



CRFM Technical & Advisory Document Series
Number 2011 / 5

BASELINE REVIEW OF THE STATUS AND MANAGEMENT OF THE CARIBBEAN SPINY LOBSTER FISHERIES IN THE CARICOM REGION



CRFM Secretariat
Belize 2011

**CRFM Technical & Advisory Document -
Number 2011 / 5**

**Baseline Review of the Status and Management of the Caribbean
Spiny Lobster Fisheries in the CARICOM Region**

CRFM Secretariat
Belize 2011

Baseline Review of the Status and Management of the Caribbean Spiny Lobster Fisheries in the CARICOM Region

@ CRFM 2011

All right reserved.

Reproduction, dissemination and use of material in this publication for educational or noncommercial purposes are authorized without prior written permission of the CRFM, provided the source is fully acknowledged. No part of this publication may be reproduced, disseminated or used for any commercial purposes or resold without the prior written permission of the CRFM.

Correct Citation:

CRFM, 2011. Baseline Review of the Status and Management of the Caribbean Spiny Lobster Fisheries in the CARICOM Region. *CRFM Technical & Advisory Document*, No. 2011/ 5. 64p.

ISSN: 1995-1132

ISBN: 978-976-8165-48-0

Published by the Caribbean Regional Fisheries Mechanism Secretariat,
Belize and St. Vincent and the Grenadines

Table of Contents

ACKNOWLEDGEMENTS.....	III
TAXONOMY.....	1
BACKGROUND.....	1
ECOLOGY AND HABITAT.....	2
LIFE HISTORY.....	2
HABITAT REQUIREMENTS.....	4
THREATS TO SURVIVAL.....	4
DISTRIBUTION AND POPULATION.....	5
REGIONAL OVERVIEW.....	5
COUNTRY PROFILES.....	6
<i>Anguilla.....</i>	<i>6</i>
<i>Antigua and Barbuda.....</i>	<i>6</i>
<i>Bahamas.....</i>	<i>7</i>
<i>Barbados.....</i>	<i>7</i>
<i>Belize.....</i>	<i>7</i>
<i>Dominica.....</i>	<i>8</i>
<i>Grenada.....</i>	<i>8</i>
<i>Guyana.....</i>	<i>8</i>
<i>Haiti.....</i>	<i>8</i>
<i>Montserrat.....</i>	<i>8</i>
<i>St. Kitts and Nevis.....</i>	<i>9</i>
<i>St. Lucia.....</i>	<i>9</i>
<i>St. Vincent and the Grenadines.....</i>	<i>9</i>
<i>Suriname.....</i>	<i>9</i>
<i>Trinidad and Tobago.....</i>	<i>9</i>
<i>Turks and Caicos.....</i>	<i>9</i>
DOMESTIC USE.....	9
REGIONAL OVERVIEW.....	9
COUNTRY PROFILES.....	12
ANGUILLA.....	12
<i>Antigua and Barbuda.....</i>	<i>12</i>
<i>The Fisheries Division is in the final stage of updating the fisheries regulations, which improves on the current 1990 regulations, by transitioning the sector from an “open access” to “limited entry” management regime through the use of special permits for Caribbean spiny lobster (Horsford 2011 pers. comm.)......</i>	<i>14</i>
<i>Bahamas.....</i>	<i>14</i>
<i>Barbados.....</i>	<i>15</i>
<i>Belize.....</i>	<i>16</i>
<i>Dominica.....</i>	<i>19</i>
<i>Grenada.....</i>	<i>20</i>
<i>Guyana.....</i>	<i>21</i>
<i>Haiti.....</i>	<i>21</i>
<i>Jamaica.....</i>	<i>22</i>

<i>Montserrat</i>	24
<i>St. Kitts and Nevis</i>	24
<i>Saint Lucia</i>	25
<i>St. Vincent and the Grenadines</i>	26
<i>Suriname</i>	26
<i>Trinidad and Tobago</i>	26
<i>Turks and Caicos</i>	27
INTERNATIONAL TRADE	28
REGIONAL OVERVIEW	28
COUNTRY PROFILE.....	31
<i>Anguilla</i>	31
<i>Antigua and Barbuda</i>	31
<i>Bahamas</i>	33
<i>Barbados</i>	34
<i>Belize</i>	34
<i>Dominica</i>	35
<i>Grenada</i>	35
<i>Guyana</i>	36
<i>Haiti</i>	36
<i>Jamaica</i>	36
<i>Montserrat</i>	37
<i>St. Kitts and Nevis</i>	37
<i>Saint Lucia</i>	37
<i>St. Vincent and the Grenadines</i>	37
<i>Suriname</i>	37
<i>Trinidad and Tobago</i>	38
<i>Turks and Caicos</i>	38
CONSERVATION AND MANAGEMENT MEASURES	38
REGIONAL OVERVIEW	38
<i>Anguilla</i>	46
<i>Antigua and Barbuda</i>	47
<i>Bahamas</i>	47
<i>Barbados</i>	48
<i>Belize</i>	48
<i>Dominica</i>	48
<i>Grenada</i>	48
<i>Guyana</i>	49
<i>Haiti</i>	49
<i>Jamaica</i>	49
<i>Montserrat</i>	49
<i>St. Kitts and Nevis</i>	49
<i>Saint Lucia</i>	50
<i>St. Vincent and the Grenadines</i>	50
<i>Suriname</i>	51
<i>Trinidad and Tobago</i>	51
<i>Turks and Caicos</i>	51
RECOMMENDATIONS AND CONCLUSION	57
WORKS CITED	58

ACKNOWLEDGEMENTS

The author would like to thank the Canadian International Development Agency (CIDA) for its generous funding; the Marine Affairs Program at Dalhousie University, especially Lucia Fanning and Becky Field, for operational support; Milton Haughton and the staff at CRFM for their hospitality; Mauro Gongora and Beverly Wade at the Belize Fisheries Department, as well as representatives from CARICOM Fisheries Departments, for their cooperation in providing me with information and data.

TAXONOMY

Panulirus argus (Latreille 1804)

Phylum: Arthropoda

Subphylum: Mandibulata

Class: Crustacea

Subclass: Malacostraca

Order: Decapoda

Family: Palinuridae

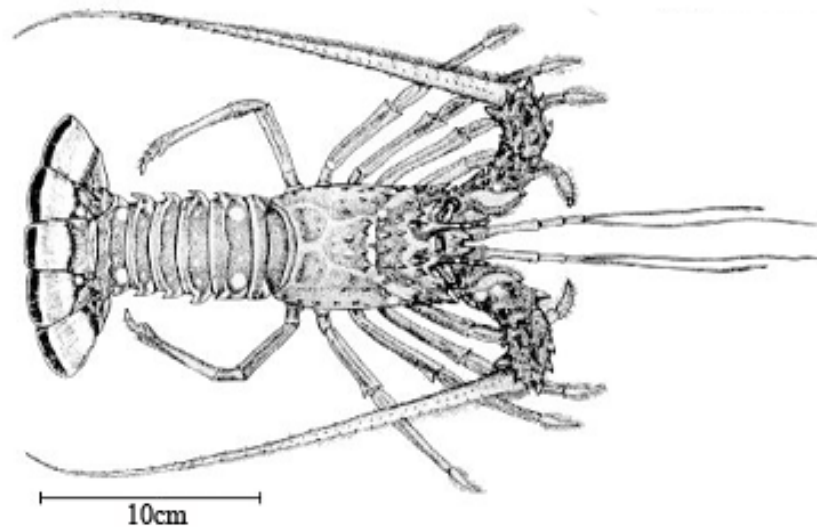


Figure 1: Spiny Lobster (*Panulirus argus*)

BACKGROUND

The Caribbean spiny lobster (*Panulirus argus*) is a highly prized luxury seafood item, despite once being considered food for the poor or bait for other fisheries. Spiny lobsters sustain one of the most economically important industrial fisheries in the Caribbean region, second only to the penaeid shrimp fishery, generating over U.S. \$456 million to fishers per year (Ehrhardt et al., unpub.; Ehrhardt N. M., 2005).

It is estimated that approximately 50,000 lobster fishers are active in the Caribbean region, with an additional 200,000 people working in positions related to the lobster fishery (FAO 2003). The fishery therefore represents a significant source of food, employment and foreign exchange earnings for a number of countries in the region (Luckhurst and Auil-Marshalleck 1995).

High demand and market prices have intensified fishing pressure on spiny lobster populations, leading to a need for wise management decisions (Phillips et al., 1994). The fishery can be characterized as one of sequential exploitation, in which resource users move to new grounds as the original ones become depleted and unprofitable (Martinez et al., 2007). Regional landings have shown a decreasing trend since

1995, indicating that most local fisheries are either fully or over exploited (Cochrane & Chakalall, 2001). Declining adult stocks have forced small scale fishermen to increasingly target lobsters during their juvenile stages to avoid moving to new grounds farther offshore or diving deeper; meanwhile, on the industrial scale, declines have led fishers to target spawning adults in deeper waters, where they often catch many berried females and larger, more fecund, animals (Martinez et al. 2007). Ehrhardt (2005) argues that not only have most (if not all) fisheries driven down local stocks through heavy exploitation, but also pushed them to dangerously low population fecundities.

The stocks of Caribbean spiny lobster cross many national boundaries and this imposes specific difficulties and requirements for their effective management. —Martinez and others (2007) identify numerous problems associated with the sustainable management of the regional fishery, including: the open-access nature of the fishery and failure to control fishing effort; poor enforcement of existing regulations, namely in the form of large-scale landings of juvenile lobster and berried females; diving accidents of lobster divers; large-scale illegal, unregulated and unreported (IUU) fishing; lack of monitoring, control and surveillance; lack of harmonization amongst fisheries regulations of the countries involved; insufficient financial resources and human capacity in government institutions; and lack of capacity (organizational, human, financial and technical) among fishers and others involved in the fishery to engage meaningfully in its management.

In an important step towards improving the governance of this important species, CARICOM States are endeavouring to prepare a regional agreement setting key principles and standards for sustainable use and conservation to safeguard the long term profitability and future of the fisheries. This report addresses an urgent need to consolidate and review available information on the status, domestic use, international trade, and management of *Panulirus argus* fisheries in the CARICOM region in order to better inform this regional policy-making process.

ECOLOGY AND HABITAT

The Caribbean spiny lobster is a fairly long-lived animal that can reach maximum ages well over 20 yrs; however, reasonable stock abundances exist for ages up to 12 years (Ehrhardt, 2005). The longevity of the species is consistent with an average annual natural mortality rate that varies between 0.30 and 0.40 per year (Ehrhardt, 2005). Size at first maturity was found to be in the range of 78-83 mm carapace length for most Caribbean countries (Arce & de Leon, 2001).

Besides serving as prey for sharks, finfish and other marine species, the spiny lobster also serves as a keystone predator upon a diverse assemblage of benthic and infaunal species (Toller, 2003). Its selective predation plays a major role in influencing species composition and size-frequency distributions of invertebrates such as sea urchins, mussels, isopods, ostracods and gastropods (Lipcius & Cobb 1994 in Munoz-Nunez, 2009).

LIFE HISTORY

There are five major phases within the life cycle of the Caribbean spiny lobster (Figure 2):

1. Adult
2. Egg
3. Phyllosoma (larval)
4. Puerulus (post-larval)
5. Juvenile

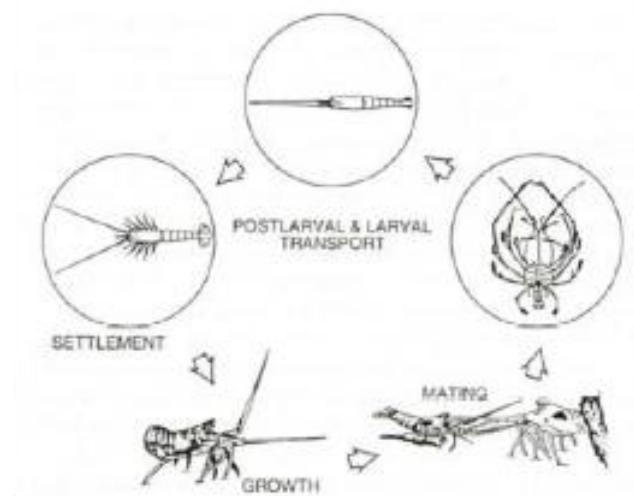


Figure 2: Life History of *P. argus* (Saul, 2004)

Reproduction in the Caribbean spiny lobster occurs almost exclusively in the deep reef environment once mature individuals have made the permanent transition from the shallow seagrass nursery to the ocean coral reef system. Spiny lobster reproduction appears to be consistently higher in the spring and summer months (March – July) although this activity is observed year-round (Arce & de Leon, 2001).

Males mate with several females during the spawning period and the gestation period for eggs is about a month (Saul, 2004). The number of females per mating period and the size of the spermatophore deposited on the female by the male is a function of the size of the males, highlighting the need to preserve larger individuals in exploited populations (MacDiarmid & Butler, 1999).

Distribution and dispersal of *P. argus* is determined by the long planktonic phase (6-10 months), during which time infant lobsters are carried by oceanic currents from spawning areas to settlement habitats. These sites are not necessarily in the same marine shelf or country. Because of the long duration of this larval phase, and the current flows in the Caribbean region, many lobster populations may serve as source of larvae for other areas (Cochrane & Chakalall, 2001).

During transformation from the puerulus to the juvenile, lobsters move into shallow, nearshore environments to grow and develop for the next 6-8 months. Individuals from two to four years old exhibit nomadic behaviour, emigrating out of the shallows and moving to deeper, offshore reef environments. Once in the adult phase of life, spiny lobsters tend to enter social living arrangements aggregating in enclosed dens (Saul, 2004).

One of the most remarkable and distinctive features of spiny lobster life history involves mass migrations into deeper water locations or alongshore (Lipcius & Cobb 1994 in Munoz-Nunez, 2009). *P. argus* migrates in single file lines with up to 64 individuals by maintaining contact between the antennules of one individual and the anterior walking legs of another. Migration typically commences after the arrival of cold fronts or hurricanes, and is considered an avoidance mechanism of physically stressful environmental conditions (i.e. severe drop in water temperature). During this time, lobsters are more vulnerable to fishing activity, given that they are easier to catch outside their shelters.

HABITAT REQUIREMENTS

Panulirus argus is able to utilize a variety of environments and, in fact, changes habitats several times depending on its life history stage (Arce & de Leon, 2001). Larvae are planktonic and are carried and dispersed by prevailing oceanic currents, from southeast to northwest in the Wider Caribbean region (Stanley, 2003).

Young benthic stages of *P. argus* typically inhabit branched clumps of red algae (*Laurencia spp.*), mangrove roots, seagrass beds and sponges, feeding on local invertebrates found within their algae microhabitat (Saul, 2004). There is compelling evidence of the importance of nursery habitat for fishery production; thus Ehrhardt and others (unpub.) argue the protection of shallow water nursery habitats should be of major concern to managers seeking to sustain viable spiny lobster fisheries.

Adult spiny lobsters occupy shallow, coastal areas and are mainly associated with coral reef assemblages (Munoz-Nunez, 2009). Preferred sheltered environments may include natural holes in a reef, rocky outcrops or artificially created environments (Lipcius and Cobb 1994 in Munoz-Nunez, 2009).

THREATS TO SURVIVAL

Habitat Degradation

Ecological studies carried out on spiny lobster habitat recognize several fundamental environmental conditions (i.e. outside the fishing sector) as negatively impacting lobster habitat in some countries, including:

- Decreased amounts of natural and anthropogenic induced nutrients with the advent of dam constructions interrupting the natural runoff of nutrient rich freshwater into catchment areas (Puga et al. 2008)
- Increased salinity in juvenile habitats affecting larvae and prey species (Ehrhardt et al., unpub.)
- Incidence of major and more frequent hurricanes and tropical storms impacting habitat structure (Ehrhardt et al., unpub.; WECAFC, 2007)
- Significant coastal zone development, including highways, that impact inshore-offshore water exchange (Ehrhardt et al., unpub.; WECAFC, 2007)
- Lobster mortality as a result of red tides (WECAFC, 2007)
- Coastal zone pollution and eutrophication (WECAFC, 2007)

Additionally, experimental studies in Florida confirm the negative effects of siltation, extreme salinity and the loss of physical structure on postlarval and juvenile lobster survival (Ehrhardt et al., unpub.).

Climate Change

Rising sea temperatures have resulted in considerable loss of critical coral habitat throughout the Caribbean region, particularly after the significant bleaching events of 1998 and 2005 (Ehrhardt et al.,

unpub.). Another important consideration regarding decreasing trends in post-larval recruitment is the close association of the coral reef habitat to spiny lobster population dynamics.

Overfishing

The WECAFC Scientific Workshop (2007) concluded that, in all countries, fishing mortality had a major impact on stocks, and that strict control of fishing effort was required to ensure that fishing mortality does not exceed sustainable levels nor compromise the productive capacity of the stock.

Disease

Discovery and research on a pathogenic and lethal viral disease (PaV1) that infects *P. argus*, suggests that the disease is a major source of mortality (primarily for juveniles) and may be widespread in the Caribbean (Butler IV et al., 2008; Behringer et al., 2008). Ehrhardt et al. (unpub) estimate that in Florida and Mexico, at least 25% of the benthic juveniles die from the disease per year (which is equivalent to a mortality rate of 1.39 – four times higher than the natural mortality rate assumed for the recruited age classes) (Ehrhardt et al., unpub.).

DISTRIBUTION AND POPULATION

Regional Overview

Panulirus argus is widely distributed in the western central Atlantic, occurring from North Carolina south to Brazil, including Bermuda, and from the Antilles islands in the east to the Gulf of Mexico, with the greatest stock abundances observed in the Western Caribbean and Brazil (Ehrhardt et al., unpub.).



Figure 3: Distribution of *P. argus* in the Caribbean Region (Munoz-Nunez, 2009)

The main spiny lobster resources in the Central Western Atlantic Ocean are predominantly located on the larger continental shelf-reef areas of that region. Thus, the shelves of Brazil, Honduras-Nicaragua,

Belize-Mexico, Florida, Bahamas and south of Cuba are areas where main fisheries are located (Ehrhardt N. , 2001).

Other lobsters of commercial value in the CARICOM region include *Panulirus guttatus* and *Scyllarides aequinoctialis*; however, these species are landed on a much smaller scale and typically only used for local consumption (Gittens & Haughton, unpub).

There has been considerable difficulty in defining discrete units of stock, due to the lengthy planktonic lifespan of the larvae. A Pan-Caribbean theory of spiny lobster population structure has been hypothesized where, given the prevailing oceanic currents in the Wider Caribbean Region, many localities probably depend on recruitment from other areas, frequently other countries (Cochrane & Chakalall, 2001). Despite a lack of conclusive statements on the existence of discrete stocks, a major decision at the 2006 WECAFC Scientific Workshop divided the stocks in the Western Central Atlantic (FAO Fishing Area 31) into four groups, based on the biogeography and knowledge of the prevailing currents in the region:

- Southern Stock (Brazil, Venezuela, Dominican Republic, Lesser Antilles)
- South-Central Stock (Colombia, Nicaragua, Honduras, Jamaica)
- North-Central Stock (Mexico, Belize, southern Cuba)
- Northern Stock (northern Cuba, USA, Bahamas, Turks and Caicos, Bermuda)

In any case, the connectivity of *P. argus* stocks, by the drift of their pelagic larvae, creates a strong ecological link among countries in the region and emphasizes the need for close cooperation in the responsible management, and effective use, of the resource (Claro et al., 2001).

The most recent information on the status of *P. argus* across the Caribbean region indicate that it is being fully or overexploited throughout most of its range, although the status could not be reliably estimated in some areas due to a lack of data (WECAFC, 2007).

COUNTRY PROFILES

Anguilla

Anguilla has not conducted any stock assessments for spiny lobster, therefore quantitative estimates of stock status are not available (Gumbs 2010 *pers. comm.*). However, it is believed that the stock is fully exploited in Anguillan waters (Gumbs 2010 *pers. comm.*).

