The Little-Known Conch (*Strombus gigas*) Fishery of Barbados

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ABSTRACT

Conch fishing in Barbados is a small-scale, legal activity that remains unregulated, unreported, and little known among the island's general population. The dearth of information has led to Barbados' inability as a range state to adequately report to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Here, we report on the fishing and marketing of queen conch in Barbados for the first time.

Approximately 49 fishers actively harvest conch from nearshore areas all around the island. The majority of fishers (84%) are free divers, although a few use SCUBA to access deeper grounds. Only 20% of fishers harvest conch year-round, whilst the majority fish conch only during the summer months in the pelagic fishing 'off-season'. The majority (71%) of harvested conch are immature. A very crude estimate of the annual harvest indicates that somewhere between 3,000 and 5,000 shells are taken, representing a processed meat weight of around 0.28 - 0.47 mt. Both the meat and shells are generally sold and are of commercial importance to fishers. There are approximately 20 full-time conch shell vendors in Barbados.

Although the harvesting of conch is small-scale, the number of fishers few, and the proportion of fishers reporting a decline in abundance of conch is relatively small (36%), the very limited shallow shelf area, the high proportion of immature conch being harvested, and the lack of a closed season to protect the breeding stock are issues of concern.

KEY WORDS: *Strombus gigas*, Barbados, CITES

La Pesca de Caracol (*Strombus gigas*) en Barbados

La pesca de caracol en Barbados es una actividad legal de pequeña escala que no esta sujeta a ninguna regulación ni documentación, y que es poco conocida por la población de la isla en general. La falta de información es responsable de que Barbados no haya podido proporcionar un estudio adecuado a la Convención sobre el Comercio Internacional de Especies Amenazadas de Fauna y Flora Silvestres (CITES). Aquí proporcionamos el primer estudio sobre la pesca y marketing de caracol en Barbados.

Aproximadamente 49 pescadores pescan caracol en las aguas costeras alrededor de toda la isla. La mayoría de los pescadores (84%) son buceadores en apnea, aunque algunos usan equipos de buceo en las zonas mas profundas. Solo 20% de los pescadores pescan caracol todo el año, mientras que la mayoría pescan en los meses de verano, que corresponden a la temporada de cese de pesca pelágica. La mayor parte del caracol pescado (71%) es inmaduro. Una estimación aproximativa de la pesca anual indica que entre 3,000 a 5,000 especimenes son pescados, lo que representa un peso de carne procesada de alrededor de 0.28 a 0.47 toneladas métricas. La carne y la concha tienen un valor económico similar para los pescadores, y ambas son vendidas. Hay aproximadamente 20 vendedores permanentes de conchas de caracol en Barbados.

La pesca de caracol es de pequeña escala, los pescadores son pocos, y la proporción de pescadores que han notado un descenso en la abundancia de caracol es relativamente pequeña (36%). Sin embargo, la muy limitada área de la plataforma costera, la proporción de caracol inmaduro pescado y la falta de una temporada de veda de pesca para proteger a los adultos reproductores son motivo de preocupación.

PALABRAS CLAVES: *Strombus gigas*, Barbados, CITES

INTRODUCTION

The queen conch, *Strombus gigas*, (Mesogastropoda: Strombidae) is indigenous to the Wider Caribbean region, and of significant commercial importance as a fishery resource (Theile 2001, Leal 2002, Valle-Esquivel 2002). Following the collapse of wild populations from heavy fishing, queen conch was listed on Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in 1992, in an attempt to protect the species from further declines through controlling the trade in conch products among the 172 member countries of CITES (Theile 2001). As an Appendix II species, monitoring of trade in queen conch is mandatory and Parties to CITES must submit, annually to the CITES Secretariat, data on trade in this commodity. In addition, any 'range state' with a conch fishery for export that is Party to the Convention, must implement Article IV, which includes the requirement to determine that the exploitation of queen conch within the state is sustainable. Queen conch underwent a significant review of trade by CITES in 1995 and the species was reintroduced into the significant trade review process in 2001, providing updated detailed information on conch biology and conch fisheries in the region (Theile 2001, CITES 2003, FAO 2007). Queen conch is further protected through its listing in Annex III of the Specially Protected Areas and Wildlife (SPAW) protocol of the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region (Cartagena Convention) (CEP-UNEP 1997). This convention is a legally binding environmental treaty for the

Wider Caribbean region, and provides the basis for the protection of organisms and habitats on which they depend for existence. As such, signatories must adopt appropriate measures to ensure the protection, recovery and sustainable use of the queen conch (UNEP 2000).

Queen Conch in Barbados

Very little has been reported on the biology of queen conch in Barbados. A single study on allelic frequencies in populations of queen conch in the Wider Caribbean (Mitton *et al*. 1989), suggests that by virtue of its position relative to prevailing ocean currents, the population of queen conch in Barbados may be self-sustaining. This lack of information on the queen conch resource in Barbados is acknowledged by the Barbados Fisheries Management Plan 2004 – 2006 (GOB 2004), which notes the need to obtain biological data on the conch fishery for an effective management strategy to be developed.

As with the biology of queen conch, very little is known about the conch fishery in Barbados. It is mentioned in several publications (e.g. Theile 2001, CITES a, GOB 2004, FAO 2007) where the fishery is reported to be small-scale, with queen conch being harvested mainly for their shells, which are sold as curios on the local market. GOB (2004) also reports that conch are harvested predominantly by free divers, fishing from small open boats or larger launches. The only available estimate of conch landings in Barbados is 100 shells annually, given in CITES (a).

At present the exploitation of queen conch in Barbadian waters is unregulated, however the Barbados government recognizes the need to properly document and manage its conch fishery. This is evident from the fact that queen conch is included in the Barbados Fisheries Management Plan 2004 – 2006 (GOB 2004). This plan outlines the need to collect information on the distribution and size of existing stocks and on the status and size of the fishery. The plan also calls for the establishment of a co-management arrangement with the conch fishermen. In 2006 the Fisheries Division also produced an information leaflet on queen conch urging fishers and vendors to stop harvesting and selling immature conch.

Barbados acceded to CITES in 1992 and enacted CITES legislation (International Trade in Endangered Species of Wild Fauna and Flora Act, 2006-3) in February 2006. Barbados acceded to SPAW in 2002. However, being a minor fishery, conch landings are not recorded in Barbados and there are no data on the status of the local conch population. As such, the relevant authorities do not have the information to manage this resource effectively and to date, Barbados has been unable to provide adequate information on their conch fishery or status of the local conch population to the CITES Secretariat. This resulted in a recommendation in 1999 that imports of conch products from Barbados be suspended until further notice (CITES 1999). This trade suspension remained in effect until May 2006 (CITES 2006).

