local, regional and global scales. Total landings figures represent only the most basic information required for management. Mean value ($US) for landings (per kg) as import to the United States are given in Fig 6 and illustrate the discrepancies in market value.

Although Queen conch meat represents the majority of the harvest and trade in conch products significant quantities of shells have been recorded. CITES annual report data from 1992 to 1999 indicate that 1,628,436 individual shells and 131,275 kg of shells have been exported from the region. Much of this activity originates from Haiti where there are concerns as to the status of Queen conch populations given the lack of information. The Bahamas and the Turks and Caicos Islands have also been identified as important exporters of conch shells (see Theile 2001 for additional details). However, it is considered that the trade in shell and products derived from shells are a by-product of the harvest for conch meat, which should be the primary area of management and enforcement.

4.0 CPUE Trends

Annual catch per unit effort (CPUE) data for the period 1990 to 1999 was incomplete (< 10 points) for all countries and sufficient data points to reveal potential trends only existed for Antigua and Barbuda (N = 5). Belize (N = 3), Jamaica (N = 5) and St Kitts and Nevis (N = 4) (Table 3). All other nations had insufficient CPUE data to describe trends. CPUE data forms an important element in fisheries assessment for use as an index of abundance in many models designed to estimate potential yields. The assumption is that CPUE is proportional to the size of the target population and will consequently reflect the population's response to exploitation and management strategies over space and time. A major problem in comparing CPUE data over various temporal and spatial scales is that standardised units are not being used (Table 3, units column). It is felt that the most convenient and appropriate unit for CPUE within conch fisheries would seem to be kilograms of meat per hour fished (kg / hr. fished) based on the activities of a single diver. An attempt was made to convert the various units of CPUE into kg/hr. fished (Table 4). These conversions have been used to construct Fig. 7. Amongst the four nations with sufficient data only Jamaica has a declining CPUE, which is dependent on the controls of total landings through a decreasing total quota system (details may be seen in Theile 2001). Remaining countries indicate little change, however, the data series are very limited.

It should be noted that the assumption that CPUE is an accurate index of stock abundance has been questioned for some time (Paloheimo and Dickie 1964). Few studies have assessed whether CPUE is an accurate index of abundance because it is often the only practical method available (Connell et al. 1998). In those studies that have made an independent evaluation of population abundance CPUE has often been shown to be a poor index and in some cases has lead to the overestimate of yield (Peterman and Steer 1981; Shardlow et al. 1985; Campos et al. 1994). It is widely agreed that in its crudest form CPUE is unable to provide a useful measure of variation in stock abundance and may lead to severe disproportionality (hyperstability or hyperdepletion) in the CPUE to abundance relationship (Hilborn and Walters 1992; Swain and Sinclair 1994; Prince and Hilborn 1998). The inaccuracy of CPUE as an index of abundance has been attributed to the aggregation of data over inappropriate scales, poor measures of fishing effort (f) and catchability (q) as well as the lack of consideration of individual fisher behaviour (Paloheimo and Dickie 1964; Hilborn 1979; Ludwig and Walters 1989; Prince and Hilborn 1998). These points should be considered when collecting and using CPUE data for use in various stock assessment models. The use of visual survey estimates of stock abundance may be very helpful in verifying results from methods using analysis of catch and effort data.

5.0 Fleet Descriptions

A reasonable amount of information is available on fishing fleets targeting Queen conch within the region. This includes data on the numbers of fisheries (divers and boat handlers} and vessels, details about those vessels, gear types used, diving range and main areas fished (Table 5). This information confirms that conch fisheries are largely artisanal in nature {predominantly small boats). Many of these fishers do not consider conch as a primary target. In some areas conch is only targeted by a limited sub-group of divers (Dominican Republic, St. Lucia, Union Island) or only during the closed season of other species such as spiny lobster (Bahamas, Barbuda, St. Vincent). Jamaica is the exception to this pattern where conch is a major target of artisanal divers as well as large industrial vessels serving as mother boats for multiple dories, often crewed by foreign divers, where fishing trips may last several weeks. Belize also has a similar pattern on a smaller scale with the use of sailing sloops as a base for canoes for multi-day trips.

With the decline of shallow water populations of conch traditional fishing (gear types) methods such as long hooked poles, tangle nets and free diving have been replaced by SCUBA and compressor (Hookah) diving techniques. Two notable exceptions exist: Belize, where both SCUBA and compressors are prohibited for use in harvest and the Bahamas where extensive shallow water populations of conch still exist. It should be noted that SCUBA and compressors might be used by local and foreign poachers in areas where they are prohibited. In other areas the use of modern diving technology has allowed fishers to access the deepest areas of adult conch habitat, which were formally effective spawning stock refugia. In addition to the threats that diving technology has on conch populations it also threatens the lives of the divers. This is in large part due to the lack of formal dive training and understanding of what prolonged diving in deep water (> 12 m) can do to the human body. In addition, dive equipment (regulators, tanks, compressors) is poorly maintained compounding the danger. Many serious diving related injuries and fatalities have occurred throughout the region within conch and lobster fisheries. Details of unsafe diving practices amongst fishers in CARICOM nations may be seen in Espeut (CFRAMP 1997). Several nations including Jamaica and St Lucia have considered the issues pertaining to dive gear and safety in their management strategies. The easiest solution to the problems surrounding diving technology would be a regional ban on the use of such equipment but this would virtually eliminate conch fishing in some areas.

6.0 Data Collection

The promotion of baseline data gathering and the development and enhancement of ongoing data collection capabilities (monitoring) is at the heart of the CFRAMP Lobster and Conch Sub-project objectives. Without such data collections no meaningful assessment and proactive management of fisheries can take place. Given the limitations in the data collection capabilities (specifically with respect to trained staff, finances and logistical support) of many countries in the Caribbean region, it is extremely important that the data that is collected be targeted for specific purposes. The following section wilt outline the specific types of data that should be collected, the types of information gained from each type of data collection, and the way in which various data collection types support one another. The dependence on only one type of data for assessment purposes is a flawed approach, which ignores inherent errors that are associated with all individual types of data and all methods of stock assessment.

There are some basic considerations that should occur with all data collection activities that will allow the greatest return on the investment of time, effort, and resources. Data collections should involve the user groups (fishers, processing plant staff, vendors) as much as possible to facilitate accurate reporting and a co-operative approach to management. Information should be collected in a manner that appropriately samples the largest portion of the fishery over both spatial (fishing grounds) and temporal (fishing season) ranges. Data collections should consistently use the most appropriate units to measure parameters. The example of CPUE has been previously described (see section 4.0). Data collection techniques should be transferred to new staff by trained staff before their departure or promotion. Finally, there should be no hesitation to terminate a data collection system if the data does not support the overall assessment and management of the resource. Data collection activities can be sub-divided into three main categories all of which may have some overlapping elements if the data collection strategy is so configured. These have been termed as fisheries data, biological data, and visual Surveys. In general no country has a 100% complete data collection program however several, including Antigua and Barbuda, Belize, Dominican Republic, Jamaica, and St. Lucia have initiated all thee types of data collection at one time (Table 6 a, b).

6.1 Fisheries Data

The first and most fundamental category is fisheries data. This pertains most importantly to catch and effort information from the fleet targeting the resource of interest. This information may be obtained through vessel logbooks, fisher interviews, processing plant reports, or direct sampling at landing sites although it should be apparent that some techniques would be more accurate than others. Fisheries data is not limited to catch and effort. Other important information including areas fished, details on vessels and fishers, gear used and meat grades landed and processed should also be collected. A review of these data can be seen in sections specific to landings (Table 1, 2, Fig. 2, 3, 4, 5), CPUE (Table 3, 4, Fig. 7), meat grades (Table 2a) and fleet descriptions (Table 5). Although all countries, with the exception of Haiti, have collected some fisheries data it is often limited in its spatial or temporal extent. This results in the data being biased to specific fishing grounds, landings sites or seasons and may therefore not give a true reflection of harvest rates and fleet dynamics.

6.2 Biological Data

The second major category of data collection is biological information. This information pertains directly to the population being harvested. In the case of conch such information should include: population structure (size/age, sex ratio, juvenile/adult), distribution of the population across habitats and depth strata; spawning season; growth and mortality rates, morphometric measurements (shell length, shell lip, tissue weight, etc.), and relationships (e.g. shell length to meat weight). Such data may be obtained by sampling directly in nearshore habitats (fisheries independent) or from fisheries landings (fisheries dependent) either on vessels, at landing sites or in processing plants and co-operatives. The fisheries dependent samples will obviously not include portions of the population that remain unharvested (i.e. proportion below min. sizes). Fisheries dependent data may be very useful in determining levels of non-compliance with regulations and associated effectiveness of enforcement.