Antigua and Barbuda

In order to assess the status of the resource, a data collection program for spiny lobster was initiated in 1995. Based on the data collected, stocks are thought to be sustainable at the current level of fishing, as levels of production are consistent with the most conservative estimate of the maximum sustainable yield (Horsford & Archibald, 2006). According to the data, the average carapace length of landed lobsters was significantly greater than the minimum legal size, and the majority of samples appear to be older than 3 years, suggesting relatively healthy stocks. Additionally, great effort is being made to reduce landings of undersize lobsters to an acceptable level (Horsford & Archibald, 2006).

Bahamas

The status of the Bahamian Caribbean spiny lobster fishery is classified as unknown, due to a large degree of uncertainty in the length converted catch curve (LCCC) estimates as well as estimates based on the available catch per unit effort data (CRFM, 2008). A declining trend in stock biomass was recorded over the time period 1991 - 2002, from 11,793.4 tons to 7,257.5 tons of tails, representing a decrease of 33% (Gittens & Braynen, 2003). The Department of Fisheries still considers Bahamian spiny lobster stocks to be in fairly good condition, though these reported declines in landings, abundance and mean size coupled with steadily increasing fishing mortality may be cause for concern (Gittens & Braynen, 2003).

A lobster Fisheries Improvement Project (FIP) aimed at bringing the Bahamian spiny lobster fishery up to Marine Stewardship Council (MSC) certification standards was initiated in 2010 and has seen significant progress. The FIP addresses a broad range of shortfalls that were identified as part of an MSC pre-assessment of the fishery. The shortfalls that the FIP seeks to correct include a number of specific areas under the general areas of management/governance, environmental and ecological impacts as well lobster stock status. The FIP has seen unprecedented cooperation in terms of time, manpower, advice and funding to varying extents from various groups including the private sector, government, NGOs, and fishermen. All groups recognize the potential benefits to obtaining MSC certification which includes maintaining access to foreign markets, greater assurance that the fishery is being managed in a sustainable manner and global recognition that a fishery is being well managed.

Barbados

Currently there is no data collection program and therefore no quantitative data on the status of Barbados' spiny lobster stock are available at this time; however, anecdotal information suggests that although populations appear to be small (FAO, 1999), recently there has been a possible increase in spiny lobster abundance (FAO, 2005).

Belize

Over the past decade, estimated lobster stock biomass (calculated as tail weight) has exhibited a general declining trend (Gongora 2010). The stock biomass decreased by 17.4%, from 352 tons in 1999 to 292 tons in 2009, but has remained relatively stable from 2006 - 2009 (Figure 4). Further, a slight decline in estimated lobster spawning stock biomass (SSB) has also been observed over the past decade, decreasing by 8.74% from 212 tons in 1999 to 193 tons in 2009. It is noted however, that SSB has remained relatively stable, around 200 tons, over the last four years (Gongora 2010).

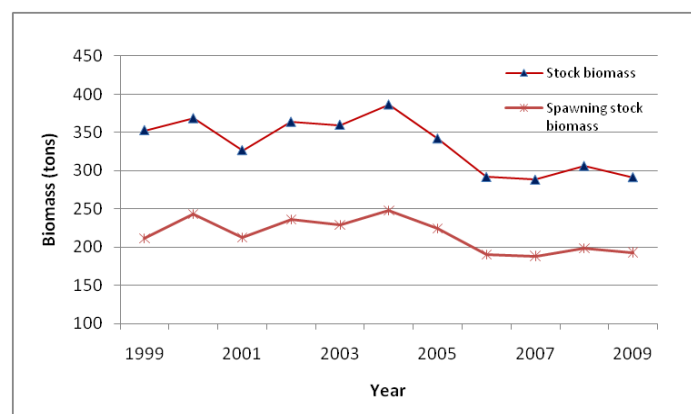


Figure 4: Lobster stock (calculated as tail weight) and spawning biomass during the period 1999 to 2009 (Gongora 2010)

Dominica

No quantitative data on the status of Dominica's spiny lobster stock are available. However, the lobster fishery is considered fully exploited by the Department of Fisheries (Stoute 2010 *pers. comm.*).

Grenada

Currently there is no data collection program and therefore no quantitative data on the status of Grenada's spiny lobster stock or spawning biomass are available at this time; however, anecdotal information suggests that lobster populations are considered fully exploited in nearshore areas (Rennie *pers. comm.*).

Guyana

No data on the status of Guyana's spiny lobster stock are available as there is no directed commercial fishery for the species.

Haiti

While there is some information available on Haiti's fisheries, it is generally incomplete, contradictory and difficult to locate, nor are there systems in place for collection and analysis of fisheries data (Mateo and Haughton 2003). Available information suggests that Haitian fishery resources and associated coastal habitats have been severely depleted and degraded. The insular shelf around Haiti is relatively small and easily accessible to fishermen and, as a result, coastal demersal fish stocks (particularly spiny lobster) are heavily over-exploited (Mateo and Haughton 2003). There is an urgent need to undertake studies on the biology of the lobster stocks in order to determine the species being captured, length at first maturity, population parameters and general status of the lobster stocks as many of Haiti's marine resources appear to be disappearing before scientists have the chance to account for their existence (Mateo and Haughton 2003).

Jamaica

The populations of *P. argus* are reported to have changed considerably over the last several decades with stocks, particularly on the northern coast, showing signs of significant depletion (CFRAMP, 2001). Fishing effort has increased significantly and the present level of fishing mortality appears to be greater than the optimum recommended for the fishery (Kelly, 2003). CRFM (2008) conducted preliminary stock assessments for Jamaican spiny lobster using the limited data available at the time. The results suggest that a MSY above 200 tons were unlikely to be sustainable, and that catches in general should be kept below this level. The catch in 2004 was 450 tons (Murray, unpub), indicating substantial overfishing. Past studies have confirmed a significant reduction in the mean and modal size of the lobster population in Jamaica (Aiken 1977; Munro 1983; Haughton 1988). Gittens (2001) reported 30% of lobsters landed from Pedro Bank were below the size of 50% maturity and that spawning stock biomass was low. It was further suggested recruitment overfishing may be occurring, but that the effects may not be seen locally due to new recruits originating from a shared regional stock (Gittens L., 2001).

Montserrat

No data on the status of Montserrat's spiny lobster stock are available, as there is no directed commercial fishery for the species. Lobsters are caught as by-catch mostly in traps with other targeted reef fishes. The main reef fish targeted are Red hind, Blue Tang, and Queen Trigger (Ponte 2010 *pers. comm.*).

St. Kitts and Nevis

Lobster populations are considered to be over-exploited in nearshore areas, with fishermen reporting increasing scarcity in traditional fishing areas (Anon., 1997).

St. Lucia

Lobster populations are considered overexploited in nearshore areas and fishermen increasingly report scarcity in traditional fishing areas (CRFM, 2001). Concerns in this regard have been expressed by both management and fishers; however, efforts by management to curtail or keep the level of effort constant have not been successful due to both financial and technical resource limitations and failure of pot fishers to unanimously sustain the limited entry system (Joseph W. , 2003).

St. Vincent and the Grenadines

Lobster populations are considered overexploited in nearshore areas (Anon., 2004).

Suriname

No data on the status of Suriname's spiny lobster stock are available as there is no directed commercial fishery for the species.

Trinidad and Tobago

No data on the status of Trinidad and Tobago's spiny lobster stock are available as there is no directed commercial fishery for the species.

Turks and Caicos

Fisheries statistics indicate that the stock has been fully exploited since 1977. Lobster populations in the Turks and Caicos Islands are considered fully exploited/stable by the FAO (WECAFC, 2007; FAO, 2006). Lobster landings have fluctuated over the years, but it wasn't until 2008 when Hurricanes Hanna and Ike threatened the fishery; catch decreased slightly at this period of time.

DOMESTIC USE

Regional Overview

In the Wider Caribbean Region, the fishery for *P. argus* has evolved from circumstantial operations in the early 1960s to an industrial, heavily capitalized fishery by the mid-1990s (Ehrhardt et al. unpub). This increased fishing effort is reflected in the total landings for the region that steadily increased from about 2,000 metric tons (mt) whole weight in the mid 1950s to about 29,000 mt whole weight in the early 1980s. After reaching an average of 36,055 mt from the mid-1980s until 1995, regional landings decreased 55% in the 2000s (Figure 5), likely a result of intensive exploitation and environmental changes in spiny lobster habitat (Ehrhardt et al. unpub.). Most conspicuous are declines in Cuba and Florida (up to 75%), whereas declines from Nicaragua-Honduras and Bahamas appear to be less drastic, at 18% and 28% respectively (Ehrhardt et al. unpub).

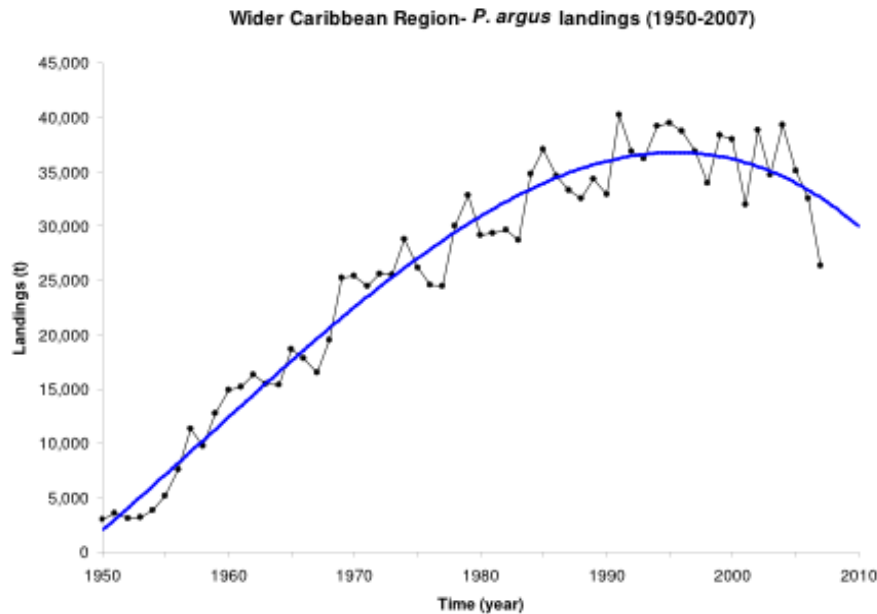


Figure 5: Total annual landings of *P. argus* for the entire Caribbean region including Brazil (Munoz-Nunez, 2009)

Panulirus argus is exploited throughout its range in the Western Central Atlantic, supporting one of the most economically important fisheries in the region (Ehrhardt, 2005). Major countries harvesting spiny lobster in the Caribbean region are the Bahamas, Brazil, Cuba, Nicaragua and the United States of America, each with landings above 1,000 tons per year according to national reports submitted to FAO (Table 1) (Cochrane & Chakalall, 2001). The Bahamas is the major lobster producer in the CARICOM region, followed by Haiti, Belize, Jamaica and the Turks and Caicos (Figure 6).

Assessments undertaken under the auspices of the Western Central Atlantic Fisheries Commission (WECAFC) have indicated that the resource is fully or over-exploited over much of its range. Results also revealed widespread deficiencies in available data, which create problems in undertaking reliable assessments and in subsequent provision of management advice (Cochrane & Chakalall, 2001).

Table 1: Top 15 countries harvesting *P. argus*, as measured by average annual landings from 2000-2007 inclusive, and the percentage of the total average landings (34, 578 t) by all countries over the same period of time (adapted from Munoz-Nunez, 2009)

Lobster Harvesting Country	Average Landings (t) 2000-2007	% of Total
Bahamas	8,211.0	23.7
Brazil	6,944.3	20.1
Cuba	6,263.1	18.1
Nicaragua	4,192.3	12.1
U.S.A	1,954.4	5.7
Dominican Republic	1,209.5	3.5
Honduras	888.9	2.6
Mexico	833.4	2.4
Haiti	771.3	2.2

Lobster Harvesting Country	Average Landings (t) 2000-2007	% of Total
Venezuela	696.4	2.0
Belize	520.0	1.5
Jamaica	394.1	1.1
Colombia	325.4	0.9
Turks and Caicos Islands	314.0	0.9
Puerto Rico	167.8	0.5

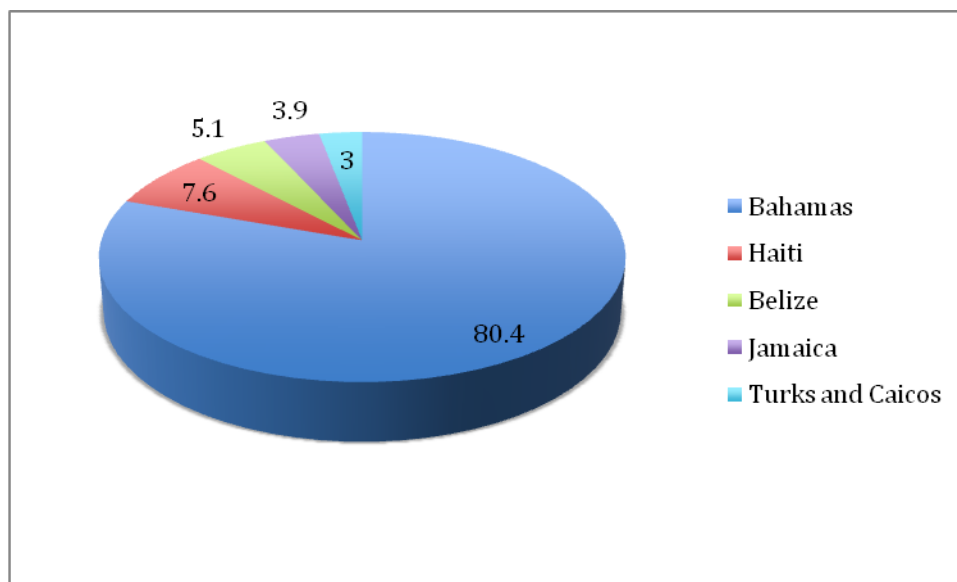


Figure 6: Top 5 CARICOM countries harvesting lobster as a percentage of total average landings (10, 210.4 t) from 2000-2007 inclusive

Landings records in individual CARICOM countries do not appear to display an overall trend, though statistical analysis is needed to arrive at a more reliable conclusion (Gittens & Haughton, unpub). CPUE trends representing the entire CARICOM region were unobtainable. Only Belize, Jamaica and Antigua were able to report CPUE, albeit with variable units of measurement. The inability to standardize units hindered the possibility of comparing trends among reporting countries, highlighting the need for improved data collection within the region as a whole (Gittens & Haughton, unpub).

Fishing methods/gear types are quite varied, even within the same country (Chavez E. , 2001), and include: SCUBA, drop nets, trammel nets, spears, hooks, nooses, Z-traps, bamboo traps, wooden lath traps, shades, casitas, Caribbean traps and collection by hand. Casitas are rectangular structures consisting of a wooden frame to which a sheet of zinc is nailed; the traps are placed on the seafloor, providing a shelter that mimics the crevices where lobsters typically hide (WWF & PROARCA, 2004). No single country uses all gear types (Gittens & Haughton, unpub).

COUNTRY PROFILES

Anguilla

Anguilla does not have a time series of data available, as a data collection program was only implemented in 2009. Reported landings for 2009 were 131 tons (Gumbs, pers. comm.). Primary gear in Anguilla is the Antillean fish pot, which consists of a steel frame over which hexagonal galvanized mesh wire is stretched in an arrow-head or chevron shaped trap with one horse-necked entrance funnel. A quantitative estimate of lobster fishing effort for Anguilla is not available. Since there are only about 30 boats operating in the fishery, effort is likely to be fairly low from the standpoint of Anguilla's fishing vessels, however there are boats operating illegally in Anguillan waters from nearby islands (Gumbs 2010 *pers. comm.*). Fishing grounds include the entire Anguilla Bank (Gumbs 2010 *pers. comm.*). The spiny lobster fishery is the most profitable fishery in Anguilla and, from a socio-economic standpoint, lobster fishers seem to be better off financially than those targeting finfish (Gumbs 2010 *pers. comm.*). There are no lobster cooperatives in Anguilla as very little lobster is exported. Gumbs (2010 *pers. comm.*) assumes that approximately 1% of the total catch value is exported. The primary use of lobster is for the tourist industry, with lobster fishers selling their catch directly to hotels and restaurants (Gumbs 2010 *pers. comm.*).

Antigua and Barbuda

Antigua and Barbuda has a fairly sizeable commercial Caribbean spiny lobster fishery, valued at about US\$ 1.0 – 2.9 million (Horsford & Archibald, 2006). Landings have remained fairly stable (between 243 – 318 metric tons) over the period 1999 – 2007 (Figure 7), though they increased sharply from 1995 – 1998, and decreased sharply in 2008 and 2009. The increase from 1995 – 1998 was attributed to the re-registration of all fishing vessels under the CARICOM Fisheries Resource Assessment and Management Program; the re-registration process started in 1995 was not completed until 1997. The passage of hurricane Luis in 1995 also significantly impacted the fishing fleet: 34 vessels were destroyed; 6 were lost at sea; and 79 were severely damaged (Horsford 2004). The sharp decrease of catches in 2008 and 2009 can be attributed to a decline in demand for lobster exports in the neighbouring French overseas territories as well as the contraction of the national economy as a result of the economic downturn. The situation was further compounded in 2009 when general strikes in Guadeloupe and Martinique “crippled” their tourism sector resulting in a decrease demand for lobster exports from Antigua and Barbuda; simple linear regression indicated that 47% of the variation in monthly lobster exports to Guadeloupe can be explained by monthly tourist arrivals at hotels in Guadeloupe (Horsford 2011 *pers. comm.*).

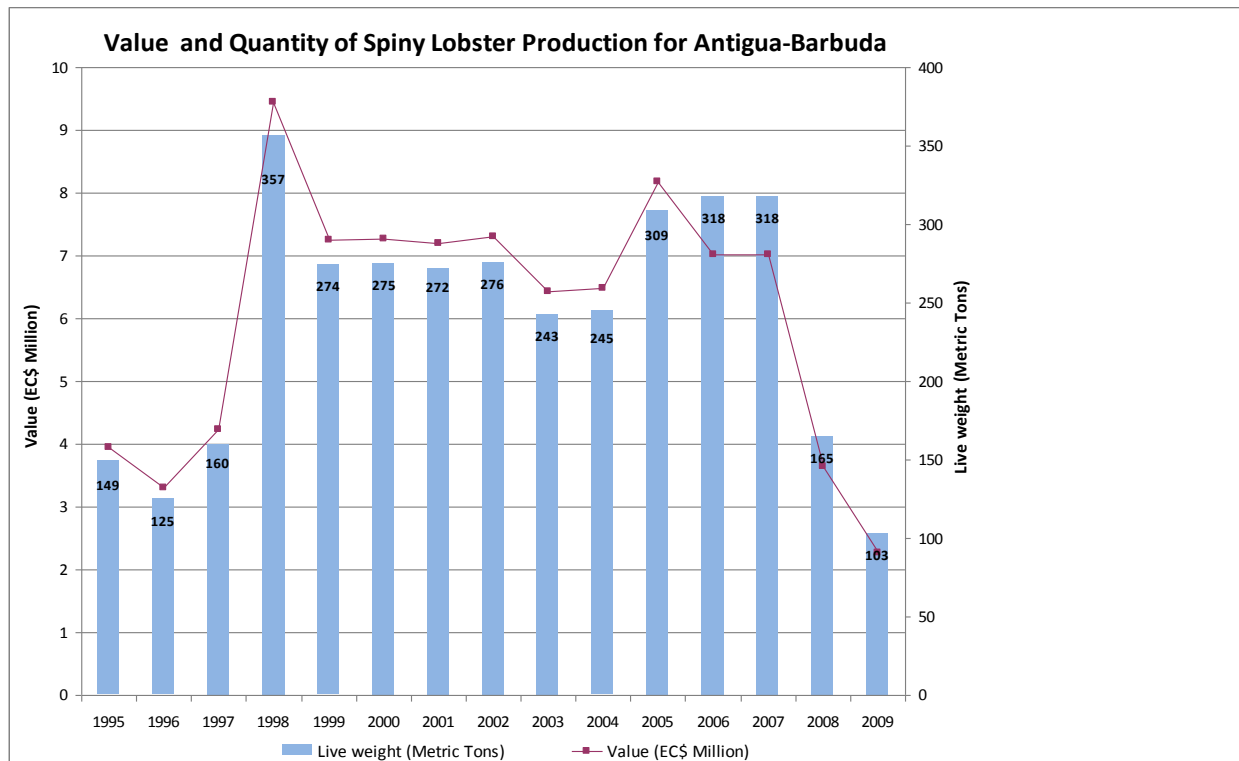


Figure 7: Value (\$EC) and Quantity (MT) of Spiny Lobster Production for Antigua-Barbuda (Horsford & Archibald, 2006)

The Caribbean spiny lobster fishery is based primarily on traps constructed from mesh wire braced with wattle or steel (Horsford & Lovell, 2001), with gill nets also contributing marginally in terms of by-catch (Luckhurst & Marshalleck, 1995). Traps are normally baited with non-marine products such as coconut or animal hide and left to soak for 2 – 7 days (Horsford & Lovell, 2001). There are 187 vessels and approximately 476 fishers that target both reef fish and spiny lobster commercially, accounting for about 66% of the active fishing fleet (Horsford & Archibald, 2006). Vessels range from small pirogues to large launches, with the latest fishing equipment (depth sounder, trap haulers, etc.). The vessels are located at 25 landing sites around Antigua and 5 in Barbuda; major landing sites in Antigua include St. John's Harbour, Urlings and Jolly Harbour and the main landing site in Barbuda is Codrington Wharf (Horsford & Lovell, 2001).