The purpose of this study is to document the extent and nature of the conch fishery in Barbados for the first time. This information should allow Barbados to partly fulfil its commitment to CITES, and begin to address its obligations under the SPAW Protocol by providing essential information for the development of a sound national management strategy for queen conch.

METHODS

Information about conch fishing and marketing in Barbados was collected primarily from fishers and shell vendors between October 2005 and November 2006. Conch fishers were located and counted largely through referral by other fishers. Details about conch fishing including: the location and description of conch fishing grounds, landing sites, fishing techniques, frequency and length of conch harvesting trips, species of conchs targeted, processing techniques, market prices and observed changes in the abundance of conch over time, were sought through formal interview and informal exchanges with conch fishers. Formal interviews were conducted at a time and place convenient to the fisher, usually on the beach at the landing site, and took approximately 20 - 30 minutes to complete. Not all fishers approached were willing to take part in the interview, although the general reaction was very helpful. The former were counted, but no further attempt was made to interview them.

Additional information on conch fishing practices (harvesting strategy, catch rate) and biological data on the catch (species composition, size frequency) were collected through observation and measurement whilst accompanying fishers on harvesting trips from October 2005 – November 2006, and in July 2007. These trips were conducted using snorkelling gear and/or a boat, depending on the fisher being accompanied. Biological data were also collected for shells displayed on vendors' stalls. All queen conch were measured for shell length (to the nearest 0.1 cm) using a tape, and lip thickness (to the nearest 0.5 mm) using callipers, following the method described by Appeldoorn (1988). Wet and processed meat weight (to the nearest 1 g) was also recorded opportunistically, using a field scale. Shells were classified into size/maturity categories (small juveniles, medium juveniles, large juveniles, subadults, adults, stoned conch) following Appeldoorn (1995).

Shell vendors where located simply by visiting all well-known tourist areas around the island including beach and craft markets, popular shopping areas, site seeing spots, and the road outside the Bridgetown Port. Unlike the conch fishers, they were easy to find since they usually set up their stalls for the entire day. Information on the species sold, the sources of shells, the number and prices of shells on display, and a brief profile of customers was obtained by formal interview, conducted on site. Interviews were brief, taking approximately 5-8 minutes to

complete. If vendors were unwilling to talk or too busy with customers, they were simply recorded and the shells on display were noted.

RESULTS

Fishers

The fisher registration database held at the Barbados Fisheries Division indicates that a total of 186 fishers are involved in conch harvesting. Whilst this may represent the absolute total number of fishers who would harvest a conch if seen, this database is likely to greatly over-estimate fishers who are regularly active, particularly in the minor fisheries, since fishers tend to register themselves for a broad range of fishery types, rather than restrict themselves to their primary fishery (Chris Parker, Fishery Biologist, Fisheries Division, personal communication). Furthermore, since conch landings are not recorded at any of the fish markets, there is no way of checking the names of fishers actively fishing conch in any given year.

From observation and interviews conducted with fishers, we estimate that there are currently around 49 active conch fishers in Barbados, who frequently take queen conch along with other species on at least some fishing trips (Table 1). Twenty five (51%) of these conch fishers were formally interviewed.

Conch fishers are active in 15 fishing communities around the island, with most along the south coast (30 conch fishers), ten from the west coast, five from the north coast and four from the east coast (Table 1, Figure 1). The fishing community of Oistins has the largest number of active conch fishers (11 fishers), whilst Sam Lord's and Silver Sands have a further seven and five conch fishers respectively (Table 1).

All of the fishers interviewed were male, and all considered themselves to be part-time conch fishers, although they noted that the income they received from conch fishing was an important component of their total annual income. Alternative sources of self-employment included store owner, shell vendor, painter, and participation in other fisheries, whilst other jobs included employment as a security guard and a clerical officer. Participating in other fisheries was the most common alternative occupation with 72% of respondents indicating that they spearfished, potfished, harvested 'seaeggs' (sea urchins) and 'seacats' (octopus), and/or worked full-time in the flyingfish fishery during the pelagic fishing season (November to June).

Fishing Grounds

Conch fishing grounds occur on every coast of the island (Table 1, Figure 1). The vast majority are shallow (7 - 12 m), nearshore areas inside (to shoreward of) the outer bank and bank-barrier reef. These areas are accessible to free divers with small open vessels or by swimming from shore. There are also a few deeper fishing grounds (> 15 - 33 m) that require the use of SCUBA.

Along the semi-windward southwest coast, the majority of conch fishing grounds are in the sand and patch reef areas to landward of the bank reef. Along the exposed southeast coast there are numerous "shoals" or shallow rubble reef areas inside the bank-barrier reef, around which conch are harvested. Along the windward east coast, conch fishing grounds are restricted to areas inside semi-protected lagoons. The exposed north coast has conch fishing grounds that are mostly restricted to small bay areas, although there are two deeper offshore areas. Along the sheltered leeward west coast, conch fishing grounds are virtually continuous in the shallow, nearshore areas in the vicinity of the fringing reefs.

Fishing Techniques

The majority (84%) of conch fishers interviewed harvest conch by free diving, using mask, snorkel and fins (Table 2). Some of these (2 of 21 free divers) also use SCUBA gear occasionally to dive conch, but only when going back to harvest a large aggregation of conch spotted earlier. Four fishers stated that they always use SCUBA and often fish the deeper grounds from 17 - 33 m.

The majority of fishers interviewed stated that they carry their spearguns with them when going on conch harvesting trips, or will take any conch seen while on a spear fishing trip. Four of the interviewed fishers actively search for conch while on trips to haul up their fish pots.

Most (88%) conch fishers interviewed use a boat at least some of the time to access their conch fishing grounds. Three fishers stated that they always swim from shore, whilst a further six sometimes swim and sometimes use a boat (Table 2). A typical conch fishing boat is a small (3.6 - 6.0 m), open, wood or fibreglass 'moses', or pirogue powered by a single outboard engine. When using a boat, wide areas are generally searched for the presence of conch. Typically, fishers will leave the boat and search in the vicinity for any signs of conch. If any are located, the fisher will free dive for the conch, bringing them up 1 - 4 shells at a time and placing them in the nearby boat. The search will continue until the fishers are satisfied that there are no more conchs in that area. The fishers will then return to the boat and move to another area. To improve searching efficiency, a surface diver is often towed behind the boat until he observes conch, or at least an area where conditions appear to be suitable for finding conch. When swimming from shore, fishers carry a mesh bag and tow a surface float. The float serves a double purpose since it alerts boat traffic to the presence of a diver in the water and is also used to suspend the mesh bag so that a fisher can carry a large number of shells and still have his hands free to continue harvesting or using a speargun to catch fish and octopus.