In general biological data collections have been attempted by all countries but again they are often limited in spatial and temporal extent (Table 6a). Estimates of von Bertalanffy growth parameters are well known for juveniles (Table 7) although several nations including Antigua and Barbuda, Grenada, Haiti, and St. Vincent and the Grenadines have no such data. However, the growth of adults is not well understood given the complications of shell length growth termination, shell lip growth and effects of bioerosion. The use of less quantitative shell state categories (smooth, eroded, heavily eroded) may provide a useful solution to overcome this problem. The Jamaican visual surveys have made successful use of this system modeled after work by Tewfik (1996). Age of on-set of flared lip growth has been previously summarised at the Belize workshop (CFRAMP 1999) (Table 8). Morphometric measurements and the relationships between them are fairly well known with all but Haiti having some data collections in this area. Information on the reproductive season has again been previously summarised in Belize (CFRAMP 1999) and such information will be useful in potentially establishing a regional wide closed season (Table 9). Poor information is available on natural mortality rates for juveniles and adults throughout the region and this was mentioned as an important area of future study at the stock assessment workshop in Belize (CFRAMP 1999). Some population parameters, such as natural mortality, may be best understood through the use of tagging experiments which can also yield very accurate growth data and would most appropriately be conducted in a protected area where the effects of fishing are substantially reduced or absent.

6.3 Visual Surveys

The last major category of data collection is visual surveys. Visual surveys may give fishery independent details on population structure, estimates of exploitable biomass (requires data on meat weights), levels of recruitment, as well as habitat and depth strata distribution and use by conch populations as nursery, feeding and spawning areas or depth refugia. The benthic nature of conch resources requires that divers survey the substrate over a measured area. This allows absolute determination of density and direct observation of individual conch on various substrate types.

Certain biological data collections (see previous section) may also be preformed during such visual surveys. Such surveys may be reasonably inexpensive and short in duration given the limited shelf areas of most countries. Large-scale surveys may only be needed every few years as long as other data collections continue in the interim periods. Visual assessments for conch have been done over the years on various spatial scales including: Berg *et al.* (1992, 1993). Friedlander *et al.* (1994), Appeldoorn (1995), Berg and Glazer (1995), Appeldoorn and Rolke (1996), Tewfik *et al.* (1998), Tewfik and Appeldoorn (1998), Posada et al. (1999) and Tewfik et al. (2001). Table 10 attempts to summarize all visual survey data throughout the region. Such data is notably absent for the Bahamas, Grenada, St. Kitts and Nevis, St. Lucia and St. Vincent and the Grenadines (Table 6a). Many visual surveys that have been conducted again often suffer from limited spatial range and are often biased to historic fishing grounds where present and future fishing pressure may be limited.

Visual surveys are particularly valuable when used in conjunction with other data, such as catch and effort, and when a number of surveys have been completed (CFRAMP 1999). Methods need to be developed which allow the combined use of visual survey and catch-effort data. Methods based on the analysis of catch and effort data often suffer from a lack of fisheries independent information. Visual census data should make stock assessment much more robust if properly included in the assessment method.

6.4 Specific National Data Collection Activities

Table 6a (6b summary) lists the specific data collection activities of participating nations. Antigua and Barbuda has initiated all three types of data collection however all have been limited in scope. This is perhaps most relevant to the visual survey as new fishing grounds have begun to be exploited in unsurveyed areas (Barbuda).

The Bahamas has well established catch and effort data systems however they are not collected in a spatially discrete manner which is significant given the clear differences in morphornetric patterns have been seen in biological data collections. The initiation of visual surveys especially in areas of suspected depletions may provide evidence for imposing temporary closures to permit recovery.

Belize has good visual survey data in fished areas but the location of the adult spawning stock is still in question. A new survey should commence soon and be expanded to deeper areas in hopes of locating the spawning stock. Alternatively, studies should be aimed at determining the source and quantity of larval conch recruitment supplying Belize waters in absence of a local spawning stock. Fisheries and biological data collections need to be greatly expanded to cover all fishing grounds. This includes growth, specifically for juveniles, and mortality rates as well as information on meat weights.

Work in the Dominican Republic has included all three areas of data collection, however, these studies are limited and no comprehensive national data collection program seems to be in place leading lo poor information on overall landings and CPUE trends. Comprehensive visual surveys are available for Park del Este however the majority of conch landings are thought to occur in the area of Jaragua National Park, in the Southwest, where future visual surveys are planned.

Grenada needs to initiate basic data collection systems in all three areas, as available information is very limited. A visual survey would provide a quick assessment of available resources. This is also true for Haiti but on a much larger scale given the extent of potential conch habitat and number of fishers that may exploit the resource.

Jamaica has invested a significant amount of its resources into conch data collections in all three areas, which has provided valuable information for its management plan and CITES officials. This has been partially successful due to the good co-operation of resource users. However, given the high level of fishing, the extent of the grounds and the suspected high level of poaching these data collections must be continued and enhanced. Catch and effort data need to be collected on the artisanal fishery on Pedro Bank. A third abundance survey has been partially completed during early 2002 that should highlight the effects of approximately 10 years of large-scale commercial harvesting. Finally, it is imperative that suspected levels of poaching on offshore banks be verified. This may be facilitated by cooperation with other nations whose fishers may be accessing Jamaican conch resources.

St. Kitts and Nevis have concentrated data collections towards catch and effort with almost 20 years of data. However, this may be improved by fine-tuning the effort component. A visual survey is also recommended which would facilitate improved biological data collections that are presently very limited. St. Lucia has initiated all three data collection categories but with limited success. A visual survey is reported to have been done (Nichols and Jennings-Clark 1994) however no data has been reported. Biological data includes a large set of shell length and lip measurements (N = 4300+) however this needs to be linked to other morphometric measures including meat weights. Estimates of growth and mortality do not exist. Although catch and effort data have been collected total landings appear to be absent. Activities in <u>St. Vincent and the Grenadines</u> appear to be limited to landings and biological data collections for a few months.

7.0 Regulations

Management regulations for queen conch stocks include various minimum size restrictions, closures, gear and vessel restrictions, bulk harvest restrictions (quotas) and limited entry (Appeldoorn 1997; Tewfik 1997). The logic of regulations must be clear to user groups especially in areas where limited enforcement is possible. Again, a sense of co-operative management stimulates a significant level of community enforcement in the absence of government resources. The fears of the disappearance of commercial conch fisheries has also prompted S, *gigas* to be included under ***Appendix II*** of the Convention for the International Trade of Endangered Species (CITES) in 1992. This is a powerful piece of international legislation, which can limit or terminate exports in the absence of national management plan for the sustainable use of queen conch resources. However, this will not influence the local use of conch resources.

Minimum size restrictions (shell length, shell lip thickness, tissue weight, total weight) attempt to limit the harvest of the target species to some specific portion of the population, generally the mature adults, giving all individuals in the population a chance to breed. A minimum is legislated by all participating nations (Table 11a). However, given the distinctive biology and growth pattern of Queen conch protection of immature individuals is most effectively achieved with the use of a lip thickness minimum or simply the prohibition of juvenile harvest (those individuals without a flared lip). Shell length minimums without associated lip minimums will simply select for a population dominated by small individuals resulting in overall decreases in meat yield. In areas where animals are not landed whole (in the shell) minimum soft tissue or meal weights are used to achieve protection of immature individuals. This is only effective if independent biological data and analysis has established the relationships between mature conch and their soft tissue or meat weights. The use of soft tissue minimums should also be supported by the condition of mature external reproductive parts (verge, vaginal groove) that are easily seen on mature individuals.

Closures effectively limit where (closed area) and when (closed season) fishing activity can take place. The implementation of such closures needs to be supported by information on the location of important nursery grounds and spawning areas (closed areas) or the peak time of reproductive activity (closed season) (Table 9). All nations but Haiti have legislated some form of closure (Table 11).

Gear restrictions within conch fisheries refers directly to the prohibition of advanced diving technology including SCUBA and compressors (Hookah) which effectively limits the areas (depths) that can be fished and may be important in protecting spawning stocks located in depth refugia during non-reproductively active periods. Such gear restrictions are in place for The Bahamas, Belize and Haiti limiting conch exploitation to largely free diving methods. Vessel restrictions and limited entry are intended to limit the amount of total fishing effort, ultimately the number of divers that the target population is exposed to during the fishing season. At this time only Jamaica is actively using such regulations with St. Lucia moving towards its implementation. Finally, bulk harvest restrictions or quotas limit total removals of biomass from the population and can only be used when there is good confidence in sustainable yield calculations from a combination of visual survey and catch and effort data. Again, only Jamaica is presently using such a regulation.