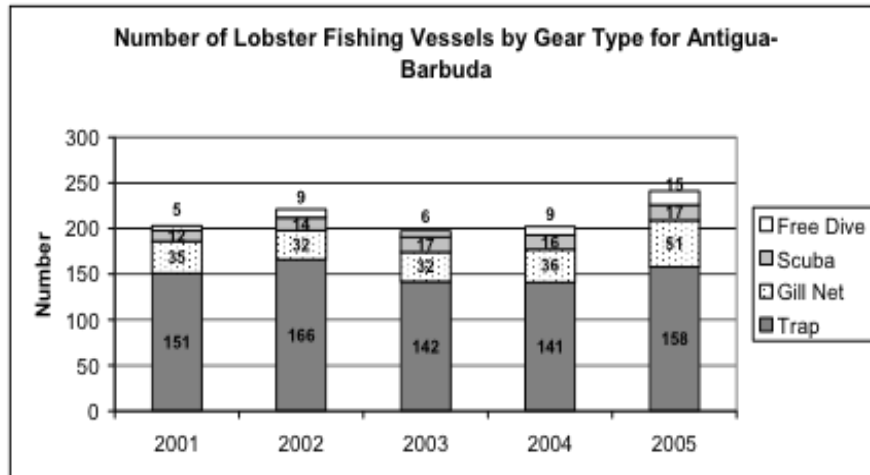


Figure 8: Number of Lobster Fishing Vessels by Gear Type for Antigua-Barbuda (Horsford & Archibald, 2006)

In Barbuda, the fishery supports about 118 fishers operating from 54 vessels (Horsford & Archibald, 2006). Typical investment cost, including vessel, gear and fishing equipment, range from US\$13,705 for a 22 ft. pirogue to US\$72,965 for a 38 ft. launch (Horsford & Archibald, 2006). In Barbuda especially, spiny lobsters are the principal species of commercial interest and the export of live lobsters to the EU territories in the region (e.g. Guadeloupe, St. Maarten, St. Bathelemy) represents the principal source of income for Barbudan fishers (Horsford & Lovell, 2001). Horsford (1999) estimated that approximately 26% of the population of Barbuda is directly dependent on this fishery. In Barbuda, estimates of the value of the fishery range from US\$ 370,000 – 782,000 per annum, emphasizing its importance to the island's residents.

The Fisheries Division is in the final stage of updating the fisheries regulations, which improves on the current 1990 regulations, by transitioning the sector from an “open access” to “limited entry” management regime through the use of special permits for Caribbean spiny lobster (Horsford 2011 *pers. comm.*).

Bahamas

The harvesting of spiny lobster is, by far, the most important commercial fishing activity in the Bahamas (Gittens & Braynen, 2003), and the nation supports the largest commercial fishery for Caribbean spiny lobster in the CARICOM region. During 2001, it contributed 48% by weight and 81.7% by value of the total recorded landings of fishery products in the country, with a value of approximately US\$53 million (Gittens & Braynen, 2003). This represented a substantial decrease from 2000, where recorded landings were valued at approximately US\$71 million (Gittens & Braynen, 2003).

Data collected over the last few decades indicate that both the weight and value of the total landings of whole lobster were fairly stable up to 2000, peaking at 9,023 tons. From 2000 to 2001, landings declined 25.7% to 6,703 tons, prompting a cause for concern. Since 2001, landings have continued to decline, with the spiny lobster fishery accounting for 88% (\$71 million) of landings value and 63% (2600 tons) of landings weight in 2007, representing a 72% decline in landings compared to 2000 (CRFM, 2008). Virtually all landings from the fishery are lobster tails.

Table 2: Total Recorded Spiny Lobster Landings (tons, whole weight) and Value (USD) for the Bahamas 1982 – 2001 (adapted from Gittens & Braynen, 2003)

Year	Production (tons)	Value (US \$millions)
------	-------------------	-----------------------

Year	Production (tons)	Value (US \$millions)
1982	2427	10.76
1983	2599	10.53
1984	3455	14.47
1985	5543	23.47
1986	3579	15.81
1987	4591	28.65
1988	5103	26.24
1989	6192	31.12
1990	5806	32.32
1991	7570	51.01
1992	8156	54.12
1993	7855	45.29
1994	7587	57.26
1995	7788	59.98
1996	8262	54.01
1997	7798	59.35
1998	7552	54.14
1999	8224	62.82
2000	9023	70.62
2001	6703	52.96

Commercial fishing vessels range in size from 11 ft to 100 ft. In the commercial fishery, there is often a “mothership” that works with up to eight vessels, with some staying at sea up to five weeks. Some motherships have a freezer capacity of 40,000 lbs, however, landings of 20,000 pounds is the typical maximum landed at one time. Fishing effort for lobster is not constant throughout the open season. A number of part time fishers only fish during the opening of the lobster season in August; many of the smaller vessels and persons who fish only at the beginning of the lobster season make only day trips. In addition, some of the fulltime fishers with very large vessels elect to undertake only a few 4-5 week trips starting at the beginning of the lobster season and finishing with a few months left in the open season.

Gears used in the Bahamian lobster fishery include spears, hooks, compressors, traps and casitas. There was an unrecorded shift in fishing methods throughout the country beginning in the late 1980s, when the use of casitas started to become the predominant methods, displacing spears and traps (Bethel et al., 2001). Most lobsters are still caught with the aid of casitas (locally known as condominiums). The number of casitas is unknown; however, their use is widespread, with records showing approximately 60,000 traps in use (CRFM, 2008). The commercial spiny lobster fishery of the Bahamas is based primarily on the Little Bahama Bank and the Great Bahama Bank and, to a lesser extent, Cay Sal Bank (CRFM, 2008); most spiny lobster are landed in Abaco, Nassau, and Eleuthera.

In the Bahamas, the total fishing industry component of the GDP averages between 2.3-2.5%, and the Caribbean spiny lobster fishery contributes 95% of this value (Bethel et al., 2001). Gross receipts from the Caribbean spiny lobster industry have averaged U.S. \$54.4 million since 1991. There are approximately 8,800 fishers in the Bahamian fisheries sector, 98% of whom are involved with the Caribbean spiny lobster; earnings average between U.S. \$17,000 – 23,000 per year (Bethel et al., 2001).

Barbados

The Barbados lobster fishery is minor and highly seasonal (June – October), with potential for increased importance through links to tourism (FAO, 2005; Luckhurst & Marshalleck, 1995). The spotted spiny

lobster (*P. guttatus*) is the dominant species harvested off the east coast, primarily by free-diving, with some fishers using SCUBA. Along the west coast, lobsters (mainly *P. argus*) are harvested primarily by fish pots. The smoothtail spiny lobster (*P. laeicauda*) is the second most abundant species in catches off both coasts (Luckhurst & Marshalleck, 1995). Currently there is no data collection and therefore no catch and effort data available; however, anecdotal information suggests that recently there has been a possible increase in *P. argus* abundance (FAO, 2005). The most important fishery in Barbados is the flyingfish fishery (comprising approximately 64% of total annual landings), followed by the fishery for large pelagics such as dolphinfish, kingfish, billfish and tunas (FAO, 2005).

Belize

The spiny lobster fishery is the most important small-scale fishery in Belize, with approximately 227 tons of lobster tail exported annually, on average (Belize Fisheries Department, 2009). It is a seasonal fishery, kept as “open access” for eight months of the year. Lobster tails and lobster head meat are bought from the fishermen by five fishing cooperatives, which are owned and operated by the fishermen themselves. The cooperatives purchase catches from fishermen and are responsible for processing, packaging and exporting the products (Gongora, 2010). While there are five fishing cooperatives currently in operation, only two – Northern Fishermen Cooperative Soc. Ltd. And National Fishermen Producers Cooperative Soc. Ltd., both based in Belize City – process and export lobster products. The others sell fishery products locally or export through one of the export fishing cooperatives. These cooperatives are required to sell 5% of their processed lobster locally (Belize Fisheries Department, 2009).

Lobster fishing, as an economic activity, started in Belize in the mid to late 1950s. As the fishery developed, catches increased rapidly, peaking in 1981 at 1021 tons live weight (Gongora, 2010). A declining trend in lobster catches has been observed over the last decade, while fishing effort has gradually increased over the same time period (Figure 9).

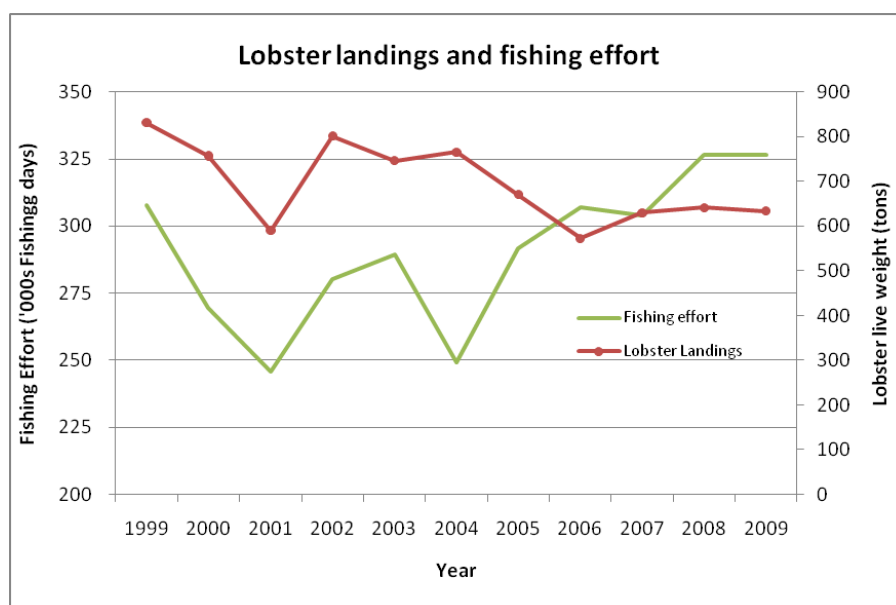


Figure 9: Lobster landings (tons live weight) and fishing effort ('000s of fishing days) during the period 1999 to 2008 (Belize Fisheries Department 2010)

Despite some variability in catches, lobster production over the past two decades has remained fairly stable, averaging around 700 tons per year (live weight). From 2007 to 2008, production increased by 1.4% from 630 tons (210 tons lobster tails) to 642 tons (214 tons lobster tails). The increase in lobster

catches was attributed to a 7% increase in the number of licensed fishermen compared to 2007 (Belize Fisheries Department, 2008). Landings of lobster tail and head meat at the cooperatives have fluctuated between 192 – 328 tons over the last two decades (Belize Fisheries Department, 2009).

Table 3: Belize Lobster Production (Tails and Head Meat) 1990-2009 (adapted from: Belize Fisheries Department, 2009)

Year	Lobster Tails (tons)	Head Meat (tons)
1990	211.62	7.90
1991	278.30	9.75
1992	260.89	6.44
1993	214.15	6.83
1994	281.54	11.67
1995	361.24	15.42
1996	261.26	15.71
1997	312.33	18.67
1998	258.14	18.43
1999	304.76	23.98
2000	277.63	25.32
2001	216.44	22.58
2002	293.94	23.23
2003	273.59	25.23
2004	280.57	25.65
2005	245.81	22.59
2006	209.93	18.92
2007	231.08	20.65
2008	235.24	20.45
2009	232.48	23.33

Overall, lobster landings declined by 24%, from 277 tons in 1999 to 211 tons in 2009 (Figure 10). The steep decline observed in 2000-2001 is attributed to declines in fishing effort (number of licensed fishermen) during these two years (Gongora, 2010). Lobster landings declined from 255 tons in 2004 to 191 tons in 2006 and have since increased slightly and appear to have stabilized. The CPUE follows the trend of the landings.

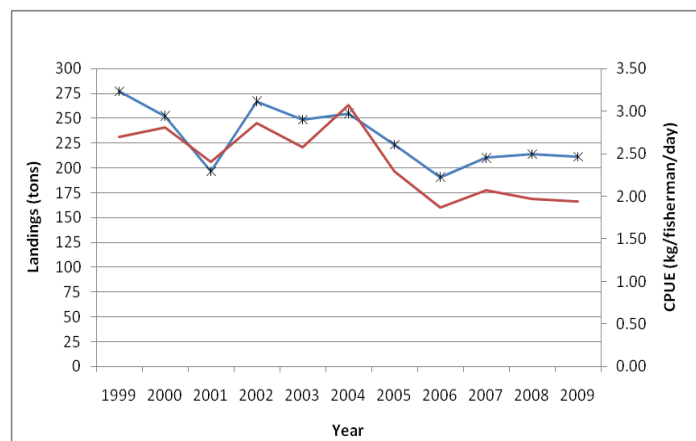


Figure 10: Lobster landings (tons tail weight) by two fishing cooperatives and CPUE during the period 1999 to 2009(Gongora, 2010)

Wooden traps are the most popular gear for fishing lobster in Belize, accounting for over 60% of extraction (WWF & PROARCA, 2004). Traps are rectangular “palmetto” traps that are normally unbaited, with a funnel entrance on one side, and are typically set in seagrass beds behind the reef crest in shallow waters (Carcamo Jr., 2003). Free diving using hook sticks and casitas are other common fishing methods.

Fiberglass and wooden skiffs propelled by outboard engines (25-75HP) are used in the lobster fishery. Fishermen in both the lobster and conch fisheries also use wooden sailboats, equipped with an auxiliary engine and capable of carrying up to 8 small canoes and 10 divers (Belize Fisheries Department, 2008). Outboard motors were introduced in the 1980s, facilitating access to shallow fishing grounds and increasing the use of wooden traps. Nowadays, fishers may have as many as 400 traps (WWF & PROARCA, 2004).

Gongora (2010) estimated fishing effort (fishing days) to be 326,448 fishing days in 2009, an increase of about 6% from 1999. The CPUE declined by 28% over the same time period, from 2.7 kg/fishing day in 1999 to 1.94 kg/fishing day in 2009 (Figure 11). The increase observed in CPUE during the 2004 season is attributed to a decline in fishing effort in that year and not due to an increase in lobster biomass (Gongora, 2010).

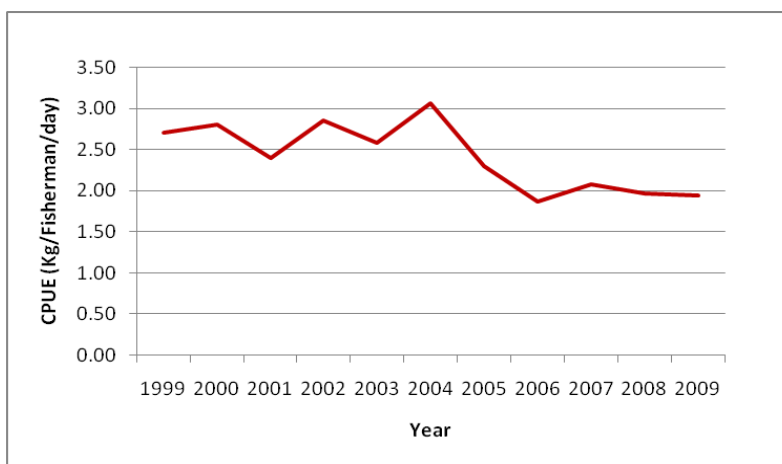


Figure 11: Estimated lobster CPUE during the period 1999 to 2009 (Gongora, 2010).

In 2008, 2267 fishermen and 643 fishing vessels were registered in the capture fisheries sector. Additionally, it is estimated that some 15,000 Belizeans also benefitted indirectly from fishing activities (Gongora, 2010). The number of licensed fishermen continues to rise; recent data shows an increase from 1,731 to 2,267 fishermen from 2004 to 2008, representing a cumulative increase of 30% (Gongora, 2010). The number of boats also increased from 621 to 643 during the same period, representing an increase of over 8%. Despite this increase in fishing effort, however, catches increased by only 2.42% when compared to 2007 (Belize Fisheries Department, 2008).

Fishing effort resulting from lobster traps and shades is unknown as these fishing gears do not require a special license. Lobster traps and shades have high gathering capacity and, therefore, result in a relatively high fishing mortality (Gongora, 2010).

Commercial fishing for lobster is carried out primarily in the shallow waters (5-15 m) within the reef lagoon, an area between the barrier reef and the mainland, and along the entire length of the barrier reef, which extends for about 300 km from north to south along the coast (Gongora, 2010).

The fishing industry, centred on the lobster and conch fisheries, is a major contributor to the Belizean economy, primarily in terms of foreign exchange earnings. Over the past few years, the lobster fishery has dominated the fishing industry by becoming the highest and most important income grossing small-scale fishery in Belize (Belize Fisheries Department, 2009). Fishing provides direct employment to over 2,000 registered fishers and over 500 processing and market workers (Carcamo Jr., 2003).

Table 4: Summary of spiny lobster fishery descriptors for Belize (adapted from Gongora 2010)

Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Tails (t)	277	252	197	267	249	255	223	191	210	214	211
Live weight (t)	831	757	590	802	746	765	670	573	630	642	634
# fishers	2,137	1,872	1,707	1,947	2,009	1,731	2,026	2,131	2,110	2,267	2,267
Effort ('000s days)	308	270	246	280	289	249	292	307	304	326	326
CPUE	270	281	240	286	258	307	230	187	207	197	194

Dominica

The Caribbean spiny lobster fishery in Dominica is primarily a by-catch fishery with few fishers targeting the resource directly (Luckhurst & Marshalleck, 1995). Landed lobsters are used exclusively for the domestic markets, which are said to be quite limited (Luckhurst & Marshalleck, 1995). No mechanisms for export are in place (Stoute, pers. comm.).

Only 0.98 tons of lobster have been landed from 2007 – 2010 inclusive (Figure 12). Over this short time period, landings have shown an increasing trend, roughly doubling from one year to the next (Stoute 2010 *pers. comm.*).