Table 1. Estimated number of active conch fishers shown by fishing community. The names, depths and distance from shore of conch fishing grounds, and the landing sites used by conch fishers from each community are also indicated. Data represent a summary of information from fisher interviews conducted between November 2005 and October 2006. Locations are shown in Figure 1.

Coast	Fishing Community	No. conch fishers	Conch Fishing Ground						Landing Site
			Name	Depth (m)	Shore (m)	Name	Depth (m)	Shore (m)	
North	Crab Hill	3	Animal Flower	11	-	Crab Hill	7-12	-	Crab Hill
	Checker Hall		Jurdines	7-8	900	The Head	7-8	900	
		2	Cluffs	4	-	Harrison Point	18	-	
			Archer's Bay	18-27	900				
West	Half Moon Fort	1	Maycock's	-	-	Bombas	15	-	Half Moon Fort
	Weston	4	Six Men's	3-9	200	Fitts Village	12-15	200	Six Men's
	Paynes Bay	2	Speightstown	7-11	600	Prospect	9-12	200	Weston
	Pile Bay	3	Mullins	9-2	-	Escape Hotel	7-9	-	Paynes Bay
			Gibbs	-	-	Batts Rock	7-9	-	
			Tropicana	12	-	Paradise	5-12	100-200	
			Weston	3	-	Pile Bay	3	600	
			Sandy lane	8-12	200	Brandons	-	-	
			Paynes Bay	7-9	200				
South	St. Lawrence	2	Carlisle Bay	9-12	-	Paragon	-	-	St. Lawrence
	Oistins	11	Kentucky	>30	-	Airport	3	-	Oistins
	Sam Lord's	7	Welcome Inn	>30	-	Penny Hole	7	200-300	Silver Sands
	Silver Sands	5	Welches Gut	9-27	-	The Oven	7-9	-	Foul Bay
	Foul Bay	2	Oistins Caves	7-12	600-700	Foul Bay	7-8	200-600	Sam Lord's Bay
	Crane	3	Heady Ground	18-33	900	Crane	8	200	
			Kendal Point	3-7	100-200	Sam Lord's Bay	7-9	300-1600	
			Silver Sands	3-15	100-200	Bottom Bay	17	900	
			Long Beach	7-12	150-3000	Peat Bay	-	-	
East	Consett Bay	2	Morgan Lewis	12-15	-	Bath	5	-	Consett Bay
	Bath	1	Tent Bay	12	-	Ragged Point	5	-	
	Martin's Bay	1	Martin's Bay	12	-				
All	15	49	47						11

Table 2. Summary of fisher attributes and harvesting habits as given by interviewed conch fishers.

Fisher group	Coast fished	Other occupation	Harvest season	Harvest frequency	Harvest method			
					Free dive	SCUBA	Boat	Swim
Not year-round (seasonal)	SW,SE	fisher	Jul-Sept	weekly	Y		Y	
	E	fisher	Jun-Oct	weekly	Y		Y	Y
	SE	clerical officer	July-Sept	fortnightly	Y		Y	
	W	Security guard	July-Sept	fortnightly	Y			Y
	SE	shop owner/fisher	Jul-Oct	on request	Y		Y	
	W	fisher	Jul-Sept	on request	Y		Y	
	SW,SE	fisher	Jul-Sept	on request	Y		Y	
	SW	fisher	Jun-Sept	on request	Y		Y	
	SE	fisher	Jul-Sept	by chance	Y		Y	Y
	SE	shop owner/fisher	May-Nov	by chance	Y		Y	
	W	fisher	Jun-Oct	by chance	Y		Y	
	SE	fisher	Jun-Sept	by chance	Y		Y	
	N,SW,SE	fisher	Summer	-		Y	Y	
Not year-round (not seasonal)	N,W,SW	fisher		full moon	Y		Y	
	SW	fisher		full moon		Y	Y	
	SE	fisher		on request	Y		Y	Y
	SE	fisher		on request		Y	Y	
	SW	fisher		on request	Y		Y	
	SE	fisher		by chance	Y			Y
	N	fisher		by chance		Y	Y	
Year-round	SE	painter		weekly	Y		Y	Y
	SE	fisher		weekly	Y		Y	
	W	security guard		weekly	Y	Y	Y	Y
	N	fisher		monthly	Y			Y
	N,W,SE	shell vendor		fortnightly	Y	Y	Y	Y

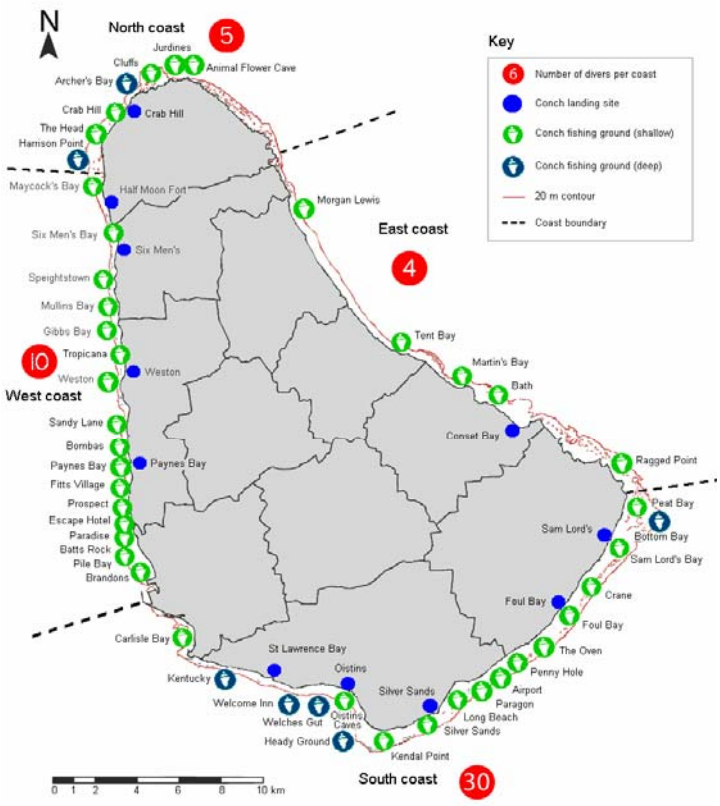

Figure 1. Map of Barbados showing conch fishing grounds, landing sites and number of conch divers active on each coast. Deep fishing grounds are > 15 m, requiring SCUBA gear to access them.