In general reasonable regulations are in place in all nations but the lack of enforcement makes such regulations ineffective at limes. All but Belize, Dominican Republic and Jamaica have regulations pertaining to a minimum lip or prohibition of juvenile harvest in addition to shell length minimums that should be addressed. It should again be emphasised that the use of a soft tissue minimum should be used if landings are not whole animal (with shell) along with signs of sexual maturity. However, soft tissue minimums must be associated with information on hard to soft tissue (morphometric) relationships. The period or existence of closed seasons varies throughout the region, which may facilitate poaching in areas that are closed and the subsequent landing of product in nations that are open. Limited entry may be required where fisheries are rapidly expanding without suitable data being collected or when the surplus biomass of a stock has been substantially culled as may be seen in Jamaica.

8.0 Resource Status

The rapid expansion of export markets, and subsequent overfishing, has caused significant declines in conch populations in many areas of the Caribbean particularly in shallow inshore areas (< 20 m) where they are easily collected by free-diving (Berg and Olsen 1989; Appeldoorn 1994; Berg and Glazer 1995). Former deep-water refugia (>20 m) for conch have also come under heavy exploitation as the use of SCUBA and compressor (Hookah) gear has become economical and widespread due to increasing market value of conch (Tewfik 1996; Tewfik 1997).

Although, many unknowns remain regarding the status of various conch stocks in the region in general it can be said that viable fisheries still exist or may be rehabilitated where they have been overexploited. Table 12 provides an overview of conch resource status. Four broad criteria have been used for this summary and include the status of landings, CPUE, fleet, and stock densities. Many areas have now entered a situation of overfishing with large landings of juveniles (Anituga and Barbuda, The Bahamas, Dominican Republic, Grenada) or extensive harvesting of adults in the deepest areas (St. Kitts and Nevis, St. Lucia) of the stock using SCUBA and compressors. However, even within these areas juvenile recruitment is apparent although adults may be extremely rare (Dominican Republic) or absent (Belize). This is largely due to the planktonic dispersal mode of conch veliger larvae, which may travel hundreds of kilometres and supply areas that are not self-recruiting. Such self-recruitment may be severely limited in heavily exploited populations due to the "Allee effect" where negative rates of per capita growth occur below critical population levels Stoner (2000). Stoner (2000) found that mating never occurred when adult densities fell below 56 ind. / ha and spawning never occurred with densities below 48 ind. / ha with a population The Bahamas. This is an important reason for the promotion of regional management of conch resources as nations may be dependent on each other for larvae and the loss of one conch stock may have a domino effect throughout the region. These concepts of larval dispersal and metapopulation dynamics have been detailed by Stoner (1997) in the Proceedings of the International Queen Conch Conference (San Juan, PR., July 1996).

In all cases a precautionary approach should be taken in the management of stocks. Jamaica, St Kitts and Nevis, and St. Lucia seen to be in reasonable shape with landings of mature conch although the size of the Jamaican exploitation and the depth of harvest in St. Kitts and St. Lucia require persistent monitoring of activities. Antigua and Barbuda, The Bahamas, Belize, Dominican Republic, and St. Vincent and the Grenadines deserve caution due to significant juvenile landings or limitations on available data. Finally, Haiti and Grenada require extreme caution in management largely due to severe data limitations.

9.0 Conclusions

In general, it should be clear that data collection priorities and systems needs to be reviewed and improved in all countries. Significant gaps in information exist for all countries for even the most basic data including landings and effort, fleet statistics and basic biological information. Data needs to be collected and evaluated over broader spatial and temporal scales, using fisheries independent methods in some cases, in order to better understand the stock dynamics and effects of exploitation. The specific purpose and goals of data collection activities need to be made clear to all participants including data collectors, managers, resource users, as well as local and national leadership. As outlined during the queen conch stock assessment workshop (CFRAMP 1999), the use of visual surveys data may be particularly useful in verifying the results of catch-effort analyses that often suffer form a lack of fisheries independent information. Furthermore, studies on natural mortality using tagging methods may again significantly improve the modeling of stock dynamics.

As previously outlined all areas are still capable of supporting viable conch fisheries although several areas will require strict enforcement of regulations and support of local resource users in order to rehabilitate overfished stocks. Regulations used within the fishery must be those that can be reasonably supported by both local data collection and enforcement capabilities and should also be harmonized with adjacent territories to maximize mutual benefits.

It is hoped that this document, which reflects the ongoing hard work of local and regional fisheries officers, scientists and managers, will assist in the ongoing sustainable use of Queen conch throughout the Caribbean. The social, cultural and economic importance of conch resources to a great variety of people from many countries demands that we work together for the long-term management and preservation of these stocks for future generations.

10.0 References

Alcolado, P. M. 1976. Growth, morphological variations in the shell, and biological data of the conch ("Cobo") *Strombus gigs* L. (Mollusca, Mesogastropoda). Acadernia De Ciencias De Cuba, Institute De Oceanologica, Serie Oceanologica No. 34. (translation)

Appeldoorn, R. S., G. D. Dennis, O. Monterrosa Lopez. 1987. Review of shared demersal resources of Puerto Rico and the Lesser Antilles region. FAO Fish. Rep. 383 : 36 - 106.

Appeldoorn, R. S. 1988a. Age determination, growth, mortality, and age of first reproduction in adult queen conch, *Strombus gigas,* off Puerto Rico. Fish. Res. 6 : 363 - 378.

Appeldoorn, R. S. 1990. Growth of juvenile queen conch, *Strombus gigas* L., off La Parguera, Puerto Rico. J. Shellfish Res. 9: 59 – 62.

Appeldoorn, R. S. 1994. Queen conch management and research: Status, needs, and priorities in Queen conch biology, fisheries, and mariculture. R. S. Appeldoorn and B. Roodriquez. Caracas, Venezuela, Fundacion Cientifica Los Roques: 301-320.

Appeldoorn, R. S. 1995. Stock abundance and potential yield of queen conch of Pedro Bank. Ms. Rept. to Jamaican Fisheries Division.

Appeldoorn, R. S., F. E. Pagan. 1995. Analysis of juvenile and adult growth of queen conch in the area of Punta Beata, Dominican Republic. Report to PROPESCAR - SUR. 11 p.

Appeldoorn, R. S., W. Rolke. 1996. Stock abundance and potential yield of the queen conch resource in Belize. Rept. to the CARICOM Fisheries Research Assessment and Management Program (CFRAMP) and Belize Fisheries Department.

Appeldoorn, R, S. 1997. Status of Queen conch fishery in the Caribbean Sea. International Queen Conch Conference, San Juan, Puerto Rico, Caribbean Fisheries Management Council.

Berg, C. J., Jr. 1976. Growth of the queen conch *Strombus gigas,* with a discussion of the practicality of its mariculture. Mar. Biol. 34 : 191 - 199.

Berg, C. J., Jr. and D. A. Olsen 1989. Conservation and management of queen conch (*Strombus gigas)* fisheries in the Caribbean. Marine invertebrate fisheries: their assessment and management. J. F. Caddy. New York., John Wiley and Sons: 429 - 442.

Berg, C. J., Jr., F. Couper, K. Nisbet, J. Ward. 1992. Stock assessment of queen conch, *Strombus gigas,* and harbour conch, S. *costatus,* in Bermuda. Proc. Gulf Caribb. Fish. Inst. 41 : 433 - 438.

Berg, C. J., Jr., J. Ward, B. Luckhurst, K. Nisbet, F. Couper. 1993. Observation of breeding aggregations of the queen conch, *Strombus gigas,* in Bermuda. Proc. Gulf Caribb. Fish. Inst. 42: 161-171.

Berg, C. J. and R. A. Glazer 1995. Stock assessment of a large marine gastropod *(Strombus gigas)* using randomized and stratified towed-diver censusing. ICES Mar. Set.. Symp. 199:247-258.

Brownell, W.N. 1977. Reproduction, laboratory culture, and growth *of Strombus gigas, S. costatus,* and S. *pugitus* in Los Roques, Venezuela. Bull. Mar. Sci. 27: 668-680.

Brownell, W. N., and Stevely, J. M. 1981. - 43: 1-12. 1981-The biology, fisheries, and management of the queen conch, *Strombus gigas.* Mar. Fish. Rev$_{i}$43: 1-12.

Buckland, B.J. 1989. Reproduction and growth of the queen conch, *Strombus gigas,* off St. Christopher and Nevis in the Eastern Caribbean. M.Sc. thesis, University of Guelph, Guelph, Ont., 52 p.

Campos, W. I., A- G. C. Del Norte-Campos, et al. 1994. "Yield estimates, catch, effort, and fishery potential of the reef flat in Cape Bolinao, Philippines." J. App. Ichthyol. 10: 82-95.

CFRAMP. 1997. Lobster and Conch SubProject Specification and Training Workshop Proceedings, 9-12 October, Kingston, Jamaica. CARICOM Fishery Research. Doc. 19: 290 p.