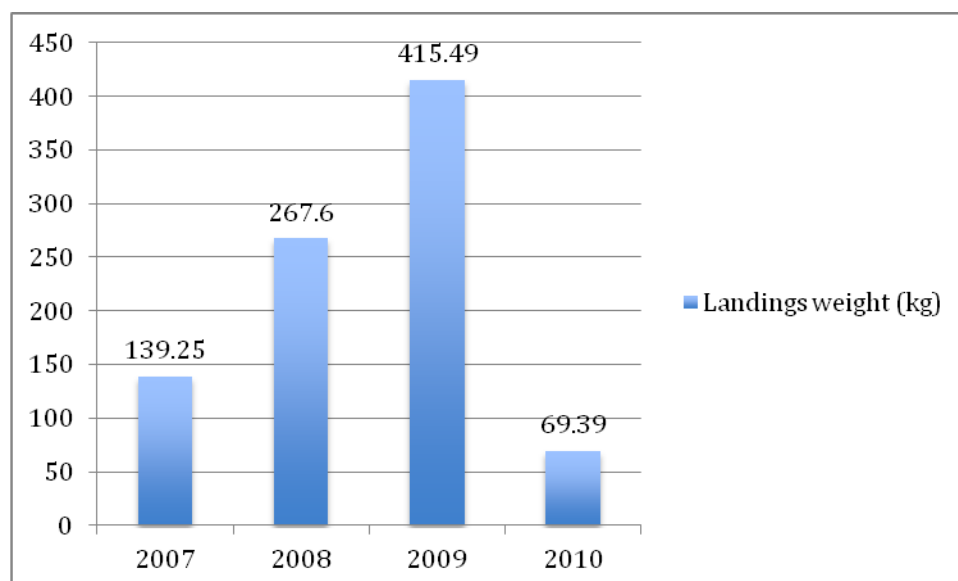


Figure 12: Lobster landings (kg) in Dominica 2007 – 2010 (Stoute 2010 *pers. comm.*)

The majority of lobsters landed are taken with pots set in deeper water and soaked for a period of 7 to 10 days; however, trap loss is reportedly high due to strong currents on the narrow shelf (Luckhurst & Marshalleck, 1995). Other gear types include beach seines, hand lines and spear guns (Figure 13) (Stoute 2010 *pers. comm.*).

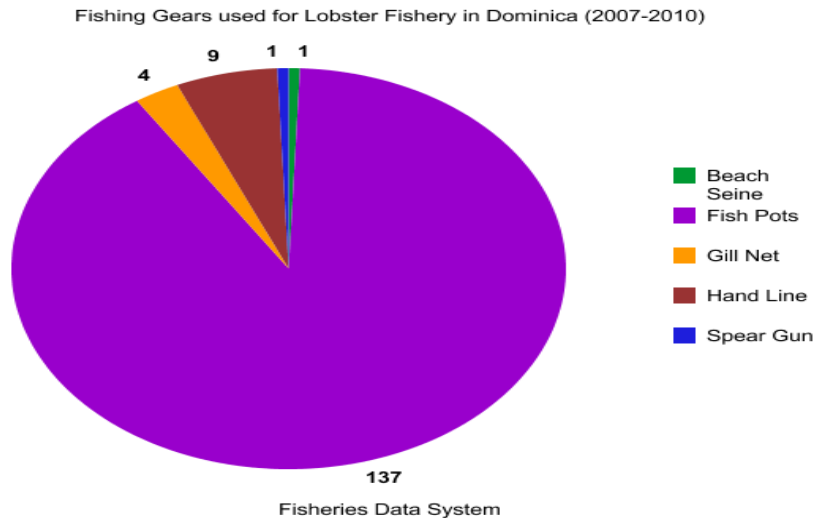


Figure 13: Breakdown of gear types used in Dominica's lobster fishery (Stoute 2010 *pers. comm.*).

Major fishing areas for lobster include Marigot, Wesley, San Sauveur, Fond St. Jean, Portsmouth, Anse De Mai, Bioche, Scotts Head and Layou. Some diving for the spotted spiny lobster (*P. guttatus*) occurs on the east coast. There is currently no recent data estimating and/or quantifying lobster fishing effort in Dominica. Catch and effort data for lobsters appears not to be consistently recorded (Luckhurst & Marshalleck, 1995).

Grenada

Pelagics (particularly tuna) are the major fishery in Grenada, comprising almost 80% of the total landings; however, the Caribbean spiny lobster fishery is considered a major fishery, not in terms of landings, but in terms of value (Anon., 1996). There is not much information on present populations and landings are difficult to monitor, especially in the southern part of the country (McConney, 2003). Landings of spiny lobster make up a small proportion of overall landings (about 1.3%) in Grenada's fisheries (Figure 14).

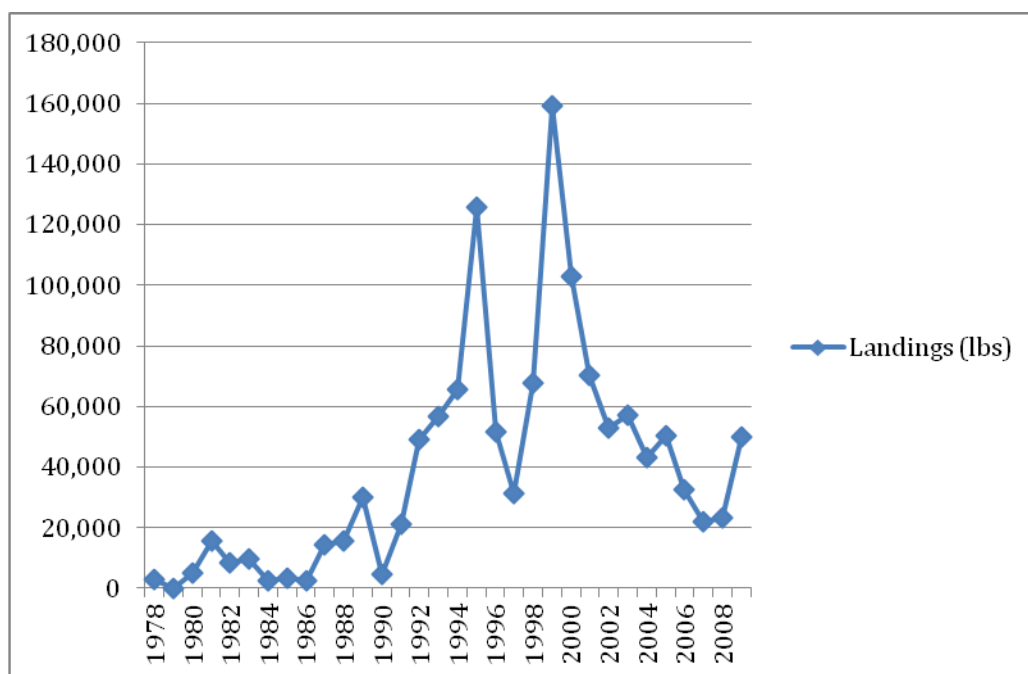


Figure 14: Landings of *P. argus* in Grenada from 1978 – 2009 (adapted from Rennie, pers. comm.)

This fishery is carried out primarily by SCUBA and free divers using nooses and, to a lesser extent, by trammel nets and traps, mainly on the southern shelf. Use of trammel nets is prohibited in Grenada, as they are non-selective and cannot target lobster without significant bycatch (McConney & Baldeo, 2007). Lobsters are also taken incidentally in traps set for finfish. The number of boats involved in the commercial fishery at any one time fluctuates between 30 and 45 (Isaac, 2001). Vessels tend to be small wooden or fibreglass pirogues, about 7 m in length (Isaac, 2001).

Catch and effort data are collected, but not compiled (Rennie, pers. comm.). In terms of effort, there are approximately 100 boats and 300 fishermen operating in the lobster fishery (Rennie, pers. comm.). In the area around Sauteurs and Isle de Ronde in the north of Grenada, lobsters are a main livelihood and closely linked to fishing identity (McConney & Baldeo, 2007). Estimates of personal and fishery wide income vary considerably. However, fishers are said to expect about US \$2,000 per season. The value of the lobster fishery at these locations may be around US \$100,000 annually, not counting indirect employment and value added in final marketing through hotels (McConney & Baldeo, 2007).

Guyana

There is currently no directed Caribbean spiny lobster fishery in Guyana, though trawlers from the offshore industrial fishery have been known to exploit small amounts of lobster and squid (CRFM, 2008). The penaeid shrimp fishery is economically the most important fishery in Guyana. Lobster specific fishery data are not collected, likely because it makes such a minor contribution to the fisheries sector overall. The country's data collection program instead focuses on the major fisheries for shrimp, finfish and seabob.

Haiti

Haiti's coastal resources are probably the most over-exploited and the most poorly managed in the CARICOM region (Mateo & Haughton, 2003). The lobster fishery is one of the most important in Haiti.

Average landings from 2000 – 2007 were reported to be 771.3 tons (Munoz-Nunez, 2009), representing 7.6% of the lobster production in the CARICOM region, second only to Bahamas. No system of data collection, whether catch and effort, biological or socio-economic has been established; hence the process of scientifically assessing the stock, developing policy advisory and ultimately devising management plans for the sustainable management of the fisheries resources cannot be pursued (CRFM, 2010).

Many fishermen operate from small wooden artisanal boats, which are propelled by oars or sails. More than 60% of the fishing boats operate from beaches on the west and southeastern parts of the country; however, many fishers operate directly from the coast without the aid of a boat (Mateo & Haughton, 2003). Haitian fishers targeting lobster use mainly Antillean Z traps made from bamboo, nets (e.g. trammel nets), free diving and hookah diving (Mateo & Haughton, 2003).

The number of fishers and fishing boats in Haiti is difficult to determine with any degree of accuracy. Estimates of the number of fishers range between 11,000 and 30,000 (Breuil 2000 in Mateo and Haughton 2003). Approximately 80% of these are reportedly full-time fishers (Mateo & Haughton, 2003). The fishing fleet is composed of 5,000 – 6,000 small artisanal fishing boats that operate mainly within the coastal waters (FAO 1999 cited in Haughton and Mateo 2003). The emergence of fishers' cooperatives and associations in Haiti has proceeded at a rate unprecedented in the Caribbean: by the year 2000 the number of these organizations was estimated conservatively at about 140 (CRFM, 2010).

Jamaica

The Caribbean spiny lobster fishery is the second most important for Jamaica, representing a significant portion of the total landings of the Jamaican fisheries sector (Murray, unpub). The domestic demand for lobsters is high because of the tourism industry. A major portion of landings from western Jamaica supports the local tourist market, although this portion has not yet been quantified (Kelly, 2003). Landings for lobster usually peak in March and late September (Kelly, 2003).

In Jamaica, the lobster fishery can be divided into 2 components: artisanal and industrial. The artisanal fishery can be further sub-divided into mainland and offshore categories. Mainland artisanal fishers primarily use Antillean Z-traps, diving and gill nets, selling their catch to the local food and tourism industry, as well as directly to households (Kelly, 2003). Offshore artisanal fishers are mainly divers (SCUBA, free and hookah) based on Pedro and Morant Banks. Their catch is marketed to 'packer' boats that subsequently distribute to the same markets as the mainland fishers.

The industrial fishery for Caribbean spiny lobster is limited entry in Jamaica (CFRAMP, 2001). Fishers in the industrial fishery are based on the mainland but operate mostly on the Pedro and Morant Banks, spending up to three months at sea at a time. These fishers are licensed to use Florida wooden traps only and are usually contracted by processors to whom they are obliged to sell their catch. The processors primarily cater to the export market (Kelly, 2003).

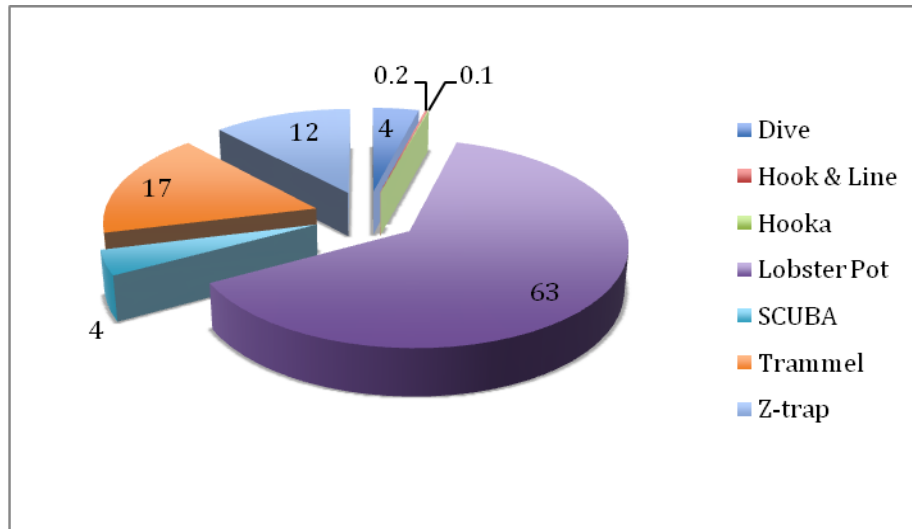


Figure 15: Percent distribution of weight of spiny lobster landed by gear type on the south shelf of Jamaica (adapted from Murray 200x)

The artisanal fishing fleet consists of about 2,000 registered fiberglass boats and about 900 registered non-mechanized dugout canoes (Kelly, 2003). In contrast, about 4 industrial licenses were issued to 4 companies in 2001. Industrial vessels are steel hulled with inboard engines, and have crews ranging from 8-12 individuals. Each vessel transports about 1,000 traps, 500 of which are in the water at any one time with an average soak time of about 3 days (Kelly, 2003).

Fishing for lobster is done mainly on the island shelf and the banks (Pedro, Morant and Formigas), though this has not been recently quantified (Kelly, 2003). Large concentrations of lobsters are found on Pedro Bank, which accounts for about 60% of the total landings in the industrial fishery, although this proportion declined to 20% during 1996 -1997. Landing sites in Jamaica range from beaches with a small number of canoes through to hundreds of vessels including steel-hulled industrial ships. Key fishing beaches are located in Old Harbour Bay, Port Royal, Rocky Point and the modern fishing port complex in Whitehouse, Westmoreland.



Figure 16: Major Fishing Grounds in Jamaica (Murray, unpub)

The spiny lobster fishery is the second most lucrative export fishery in Jamaica. In 2001, total production was estimated to be 308.92 tons with a value of about US\$2 million (Kelly, 2003).

Montserrat

In Montserrat, there is no directed fishery for Caribbean spiny lobster – the fishery is by-catch only (Luckhurst & Marshalleck, 1995). Lobsters are fished on the island shelf and are landed at two main sites: Little Bay located on the North coast and Isle Bay located on the West Coast. Lobsters are sold locally for 5USD per pound (Ponteen 2010 pers. comm.). The fishery for coastal pelagic species (e.g. gar, ballyhoo, sardines and herring) is the dominant fishery, comprising over 50% of landings (Blue Ocean Institute, n.d.).

Year	Catch (LBS)	Value (USD)
1997	434.5	2172.5
1998	387.5	1937.5
1999	403	2015.00
2000	404	2020.00
2001	162	810.00
2002	341	1705.00
2003	160	800.00
2004	521.5	2607.5
2005	578	2890.00
2006	404	2020.00
2007	157	785.00
2008	160	800.00
2009	139	695.00
2010	472	2360.00

*note that the conversion rate used to calculate these values: 1 USD = 2.7169 ECD

The fluctuation in landings is attributed to volcanic ash, which has significantly impacted the habitat of the spiny lobster over the past 15 years (Ponteen 2010 pers. comm.).

St. Kitts and Nevis

The Caribbean spiny lobster fishery in St. Kitts and Nevis is a small year-round fishery (Luckhurst & Marshalleck, 1995). The fishery is artisanal in nature, with most full-time fishers averaging about 3 or 4 trips per week. Landings have fluctuated considerably since 1999, ranging from 2.72 – 28.95 tons (Table 5).

Table 5: Production and value of spiny lobster landed in St. Kitts from 1999-2006 (adapted from CRFM 2008)

Year	Production (tons)	Value (USD)
1999	16.05	142,622.08
2000	5.93	52,666.61
2001	16.90	150,177.63
2002	10.59	94,133.24
2003**	2.72	25,288.86
2004	4.22	37,466.63
2005	28.95	257,288.63
2006	14.49	128,755.43

*note that the conversion rate used to calculate these values: 1 USD = 2.70 ECD

** note that 2003 data is incomplete

On St. Kitts, the Fisheries Department estimated that 90% of the lobster landed is taken by traps, with most fishing occurring on the north and east coasts (Luckhurst & Marshalleck, 1995). Dieppe Bay is considered the main lobster landing area (CFRAMP, 1997). About 50% of the catch is sold to hotels and the other half is exported. On Nevis, it is estimated that 65% of the lobsters landed are taken by SCUBA divers, predominantly from the bank to the south of the island (Luckhurst & Marshalleck, 1995). Most of the fishing is done from small wooden open fishing boats with outboard motors ranging from 25 to 150 hp though most boats use 40 hp motors. The length of the boats ranges from 4.8-7.6 m.

Saint Lucia

The spiny lobster fishery is one of the most important in the nearshore of Saint Lucia, second only to the conch fishery in terms of landings (Joseph W. , 2003). The fishery has expanded rapidly due to increasing development within the tourism sector. Estimates for total lobster catch are precluded by the nature of these landings and illegal trade thought to occur with the neighbouring island of Martinique (CRFM, 2001). The majority of lobster landings occur during the first four months of the fishing period, or the “low season” (Joseph W. , 2003).

Table 6: Production and value of spiny lobster landed in Saint Lucia from 1999-2006 (adapted from (Joseph A. , pers. comm.)

Year	Production (tons)	Value (USD)
1991	10	122,222.10
1992	21	256,666.41
1993	15	183,333.15
1994	15	183,333.15
1995	13	158,888.73
1996	13	158,888.73
1997	13	158,888.73
1998	32	391,110.72
1999	30	366,666.30
2000	24.9	304,333.03
2001	36.1	441,221.78
2002	9.2	125,077.24
2003	23.37	306,501.81
2004	10.6	154,271.22
2005	15.34	219,740.99
2006	9.36	141,368.71
2007	12.66	184,343.62
2008	12.64	181869.8737
2009	9.63	144,108.73

*note that the conversion rate used to calculate these values: 1 USD = 2.70 ECD

The primary gear used in Saint Lucia is the Antillean fish trap. Fishermen operate out of a variety of small, wooden vessels, mostly wooden canoes or fiberglass pirogues powered by outboard motors (Joseph W. , 2003). The majority of lobster landings come from traps set on the island shelves in depths in excess of 30 metres (Luckhurst & Marshalleck, 1995). Previously, lobsters were fished with trammel nets and spear guns, which are now both banned from the island fishery; however, they are still used illegally on a small scale (Joseph W. , 2003).

Fishing in St. Lucia is still largely open access such that the potential effort that can be applied to the lobster fishery is high. In 2009, 2429 fishers and 600 boats were registered in the fisheries sector (Joseph A. , pers. comm). Landings are concentrated on the southern and eastern coasts, with major landings at Dennery, Micoud, Savannes Bay, Vieux Fort and Laborie. Landings in the northeast (Gros Islet, Castries and Canaries) have declined significantly, largely due to habitat degradation (Joseph W. , 2003).

The quantity of lobsters landed in Saint Lucia is not sufficient to meet export demand; instead, lobsters are sold to local hotels, restaurants and the general public (Joseph 2010 pers. comm). There are 8 fishing cooperatives established island wide.

St. Vincent and the Grenadines

The most important commercial fishery for St. Vincent and the Grenadines in terms of landings and value is the pelagic fishery; however, the Caribbean spiny lobster is also an important commercial activity, particularly for the Grenadines (CFRAMP, 1997). The lobster population is considered overexploited in nearshore areas and the potential yield is 90 tons per year (FAO, 2002). No time series of landings data was available at this time.