Harvest Season and Fishing Effort

The majority of conch fishers interviewed (20 fishers, 80%) stated that they do not harvest conch year-round (Table 2). Of these, most (13 fishers) stated that they only harvest conch seasonally, specifically during the summer period. The other seven did not indicate a specific season although several acknowledged that the summer months were the best. The stated reason for summer seasonal harvesting was that the conch are believed to migrate shoreward during the warm water months forming breeding aggregations, and are therefore much easier to find. Several of the interviewed fishers also stated the best time to harvest conch during the 'season' is within one week before and after a full moon, since conch will partially or fully uncover themselves during this period and move about, leaving obvious tracks in the substrate, thus making them easier to spot and harvest.

The frequency of conch fishing trips for summer season fishers varied from once a week (two fishers), once a fortnight (two fishers) to *ad hoc* (11 fishers) depending on chance sightings or specific requests from customers (Table 2). Likewise, fishers stating that they do not fish for conch year-round but also do not restrict themselves to only harvesting conch during the summer also have an unpredictable frequency. Two fishers only harvest conch around full moon, but not every full moon whilst the others take conch at the request of a customer (three fishers) or opportunistically during other fishing trips (two fishers).

Five (20%) of the interviewed fishers harvest conch year-round (Table 2). All had a regular schedule of conch fishing with fishing trips from once a week (three fishers), once a fortnight (one fisher), to once a month (one fisher).

The typical time spent per conch fishing trip (as given in interviews and observed during fishing trips with free divers) was 4 - 5 hours, although the time may range from one to more than six hours. The number of dive partners used by the conch fishers varied from zero to six, with divers who swam out from shore often harvesting alone or with 1 partner, while those using a boat almost always carried multiple partners with them on harvesting trips.

Catch

Species composition — Conch fishing in Barbados is not usually a targeted activity. Conch are landed opportunistically, generally as part of a multi-species catch including reef fishes, lobster, and octopus. A total of 295 strombids (comprising five species) were sampled from free-diving conch fisher catches at landing sites around the island. Queen conch (*Strombus gigas*) was by far the most common species taken, comprising 88.8% of the sampled strombid landings, while the West Indian fighting conch (*Strombus pugilis*) accounted for 6.4% of the total and the

other three species (milk conch, *S. costatus*; hawkwing conch, *S. raninus*; and roostertail conch, *S. gallus*) together accounted for the remaining 4.7% (Figure 2).

A further 94 strombid specimens, all reported to be from the Barbados fishery, were sampled from shell vendors' stalls. As with the landed catch, queen conch was the dominant species, representing 79.8% of the conch specimens displayed for sale, and West Indian fighting conch was the second most abundant species (12.8%). Milk conch accounted for 7.4% of the vendors' conch stock, whilst the hawkwing and roostertail conchs were not found for sale during the survey (Figure 2). Vendors reported that these species were occasionally sold, although they were generally kept by the fishers for personal use as curios.

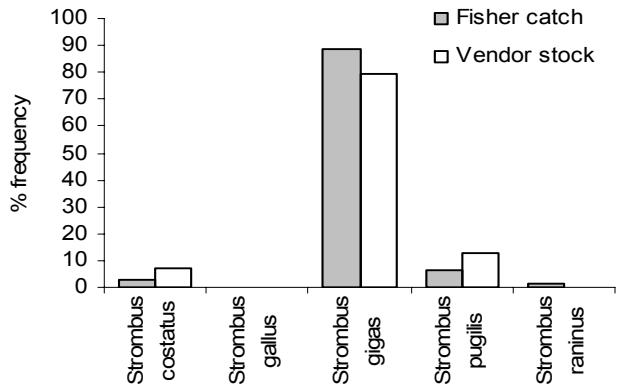

Figure 2. Species composition of conch landings and shell vendors' stock around Barbados.

Size composition — A total of 337 queen conch sampled opportunistically (262 from free-diving fishers, 75 from vendors) were measured for shell length and lip thickness. A further 182 queen conch were observed, but not measured, on vendor stalls and categorised visually as mature, intermediate or juvenile. Since the mean size of conch from fishers did not differ significantly from those of vendors (Mann-Whitney U test, for shell length: U = 9150, n = 262, 75, p = 0.364; for lip thickness: U = 9592, n = 262, 75, p = 0.754), the samples were pooled to give a representative size-frequency distribution for queen conch harvested in Barbados. Harvested queen conch range in size from 5.4 - 31.0 cm shell length and from 0.5 - 24 mm in lip thickness (Figure 3). There is a large overlap in shell size between harvested immature and mature conch (the latter being determined by a shell lip thickness ≥ 4 mm). For example, immature conch range in size from 5.4 - 29.5 cm shell length whilst mature conch range from 19.0 - 31.0 cm shell length (Figure 3). The majority (70.9%) of queen conch harvested in Barbados appear to be immature. Mature conch, referred to by fishers as 'broad-lips', make up only 28.6% of the sampled free divers' catch (n = 262) and 37.7% of the vendors' stock (n = 257). Considering the size/maturity structure in more detail, the most commonly harvested group is that of the large juveniles, referred to as 'box conch', which account for 41% of all the conch measured (n = 337) (Figure 4). Small and medium juveniles, generally referred to by fishers as 'rollers' are taken less frequently (comprising 3 and 14 % of the sampled conch, respectively). Likewise, sub-adults recognised by the presence of a newly forming flared lip, also comprise a small portion of the total sample (13%). Some (8.2%) of the sexually mature adults may be considered as 'stoned conch', with heavy, eroded shells and known to local fishers as 'old poles'.

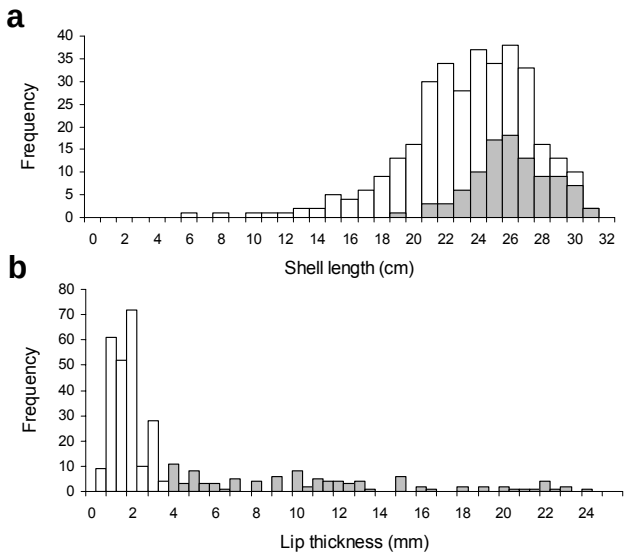

Figure 3. Size frequency distribution of queen conch harvested in Barbados (sampled from divers and vendors), shown as (a) shell length and (b) lip thickness. Shaded bars indicate sexually mature conch as determined by a flared lip of ≥ 4 mm thick.