CFRAMP 1999. Queen conch stock assessment workshop. 15-22 Belize City, Belize. *CARICOM Fisheries Research. Doc.* 00: 105 p.

Chakalall, B. and K. L. Cochrane. 1997. The Queen conch fishery in the Caribbean - An approach to responsible fisheries management. International Queen Conch Conference, San Juan, Puerto Rico, Caribbean Fisheries Management Council.

Connell, S. D., M. A. Samoilys, M.P. Lincoln Smith, J. Leqata. 1998. Comparison of abundance of coral-reef fishes: Catch and effort surveys vs. visual census. Australian Journal of Ecology 23: 579-586.

D'Asaro, C.N. 1965. Organogenesis, development and metamorphosis in the queen conch, *Strombus gigas,* with notes on breeding habits. Bull. Mar. Sci. 15: 359-416.

Davis, M., C. Hesse. 1983. Third world level mariculture in the Turks and Caicos Islands. Proc. Gulf Caribb. Fish. Inst. 35: 73-82.

Delgado, G.A., M. Chiappone, F.X. Geraldes, E. Pugibet, K.M. Sullivan, R.E. Torres and M. Vega. 1998. Abundance and size frequency of queen conch in relation to benthic community structure in Parque Nacional del Este, Dominican Republic. Proc. Gulf Carib. Fish. Inst. 50: 1-31.

Doran, E. 1958. "The Caicos conch trade." Geogr. Rev. 48: 388-401.

Friedlander, A., R.S. Appeldoorn, J. Beets. 1994. Spatial and temporal variations in stock abundance of queen conch, *Strombus gigas,* in the U.S. Virgin Islands. Pp. 51-60 *in:* Queen conch biology, fisheries and mariculture. R.S. Appeldoorn, B. Rodriguez Q. (eds.). Fund. Cientif. Los Roques, Caracas, Ven.

Gallo, J., E. Chiquillo, J.F. Ospina. 1996. Algunos aspectos de la dinamica poblacional del caracol pala *Strombus gigas* (Linnaeus, 1758) en el Departamento Archtpielago de San Andres, Providencia y Santa Catalina (Caribe Colombiano). INPA. Informe final a COLCIENCIAS.

Garcia, M.I. 1991 Biologia y dinamica poblacianal del caracol de pala *Strombus gigas* L. (Mollusca, Mesogastropoda) en las diferentes areas del Archipielago de San Andres y Providencia. Tesis Profesional de Biologia. Facultad de Ciencias Univ. del Valle. 183 p.

Hesse, K.O. 1976. An ecological study of the queen conch *Strombus gigas* . M.S. Thesis. Univ. of Connecticut, Storrs, Conn., U.S.A. 107p

Hilborn, R. 1979. Comparison of fisheries control systems that utilize catch and effort data. J. Fish. Res. Bd. Can. 36: 1477-1489.

Hilborn, R. and C. Walters. 1992. Quantitative fisheries stock assessment: Choices, dynamics, and uncertainty. New York, Chapman and Hall.

Iversen, E.S., E.S. Rutherford, S.P. Bannerol, D.E. Jory. 1987. Biological data on Berry Islands (Bahamas) queen conchs, *Strombus gigas,* with mariculture and fisheries management implications. U.S. Fish. Bull. 85: 299-310.

Ludwig, D. and C. Walters. 1989. A robust method for parameter estimation from catch and effort data. Can. J. Fish. Aquat. Sci. 46: 137-144.

Marquez, E. 1993. Biologia poblacional y pesquera del caracol *Strombus gigas* Linnaeus, 1758 en las Islas de Providencia y Santa catalina. Univ. Jorge Tadeo Lozano. Tesis Profesional de Biologia Marina. 102 p.

Martinez Vasquez, D. 1995. ^Que pasa con las poblaciones de caracol en Cozumel? Informe CRIP, Puerto Morelos 2(2).

Mateo, I., R. Appeldoorn and W. Rolke. 1998. Spatial variations in stock abundance of queen conch, *Strombus gigas* (Gastropoda: Strornbidae), in the west and east coast of Puerto Rico. Proc. Gulf Caribb. Fish. Inst. 50: 32-48.

Mulliken, T. A. 1996. Status of the queen conch fishery in the Caribbean. TRAFFIC Bulletin 16: 17-28.

Nichols, K., S. Jennings-Clark. 1994, An overview of the conch industry in St. Lucia, West Indies. In: Queen conch biology, fisheries and mariculture. R.S. Appeldoorn and B. Rodriquez, Eds. Fundacion Cientifica Los Roques, Caracas, Venezuela, pp.25-28.

Ninnes, C. 1994. A review on Turks and Caicos Islands fisheries for *Strombus gigas L.* In: Queen conch biology, fisheries and mariculture. R. S. Appeldoorn and B. Rodriguez. Caracas, Fundacion Cientifica Los Roques: 67-72.

Paloheimo, J. E. and L. M. Dickie. 1964. Abundance and fishing success. Rapp. P.-v. Reun. Cons. Int. Explor. Mer. 155: 152-163.

Peterman, R. M. and G. J. Steer. 1981. Relation between sport fishing catchability coefficients and salmon abundance. Trans Am. Fish, Soc. 110: 585-593.

Posada, J.M.; I. Mateo; M. Nemeth. 1999. Occurrence, abundance and length frequency distrubution of queen conch, Strombus gigas (gastropoda) in shallow waters of the Jargua National Park, Dominican Republic. Caribb. J. Sci. 1-2: 70-82.

Prince, J. and Hiiborn. 1998. Concentration profiles and invertebrate fisheries management. Can. Spec. Publ. Fish. Aquat. ScL 125: 187-196.

Randall, J.E. 1964, Contributions to the biology of the queen conch *Strombus gigas.* Bull Mar. Sci. 14: 246-295.

Rathier, I., A. Battaglya. 1994. Assesment of the Martinique queen conch fishery and mangement perspectives. *In:* R.S. Appeldoorn & B. Rodriguez Q. (eds.). Queen conch biology, fisheries and management. Fundacion Cientifica Los Roques, Caracas, Ven. pp. 29-49.

Sally, S. 1986. Development of the statocyst of the queen conch larva, *Strombus gigas* L. (Gastropoda: Prosobranchia). M.S. Thesis. McGill University, Montreal, Can. 116 p.

Shardlow, T., R. Hilborn, R.M. Peterman, G.J.Steer, M.J. Bradford, 1985. Density-Dependent Catchability Coefficients {Comments). Trans. Am. Fish. Soc± 114: 436-440.

Smith, G.B., M. van Neirop. 1984. Distribution, abundance, and potential yield of shallow-water fishery resources of the Little and Great Bahama Banks. UNDP/FAO Fish. Dev. Proj., BHA/82/002, 78 pp.

Stephens, I. 1997. An assessment of the queen conch *(Strombus gigas)* population around the Morant Cays, Jamaica. Queen Mary and Westfield College, U.K./Fisheries Division, Jamaica.

Stoner, A. W. and J. M. Waite. 1991. Trophic biology of *Strombus gigas* in nursery habitats: Diets and food sources in seagrass meadows. J Moll. Stud. 57: 451-460.

Stoner, A.W., V.J. Sandt, I.F. Boidron-Metairon. 1992. Seasonality of reproductive activity and abundance of veligers in queen conch, *Strombus gigas.* Fish. Bull. 90: 161-170.

Stoner, A. W., M. Ray, J.M. Waite. 1995. Effects of a large herbivorous gastropod on macrofauna communities in tropcal seagrass meadows. Mar. Ecol. Prog. Ser. 121: 125-137.

Stoner, A.W. 1997. Status of queen conch research in the Caribbean. International Queen Conch Conference, San Juan, Puerto Rico, Caribbean Fisheries Management Council.

Stoner, A. W. and M. Ray-Culp 2000. Evidence for Allee effects in an overnarvested marine gastropod: density-dependent mating and egg production. Mar. Ecol. Prog. Ser. 202: 297-302.

Strasdine, S.A. 1984. The ecology and biology of the queen conch (Strombus gigas). MS rept. To Belize Fisheries Department and the IDRC, Ottawa, Canada (File 3-p-70-0097), 87 p.

Strasdine, S.A. 1988. The queen conch fishery of Belize: an assessment of the resource, harvest sector and management. M.S. Thesis. Univ. British Columbia, Vancouver, B.C. 216 p.

Swain, D. P. and A. F. Sinclair 1994. Fish Distribution and catchability: What is the appropriate measure of distribution. Can. J. Fish. Aquat. ScL 51: 1046-1054.

Tewfik, A. 1996. An assessment of the biological characteristics, abundance, and potential yield of the queen conch *{Strombus gigas* L.) fishery on the Pedro bank off Jamaica. M.Sc. thesis. Wolfville, NS, Acadia University: 139 p.