The fishing industry in St. Vincent and the Grenadines is predominantly small scale and artisanal, employing traditional gear, methods and vessels. Most fishers are daily operators, going out to sea in the morning and returning to land in the late afternoon or evening. There are approximately 2,500 full-time and part-time fishers (FAO, 2002). Spiny lobster is harvested in the Grenadines by teams of a dozen or so men, of whom five to six are SCUBA divers carrying several stainless steel wire nooses (FAO, 2002). Each team deploys four to five open boats or quarter-decked speedboats of about 4.6 – 5.5 m long, mainly constructed of wood with a 35-45 hp outboard motor. Flat transom boats, also known as bow and stern boats or dories, powered by one or 2 gasoline outboard engines, are the most commonly used vessels (Headley & Singh-Renton, 2009).

According to a questionnaire developed and administered by CRFM, Battowia, Pillores, Savan, Mustique and Balliceaux were identified as the five areas most frequently fished for spiny lobster (Headley & Singh-Renton, 2009). Additionally, of the fishers interviewed, the majority (97.5%) depended on the lobster fishery for 75-100% of their income, while only 2.5% depended on it for 50-75% of their income (Headley & Singh-Renton, 2008).

Suriname

There is no commercial spiny lobster fishery in Suriname. Major fisheries primarily target shrimp and finfish (CRFM, 2008).

Trinidad and Tobago

There is no directed commercial spiny lobster fishery in Trinidad and Tobago, though lobsters are caught incidentally. Major fisheries primarily target shrimp and finfish (CRFM, 2008). From 2005-2008, a total of 29,086.3 kg of lobsters were landed (Barran, *pers. comm*)

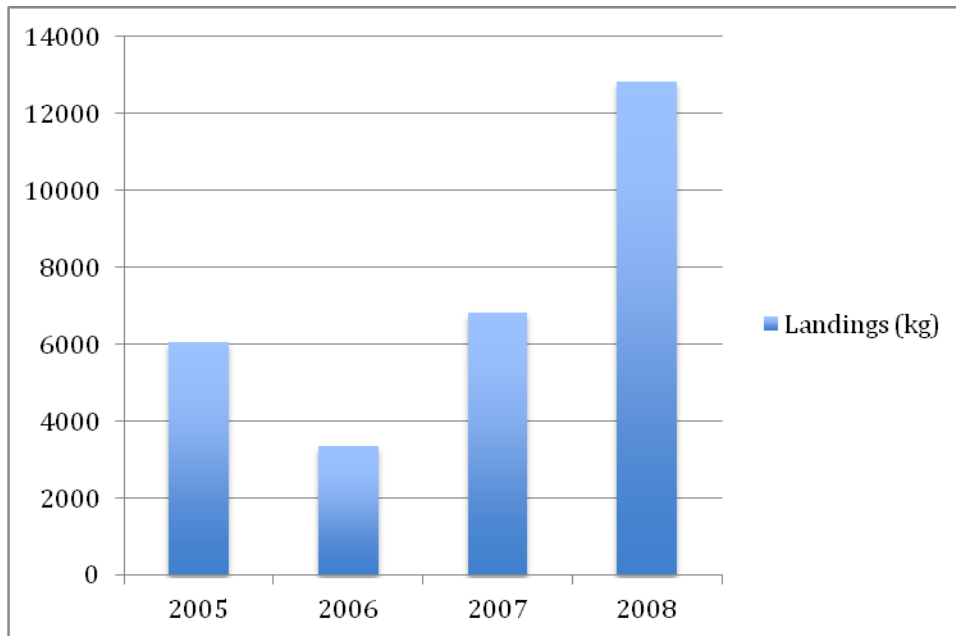


Figure 17: Landings (kg) of Lobster in Trinidad & Tobago from 2005 – 2008 (adapted from Barran pers. comm)

Turks and Caicos

Since 1957, when the first land-based processing plant was established, the Caicos Bank lobster fishery has been centred around a well organized processing sector. Almost all catches were, and still are, exported – primarily as frozen tails (Ninnes & Medley, 1995). The spiny lobster fishery in Turks and Caicos shows high annual variations in landings, although a complete time series of landings data was not available at this time. Fisheries statistics indicate that the stock has been fully exploited since 1977, with a peak of 590 metric tons in 1992/93 followed by a steady decline to an all time low of 320 metric tons in 2002/03 (CRFM, 2007). Another decline was observed after Hurricanes Hanna and Ike passed through the region in 2008 (Clerveaux pers.comm., 2011). In addition to overfishing, fluctuations in landings may be linked to changes in recruitment and stock size (Bethel et al., 2002) or to the dynamics of the fishing fleet related to the high cost of fishing effort (Clerveaux et al., 2002).

Spiny lobsters are typically landed whole by free divers (CRFM, 2008). Analysis of size composition data suggest that approximately 40% of the landings in numbers are comprised of undersized lobsters, which converts to 22% of the catch in weight (Clerveaux et al., 2002). More recent analysis suggests that landings of undersized lobster decreased by more than 15% from 2002-2006 (FAO, 2006). It is assumed that undersized lobsters are rejected by the processing plants and possibly sold for local consumption.

Industrial fishing for spiny lobster is based primarily on the Caicos Bank, the largest of the shallow water banks. A small number of vessels periodically engage in subsistence fishing around the Turks Bank while the Mouchoir Bank is neglected owing to its proximity to landing sites (Clerveaux et al., 2002). From 1985 to 2001, CPUE remained relatively stable at around 58 kg/boat-day (Clerveaux et al., 2002).

In terms of production, employment and government revenue, the spiny lobster is the most important marine resource in the Turks and Caicos Islands and has played an integral part of community life for generations (Clerveaux et al., 2002). Annual value of production of the lobster and conch fishery, including domestic consumption, is estimated at about US \$4 million, or about 10% of the country's GDP (Clerveaux et al., 2002). A socio-economic study of the fishing industry indicated that it provided direct

employment for approximately 8% of the country's labour force in the harvesting (370 fishers) and processing (80 plant workers) sectors (Clerveaux et al., 2002). The importance of the fishing industry, and the lobster fishery in particular, is more apparent on the lesser-developed Caicos Islands (primarily the Island of South Caicos). Here the fishing industry is important in providing economic stability and maintaining the structure and cohesion of the community. Clerveaux et al. (2002) report that over 75% of the working population on the island of South Caicos is dependent, directly or indirectly, on the fishing industry.

INTERNATIONAL TRADE

Regional Overview

The lobster chain, from harvest to distribution, is wide ranging throughout the Caribbean (Monnereau, 2007). Apart from retailers and restaurants, the principal chain actors are the importers, processors/exporters located in the Caribbean, various types of intermediaries and fishers (Monnereau and Helmsing, 2010). Lobsters (whole or tails) are sold to intermediaries or directly to processing plants by fishers and the plants then process, weigh, pack and export frozen lobster to its final market (Monnereau and Helmsing, 2010). The major market is the United States but also the European Union, Asia and Canada.

Annual global production of Caribbean spiny lobster averages about 54 percent of all spiny lobster production (*Panulirus* spp. And *Palinurus* spp.) and about 17 percent of global production of all lobster (CFMC et al., 2008). According to the FAO, world capture of Caribbean spiny lobster has greatly increased from 1950 through 2005, starting at a low of 2,957 metric tons in 1950 to 35,540 metric tons in 2005. Twice annual global production has exceeded 40,000 metric tons; and since 1984, annual global production has varied between 30,000 and 41,000 metric tons.

As mentioned earlier, among the countries that harvested Caribbean spiny lobster from 1996 through 2005 and reported those landings to the FAO, the Bahamas had the largest average annual landings, followed by Cuba, Brazil, Nicaragua, and the United States (CFMC et al., 2008). Globally, the United States is the major importer of *P. argus*: over the last 10 years, over 88,000 tons of the species has been imported, worth a value of approximately \$2.27 billion (Figure 18) (CFMC et al., 2008). The U.S. receives 90% of the exports from Central and South American countries (Figure 19) and spiny lobster is considered an important product for major dealers and distributors (Kimmel & Rueter, 2007).

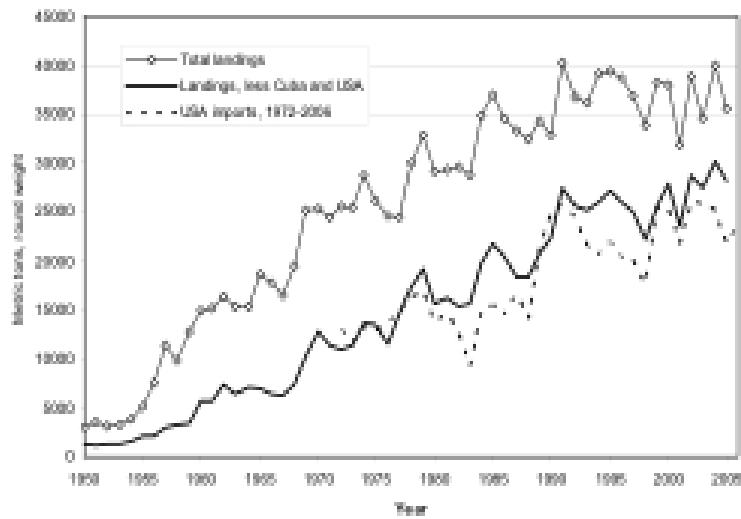


Figure 18: Global landings of Caribbean spiny lobster and U.S. imports of frozen spiny lobster (FAO Fishstats)

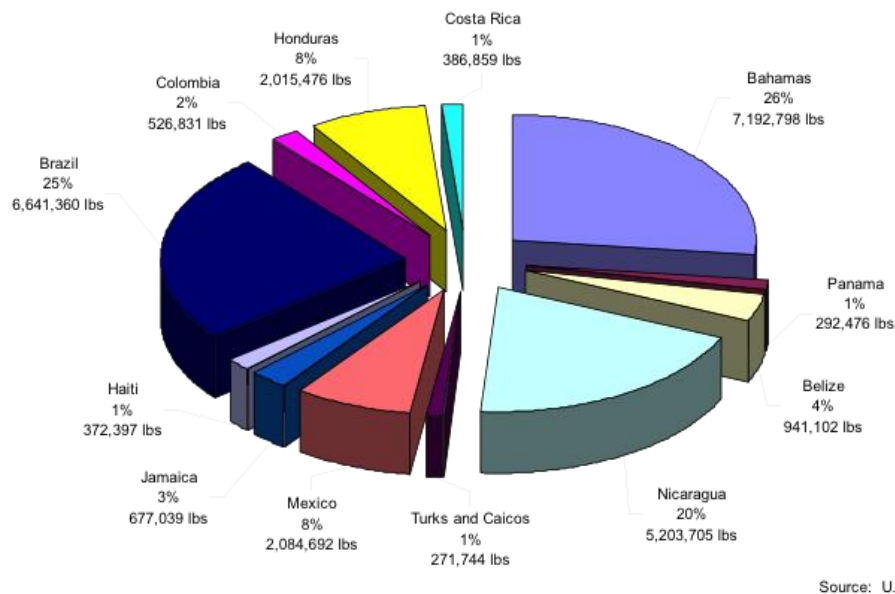


Figure 19: Spiny lobster imports into the United States broken down by country of origin (1999 – 2001)

Historically, and in decreasing order, Cuba, the Bahamas, Nicaragua-Honduras and Brazil have been the most important *P. argus* producers. This order is changing rapidly as Nicaragua-Honduras and the Bahamas, followed by Brazil are becoming the principal producers (Figure 20) (Ehrhardt et al., unpub.)

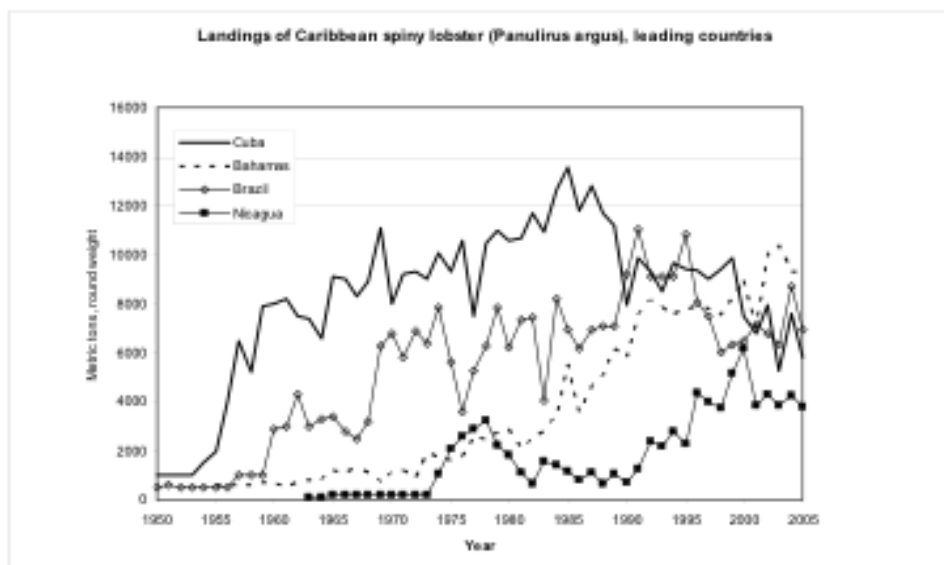


Figure 20: Top 4 producers of Caribbean spiny lobster, 1950 – 2005 (FAO Fishstats)

Imports of frozen lobster that originate from the Caribbean basin are almost exclusively Caribbean spiny lobster (*P. argus*) tails, with the exception being boxes shipped from Brazil¹. The commercial value of a Caribbean spiny lobster is found virtually entirely in its tail; as such, most international trade of the species has been in frozen lobster tails. However, whole cooked frozen lobsters, live lobsters, and meat are traded as well (CFMC et al., 2008).

Spiny lobsters imported into the U.S. that originate from the Caribbean basin are typically tailed, sorted by weight, packed in 10-pound boxes, and shipped frozen to the U.S. for consumption. Size is the critical element in the pricing of lobster tails and, Caribbean lobster tails are sorted by the industry into the following sizes: 4 oz, 5 oz, 6 oz, 7 oz, 8 oz, 9 oz, 10 oz, 11 oz, 12 – 14 oz, 14 – 16 oz, 16 – 20 oz, and 20 – 24 oz. A 5-oz tail weighs from 4.5 to 5.4 oz, while a 6-oz tail weighs from 5.5 to 6.4 oz (CFMC et al., 2008). Quality controls are not always sufficient; for example, processors might soak lobster in a salty solution for it to absorb extra water weight, tails might be excessively glazed to hold extra weight, and producers might pack 10-pound boxes with a few ounces less (Monnereau and Helmsing, 2010).

There are approximately 20 importers of Caribbean lobster tails in the United States, whom frequently import other marine products as well, such as shrimp, fish and lobster. As lobster is a luxury product with high unit prices, a container of lobster might be worth US \$600,000–700,000 (Monnereau and Helmsing, 2010). Although all exporting processing plants follow Hazard Analysis and Critical Control Point (HACCP) regulations, quality is diverse and is highly dependent on the time period a lobster is kept until it is frozen, and the use of ice or freezers on board fishing vessels (Monnereau and Helmsing, 2010). Conditions for exporters are similar throughout the region and defined, above all, by US public food safety standards.

The number of processors differs per country involved, depending on the volume and organization of the industry. For instance, in Belize there are two certified processors who export lobster, and fishers either

¹ Brazil also exports Brazilian spiny lobster (*Panulirus lauvicauda*), and some shipments have contained both Caribbean and Brazilian spiny lobsters. The Government of Brazil is acting to implement a rule that would not allow the two species to be exported in the same box.

sell directly to these processors (which are fishing cooperatives) or to collection points for these co-ops. In Jamaica there are officially only two processing plants; however, the fisheries department believes that as many as 20 smaller processors lacking official permits are in operation in the country (Monnereau and Helmsing, 2010.).

There are different types of intermediaries between fishers and processing plants, ranging from small informal actors to more official intermediaries. Fishers who are members of a cooperative in Belize are not supposed to sell their catch to intermediaries, but fieldwork shows that a large percentage of fishers do so (35-50%) because they can get a higher initial price but lose their so called 'second payment' (Monnereau and Helmsing, 2010). In Jamaica small-scale fishers are highly dependent on intermediaries who buy their catch and supply them with money, food and drinking water (Monnereau and Helmsing, 2010).

Regional ex-vessel prices paid for spiny lobsters vary widely in western central Atlantic fisheries, from US\$4–25 per kilogram whole weight, with an average of US\$12 per kilogram (Ehrhardt N. , 2001). The estimated value of the regional fisheries, considering the average landings in the last 20 yrs and the average price paid per kilogram, is about US\$456 million at dockside (Ehrhardt, 2005).

The 2008 economic crisis severely affected the lobster fishery in the Caribbean Basin: demand dropped as consumers opted for cheaper marine products or reduced their consumption of seafood. According to Urner Barry's Seafood Price-Current prices dropped from US\$21–22 per pound in 2007 to \$13.50 in December 2008, while the same happened with US lobster prices, which fell to an all-time low of \$3.50 per pound, down 21 per cent from 2007 (Monnereau and Helmsing, 2010).

Among the CARICOM countries, the Bahamas has the greatest export earnings from its spiny lobster fishery, earning up to US \$87 million (Gittens & Haughton, unpub). The percentage of landings exported varies greatly between countries; for example, the Bahamas and Barbuda export over 90% of lobster landings, while in Dominica most of the catch is consumed within the local market. Much of the lobster that is not exported is used in hotels and restaurants to support the tourism industry.

The potential for overfishing *P. argus* is relatively high because a lucrative market exists for all sizes of this species (CFMC et al., 2008). Ehrhardt et al. (unpub) report that illegal size lobsters are often transshipped to international markets, usually via third party countries. Additionally, they indicate that sophisticated markets have developed to dispose of the very large quantities of illegal size lobsters landed throughout the region (e.g. Chinese restaurants). A positive step forward is newly enacted legislation in the United States (as of 2009) that bans all imports of spiny lobsters that do not meet U.S. minimum size or weight regulations.

COUNTRY PROFILE

Anguilla

Anguilla exports very little lobster. Gumbs (pers. comm) estimates approximately 1% of total catch value is exported, worth about US \$21,600.

Antigua and Barbuda

The French territories of Guadeloupe, Martinique, St. Martin and St. Barthelemy are Antigua and Barbuda's main export market. These islands are considered more lucrative for business due to their close proximity and higher market prices offered for seafood (Horsford & Archibald, 2006). It is estimated that

at most 20% of the lobsters landed in Antigua are exported, with the remainder being sold locally to restaurants and hotels (Horsford 2011 per comm.). On average, 84% of the lobsters landed in Barbuda are exported to the French territories (Horsford & Archibald, 2006). Peaks in exports tend to coincide with the tourism season in the French islands, running from December to April.

Antigua and Barbuda's export sector was drastically affected by the formation of a single European market in January 1993. Legislation governing the production of food was harmonized throughout the European Union and the associated stringent technical standards, the need for accompanying legislation and infrastructure have made the export process an arduous task (Horsford & Archibald, 2006). In 1989, domestic export of spiny lobster from Antigua and Barbuda was 47 tons, valued at US\$0.46 Million (based on constant 1990 prices). Exports peaked in 1991 with 99 tons of live lobster being exported, valued at US\$0.97 Million. As of 2002, lobster exports have been declining. The low exports observed in 2008 and 2009 can be attributed to economic declines in the tourism sector of neighbouring French overseas territories.