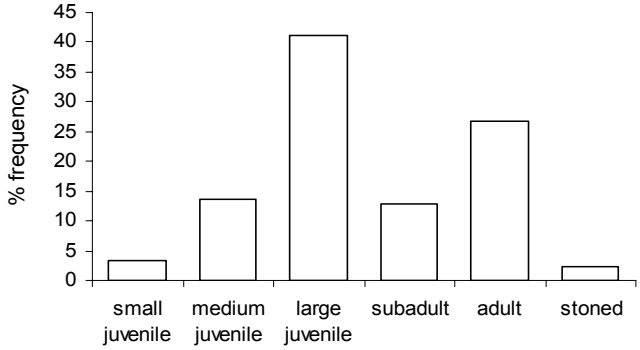

Figure 4. Size/maturity class distribution for queen conch harvested in Barbados (sampled from fishers and vendors). Adults ≥ 4 mm lip thickness.

Catch per trip — Based on a relatively small sample size of year-round, free-diving conch fishers, the average catch rate per trip did not differ between south coast fishers using a boat and 2 - 4 divers (18.44 conch per trip) and west coast fishers swimming alone from shore (18.25 conch per trip) (Mann Whitney test: U = 16.5, n = 9, 4, p = 0.816; Table 3). As such the overall mean catch per fishing trip for conch fishers in Barbados can be crudely estimated as 18.38 queen conch per trip. This translates to a mean catch rate/fisher/trip of 9.48 conch.

From the very limited data available, it would appear that the average catch rate per fisher per trip varies markedly between south coast fishers (mean: 5.6 conch) and west coast fishers (mean: 18.3 conch) (Table 3; Mann Whitney test: U = 0.5, n = 9, 4, p = 0.007). However, this is perhaps more a reflection of the fishing operation than a real difference in the harvest success of the fishers, since the south coast fishers share their catch among all fishers present in the boat (which includes both the free-divers and a non-fishing boat operator), whilst the west coast fisher swims alone and does not share his catch.

Annual Harvest

A very crude, but conservative, estimate of the annual harvest was obtained using the overall observed catch per free-diving fisher per trip data, the number of year-round (12 months) and seasonal (four months) fishers as obtained by interview, and an approximate annual frequency of conch harvesting trips per diver as obtained from interview data modified according to observational data. For example, a fisher who says he is a weekly fisher in actual fact may not fish every week due to bad weather, mechanical problems, or other constraints. From observation, weekly fishers appear to fish about 60% of the times they intend to go out. As such, a year-round weekly fisher is likely to make around 31 trips a year, whilst a seasonal weekly fisher may make 10 trips. This 60% level of activity was generally applied to all weekly, fortnightly and monthly fishers, whilst *ad hoc* fishers were conservatively estimated to fish once a season or twice a year (Table 4).

The crude, conservative estimate of total landings in Barbados amount to 3,121 queen conch a year (Table 4). This can be extrapolated (using the mean processed meat weight per conch of 90 g; see 'Processing catch' below) to around 281 kg (0.28 mt) of processed conch meat per year. The year-round weekly fishers who represent about 12% of all conch fishers are responsible for the vast majority of the catch (55.4% of the total conch landed) (Table 4). Seasonal weekly fishers land a further 11.9% of the total annual landings. *Ad hoc* fishers (representing 63.9% of all conch fishers), who harvest conchs opportunistically or when requested to do so by customers account for an estimated 13.7% of conch landings (Table 4).

It is not inconceivable that every fisher listed in the fisher registration database as a conch harvester (an additional 137 fishers) might take on average at least two shells a year. This would push the annual harvest estimate up by a further 274 conch. Furthermore, if the presumed 60% level of activity is not generally applied, and fishing frequency is taken as given by interviewed fishers, then a further 1,803 conch may be landed. This gives a very crude upper estimate of 5,198 conch harvested annually. Catch rates for the relatively few SCUBA fishers remain unknown, but are likely to be higher than free divers.

Table 3. Observed catch rates for free diving conch fishers shown as number of conch per trip and number of conch per fisher per trip, overall and separately by coast and trip type.

Date	No. fishers	Trip type	Coast	Fishing ground	Catch rate	
					Conch/trip	Conch/fisher/trip
20-Mar-06	3	Boat	S	Sam Lords	27	9.00
29-Jul-06	4	Boat	S	Sam Lords	15	3.75
05-Aug-06	4	Boat	S	Sam Lords	12	3.00
12-Aug-06	4	Boat	S	Sam Lords	15	3.75
19-Aug-06	4	Boat	S	Sam Lords	8	2.00
11-Oct-06	4	Boat	S	Sam Lords	14	3.50
28-Oct-06	4	Boat	S	Sam Lords	30	7.50
04-Nov-06	4	Boat	S	Sam Lords	19	4.75
14-Jul-07	2	Boat	S	Sam Lords	26	13.00
S coast mean					18.44	5.58
SE					2.52	1.19
6-Mar-06	1	Swim	W	Paradise	14	14.00
13-Mar-06	1	Swim	W	Pile Bay	13	13.00
12-Nov-06	1	Swim	W	Pile Bay	21	21.00
15-Nov-06	1	Swim	W	Pile Bay	25	25.00
W coast mean					18.25	18.25
SE					2.87	2.87
Overall mean					**18.38**	**9.48**
SE					**1.89**	**2.03**

Table 4. Crude, conservative estimate of total annual conch landings in Barbados using the estimated number of conch fishers in each fisher group, the number of trips per year based on a 60% level of stated activity and an overall mean catch rate of 9.48 conchs per fisher per trip.

Fisher group	Harvest frequency	Total trips/yr/ ind.	% conch fishers	Estimated actual no. conch fishers	Estimated total no. trips/yr	Estimated no. conchs harvested/yr
Not year-round (seasonal)	weekly	10	8	3.9	39.2	372
	fortnightly	5	8	3.9	19.6	186
	monthly	2	0	0.0	0.0	0
	ad hoc	1	36	17.6	17.6	167
Not year-round (not seasonal)	*ad hoc*	2	28	13.7	27.4	260
Year-round	weekly	31	12	5.9	182.3	1728
	fortnightly	15	4	2.0	29.4	279
	monthly	7	4	2.0	13.7	130
	ad hoc	2	0	0.0	0.0	0
Total			**100**	**49**	**329.3**	**3121**

Changes in Conch Availability

Most (64%) of the fishers interviewed said that they had not noticed any change in the abundance of conch on their fishing grounds in recent years. However, 36% of the interviewed fishers did say that there had been a change, noting that there were slightly fewer (six fishers) or a lot fewer (three fishers) than there used to be. Perceived declines could not be attributed to any particular coast or fishing ground.