Tewfik, A. 1997. Life history, ecology, fisheries, stock status, and management measures of the queen conch, *Strombus* gigas. CARICOM Fisheries Research. Doc, 19: 84-117.

Tewfik, A., R.S. Appeldoorn. 1998. 1997 Queen conch *(Strombus gigas)* abundance survey and potential yield estimates for Pedro Bank, Jamaica. Fisheries Divison, Jamaica. 31 p.

Tewfik, A., H. M. Guzman, G. Hacome. 1998. Assessment of the queen conch, *Strombus gigas,* (Gastropoda: Strombidae) population in Cayos Cochinos, Honduras. Rev. Biol. Trap., 46. Supl. (4): 137-150.

Tewfik, A., S. Archibald, P James, I. Horsford. 2001. Antigua and Barbuda Queen Conch Abundance Survey (1999). *CARICOM Fishery Report. Doc.* 7: 30 p.

Theile, S. 2001. Queen Conch Fisheries and Management -TRAFFIC Europe. Technical report to the CITES Secretariat.

Torres Rosado, Z.A. 1987. Distribution of two mesogastropods, the queen conch, *Strombus gigas* Linnaeus, and the milk conch, *Strombus costatus* Gmelin, in La Parguera, Lajas, Puerto Rico. M.S. Thesis, Univ. Puerto Rico, Mayagiiez, PR. 37 p.

Torres, R.E. and K.M. Sullivan-Sealy. 2000. Abundance, Size Frequency and Spatial Distribution of Queen conch (S. *gigas)* in Southeastern Dominican Republic: A Four-year Population Study in Parque Naciona! del Este. Proc. Gulf Caribb. Fish. Inst. 53: (in press).

Valle-Esquivel, M. 1998. Growth of queen conch in Quitana Roo, Mexico. Proc. Gulf Caribb. Fish. Inst. 50: 66-77.

Wefer & Killingley 1980 Growth histories of strombid snails from Bermuda recorded in their O-18 and C-13 profiles. Mar. Biol. 60: 129-135.

Well M., E., R. Laughlin G. 1984. Biology, population dynamics, and reproduction of the queen conch *Strombus gigas* Linne in the Arcnipielago de los Roques National Park. J. Shellfish Res. 4: 45-62.

Wilkins, R.M., M.H. Goodwin, D.M. Reed. 1987. Research applied to conch resource mangement in St. Kitts/Nevis. Proc. Gulf Caribb. Fish. Inst. 38: 370-375.

Wood, R. and D.A. Olsen. 1983. Application of biological knowledge to the management of the Virgin Islands conch fishery. Proc. Gulf Carib. Fish. Inst. 35: 112-121

Table 1: Trends in Landings Data for Strombus gigas in Metric Tonnes from country data

	1990	1991	1992	1993	1994	199	1996	1997	1998	1999	2000
Antigua and Barbuda	17	15	9		69	45.6	38.8	35	44.7	46	
The Bahamas	410					493	589	635	680	454	668
Belize	155	178	196	192	149	165	138	257	209	178	235
Dominican Republic				2600	1857	2210	1958	1574	2669	1243	1146
Grenada				26							
Haiti						55	70				250
Jamaica	1500	2300	1500	3000	2051	1950	1900	1645	1700	1008	
St. Kitts and Nevis	44.7		41.1	22.7		15.6	19.8	8.9	59.2	46	41.7
St. Lucia					20	34	28	26	29	34	40
St. Vincent and the Grenadines					34	_ _	12.4	8.2	20.7	6.9	6.9
Total	**2127**	**2493**	**1746**	**5841**	**418O**	**4976**	**4754**	**4189**	**5412**	**3016**	**2388**

Table *2.* Trends in Landings Data for *Strombus gigas* in Metric Tonnes from FAO data

	1990	**1991**	**1992**	**1993**	**1994**	**199**	**1996**	**1997**	**1998**	**1999**
Antigua and Barbuda	104	175	201	70	74	46	39	35	45	46
The Bahamas	335	409	358	527	693	494	589	648	670	472
Belize	185	229	231	232	208	137	148	257	252	140
Dominican Republic	5,120	4,300	2,640	2,600	4,680	2.210	1,889	1,594	2,683	1,257
Grenada	8	15	<0.5	11	1	2	6	1	24	6
Haiti	400	400	350	400	380	350	400	38O	350	300
Jamaica	800	1.000	1,500	2,000	2,300	2.133	2,850	1,821	1,700	1,366
Saint Kitts and Nevis	0	0	0	0	21	29	49	29	81	45
Saint Lucia	4	6	8	10	13	15	15	25	28	25
St. Vincent and the Grenadines	0	0	0	0	32	30	25	10	21	7
TOTAL	**6956**	**6534**	**5288**	**5850**	**8402**	**5446**	**6010**	**4800**	**5854**	**3664**

Table 2a: Meat Grades for *Strombus gigas* harvested from Pedro Bank, Jamaica

Processing	N/kg	N/lb
Unprocessed	6.6	3
50% Cleaned	7.7	3.5
65% Cleaned	9.9	4.5
85% Cleaned	12.1	5.5
100% Cleaned	14.3	6.5

Table 3: Trends in CPUE for *Strombus gigas*

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	Units
Antigua and Barbuda						63.3	53.8	48.7	62	63.8	Kg/day/trip Man-days fishing
The Bahamas	Data available 1990-1998 (Belize Workshop 1999										Lbs/day fished
Belize							13	21	15		Kg/trip
Dominican Republic					40						
Grenada	Collected but not entered in computer (1997-1998)										
Haiti											
Jamaica					45	32	22	20	21		Kg/hr fished
St. Kitts and Nevis						3.3	4.23	1.9	8.4		Kg/hr fished Conch/trip
St. Lucia								300-700			
St. Vincent and the Grenadines											

Table 4: Trends in CPUE for Strombus gigas standardized to kg/hr fished

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	Units
Antigua and Barbuda						63.3	5.4	4.9	6.2	6.4	2 divers/boat, 5 hrs diving
Belize							1.2	1.9	1.4		1 dive, 5 hrs diving, 0.45 kg: 1.0lbs
Dominican Republic					8.9						1 diver, 4.5 hrs diving
Jamaica					45.0	32.0	22.0	20.0	21.0		no conversion
St. Kitts and Nevis						3.3	4.2	1.9	8.4		no conversion
St. Lucia									15.4		500 conch, 2 divers 5 hrs diving, 307kg/ch

Table 5: Description of Fishing Fleets targeting *Strombus gigas*

		Fishers	Vessels	Vessel type (s)	Main Gear type (s)	Diving Range (m)	Main Areas
Antigua and Barbuda		16-28	7	1 Large (13 m) 6 Small (7 m)	SCUBA Free (in shallows)	to 33	SW shelf (traditional NE shelf (developing) Barbuda underdeveloped
The Bahamas		N/A	N/A	Small boats	Free, compressor	shallow	Throughout shallow banks
Belize		1800	550	Canoes based from Sailing Sloopes (10 m)	Free	3 to 18	Throughout shallow shelf & atolls Highest landings in area 5
Dominican Republic		N/A	N/A	Larger boats (20 m)	Free, compressor	to 30+	Jaragua (highest), del Este Plata & Navidad Bank
Grenada		138-168	46-55	Small boats (5-8 m)	SCUBA (main), Free	to 30+	North zone Grenada Grenadines
Haiti		N/A	17	5 large 12 small	Free, compressor	10 to 30+	North side, Gonaives, La Gonave, Rochelios Is. Western end
Jamaica	Industrial Artisanal	332 50 – 100+	11 N/A	25 m mother vessel w/ dories 8-12 m	SCUBA, compressor	10 to 30+	Pedro & Morant Banks Southern shelf

St. Kitts and Nevis	30	10	Small boats (5 m)	SCUBA, Free	18 to 36	North and South Nevis
St. Lucia	40	12	Small boats (8 m) 115-250 ph	SCUBA (main), Free	11 to 43	NE (main) and SE side
St. Vincent and the Grenadines	500	160	Small boats (6 m) Oar, sail, outboard	SCUBA, Compressor, Free	10 to 30	Union Island, other areas during lobster closed season

Table 6a: Recent Data Collection Avtivities for Conch Fisheries.