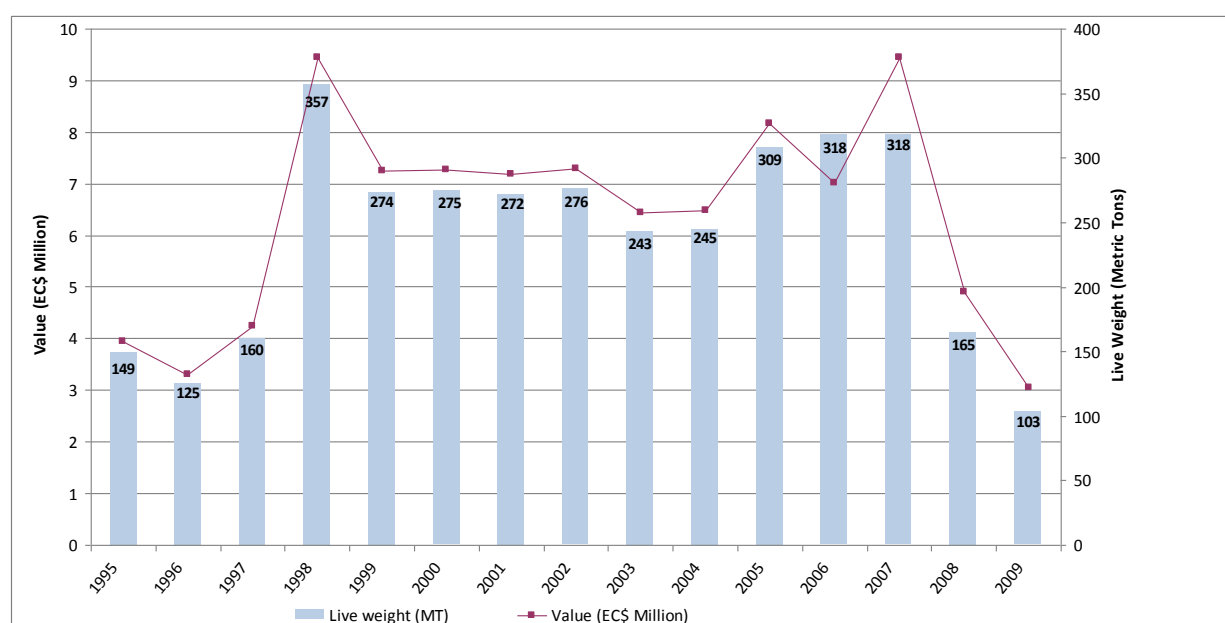


Figure 21: Domestic Export of Fishery Products from Antigua & Barbuda (Horsford & Archibald, 2006)

Lobster exports have not recovered the market share of capture production; values range from 14 to 26% of production since 2001 (Figure 22). In 1989, 52% of lobsters captured were exported; nowadays, high domestic retail value for seafood due to relatively high cost of production has limited the viability of alternative markets such as the United States and Canada, as comparable prices can be obtained from the local tourism sector (Horsford & Archibald, 2006).

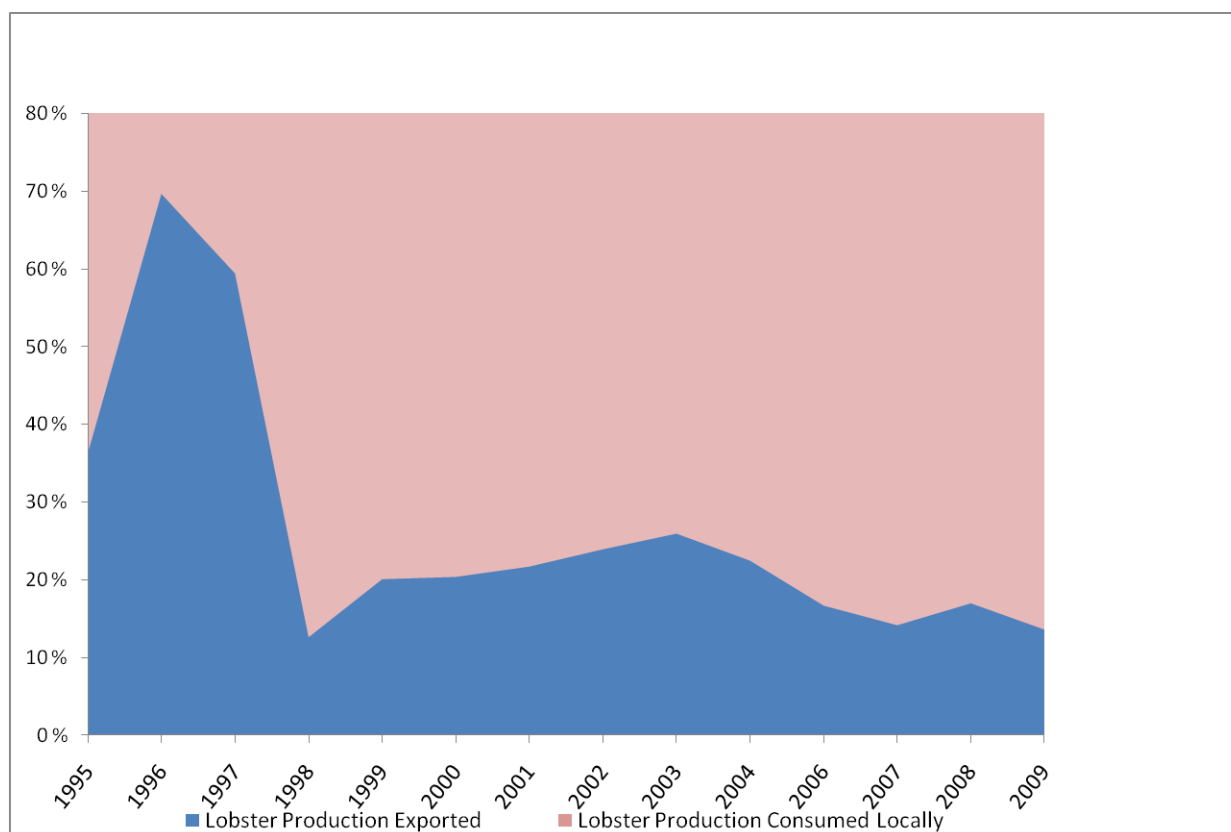


Figure 22: Domestic Export of Spiny Lobster as a Percentage of Capture Production

In terms of vulnerability, the Barbudan economy is particularly at risk due to its heavy reliance on lobster exports as a foreign exchange earner. As much as 84% of landed lobsters are shipped to the French territories in the region (Horsford, 2006). Hence, trade sanctions resulting from failure to meet European standards, can have dire implications, particularly when the lobster fishery offers the highest per capita earnings, with one in four persons directly dependent on this fishery (Horsford & Archibald, 2006). In 2005, retail value of spiny lobster exports from Barbuda was reported as US \$0.4 million.

Bahamas

Caribbean spiny lobster is the single most important fishery product exported from the Bahamas. The major markets are the USA and France, with smaller numbers of exports shipped to Canada, Japan and Barbados (Gittens & Braynen, 2003).

Table 7: Lobster Tail Exports (weight and value) by Destination (adapted from Gittens and Braynen 2003)

Season	2000/2001		2001/2002	
	Tons	\$US (millions)	Tons	\$US (millions)
USA	999.20	29.56	1 319.50	44.29
France	714.81	21.17	750.54	23.52
Canada	71.87	3.11	123.18	3.71
Japan	-	-	-	-
Barbados	0.67	0.22	0.67	0.22
TOTAL	1 786.55	53.87	2 193.89	71.54

Barbados

Barbados is reportedly a major importer of regional Caribbean spiny lobster. Though now dated, Mitchell (1992) in (Luckhurst & Marshalleck, 1995) reported that Barbados imported, on average, approximately 26 metric tons of lobsters per year from Belize (tails and meat) and Grenada and Carriacou (whole).

Belize

In the lobster export trade, Belize enjoys several competitive advantages over other CARICOM and Central American countries, namely a combination of a location ideal for rapid access to seafood markets in the United States, Mexico and Europe (WWF 2004) and duty-free access for all exports to the U.S. market under the Caribbean Basin Initiative (Belize Fisheries Department, 2009).

The first lobster buying companies that operated in Belize in the late 1950s paid as little as US\$0.05 per pound of lobster tails to fishermen from Caye Caulker and, in turn, sold it for much higher prices in the U.S.A. (Gongora, 2010). Things have changed since then, with spiny lobster drawing a lucrative average price of US\$29 per kg export value on international markets (Carcamo Jr., 2003).

International market prices for lobster fell sharply in the latter half of 2008, to approximately US\$22/lb., causing a decline of almost 19% in lobster export earnings from US\$8.5 million in 2007 to US\$6.9 million in 2008 (Belize Fisheries Department, 2008). In 2009, Belizean fishing cooperatives exported 486,600 lbs (243.3 tons) of lobster tails to the U.S.A. valued at US\$5.9 million (Figures 23 and 24). Compared to 2008, these figures represent a 19.4% increase in export weight but a 15.7% decrease in foreign exchange earnings (Gongora, 2010).

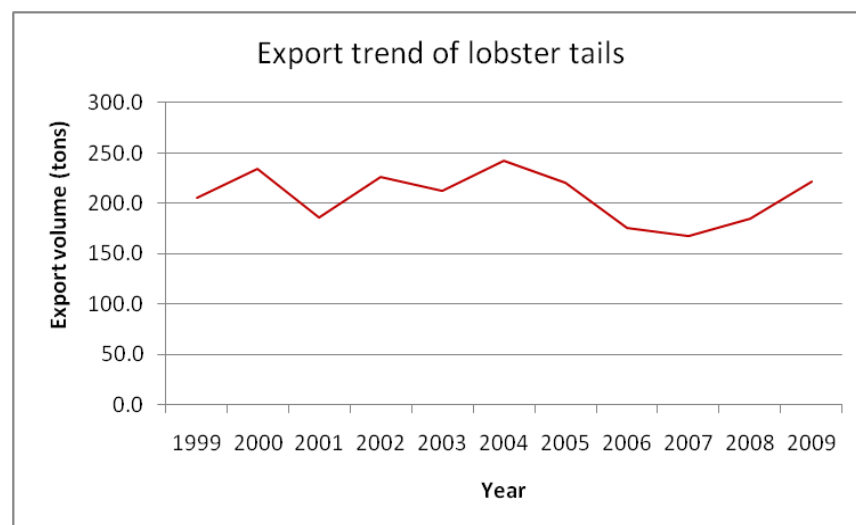


Figure 23: Export trend of lobster tails (all size classes) of two fishing cooperatives during 1999 to 2009 (Gongora, 2010)

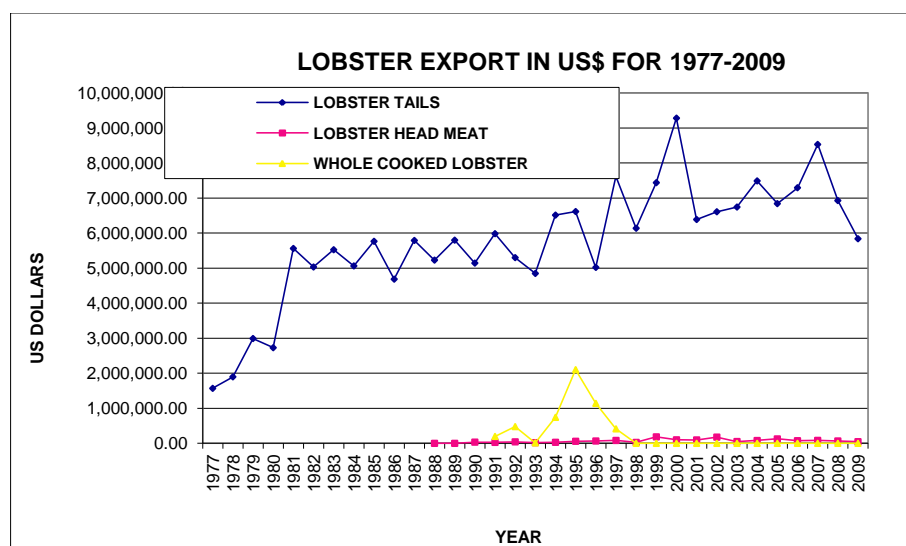


Figure 24: Lobster export values in US dollars 1977-2009 (Belize Fisheries Department, 2009)

Dominica

Dominica does not have an export fishery for lobster. Most of the catch is consumed within the local market, at an average price of US\$4-6 (Stoute, pers. comm.). Dominica does not have any legal structures in place to support export of the resource, nor is there a fishing cooperative in existence (Stoute, pers. comm.).

Grenada

All fishing in Grenada is relatively small-scale (McConney & Baldeo, 2007). Approximately 200 tons of fishery products are exported annually, of which, Caribbean spiny lobster is a small but valuable part (McConney & Baldeo, 2007). Exports have, in general, fluctuated over time with a fairly recent and sizeable decrease occurring over the 2006 fishing season (Table 8).

Table 8: Lobster Export and Value for Grenada 1998 – 2006 (Rennie, pers. comm)

Year	Export (lb)	Value (US\$)
1988	3,744	44,928
1989	15,558	186,696
1990	4,426	64,620
1991	8,689	129,435
1992	20,245	258,952
1993	22,868	356,788
1994	51,854	617,822
1995	62,171	666,320
1996	29,072	307,682
1997	19,435	133,877
1998	33,131	485,548
1999	22,348	256,745
2000	1,511	27,398
2001	6,858	76,554
2002	2,360	28,708

Year	Export (lb)	Value (US\$)
2003	6,750	118,400
2004	12,685	305,683
2005	17,431	522,860
2006	7,374	86,740

Guyana

Guyana does not have a directed commercial fishery for Caribbean spiny lobster.

Haiti

The export of fish products from Haiti to the European and North American markets had suffered a major set-back as a consequence of their failure to satisfy the high sanitation and marketing standards required. As a result, a greater portion of the fish products exported finds its way into the neighboring Dominican Republic market. Total fishery exports are estimated between 350 – 500 tons per year, with an estimated annual value of US\$6 – 7 million (CRFM, 2010). The main export species are lobster, conch, shrimp, octopus and crabs, while frozen horse mackerel, salted and sour herring constitute some of the main imports. The lobster fishery is one of the most important in Haiti with average annual export of approximately 147.71 tons between 1994-1999 (FAO 1999).

Jamaica

The Caribbean spiny lobster fishery is the second most lucrative export fishery in Jamaica. The export of lobsters increased significantly, from 0.68% of total fish exports in 1962 to 69% in 1995 (Kelly, 2003). Major export markets for Jamaican lobsters include the USA, Canada, Panama, Netherlands Antilles, Cayman Islands and Martinique in various forms, including frozen, live, fresh, dried salted or in brine (Kelly, 2003). The average price of whole lobster is US\$2.90/kg and of tails US\$9.70/kg. Up to 2001, the Jamaican spiny lobster export fishery earned an average of US \$4 – 6 million per year (CFRAMP, 2001). However, by 2007 the quantity and value of exports had decreased to 115 tons of lobster, valued at almost US\$1.8 million (Murray, unpub).

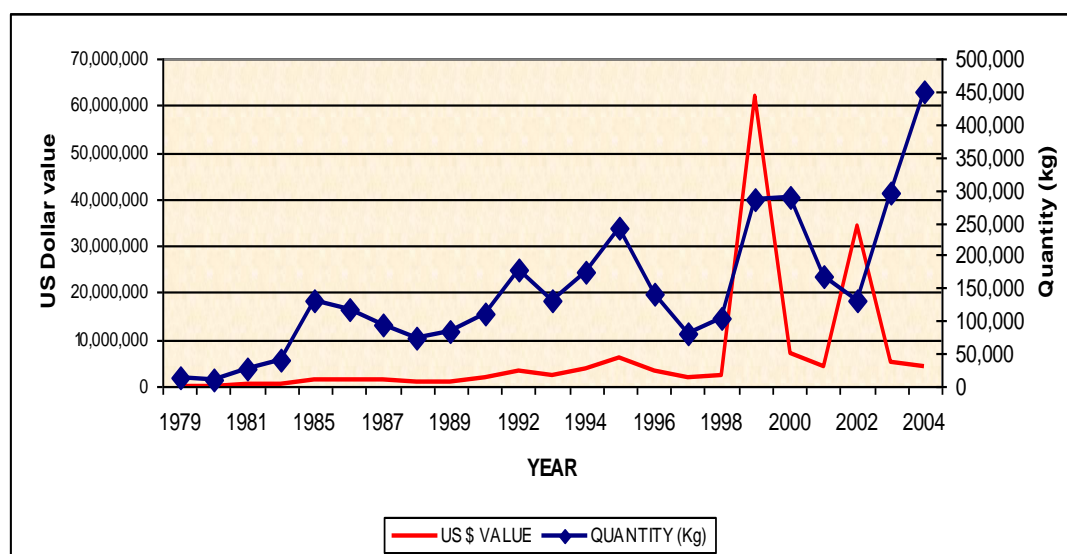


Figure 25: Export quantities and US\$ value of the spiny lobster for Jamaica period 1979 – 2004
(Statistical Institute of Jamaica)

Montserrat

Montserrat does not have a directed commercial fishery for Caribbean spiny lobster.

St. Kitts and Nevis

Dating back to the early 1970s, fishermen from St. Kitts and Nevis have been engaged in exportation of live lobsters to Puerto Rico, the U.S.A and the British Virgin Islands (CFRAMP, 1997). Lobster exports have decreased considerably over the years and, only minimal quantities are exported (CFRAMP, 1997). Nowadays, the export fishery for Caribbean spiny lobster in St. Kitts and Nevis remains primarily intra-regional, with approximately 19-37% of landed lobsters exported to the French Islands, Montserrat and Anguilla (Luckhurst & Marshalleck, 1995; Gittens & Haughton, unpub). Export figures for Nevis are presented in Table 9 below.

Table 9: Caribbean spiny lobster export and value for Nevis 1996 – 2000 (adapted from CFRAMP, 2001)

Year	Export (lb)	Value (USD)
1996	2253.12	11,070
1997	0	0
1998	3220.95	15,830
1999	11514.74	56,670
2000	8406.23	41,371

Saint Lucia

Until 1993 Saint Lucia prohibited the export of lobster, yet it was known to be illegally exported to the neighbouring island of Martinique (CFRAMP, 1997). Exports have been permitted since 1993; however, the quantity of spiny lobsters landed by fishers is not sufficient to meet export demand. As such, most of the lobsters landed are used domestically, sold locally to hotels, restaurants and the general public (Joseph A. , pers. comm).

St. Vincent and the Grenadines

In terms of export revenue generated, the spiny lobster fishery is one of the most valuable fisheries in St. Vincent and the Grenadines. Approximately 25 tons are exported annually and an estimated 10-20% of the catch is consumed locally (FAO, 2002). Tuna and lobster together account for more than 75% of fish exports (FAO, 2002b). Major export markets for spiny lobster from St. Vincent and the Grenadines include neighbouring Caribbean islands such as Anguilla, Barbados, Grenada, Martinique, St. Lucia, Trinidad and Tobago, as well as the USA, with marketing routes by sea and air (Headley & Singh-Renton, 2008).

Suriname

Suriname does not have directed commercial fishery for Caribbean spiny lobster.

Trinidad and Tobago

Trinidad and Tobago does not have a directed commercial fishery for Caribbean spiny lobster. These data provided (Table 10) are aggregated for all species of lobster, and are from the incidental fishery (Barran, *pers. comm.*).