Processing the Catch

All of the conch fishers interviewed stated that they process and sell at least some, if not all, of their conch meat and shells. Most fishers (76%) retain some meat and the occasional shell for personal consumption or to give away. No meat is ever discarded, but shells are sometimes discarded, especially if they are heavily eroded (e.g. old poles).

Typically, if the shell is to be sold, the entire conch is frozen in a home freezer overnight. The frozen conch meat can then be extracted without damage to the shell by giving the shell a sharp tap and simply pulling the frozen meat out by the foot. The shell is then left to dry out in a shaded area for approximately one week, before being washed with soap and scrubbed to remove any algae, sediment, or other epizooytes. After a final buffing, the shell is then ready for sale.

If the shell is to be discarded and only the meat sold, then the meat is extracted live, often while the boat is returning to shore, or on the shore immediately after landing. In this case, the shell is typically smashed to pieces using a metal rod and the meat removed. The fishers noted that broken shells are never dumped on a fishing ground as they believe that this causes live conchs to avoid the area. At least one fisher extracts live conch meat by knocking a small aperture near the apex of the shell, severing the tissue attachment and pulling the meat out by the foot, but this is not the general practise among the local fishers in Barbados.

Once the meat is removed, it is then processed by cutting off the operculum, head, and entrails leaving only the muscular part of the conch. This is then rubbed in sand to remove the mucous covering, washed and sold fresh, or frozen for later. From the few samples obtained (n = 11), meat processing appears to reduce the soft body weight by 65% from an average unprocessed meat weight of 247 g per conch to 90 g of useable meat.

Sale of Conch Meat

Fishers — Fourteen of the interviewed fishers shared information about the sale of meat. The majority (10 fishers) sell their conch meat (mostly queen conch but occasionally milk conch) directly to friends and private customers who regularly request conch. Some (five fishers) sell to local vendors or agents. A further two fishers provide conch meat to a local shop that serves conch "pudding and souse", and directly to a restaurant with a predominantly tourist clientele.

The stated selling price for processed conch meat varies from US$7.70 - 17.60/kg, although the typical price, as given by the majority of fisher respondents is US$11.00/ kg. This could translate to an annual income of US$291 in meat sales for an average year-round weekly conch fisher (expected to make 31 trips, catch 9.48 conch per trip, and process 90 g meat per conch).

Seafood wholesalers/processors — Of the 16 local seafood wholesalers/processors contacted, seven sell conch meat, with queen conch being the only conch species sold. One other used to deal in conch meat, but has not bothered since the CITES permit requirements. The conch meat is generally sourced from overseas, regionally (from Belize and St Vincent) and internationally (from the USA). Four companies import very small amounts (between 46 - 91 kg a year) stating that conch is not in high demand in Barba-

dos. One company however brings in around 1815 kg of conch meat annually. This company, along with one other wholesaler, also purchases conch meat from local conch fishers to satisfy demand. These companies sell predominantly to the high-end hotels and restaurants and to one local supermarket chain.

Sale of Conch Shells

Fishers — Typically, shells are sold by the conch fishers to curio/shell vendors who then market the shells to the public. Of 23 fisher respondents, 15 market their shells through vendors, six sell to both vendors and individual customers and two sell only to individuals. According to the fishers, the price obtained for a shell depends on the size and condition and can vary from US$1.00 - 40.00, with the lowest price being for small juveniles (< 8 cm shell length) sold to a shell vendor, and the highest price for large, richly coloured shells sold directly to a tourist. However, the typical price for an adult shell (a 'broad lip') is US$10.00 - 12.50, and for a medium to large juvenile (a 'roller' or 'box conch') is US$5.00 - 7.50. This could translate to an annual income of around US$1,130 in sale of shells for an average year-round, weekly, conch fisher (expected to catch 294 conch of which 209 are rollers and box conch, and 85 are broad lips).

Vendors — Shell vendors typically sell from temporary stalls, often comprising only a table and cloth that they can set up opportunistically along the roadside, particularly in areas frequented by tourists. However, most have a favoured location and will remain there unless moved on by the law. Some move around to several different locations to coincide with high tourist visitation. A few sell from government beach market booths.

A total of 20 shell vendors were observed during this study, which is believed to represent the majority of shell vendors in Barbados. Of these, 17 were interviewed. There are also a large number of other vendors, particularly beach vendors selling clothes, jewellery, and snacks who might sell one or two conch shells along with their primary stock when they get the chance. These were not interviewed.

Interviewed shell vendors stated that the majority of their customers are tourists, although locals also buy queen conch shells from time to time. All except one stated that they are supplied by local conch fishers with vendors buying from one to five different fishers. One vendor stated that he bought his shells from a Vincentian source.

Shell vendors sell mature adult queen conch (broad lips) for between US$15.00 - 25.00, large juveniles (box conch) for US$10.00 - 15.00 and other juveniles (rollers) for Bds$2.50 - 15.00. Interviewed vendors indicated that queen conch are the most popular and frequently sold shells, and the majority of respondents indicated shell vending was their primary source of income. One vendor noted that they could earn as much as US$150 a day from the sale of conch shells during the height of the tourist season.

Although none of the vendors admitted to knowing anything about the CITES regulations for queen conch, the initial reaction of many to being interviewed, was one of suspicion. The reason given was that they assumed data were being collected for the purpose of regulating conch sales. Two vendors did acknowledge that they knew of countries (e.g. Germany) where tourists could not take the shells purchased in Barbados.

DISCUSSION

The Fishery

The conch fishery in Barbados is a small-scale fishery with queen conch often taken as incidental catch when fishers are targeting other species, or harvested to fulfil specific orders from private customers. The nature of the fishery in Barbados is similar to that reported for other eastern Caribbean islands with limited shelf area, such as Montserrat, Dominica, St.Lucia, and St. Kitts (e.g. Luckhurst and Marshalleck 2004, FAO 2007). Techniques used for harvesting conch in Barbados are those seen in artisanal fisheries elsewhere, with fishers free diving or perhaps using SCUBA, and none of the conch fishers relying solely on the income generated by their activity in the conch fishery. However, the estimated number of fishers (49) and boats (16 - 22) actively involved in the conch fishery in Barbados, is greater than that reported for the other small islands (< 10 boats in St. Kitts and St. Lucia; < 10 fishers in Montserrat and Dominica; Luckhurst and Marshalleck 2004; approximately 20 fishers in St Kitts and 40 in St. Lucia; FAO 2007).