Location	Type of Study
Antigua and Barbuda	1. Visual Survey {1999, Tewfik etal. 2001)- Southwestern side of Antigua 2. Biological/Morphological (Horsford 1999)- 2 sites -Western side of Antigua 3. Catch and effort (1995-1999. unpublished) - limited to Antigua
The Bahamas	1. Catch and effort (1990-present) - five main landing sites - not spatially discrete or specific to conch at times 2. Biological/Morphological (1997-present) (Erhardt 2000) - one area
Belize	1. Visual Survey (Appeldoorn & Rolke 1996)- shallow coastal areas to 15m 2. Biological/Morphological (1996. 1997,1999) - single fishing area 3. Catch and effort H996-1999. unpublished
Dominican Republic	1. Visual surveys: del Este (Delqado 1998. Torres & Sullivan 2000). Jaragua (Posada & Mateo 1998, Posada 1999) 2. Fishing activity: Punta Beata (Appeldoorn 1993, 1995), CPUE in Jaragua only (Tejeda 1995} 3. Biological/Morphological: Growth analysis (Appeldoorn & Pagan 19951
Grenada	1. Biological/Morphological (1997) N=562 whole, 3000 kg meat (7637 indiv) 2. Catch and effort (1997-1998) - not entered into computer
Haiti	1. Visual surveys: small-scale over 7 identified fishing grounds
Jamaica	1. Visual surveys: Pedro Bank (Appeldoorn 1995, Tewfik 1996, Tewfik and Appeldoom 1998), Morant Bank (Stephens 1997) 2. Biological/Morphological: growth etc. (Tewfik 1996) and monthly meat weight samples at processing plants 3. Catch and effort: 1993-1999 including gear analysis - no artisanal data 4. Review of Queen Conch Management Plan & Quota system (Kong 1997)
St. Kitts and Nevis	1. Catch (export forms) and effort {fisher interviews): 1979-1999 2. Biological/Morphological: (Buckland 1989) and landing sites (1998, N=702 meats. 40 shells)
St. Lucia	1. Visual survey: (Nichols & Jennings-Clark 1994) no data reported 2. Biological/Morphological: Northern and Southern populations (Nichols & Jennings-Clark 1994), 1996-1997 (4300+ indiv examined) (Joseph 2001) 3. Catch and effort: at 3 sites known for conch (Joseph 2001)
St. Vincent and the Grenadines	1. Biological/Morphological: 3-4 months at one site 2. Catch and effort: export forms, too limited for CPUE calculations

Table 6b: Summary of Recent Data Collection Activities for Conch fisheries

√ extensive (√) limited

	Visual Survey	Biological	Fisheries
Antigua and Barbuda	(√)	(√)	(√)
The Bahamas		√	√
Belize		(√)	(√)
Dominican Republic	(√)	(√)	(√)
Grenada		(√)	(√)
Haiti	(√)		
Jamaica	√	√	√
St. Kitts and Nevis		(√)	(√)
St. Lucia	(√)	√	(√)
St. Vincent and the Grenadines		(√)	(√)

Table7: Estimates of von Bertalanffv parameters for growth of juvenile *Strombus gigas* shell length.

Location	L-inf	K	t-zero	Phi'	Source
Antigua & Barbuda	N/A	N/A	N/A	N/A	
Bahamas,					
Berry Islands	300	0.2	-0.65	0.952	Iversen et al. 1987
Belize					
Boca China	268	0.223	-0.05	0.967	Strasdine 1988
Tres Cocos	332	0.207	-0.33	0.997	Strasdine 1988
Water Caye	269	0.209		0.94	Strasdine 1988
Columbia					
San Andres & Providencia	329.4	0.72		1.536	Garcia 1991
Providencia & Santa Catalina	375	0.25		1.114	Marquez 1993
San Bernardo	365	0.29		1.171	In Gallo et al. 1996
San Andres & Providencia	350	0.27		1.127	Gallo et al. 1996
Cuba					
Cabo Cruz, Zone A	383.4	0.33	-0.05	1.241	Alcolado 1976
Cabo Cruz, Zone B	380.6	0.287	-0.12	1.178	Alcolado 1976
Diego Perez, Zone A	232.7	0.429	-009	1.21	Alcolado 1976
Diego Perez, Zone B	207.6	0.442	-0.09	1.19	Alcolado 1976

Cayo Anclitas	259.8	0.571	0.09	1.366	Alcolado 1976
Rada Inst. Oceanol	334	0.36	0.13	1.239	Alcolado 1976
Dominican Republic			0		Appeldoorn &
Punta Beata	302	0.333			Pagan 1995
Mexico					
Quintana Roo	341.7	0.58			Valle-Esquivel 1998
Jamaica					
Pedro Bank (SW Cay)	280.9	0.371	0.061		Tewfik 1996
PedroBank(D-shoal)	238.5	0.533	0.167		Tewfik 1996
Pedro Bank (Juv. Garden)	204	0.628	0.142		Tewfik 1996
Grenada	N/A	N/A	N/A	N/A	
Haiti	N/A	N/A	N/A	N/A	
Martinique					
tagging	338.6	0.388			Rathier & Battaglya 1994
length freq. analysis	339	0.392			Rathier & Battaglya 1994
Puerto Rico					
La Parguera (lagging)	460	0.25	0.244	1.173	Appeldoorn 1990
La Parauera (length freo. anah	340	0.437	0.462	1.328	Appeldoorn 1990
St. Kitts & Nevis	331.9	0.347		1.221	Buckland 1989
St. Lucia	N/A	N/A	N/A	N/A	
St. Vincent & the Grenadines	N/A	N/A	N/A	N/A	
Turks & Caicos Islands					
Six Hill Cay	256	0.563	-0.16	1.356	in Appeldoorn et al. 1987
US Virgin Islands					
St. John	260.4	0.516		1.323	Berg 1976
St- Croix	241.7	0.42		1.212	Berg 1976

Table 8. Reported age when growth in length of Strombus gigas ceases and the flared-lip begins to form

Location	Age (yrs)	Source
St. John USVI	3	Berg 1976
St. Kitts/Nevis	2.3-2.8	Wilkinsetal. 1987
St. Kitts	4	Buckland 1989
Bermuda	4	Wefer & Killingley 1980
Puerto Rico	3.6	Appeldoorn 1988a
Cuba	3.0-4.0	Alcolado 1976

Belize	3.5-4	Calculated from Strasdine 1984
Turks & Caicos Islands	2.8	Hesse 1976

Table 9. Observations of spawning season for *Strombus gigas.*

Location	Spawning Season	Source
Jamaica Florida	Pre-July - late Nov	Sally 1986
Bahamas Turks	late May - Sept	D'Asaro 1965
& Caicos	April - Oct	Stoner et al. 1992
Puerto Rico St.	mid-March - mid-Nov	Davis & Hesse 1983
John, USVI St.	mid-May - mid-Nov	in Appeldoorn et al. 1987
Kitts/Nevis	Feb-March - Nov-Dei	Randall 1964
Venezuela	late-April - late Sept	Buckland 1989
Venezuela	early July-mid-Nov.	Brownell 1977
	late April - late-Nov.	Well & Laughlin 1984

Table 10: Mean densities of *Strombus qiaas* determined bv visual surveys.

Location		(No. / ha)	Source
Antigua & Barbuda	Juveniles	13.5	Tewfik et al. 2001
	Adults (lip > 4 mm)	3.7	Tewfik etal. 2001
Bahamas			
Little Bahama Bank	1983/83	28.5	
Great Bahama Bank	Unprotected Bank (1983/83)	20.8	
Bermuda	Protected Bank (1991/94)	53.6	
Belize	Protected Shelf (1991/94)	96.0	
Dominican Republic			
	1988	0.5	
	1989	2.9	
	Sublegal{*: 15cm)	14.4	
	Legal (> 15cm)	14.9	
	Juvenile (del Este 1996)	283.0	
	Adults (del Este 1996)	4.5	
	Juvenile (del Este 1997)	22.5	
	Adults (del Esle 1997)	1.6	
	Juvenile (del Este)	14.4	
	Adults (del Este)	0.6	
	Juvenile (Jaragua)	53.0	
	Adults (Jaragua)	0.6	
Florida Keys	1987-88	2.4	
	1990	1.5	
Grenada	N/A	N/A	
Haiti			
	Juveniles (Gonave Island)	10.0	Gamier 1997
	Adults (Gonave Island)	0.0	Gamier 1997
	Rochelios Bank	15.0	Gamier 1997
	Western end	160.0	Gamier 1997
Honduras	Cayos Cochinos (Juveniles)	7.3	Tewfik etal. 1998
	Cayos Cochinos (Adults)	7.3	Tewfik etal. 1998

Table 10 (con't). Mean densities of *Strombus* cf/qas determined bv visual surveys.