Table 10: Lobster export and value for Trinidad and Tobago 1995 - 2007 (adapted from Barran, *pers. comm.*)

Year	Export (lb)	Value (US\$)
1995	12,238.6	97,924.44
1996	1,124.2	2,928.41
1997	1,977.8	15,057.46
1998	842.6	3,810.00
1999	14,715.8	48,142.54
2000	7,664.8	19,614.13
2001	8,670.2	25,948.57
2002	27,629.8	55,589.21
2003	66,035.2	122,698.41
2004	33,237.6	109,230.00
2005	48,166.8	109,274.60
2006	48,136	104,488.25
2007	12,689.6	32,017.14

Turks and Caicos

In the Turks and Caicos, the majority of landed lobsters end up at one of 5 processing plants, where they are prepared for export to international markets, mainly the United States (CRFM, 2007). While lobsters are generally landed whole, they are mostly exported as frozen tails (CRFM, 2007). Data on export quantities are presented in Table 11 below; however, data on export values and average market prices were not available at this time (Lockhart, *pers. comm.*)

Table 11: Export Quantities of Spiny Lobster Product 2005 – 2010 (source: Lockhart *pers. comm.*)

Year	Frozen Meat (lbs)	Frozen Tail (lbs)	Whole (lbs)
2005	9,800	202,825	-
2006	13,560	255,356	-
2007	8,800	177,770	1,237
2008	5,965	112,446	-
2009	600	14,684	-
2010	1,160	80,250.5	-

CONSERVATION AND MANAGEMENT MEASURES

Regional Overview

Governance

The trans-boundary nature of the resource, mobile fishing fleets and international aspects of the lobster trade closely link spiny lobster fisheries throughout the Caribbean; all of these require that utilization and

management of lobster fisheries be undertaken in a cooperative and coordinated manner at the regional level (Chakalall & Cochrane, 2007). Because sustainable fisheries are largely dependent on good governance, the importance of improving management measures in the CARICOM region cannot be overstated. Currently, control of fishing capacities and landings are rare, and a region-wide lack of enforcement and illegal fishing prevent effective management of the resource (Ehrhardt et al. unpub).

Lobster management in the Caribbean has been widely recognized by institutions such as the Gulf & Caribbean Fisheries Institute (GCFI), FAO (Food & Agriculture Organization), Western & Central Atlantic Fisheries Commission (WECAFC), Caribbean Regional Fisheries Mechanism (CRFM) and the Caribbean Fishery Management Council (CFMC). FAO/WECAFC has organized five workshops on spiny lobster, in cooperation with most regional agencies and institutions: Belize City, Belize (1997); Merida, Mexico (1998, 2000 and 2006); and, Havana, Cuba (2002). Participating countries include: Antigua & Barbuda, Bahamas, Belize, Brazil, Colombia, Costa Rica, Cuba, Dominican Republic, France (Guadeloupe and Martinique), Haiti, Honduras, Jamaica, Mexico, Nicaragua, Turks & Caicos, U.S.A and Venezuela. Over the course of these workshops, countries have agreed to:

- Minimum harvest size of 74 mm cephalothorax length (though nations with size limits greater than 76mm were encouraged to retain the larger limits)
- Manage fishing mortality so as to achieve sustainable use of the resource
- Taking more action to implement and enforce existing regulations, especially in regards to the high catches of juvenile lobsters.

In February 2005 Honduras and Nicaragua, under the auspices of OSPESCA (Central American Fisheries and Aquaculture Organization), signed a lobster agreement that established new lobster management regulations, including minimum tail weights, escape gaps on lobster traps, trap limits, and prohibition of sale of lobster tail meat without the shell (OSPESCA, 2005). The memorandum also encouraged other OSPESCA countries to sign similar agreements. At a Regional Workshop on the lobster fisheries in Central America held in Managua, Nicaragua, December 10-11, 2007, sponsored by OSPESCA, the delegates representing Central American fishery management agencies, artisanal fishers, industry, and other institutions developed an 18 point workshop accord, which addressed, among other things, a minimum harvest size for lobster tails of 140 mm (CFMC et al., 2008). Additionally, in May 2009, OSPESCA nations agreed to implement a region-wide ban on spiny lobster fishing during the species' reproductive season (March 1 – June 30) (World Wildlife Fund, 2010).

There are no standardized management measures specific to the *P. argus* fishery at a regional level within the Caribbean community; rather, management of the resource is unilaterally attempted in most countries. Regulations on minimum size, spawning season closures and no-take of berried females are among the most popular management strategies implemented in Caribbean spiny lobster fisheries (Ehrhardt, 2005). However, the minimum size adopted in these fisheries varies from one country to another (mostly due to market-driven factors), which in many cases, does not correspond with the minimum size required for 50% maturity and can lead to growth overfishing (Cochrane & Chakalall, 2001; IOCARIBE, 2007).

Research and Data Collection

Management of lobster fisheries in the CARICOM region faces serious problems because of limited knowledge of the fishery, biology and ecology of the species (CFRAMP, 1997). The majority of countries in the region are unable to organize and carry out regional programs for lobster research and management.

Data that can play a significant role in successful sustainable management of lobster fisheries can be generally categorized as socio-economic, statistical (i.e. catch & effort) and biological (Gittens & Haughton, unpub). Catch and effort constitute the minimum requirements for a simple assessment of a fishery (FAO 1980). While some forms of data were collected at some point by most of the governments in the CARICOM region (Table 12), a number of problems were noted, including: lack of manpower, lack of training, shortage of equipment, uncooperative fishers, lack of transportation and distance of sites; however, no country cited all of the problems mentioned (Gittens & Haughton, unpub). The overriding constraints were identified as shortage of staff and/or funding.

Table 12: Data Collected by CARICOM Countries Between 1990 – 2001 (adapted from Gittens & Haughton, unpub)

Data	Antigua & Barbuda	Bahamas	Belize	Grenada	Haiti	Jamaica	St Kitts & Nevis	Saint Lucia	St. Vincent & the Grenadines
SOCIO-ECONOMIC									
Export quantity									
Export value									
Work status of fishers									
Investment in fishery									
Income of fishers									
CATCH									
Weight									
Numbers per trip									
EFFORT									
Hours fishing									
Number of fishers									
Number of vessels									
Days at sea									
Number of traps									
BIOLOGICAL									
Tail width									
Length Measurement									
Spawning state of females									
Puerulus monitoring									

*Filled cells indicate data was collected at some point between 1990 and 2001; empty cells indicate data was not collected or was not reported to be collected in country reports.

Management Options

CARICOM countries have begun to impose species-specific regulations and management measures for the spiny lobster fishery, and many range States have now implemented some form of management for the fishery. However, the effectiveness of these measures is largely dependent on adequate knowledge of the stock status (size, distribution, abundance, etc.), other biological and morphometric criteria (location of nurseries and spawning sites, time of the spawning period, growth and maturity, etc.) and country-specific characteristics of the fishery (CITES, 2003).

Minimum size limits are typically used to protect a population's breeding stock, and are defined at a size that will allow individuals in a population the opportunity to breed at least once before being subject to harvest (CFMC et al., 2008). The U.S. imports millions of dollars of undersized lobster each year and, historically, most imports go undetected because of various enforcement loopholes that existed for international poachers (Kimmel & Rueter, 2007). Because management measures throughout the Caribbean region are not uniform, and enforcement is severely lacking, the U.S. has adopted minimum conservation standards on imports. Not only should limiting imports to a minimum size protect juvenile lobsters and help stabilize the species' reproductive potential, it should also limit the market for undersized lobster and serve as an incentive for countries that do not have size limit measures (CFMC et al., 2008). The newly enacted legislation stipulates that any spiny lobsters imported into the U.S. must meet the minimum weight requirement of 5 ounces and/or the minimum size requirements of 76.2 mm cephalothorax length or 139.7 mm tail length (Kimmel & Rueter, 2007).

Gear restrictions, such as banning the use of SCUBA, are seen as an important and effective management tool for reproductive stocks as it helps to preserve deep-water populations and important spawning stock refugia (Appeldoorn, 1997). Banning SCUBA and/or hookah diving can serve not only to effectively limit the areas (depths) that can be fished, thereby reducing fishing pressure, but may also help to prevent the serious health risks that are associated with unsafe diving practices (CFRAMP, 1997). However, banning SCUBA may increase the fishing pressure on shallow water stocks and potentially lead to increased exploitation of juveniles in shallower waters (Appeldoorn, 1997).

Seasonal closures to protect the stock during the most reproductively active months are in place in many CARICOM states. However, as mentioned previously, these closures are not always harmonized at regional or sub-regional levels, which may undermine their enforcement, because spiny lobster taken illegally in one country during a closed season could be landed legally in a neighbouring country. Perhaps seasonal harvest closures could be supplemented with a seasonal ban on processing, trade and exports of spiny lobster during the closed season, as is done for the Queen conch fishery in some Caribbean states, such as the Dominican Republic and Jamaica (CITES, 2003).

Closed areas in the form of "no take zones" or Marine Protected Areas (MPAs) have the potential to be a valuable ecosystem based management tool to protect spiny lobster populations. For instance, MPAs can help maintain spawning stock size at high densities, provide refuge to older specimens (which are known to be more fecund than younger adults) and can be an important source of larvae and new recruits to exploited areas ("spillover effect") (CITES, 2003). The creation of no-take marine protected areas in areas where lobsters spawn have resulted in demonstrable increases in lobster size and abundance within the MPA (Lipcius, Stockhausen, & Eggleston, 2001; Ehrhardt et al., unpub.). However, as with all management measures, the effectiveness of MPAs depends on a multitude of factors, such as: metapopulation source-sink dynamics (Crowder et al., 2000); management scheme; spatial aspects such as size, geometric configuration and location (Stockhausen & Lipcius, 2001); enforcement; and, the fraction of the stock ultimately protected by regulation (Ehrhardt et al., unpub.).

Trade controls are another possible management measure, such as listing *Panulirus argus* on the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES). CITES is an international treaty designed to ensure that international trade in listed species is legal and not detrimental to the survival of the species. Species are listed on one of three Appendices, each offering a different level of protection: Appendix I includes species in danger of extinction, for which commercial trade is prohibited; Appendix II includes species which, although currently not threatened with extinction, may become so without trade controls; and, Appendix III includes species identified by a CITES member country as being subject to national regulation for 'preventing or restricting exploitation' and for which the cooperation of other countries is needed to control the trade (Daves & Noguchi, 2007). Trade is regulated through a system of permits and certificates, with importing and exporting countries sharing the responsibility for ensuring that trade is legal (Daves & Noguchi, 2007). Brazil proposed listing *P. argus* and *P. laevicauda* (Brazil populations only) in Appendix II of CITES at the 14th meeting of the Conference of the Parties to CITES in June 2007. Although the proposal was withdrawn prior to consideration, CITES is a tool that may be useful for ensuring that international trade in spiny lobster is legal and sustainable (Daves & Noguchi, 2007); for example, the CITES Appendix II listing of queen conch (*Strombus gigas*) has proven to be a valuable complement to national management schemes for this species (Daves & Noguchi, 2007).

Table 13: Seasonal closures for *P. argus* in CARICOM countries

Country	Month											
	Jan	Feb	Mar	Apr	Ma y	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Anguilla	No closed season											
Antigua & Barbuda	No closed season											
Bahamas												
Barbados												
Belize												
Dominica	No closed season											
Grenada												
Guyana	No lobster fishery											
Haiti												
Jamaica												
Montserrat	No closed season											
St. Kitts & Nevis	No closed season											
Saint Lucia												
St. Vincent & the Grenadines												
Suriname	No lobster fishery											
Trinidad & Tobago	No lobster fishery											
Turks & Caicos												

Management Issues

While a few Caribbean countries have made significant strides in improving the assessment and management of their lobster fisheries, numerous authors such as Chakalall and Cochrane (2007), Martinez and others (2007), and Ehrhardt and others (unpub.) argue that a substantial number of management problems need to be urgently addressed across the region.

The open access nature of the fishery (primarily a concern in the artisanal sector) continues to be a region-wide problem, allowing fishing effort to grow at an uncontrollable and unsustainable pace in a number of countries (with the possible exceptions of Cuba and Florida) (Chakalall & Cochrane, 2007). In Cuba, centrally planned fishing operations are based on a projected and sustainable strategic biological catch and effort quota used to control fishing capacity; and, Florida has a number of well-enforced size and effort regulations in place, including a limit on the number of traps in the fishery over the past decade (Ehrhardt, Puga, & Butler, unpub.). Despite attempts to reduce fishing effort, neither Cuba nor Florida has reversed the continued decline in landings (Ehrhardt, Puga, & Butler, unpub.).

Scientists and fisheries managers all concur *P. argus* is fully or overexploited throughout its entire range (WECAFC 2006). Additionally, lobsters are being harvested below respective minimum size limits and below the size at first maturity, adversely impacting recruitment throughout the species' range (CFMC et al., 2008). Undoubtedly, the widespread violation of minimum size is one of the most serious factors undermining the sustainable management of *P. argus* in the Caribbean (Ehrhardt et al. unpub.). A high proportion of sub-adults in total catch can only be sustained at low fishing mortality rates; therefore, when determining maximum allowable fishing effort, countries need to take into account the catch of juveniles. A related issue is the preservation or building of lobster spawning stocks via the protection of large individuals. The exponential relationship between female lobster size and egg production is well established for *P. argus* (Ehrhardt, Puga, & Butler, unpub.). In addition, there is evidence for *P. argus* that male size may also affect reproductive success via sperm limitation (Ehrhardt et al., unpub.). Thus, there is good reason for some degree of protection for large lobsters, of both sexes, which together contribute far greater to egg production than smaller individuals (Bertelson & Mathews, 2001).

Chakalall and Cochrane (2007) also identify artisanalisation of the fishery as a regional management concern, arguing that it tends to lead to more vessels and more dispersed fishing and landing sites, making the fishery harder to regulate. Catch and effort statistics are generally difficult to collect in meaningful time and space scales in artisanal fisheries; this precludes more accurate analysis of the regional characteristic of the fisheries as well as the effectiveness of fishery management (Ehrhardt, 2001). Artisanalisation and lack of alternative livelihoods can also lead to a reduction in the opportunity costs of fishing which, in unregulated fisheries, depresses the bio-economic equilibrium thereby increasing the likelihood of further reductions in the current status of the stocks (Chakalall & Cochrane, 2007).

Illegal, unregulated and unreported (IUU) fishing is a major problem in the region, particularly in the southern parts, and is often linked to illegal and unreported intraregional trade (Chakalall & Cochrane, 2007). Chakalall and Cochrane (2007) stress that governments need to be aware of the fact that illegal fishing increases the total fishing mortality and argue that legal fishing mortality may need to be reduced to compensate for this in order to avoid over-exploitation.

As mentioned earlier, minimum size violations are rampant and most likely impacting the reproductive capacity of the local populations. For example, in the Honduran fishery, about 60% of the landings (by weight) are undersized spiny lobsters while in Nicaragua the figure is about 30% (Ehrhardt N. M., 2005). This percentage is thought to be grossly underestimated given the extraordinary level of contraband of illegal lobsters that is known to exist from Nicaragua into Costa Rica, Colombia (San Andrés Island) and Honduras. The U.S. Department of Commerce detected the influx of illegal lobsters into the U.S. market

during the period 1996–2003 and levied significant fines on the transgressors, including jail terms. While this action may have stymied imports into the U.S., it also resulted in increased marketing of undersized lobsters in Central America and the Caribbean (Ehrhardt N. M., 2005).

Another significant issue the fishery faces is the practice of leaving traps in the water, where they continued to “ghost” fish during the closed season (Chakalall & Cochrane, 2007). This issue results from the excessive number of traps used in the fishery (up to 6000 traps per vessel), which would require a number of trips to and from the fishing grounds to retrieve. Ehrhardt and others (unpub.) argue that this cryptic mortality by ghost gear may be very large and its effect on stock productivity and reproductive potential could be substantial.

Concerns have also been raised about the increasing use of artificial habitats (casitas) in some countries, which leads to increases in fishing efficiency and fishing power. It also leads to a higher proportion of juvenile lobsters being caught (Chakalall & Cochrane, 2007); for example, in Florida between 100,000 and 300,000 juvenile spiny lobsters are used seasonally as attractants in traps, and although this practice makes traps significantly more efficient, the biological impact on future spawning potential fecundity and biomass production is estimated to be quite large (Ehrhardt, Puga, & Butler, unpub.).

Little or no progress has been made in enforcement and compliance with current management measures since the 2002 WECAFC workshop in Havana, Cuba (Chakalall & Cochrane, 2007). Generally, in most countries, fishers and the fishing industry try to obtain the maximum landings every season and enforcement of fishery management regulations range from limited to non-existent in most countries, with the notable exception of Florida and Cuba. This lack of enforcement is largely responsible for the egregious violation of the minimum sizes and, at present, is beyond the control of regional and national management agencies (Ehrhardt, Puga, & Butler, unpub.). Additionally, weak compliance across the region remains generally high (Chakallal & Cochrane 2008). No attempts to manage these valuable fisheries will succeed in the absence of adequate enforcement (Ehrhardt et al., unpub.).

The conditions under which some lobster divers operate in some countries, and the serious health risks posed (frequent fatalities and serious injuries) is a serious region-wide management concern (Chakalall & Cochrane, 2007). In some countries, 33% of the crew was involved in accidents in a single fishing season (Chakalall & Cochrane, 2007).

Finally, and very significantly, weak research and management capacity is prevalent in a number of countries throughout the region, as are deficiencies in the quality and nature of data to advise on lobster management (Chakalall & Cochrane, 2007). Additionally, in most countries, there is little input from the local level into the policy cycles at higher levels resulting in fractured vertical linkages and dysfunctional policy cycles at multiple levels (IOCARIBE, 2007).

COUNTRY PROFILES

Anguilla

In Anguilla, regulations specific to the Caribbean spiny lobster fishery include (Gumbs 2010 *pers. comm.*):

- Minimum size limits (carapace length >95 mm; tail weight >200g or 7.05 oz)
- Prohibition on taking berried, tar-spotted or moulting individuals
- Prohibition of the stripping of egg-bearing females

- Prohibition on taking lobsters by spear gun, harpoon or hook of any description

Lobsters must be landed whole, unless they are processed at sea by the holder of and in accordance with the terms of a Process Export License. Anguilla's Fisheries Legislation also makes provisions for closed seasons, which can be implemented at any time for the spiny lobster as well as the spotted spiny lobster. No official closed season is currently in place (Gumbs 2010 *pers. comm.*).

Antigua and Barbuda

In Antigua and Barbuda, regulations specific to the Caribbean spiny lobster fishery according to the Fisheries Act, Fisheries Regulations and Fisheries Management Plan, include:

- Minimum size limits (carapace length ≥ 95 mm; tail weight ≥ 7 oz)
- Prohibition on capture, possession or sale of berried or moulting individuals
- Prohibition on removal of eggs from a spiny lobster
- Gear restrictions (mesh sizes for pots and nets)
- Prohibition on taking lobsters by any method other than hand, loop, pot or trap.

The Regulations require lobster to be landed whole. Regarding traps or pots, the minimum allowable mesh size for the wire covering the gear is 3.81 cm or 1½ inches. The Regulations also makes provisions for a closed season by Notice published in the *Gazette*.

With the enactment of the draft amended fishing regulations in 2010, the lobster fishery will move from an open access to a limited entry management regime through the use of special permits. The removal of the tar spot or spermatophore from the lobster will become an offence under the regulations. In addition, a closed season shall commence from the 1st day of May to the 30th day of June of every year. These measures are to improve management of total fishing effort and offer some protection during the peak spawning period, thereby contributing to long term sustainability. The Fisheries Division will issue lobster gauges to fishers so that they can readily determine undersize lobster (Fisheries Division, 2010).

Antigua and Barbuda has recently established two reserves: the Codrington Lagoon National Park (CLNP) and Northeast Marine Management Area (NEMMA). CLNP covers 3600 hectares and is the largest and best preserved wetland complex of Antigua and Barbuda. The area is a primary nursery site for lobsters and fish species (Environment Division of Antigua and Barbuda, 2009). NEMMA was established in 2005 and is located on the North-east coast of Antigua; it protects mangroves, coral reefs, seagrass beds, as well as some terrestrial ecosystems (Jackson, 2007). Both reserves have a multistakeholder management structure (Horsford 2011 *pers. comm.*).