The estimated number of queen conch harvested per year in Barbados is somewhere between 3,121 and 5,198 shells, a number far greater than the 100 specimens reported previously (CITES a). From these conch, between 281 and 468 kg (0.28 – 0.47 mt) of processed meat could be extracted. Although the number of participants in the fishery is perhaps higher than in other small eastern Caribbean islands, the harvest would appear to be lower. For example, 5 mt a year were harvested in Dominica in the early 1990s (although landings are now reported to be minimal), St. Kitts harvests around 14 mt, St. Lucia some 40 - 50 mt (FAO 2007), and Montserrat landings were 3 mt in 1996 (CITES a). It is noteworthy that the fisheries in Dominica, Montserrat, St. Kitts, and St. Lucia can realize a much greater harvest than is seen in Barbados from fewer fishers. This may in part be due to a higher proportion of SCUBA fishers in the latter islands. In the present study, an overall mean catch per free-diving trip is estimated to be about 18 conch. Luckhurst and Marshalleck (2004) report that in Gros Islet in the north of St. Lucia, a catch of 200 conch per trip was not uncommon for SCUBA fishers, and the most recent national report for St. Lucia indicates

To realize their harvest, Barbadian conch fishers exploit almost the entire coastline of the island and not primarily the east coast as reported by Luckhurst and Marshalleck (2004). Most of the harvest sites are on the west and south coasts in waters < 15 m deep, and conch is fished on the east coast at only a few sites, and then by only four fishers (Figure 1). The narrow area shoreward of the bank reef appears to the main habitat for queen conch in Barbados. The depth range fished (3 - 33 m) is similar to that in the other islands with artisanal and/or industrial conch fisheries. Tewfik (1996) reports on an artisanal zone (0 - 10 m) and an industrial zone (10 - 20 m) in Jamaica; Luckhurst and Marshalleck (2004) give a depth range over which conch is fished of 18 - 27 m in Antigua, Jamaica, Nevis, St. Lucia, and St. Vincent and the Grenadines, although CFMC/CFRAMP (1999) note that conch fishing in St. Lucia may occur at depths down to 60 m.

The size of the harvest in Barbados may in fact be a result of low stock abundances around the island. GOB (2001) states, "anecdotal evidence suggests that conch populations in Barbados are much smaller than those of neighbouring islands". This may very well prove to be true and could, in part, be explained by an offshore topography with limited suitable habitat for queen conch compared with that of other range states. Barbados has a coastline that is 92 km long and a shelf area of 320 km^2, with the 180 m contour on average only 1.8 km from shore (GOB 2004). The shallow shelf area (< 30 m) where conch would typically be found is very restricted. The total shelf area of Barbados is small compared with shelf areas of other range states, e.g. Grenada – 900 km^2; St. Kitts/Nevis – 854 km^2 (CFMC/CFRAMP 1999); Pedro Bank, Jamaica – 3,750 km^2 (Aiken *et al*. 1999); Caicos Bank, Turks and Caicos Islands – 6,140 km^2 (Medley 2005). Also, seagrass beds, preferred habitats for juvenile conch (Stoner *et al*. 1988), are extremely rare around the island, and the location of Barbados upstream of most conch populations in the region, may limit recruitment to the local population. An assessment of the local conch population is need to provide definitive information on the size of the resource.

Another factor influencing the size of the fishery may be the low demand for conch meat by locals in Barbados, although with the free movement of people under the CSME (Caribbean Single Market and Economy) there may well be an increase in the local market driven by an influx of other nationalities accustomed to eating conch. There is no formal market for queen conch meat. It is not openly sold at the fish markets around the island, but instead the meat is generally consumed by the fisher or sold privately to individuals and store owners. During this study, it was observed that the only places where conch meat is regularly available are the small 'rum shops' around the island where pickled conch is sold as a seafood alternative to the traditional Barbadian Saturday dish of pudding and souse. Even in these establishments, only small amounts of conch meat are available for sale. Queen conch meat is occasionally available at the larger supermarket chains on the island, but is never a high selling item.

The low demand for conch meat may be historical and may be a consequence of historically low conch populations around the island, but there is no direct evidence at present to support this. Queen conch have been exploited in Barbados since prehistoric times when Amerindians used queen conch for food (Drewett 2002) and to make tools such as the 'Barbados-type' conch adze (Drewett 2004). There is little information on the use of queen conch by persons living in Barbados in the 18th and 19th centuries. The fishery in the 1900s presumably operated close to shore. Divers from these times did not possess masks, snorkels, and fins, but instead used a viewing box, while searching from a boat, to locate conch. According to present day fishers, the modern Barbadian queen conch fishery started in the 1950s. It was from around this time that the first diving masks, made from the inner tubes of truck tyres and glass, were used.

A conch fisher in Barbados can potentially make more money selling the shells than the conch meat. Fishers interviewed in this study typically sell processed meat for around US$11/kg, which is the equivalent of US$1.00 per conch. In contrast one shell can command a price of US$1.00 - 40.00, depending on the size of the conch and whether it is sold to a vendor or directly to a tourist. Thus, in the Barbadian conch fishery, conch shells appear to be as important a commodity as the conch meat with fishers stating that they sell at least some, if not all, of their conch meat and shells. Conch meat is never discarded, although shells may be, particularly if they are eroded. In the majority of the other range states, shells are considered a by-product of the queen conch fishery with queen conch being harvested primarily for its meat and the shells often being discarded (Theile 2001). While this is so, artisanal fishers in Dominica create artwork and lamps with conch shells (Luckhurst and Marshalleck 2004) and many other range states trade in shells or shell products locally and internationally. The volume of international trade is variable and can be quite high, for example: 261,262 shells in 1999 from Haiti; 20,093 kg of shell from Honduras in 1996 (Theile 2001).

There are no reliable figures available for imports or exports of conch shell in Barbados. All but one shell vendor in the present study reported that the queen conch shells on sale in their stalls were obtained from local conch fishers. This is contrary to the anecdotal information given for Barbados in FAO (2007), which indicates that conch shells are generally imported by shell vendors. One vendor stated that at the height of the tourist season, as much as US$150 could be made in a day from selling conch shells. At the current rates for shells, as reported by vendors, this income could represent the sale of 6 - 10 adults, 10 - 15 large juveniles/subadults, 10 - 60 juveniles or some combination thereof. Vendors interviewed during this study also stated that the majority of their customers are

tourists. As Barbados allows the export of up to three queen conch shells per person without the need for an export permit under the Personal Effects and Household Goods rule, Article VII.3 of CITES, there is no way at present of discovering how many of the approximately 3,000 conchs landed annually leave the island.