Location		(No. / ha)	Source
Jamaica			
Pedro Bank (1994)	Juvs (Artisanal Zone)	15.0	Tewfik 1996
	Adults (Artisanal Zone)	73.6	Tewfik 1996
	Juvs (10-20 m)	51.2	Tewfik 1996
	Adults (10-20 m)	152.3	Tewfik 1996
	Juvs (20-30 m)	73.7	Tewfik 1996
	Adults (20-30 m)	202.9	Tewfik 1996
Pedro Bank (1997)	Juvs (Artisanal Zone)	221.0	Tewfik & Appeldoorn 1998
	Adults (Artisanal Zone)	93.0	Tewfik & Appeldoorn 1998
	Juvs {10-20 m)	466.0	Tewfik & Appeldoorn 1998
	Adults (10-20 m)	48.0	Tewfik & Appeldoorn 1998
Morant Bank (1996)	Juvs (0-10 m)	482.1	Stephens 1997
	Adults (0-10 m)	10.9	Stephens 1997
	Juvs (10-20 m)	59.9	Stephens 1997
	Adults (1 0-20 m)	101.1	Stephens 1997
	Juvs (20-30 m)	31.8	Stephens 1997
	Adults {20-30 m)	214.5	Stephens 1997
Mexico	Cozumel (1989)	89.0	Martinez Vasquez 1995
	Cozumel (1995, after closure)	830.0	Martinez Vasquez 1995
Panama	Bocas del Toro (0-10 m)	1.4	Tewfik & Guzman (submitted)
Puerto Rico	Southwest (1985/86)	8.1	Torres Rosado
	West (1995)	4.2	1987 Mateoetal.
	East (1996)	7.2	1998 Mateoet al.
St. Kitts & Nevis St.	N/A	N/A	
Lucia	visual survey conducted by Nichols & Jennings Clark (1994**)**		
St. Vincent & the Grenadines	N/A	N/A	
			Wood &Olsen 1983
U.S. Virgin Islands	St. Croix(1981)	7.6	Friedlanderet al. 1994
	St. Thomas/St. John (1981)	9.7	Friedlander et al. 1994
	St. Thomas/St. John (1990)	12.3	

Jniversity

Location	Regulation
Antigua and Barbuda	Minimum shell length: 180 mm Minimum lip requirement: presence of flared lip, no measure Minimum tissue weight: 225 g including viscera Closed season: Provisions for in fisheries regulations
The Bahamas	Minimum lip requirement: no juvenile harvest Closed area: Exuma land and Sea park Compressor may be used Aug 1st – Mar 31st
Belize	Minimum shell length: 180 mm Minimum tissue weight: 86 g market clean Closed season: July 1st – Sept 30th Prohibition of SCUBA and Hookah
Dominican Republic	Minimum shell length: 250 mm Closed season: July 1st - Oct 31st Closed area: Canal de Catuano
Grenada	Minimum shell length: 180 mm Minimum lip requirement: no juvenile harvest Minimum tissue weight: 225 g including viscera Closed season: provisions in fisheries regulations
Haiti	Minimum lip requirement: no juvenile harvest Prohibition of SCUBA and Hookah
Jamaica	Minimum shell length: 220 mm Closed season: Aug 1st – Oct 30th Catch Quota: based on visual survey and CPUE data Limited Entry: max number of licenses
St. Kitts and Nevis	Minimum shell length: 178 mm Minimum lip requirement: no juvenile harvest Minimum tissue weight: 225 g including viscera Closed season: provisions in fisheries regulations
St. Lucia	Minimum shell length: 178 mm Minimum lip requirement: well formed lip required, no measure Must be landed in the shell Minimum total weight: 1000 g (including shell) Minimum tissue weight: 280 g including viscera Closed season: provisions in fisheries regulations Limited entry: steps being taken by licensing all fishers
St. Vincent and the Grenadines	Minimum shell length: 178 mm Minimum lip requirement: well formed lip required, no measure Minimum tissue weight: 225 g including viscera Closed season: Provisions in fisheries regulations

Table 11b: Summary of Queen Conch Regulations

Length = Shell length min., Lip = Shell lip min (may be termed as no juvenile harvest), Tiss = Tissue weight, min., Tot = Total weight min., Season = closed season, Area = Closed area(s), Gear = restriction on use of SCUBA and/or Hookah (compressors), Entry = limited entry, Quota = managed by quota

√ active (√) inactive (provisions for in the fisheries regulations)

	Length	Lip	Tiss	Tot	Season	Area	Gear	Entry	Quota
Antigua & Barbuda	√	√	√		(√)				
Bahamas		√				√	√		
Belize	√		√		√		√		
Dominican Republic	√				√	√			
Grenada	√	√	√		(√)				
Haiti		√					√		
Jamaica	√				√			√	√
St. Kitts & Nevis	√	√	√		(√)				
St. Lucia	√	√	√	√	(√)			(√)	
St. Vincent & the Grenadines	√	√	√		(√)				

Table 12: Summary of Queen conch Resource Status

	Landings	CPUE	Fleet	Densities	Overall
Antigua and Barbuda				**low**	**Caution:** traditional areas over fished, some juvenile poaching Barbuda underdeveloped
The Bahamas		?		?	**Caution**: Only exports recorded, unknown local consumption, local depletions appearing, some areas landing 90% immature
Belize			?	**low**	**Caution**: Harvest largely Juveniles, no sign of adults
Dominican Republic	?		?	**low**	**Caution**: Harvest is largely Juveniles, adults rare, poaching
Grenada		?	?	?	**Extreme Caution**: Juvenile landings Increasing, poaching, data limited
Haiti	?	?	?	(**low**)	**Extreme Caution**: data limited
Jamaica				**OK**	(**OK**): Quota controlled and culling of adult surplus but unknown level of poaching
St. Kitts and Nevis				?	**OK**: Largely mature adults being harvested
St. Lucia				?	**(OK)**: Largely mature adults being harvested, expansion of fishery should be monitored
St. Vincent and the Grenadines		?		?	**Caution**: Main fishery in Union Island has been sustained over many decades However, data limited

ig. 1: Map of Caribbean Region – CFRAMP Lobster/Conch Sub-project Participant Nations shaded dark.

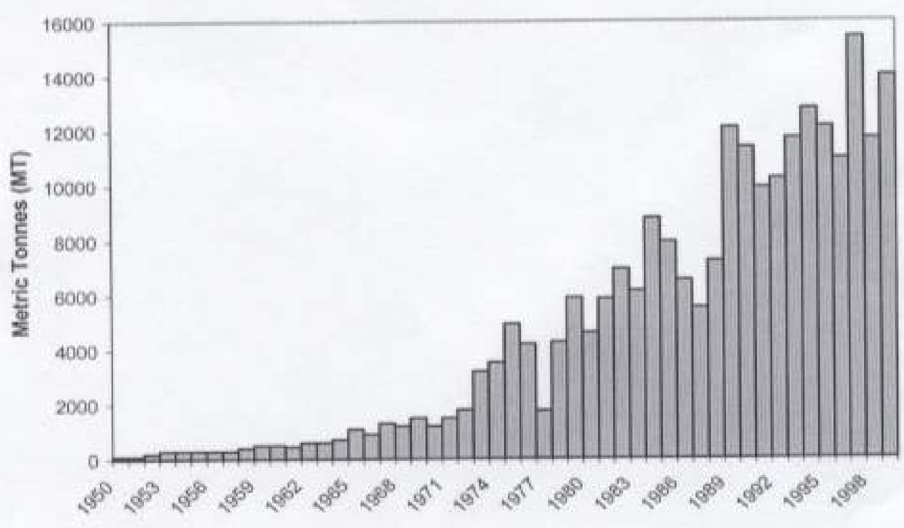


Fig. 2: Trends in Landings of Stromboid conchs nei, Western Central Atlantic (FAO 2000)