The majority of fishers harvest conch during the summer months between July and October. This period coincides with the queen conch reproductive period reported in the literature (Stoner *et al*. 1992), and indeed, the fishers in Barbados state that the summer months are good for conch fishing because it is at this time the conch move inshore and form aggregations for breeding. These fishers are potentially removing conch from the population before they have reproduced, which may be leading to reduced recruitment and population decline. In the current study, harvested queen conch include individuals of all size classes, with more than two thirds (71%) of the animals sampled in the study being immature. In contrast with many range states, Barbados has no closed season or minimum size for conch.

Economic Contribution and Trade

The queen conch fishery is small, and the revenue obtained from this fishery represents only a small fraction of the revenue generated by the other fisheries on the island. However, the queen conch fishery provides a seasonal source of income for those involved in other fisheries as the main queen conch harvesting season falls during the off-season for the pelagic flyingfish and dolphinfish fisheries. It also provides intermittent additional income to others such as spear fishers, pot fishers and seacat divers. Shell vendors also, are reliant on the sale of conch shells for a significant portion of their livelihoods.

Management

There is currently no management of the conch fishery in Barbados, although there is a management plan for the species. This open access, unregulated fishery has allowed poor fishing practices to continue, such as the indiscriminate harvesting of juveniles and breeding adults. This is likely to have already resulted in population decline, although only 36% of fishers reported a decrease in abundance over the years they have been fishing.

The small size of the conch fishery and the intermittent and dispersed nature of the landings precludes cost-effective conventional management by the Government. A co-management arrangement whereby the existing conch fishers take a lead role, or even privatisation of the fishery, would seem the most sensible way to proceed if the Barbados conch stocks and small scale conch fishery are to be sustained over the long term. Capping fishing effort at the current levels, particularly the use of SCUBA in this fishery, is likely to be an essential element for effective management and conservation of the resource.

LITERATURE CITED

Aiken, K.A., G.A. Kong, S. Smikle, R. Mahon, and R. Appeldoorn. 1999. The queen conch fishery on Pedro Bank, Jamaica: discovery, development, management. *Ocean and Coastal Management* **42**:1069-1081

Appeldoorn, R.S. 1988. Age determination, growth, mortality and age of first reproduction in adult queen conch, *Strombus gigas* L., off Puerto Rico. *Fisheries Research* **6**:363-368

Appeldoorn, R.S. 1995. Stock abundance and potential yield of queen conch on Pedro Bank. Fisheries Division, Ministry of Agriculture. Kingston, Jamaica.

CEP-UNEP 1997. SPAW Protocol: Appendix and Annexes to the Protocol:1991. www.cep.unep.org 01-08-2007

CITES 1999. Recommendations of the Standing Committee (Resolution Conf 8.9). Notifications of 1999 No. 1999/20.

CITES 2003. Review of significant trade in specimens of Appendix II species: progress on the implementation of the review of significant trade (phases IV and V). Report to the nineteenth meeting of the CITES Animals Committee. AC 19 Doc. 8.3 (Rev. 1).

CITES 2006. Recommendations of the Standing Committee (Resolution Conf 12.8, Rev. CoP13). Notifications of 2006 No. 2006/034.

CFMC/CFRAMP 1999. Report on the queen conch stock assessment and management workshop. Belize City, Belize, 15-22 March 1999, Caribbean Fishery Management Council, Puerto Rico, 105pp.

Drewett, P. L. 2002. *Amerindian Stories: An Archaeology of Early Barbados*. Barbados Museum and Historical Society, Barbados.

Drewett, P.L. 2004. Post-saladoid society on Barbados. Pages 215-230 in: A. Delpuech and C.L. Hofman (eds.) *Late Ceramic Age Societies in the Eastern Caribbean.* Archaeopress, Oxford, England.

FAO 2007. Regional workshop on the monitoring and management of queen conch, *Strombus gigas*. Kingston, Jamaica, 1-5 May 2006. FAO Fisheries Report No. 832. 174 pp.

Government of Barbados 2001. Barbados Fisheries Management Plan (2001 – 2003): Schemes for the management of fisheries in the waters of Barbados. Ministry of Agriculture and Rural Development, Barbados. 72 pp.

Government of Barbados 2004. Barbados Fisheries Management Plan (2004 – 2006): Schemes for the management of fisheries in the waters of Barbados. Ministry of Agriculture and Rural Development, Barbados. 67 pp.

Leal, J. H. 2002. Gastropods. Pages 99-147 in: K.E. Carpenter (ed.) *The Living Marine Resources of the Western Central Atlantic*. Volume 1. FAO., Rome, Italy.

Luckhurst, B. and S. Marshalleck. 2004. Current status and assessment of the fisheries for spiny lobster and conch in the Caribbean region. *Proceedings of the Gulf and Caribbean Fisheries Institute* **48**:73-89

Medley, P. 2005. Manual for the monitoring and management of queen conch. Fisheries Circular No. 1012, FAO, Rome, Italy. 58 pp.

Mitton, J. B., C.J. Berg Jr., and K.S. Orr. 1989. Population structure, larval dispersal and gene flow in the queen conch, *Strombus gigas*, of the Caribbean. *Biological Bulletin* **177**:356-362

Stoner, A. W., R.N. Lipcius, L.S. Marshall, and A.T. Bardales. 1988. Synchronous emergence and mass migration in juvenile conch. *Marine Ecology Progress Series* **49**:51-55

Stoner, A. W., V.J. Sandt, and I.F. Boidron-Metairon. 1992. Seasonality in reproductive activity and larval abundance of queen conch *Strombus gigas*. *Fishery Bulletin, U. S.* **90**:161-170

Tewfik, A. 1996. An assessment of the biological characteristics, abundance, and potential yield of the queen conch (Strombus gigas) fishery on the Pedro Bank off Jamaica. M.Sc. Thesis, Alcadia University, 139 pp.

Theile, S. 2001. Queen conch fisheries and their management in the Caribbean. Technical Report to the CITES Secretatriat, TRAFFIC Europe. 91 pp.

UNEP. 2000. International trade in species listed in both the protocol concerning specially protected areas and wildlife (SPAW) and the convention on international trade in endangered species (CITES). Ninth Intergovernmental Meeting on the Action Plan For the Caribbean Environment Programme and Sixth Meeting of the Contracting Parties to the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region, Kingston, Jamaica.

Valle-Esquivel, M. 2002. Standardized catch rates and preliminary assessment scenarios for queen conch (*Strombus gigas*) in the US Caribbean. NOAA National Marine Fisheries Service, Miami, Florida USA.