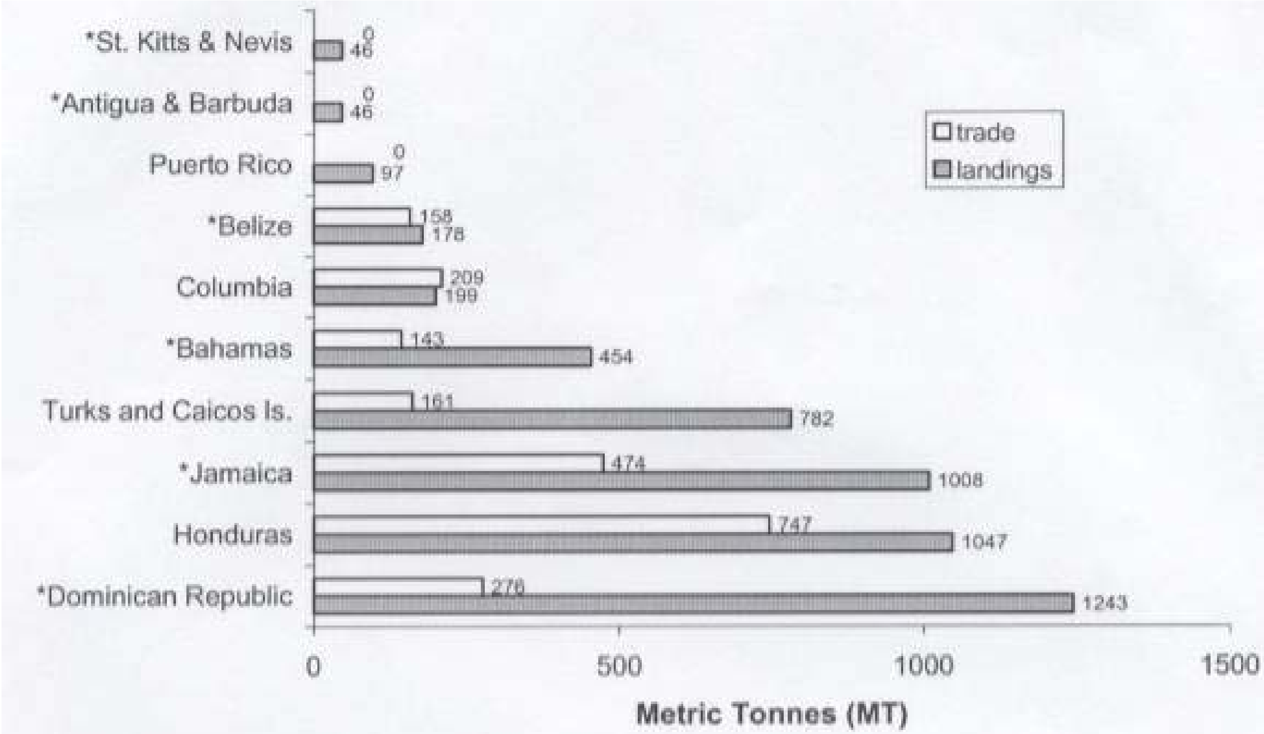


Fig. 3: Top Ten Producers (landings) and traders of *Strombus gigas* in 1999, Western Central Atlantic *CFRAMP/CARIFORUM Countries. Sources: Landings - Theile 2001, Trade - UNEP-WCMC 2001

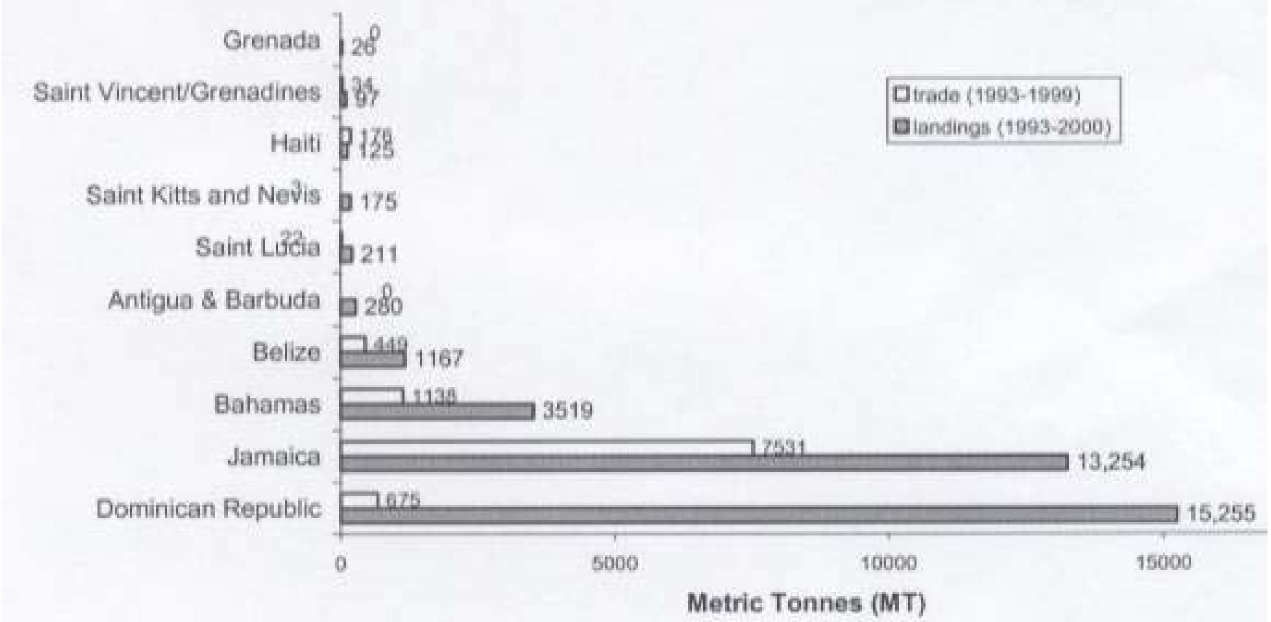


Fig. 4: Distributions of Landings and Trade of *Strombus gigas* by CFRAMP/CARIFORUM countries. Sources: Landings - Theile 2001, Trade - UNEP-WCMC 2001

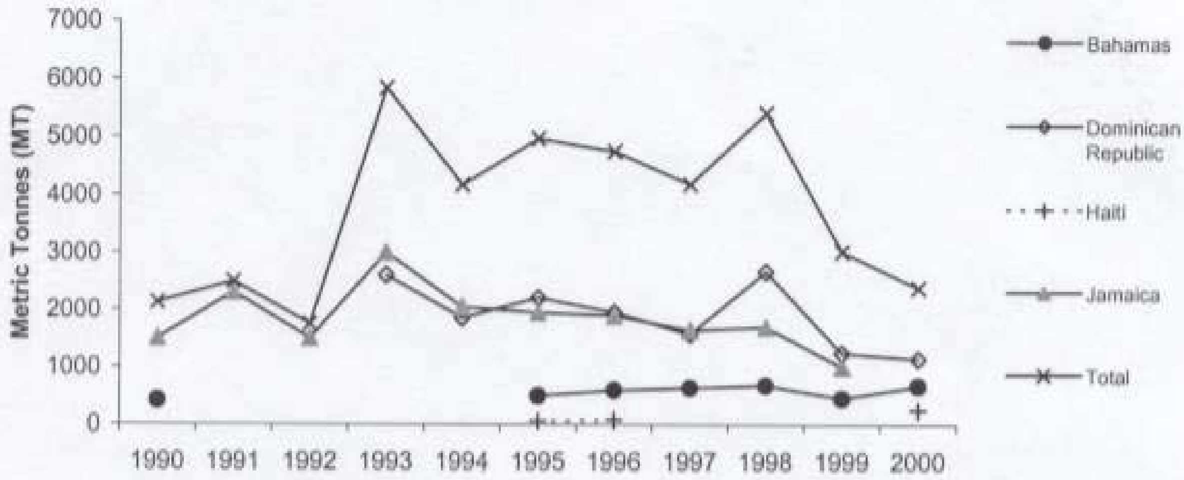


Fig. 5a: Trends in Landings of Strombus gigas by CFRAMP/CARIFORUM countries
Source: Country reports updated with Theile 2001

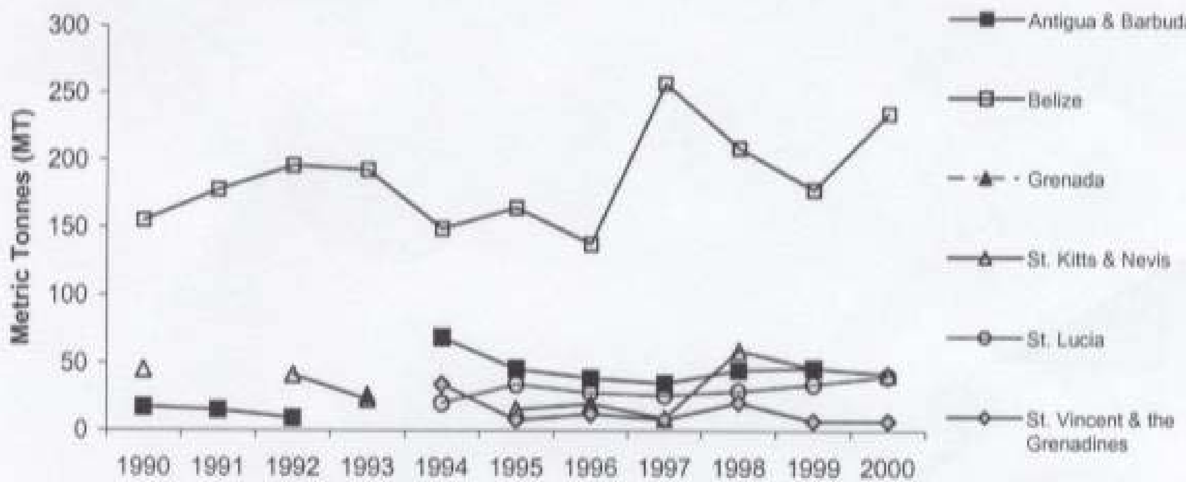


Fig. 5b: Trends in Landings of Strombus gigasby CFRAMP/CARIFORUM countries
Source: Country reports updated with Theile 2001