Bahamas

In the Bahamas, regulations specific to the Caribbean spiny lobster fishery according to the Fisheries Act include:

- Minimum size limits (carapace length < 82.55 mm; tail length < 139.7 mm)
- Prohibition on capture, possession or sale of berried individuals
- Closed season between April 1st – July 31st
- Prohibition on possession of a spiny lobster that has had the swimmerettes removed
- Prohibition on the removal of the eggs from a spiny lobster

Barbados

In Barbados, regulations specific to the Caribbean spiny lobster fishery according to the Fisheries Act include:

- Prohibition on harvest of berried individuals or removal of eggs
- Closed season
- Marine Protected Areas

Belize

In Belize, regulations specific to the Caribbean spiny lobster fishery according to the Fisheries Act include:

- Minimum size limits (carapace length >3 inches; tail weight >4 oz)
- Prohibition on taking berried or moulting individuals
- Closed season between February 15th – June 14th
- Prohibition on landing dead lobsters
- Prohibition on use of spearguns, hookah, SCUBA and explosives
- Prohibition on lobster fishing in marine reserves and the foreereef

Dominica

In Dominica, regulations specific to the Caribbean spiny lobster fishery according to the Fisheries Act include:

- Minimum size limits (not specified)
- Prohibition on taking berried or moulting individuals
- Closed season (not specified)
- Prohibition on landing dead lobsters
- Prohibition on use of SCUBA, spearguns and loops

The lobster fishery appears to be largely unregulated in Dominica as these regulations are currently not in force but, rather, used as a matter of policy.

Grenada

In Grenada, regulations specific to the Caribbean spiny lobster fishery according to the Fisheries Regulations include:

- Minimum size limits (carapace length > 90 mm)
- Prohibition on taking berried or moulting individuals
- Closed season between May 1st – August 31st
- Prohibition on landing dead lobsters
- Prohibition on landing lobsters which are not whole
- Prohibition on possession of lobster that has been speared or hooked.

Guyana

Guyana has no management regulations specific to Caribbean spiny lobster as there is no directed commercial fishery for this species.

Haiti

Fishing regulations in Haiti are scant, as there is a lack of policy, legal, institutional and administrative frameworks to ensure the sustainable use, management and conservation of Haiti's fisheries resources. Regulations specific to the Caribbean spiny lobster fishery according to the The Fisheries Law of 1977 include:

- Closed season between April 1st – September 30th
- Registration of fishers

There is generally no monitoring, surveillance or enforcement of fisheries regulations due to lack of resources and equipment, limited organizational capacity, lack of personnel, poverty and political instability (Mateo & Haughton, 2003). Additionally, it has been reported that as much as 70% of the catches taken by traps are juveniles, with a total length of less than 10 cm (Ferry and Kohler 1987 cited in Mateo and Haughton 2003). Puga and others (1998) (cited in Mateo and Haughton 2003) reported that, in Aquin Bay, more than 90% of lobsters caught are juveniles.

Jamaica

In Jamaica, regulations specific to the Caribbean spiny lobster fishery according to the Fishing Industry Act include:

- Minimum size limits (carapace length > 89 mm)
- Prohibition on taking berried or moulting individuals
- Closed season between April 1st – June 30th
- Limited access system for industrial fishery controlling number of vessels
- End of season declarations of lobster by processors and inspections of fish processing plants, hotels, beaches and restaurants

Evidence from catch and effort data indicates that landings of lobster continue throughout the closed season (CRFM 2007). In the past, concerns were raised as to whether the closed season in Jamaica was related to the peak spawning period for lobsters. Available scientific data showed two spawning peaks in Jamaica: the larger peak occurs during spring and coincides with the current closed season (April – June), while the smaller spawning peak occurs during late summer (CFRAMP, 1997).

Montserrat

Montserrat currently has no regulations specific to the Caribbean spiny lobster fishery (Anon., 1997).

St. Kitts and Nevis

In St. Kitts and Nevis, regulations specific to the Caribbean spiny lobster fishery according to the Fisheries Act include:

- Minimum size limits (carapace length > 95mm)
- Prohibition on taking berried or moulting individuals
- Ban on landing lobsters which are not whole
- Prohibition on use of spearguns and SCUBA
- Requirement for marking of traps

Saint Lucia

In Saint Lucia, regulations specific to the Caribbean spiny lobster fishery according to the Fisheries Act and Fisheries Regulations include:

- Minimum size limits (carapace length > 95mm)
- Prohibition on taking berried or moulting individuals
- Closed season between May 1st – August 31st
- Restrictions on fishing gear
- Prohibition on use of spearguns, hooks and SCUBA
- Limited entry for pot fishers

It should be noted that the limited entry system for the pot fishery was abandoned in 2003, in its third year of its implementation, because the response from fishers was so poor (Joseph W. , 2003).

In St. Lucia, the fishery is closed from May 1 – August 31. However, a maturity study conducted by Joseph (2001) noted that peak periods of spawning in the southeast were in February and September to December, which is during the fishing season, such that spawning individuals are not protected during this critical time in their life cycle. In the southwest, peak periods of spawning were found in January and March to July, which spans the end of the fishing season and part of the closed season. It appears as though the closed season coincides with a period when very few or no berried spiny lobsters were encountered in the catches. For effective management, seasonal closures should at least coincide with the peak periods of spawning or breeding activity (Joseph W. , 2003).

The fishery has been severely under-recorded by the national fisheries data collection program since landings are often decentralized and not within the areas of operation of the data collectors (Joseph W., 2003). Further, a study by Joseph (2001) revealed that, on average, between 20-44% of the landings were of undersized lobsters. This clearly has serious implications to the long term sustainability of the population, including: increased mortality of juveniles, decreased yield and potential economic returns compared to if the lobsters were allowed to remain longer in the fishery, effects on spawning biomass if the undersized lobsters are caught below the size of sexual maturity (Joseph W. , 2001).

During the closed season, lobsters caught tend to be stockpiled in holding traps in shallow waters until the start of the open season. Despite it being illegal to harvest berried and undersized lobsters, some fishers keep them in traps as attractants and, in the case of berried lobsters, until they have spawned – which possibly leads to a high rate of mortality (Joseph W. , 2003).

St. Vincent and the Grenadines

In St. Vincent and the Grenadines, regulations specific to the Caribbean spiny lobster fishery according to the Bird and Fish Protection Ordinance include:

- Minimum size limits (>22.86 cm total body length; >24 oz whole weight)
- Prohibition on taking berried or moulting individuals
- Closed season between May 1st – August 30th

Suriname

Suriname has no management regulations specific to Caribbean spiny lobster, as there is no directed commercial fishery for this species.

Trinidad and Tobago

Trinidad and Tobago has no management regulations specific to Caribbean spiny lobster, as there is no directed commercial fishery for this species.

Turks and Caicos

In Turks and Caicos, regulations specific to the Caribbean spiny lobster fishery according to the Fisheries Protection Ordinance, the Fisheries Limit Ordinance and the Fisheries Management Plan include:

- Minimum size limits (carapace length > 82.55 mm; tail weight > 5 oz)
- Prohibition on taking berried, tar spotted, or moulting individuals
- Closed season (April 1st – June 30th)
- Gear restrictions
- License restrictions
- Prohibition on use of SCUBA or hookah diving

Table 14: Summary of status, management objectives and current regulations for *P. argus* fisheries in CARICOM countries.

Country	Resource Status	Management Objectives	Current Regulations
Anguilla	<ul style="list-style-type: none"> Fully exploited 		<ul style="list-style-type: none"> Minimum size limits (carapace length > 95 mm or 7.05oz) Prohibition on taking berried or tar-spotted females Prohibition on taking moulting individuals Prohibition on taking lobsters by spear gun, harpoon or hook of any description
Antigua & Barbuda	<ul style="list-style-type: none"> Fully exploited Sustainable at current levels of fishing 	<ul style="list-style-type: none"> Rebuilding stocks in depleted areas 	<ul style="list-style-type: none"> Minimum size limits (carapace length \geq 95 mm) Prohibition on taking berried or moulting individuals Prohibition on removal of eggs from a spiny lobster Gear restrictions Prohibition on taking lobsters by any method other than hand, loop, pot or trap
Bahamas	<ul style="list-style-type: none"> Unknown (large degree of uncertainty) Recent declines in landings Fisheries Department considers stocks in fairly good condition 		<ul style="list-style-type: none"> Minimum size limits (carapace length >82.55 mm and tail length >139.7 mm) Prohibition on capture, possession or sale of berried individuals Closed season (1 April – 31st July) Ban on possession of lobster with swimmerettes removed Prohibition on removal of eggs from a spiny lobster

Country	Resource Status	Management Objectives	Current Regulations
			<ul style="list-style-type: none"> Vessels operating with a sportfishing permit are allowed only 10 lobster onboard at any time
Barbados	<ul style="list-style-type: none"> Unknown Anecdotal evidence suggests increase in abundance 	<ul style="list-style-type: none"> To promote the sustainable harvest of lobster for domestic use and the local tourism market in order to achieve the maximum economic return from the resource over the long run 	<ul style="list-style-type: none"> Prohibition on harvest of berried individuals or removal of eggs Closed season Marine Protected Areas
Belize	<ul style="list-style-type: none"> Overexploited Threatened by increase in effort, inadequate management, alteration to habitat and lack of research 	<ul style="list-style-type: none"> Ensure catch does not exceed sustainable levels Discourage destructive fishing practices Improve management through national and international collaborations 	<ul style="list-style-type: none"> Minimum size limits (carapace length >3 in. and tail weight >4 oz.) Prohibition on taking berried or moulting individuals Closed season (15th Feb – 14th June) Ban on landing dead lobsters Prohibitions on use of SCUBA, hookah, spearguns and explosives No fishing in marine reserves or on the forereef

Country	Resource Status	Management Objectives	Current Regulations
Dominica	<ul style="list-style-type: none"> Populations of the south and west coasts have declined in abundance and size Stocks off northeast coast considered in better shape 	<ul style="list-style-type: none"> Rebuild stocks in depleted areas 	<ul style="list-style-type: none"> Minimum size limits (not outlined) Prohibition on taking berried or moulting individuals Closed season (not outlined) Ban on landing dead lobsters Prohibitions on use of SCUBA, spearguns and loops <p>*Note: Regulations are not currently in force but used as a matter of policy</p>
Grenada	<ul style="list-style-type: none"> Overexploited in nearshore areas Increasing scarcity in traditional fishing areas 	<ul style="list-style-type: none"> Promote sustainable harvest for local (tourism market) use and export in order to achieve long term economic benefits Rebuild stocks in depleted areas 	<ul style="list-style-type: none"> Minimum size limits Gear restrictions Prohibition on taking berried or moulting individuals Closed season Ban on landing dead lobsters
Guyana	Guyana does not have a management plan for lobster		
Haiti	<ul style="list-style-type: none"> Overexploited 	<ul style="list-style-type: none"> Rehabilitation of degraded habitats Training of fishermen in basic literacy and more advanced topics such as fisheries assessment and management Fish stock assessments 	<ul style="list-style-type: none"> Fisher registration Closed season (April 1 – September 30)
Jamaica	<ul style="list-style-type: none"> Overexploited 	<ul style="list-style-type: none"> Restore/rehabilitate fishery Control and monitor processing activities Optimize foreign exchange earnings Protect and enhance lobster habitat 	<ul style="list-style-type: none"> Minimum size limits Prohibition on taking berried individuals End of season declaration of lobster by processors Closed season (April 1 – June 30) Gear restrictions (industrial fishery only)

Country	Resource Status	Management Objectives	Current Regulations
			<ul style="list-style-type: none"> No fishing in marine reserves
Montserrat	<ul style="list-style-type: none"> Lobster populations off west coast have declined in size and abundance Lobsters off east coast in relatively better shape 	<ul style="list-style-type: none"> Rebuild stocks in depleted areas (particularly off west coast) 	<ul style="list-style-type: none"> None
St. Kitts & Nevis	<ul style="list-style-type: none"> Overexploited in nearshore areas Increasing scarcity in traditional fishing areas 	<ul style="list-style-type: none"> Rebuild stocks in depleted areas 	<ul style="list-style-type: none"> Minimum size limits Restrictions on fishing gear Prohibition on taking berried or moulting individuals Closed season Ban on taking lobsters that are not whole Prohibition on use of speargun and SCUBA Requirement for marking of traps
St. Lucia	<ul style="list-style-type: none"> Overexploited in nearshore areas Increasing scarcity in traditional fishing areas 	<ul style="list-style-type: none"> Sustainable exploitation of stocks 	<ul style="list-style-type: none"> Minimum size limits Gear restrictions Prohibition on taking berried or moulting individuals Closed season Prohibition on use of spearguns and

Country	Resource Status	Management Objectives	Current Regulations
			SCUBA <ul style="list-style-type: none"> • Requirement for marking of traps • Limited entry for pot fishers
St. Vincent & the Grenadines	<ul style="list-style-type: none"> • Overexploited in nearshore areas 	<ul style="list-style-type: none"> • Rebuild stocks in depleted areas • Sustainable management of the resource 	<ul style="list-style-type: none"> • Minimum size limits • Gear restrictions • Prohibition on taking berried or moulting individuals • Closed season (May through August)
Suriname	Suriname does not have a management plan for lobster		
Trinidad & Tobago	Trinidad & Tobago does not have a management plan for lobster		
Turks & Caicos	<ul style="list-style-type: none"> • Fully exploited/stable 	<ul style="list-style-type: none"> • Reduce fishing effort • Stabilize fluctuations in the fishery • Improve control over size at 1st capture • To increase revenues • Reduce catches made during the closed season 	<ul style="list-style-type: none"> • Minimum size limits (CL>82.55 mm; tail>5 oz) • Prohibition on taking berried individuals • Closed season (April 1st – June 30th) • Ban on SCUBA/hookah diving • Licensing for all fishers, vessels and processing plants

RECOMMENDATIONS AND CONCLUSION

At the regional level, there are many critical steps that need to be taken towards ensuring the long-term sustainability of Caribbean spiny lobster fisheries in the CARICOM region. As a starting point, recommendations include:

1. Improved data collection and regional standardization of data types

The collection of statistical, biological and socio-economic data needs to be strengthened across the region, as it is the foundation of a successful management system. At minimum, catch and effort data should be gathered towards the undertaking of stock assessments. Additionally, it is important that CRFM work with member countries to ensure data collection is standardized (i.e. units, indicators etc.), so that comparisons can be made across countries and over time.

2. Harmonized regulations at the sub-regional level

A region wide lack of harmonization of management measures may undermine their enforcement, particularly with respect to minimum size regulations and closed seasons; for example, spiny lobster taken illegally in one country during a closed season could be landed legally in a neighbouring country. It is recommended that size at first maturity studies be completed across the region with the aim to harmonize the legal size. Additionally, a review of the closed seasons (i.e. why & when) should be completed to ensure they maximize overlap with periods of peak reproduction. Similar to the initiative undertaken by OSPESCA, where possible, the closed seasons should be harmonized in the CARICOM region.

3. Review and reform governance systems at local, national and sub-regional levels

In order to improve the functioning of multi-level governance cycles through more effective vertical and lateral linkages, it is recommended that a review of the management systems for lobster fisheries at each level (i.e. local, national, sub-regional) be conducted. Currently, the management structure across the region is largely centralized, top-down and vertical, reducing the effectiveness of, and compliance with, fishing regulations. The policy-making process needs to be more collaborative and participatory, incorporating stakeholder opinions into the establishment of management measures. Without properly defined policies, local and regional fishery sustainability may not be achievable (Ehrhardt N. M., 2005).

4. Assess and control the illegal lobster fishery

High market demand for undersize lobster, prompting rampant violation of minimum size regulations, is one of the most serious issues undermining the sustainable management of lobster stocks in the Caribbean (Ehrhardt et al., unpub.). While the volumes of illegal spiny lobster may not be as significant as those taken by the commercial lobster fleet, they are exploited with no controls, regulations, or enforcement. Ehrhardt et al. (unpub.) consider this practice as likely responsible for the largest fraction of the depletion observed in spiny lobster stock. Accordingly, an assessment of the impact of this illegal fishery on lobster populations is needed, along with the creation of a strong disincentive/enforcement program.

Upon review of available information, it is clear that scientists and fishery managers alike all concur the Caribbean spiny lobster is fully or overexploited throughout its entire range. Currently, CARICOM countries seem to lack the political will necessary to safeguard the future of the resource. Given the socio-economic importance of *P. argus* fisheries as a source of livelihood and foreign exchange earnings across the Caribbean region, the need for bold and immediate management action cannot be overstated.

WORKS CITED

- Anon. (1996). *Plan for Managing the Marine Fisheries of Grenada*. CARICOM Fisheries Unit.
- Anon. (1997). *Plan for Managing the Marine Fisheries of Montserrat*. Fisheries Division. Groves: CARICOM Fisheries Unit.
- Anon. (1997). *Plan for Managing the Marine Fisheries of St. Kitts and Nevis*. CARICOM Fisheries Unit.
- Anon. (2004). *Plan for Managing the Marine Fisheries of St. Vincent and the Grenadines*. Kingstown: CARICOM Fisheries Unit.
- Appeldoorn, R. (1997). Deep Water Spatial Variability in the Morphology of Queen Conch and its Implication for Management Regulations. In CFRAMP, *Lobster and Conch Subproject Specification and Training Workshop*. Kingston, Jamaica: CARICOM Fishery Research Document No. 19.
- Arce, A., & de Leon, M. E. (2001). *FAO Western Central Atlantic Fishery Commission Report on the FAO/DANIDA/CFRAMP/WECAF Regional Workshops on the Assessment of Caribbean Spiny Lobster*. Rome: FAO Fisheries Report.
- Behringer, D., Butler IV, M. J., & Shields, J. D. (2008). Effect of PAV1 Infection on Caribbean Spiny Lobster (*Panulirus argus*) Movement, Condition, and Survival. *Journal of Experimental Marine Biology*, 359, 26-33.
- Belize Fisheries Department. (2008). *Assessment of the Lobster Fishery by Renato Guervarra and Ramon Carcamo*. Belize City: unpub.
- Belize Fisheries Department. (2009). *Fisheries Statistical Report 2009*. Belize City: Belize Fisheries Department.
- Bertelson, R., & Mathews, T. R. (2001). Fecundity Dynamics of Female Spiny Lobster (*Panulirus argus*) in a South Florida Fishery and Dry Tortugas National Park Lobster Sanctuary. *Marine Freshwater Research*, 52, 1559-1565.
- Bethel, G., Cruz, R., Deleveaux, V., Harper, D., Luckhurst, B., Joseph, W., et al. (2001). Region 4: Bahamas, Bermuda, North Cuba, St. Lucia, Turks and Caicos Islands and the United States of America. In FAO, *Report of the Second Workshop on the Management of Caribbean Spiny Lobster Fisheries in the WECAFC Area* (Vol. 619). Havana, Cuba: FAO Fisheries Report.
- Blue Ocean Institute. (n.d.). *Country Profile: Monserrat*. Retrieved June 24, 2010 from Project Global: Global Bycatch Assessment of Long-Lived Species: <http://bycatch.env.duke.edu/regions/Caribbean/Montserrat.pdf>
- Butler IV, M., Behringer, D. C., & Shields, J. D. (2008). Transmission of *Panulirus argus* Virus 1 (PAV1) and its Effect on the Survival of Juvenile Caribbean Spiny Lobster. *Diseases of Aquatic Organisms*, 79, 173-182.
- Carcamo Jr., R. (2003). Report on the Spiny Lobster Fisheries of Belize. In FAO, *Report of the Second Workshop on the Management of Caribbean Spiny Lobster Fisheries in the WECAFC Area* (Vol. 715). Havana: FAO.

CFMC; NMFS; GMFMC; SAFMC. (2008). *Final Amendment 4 to the Fishery Management Plan for the Spiny Lobster Fishery of Puerto Rico and the U.S. Virgin Islands and Amendment 8 to the Joint Spiny Lobster Fishery Management Plan of the Gulf of Mexico and South Atlantic*. Caribbean Fishery Management Council, National Marine Fisheries Service, Gulf of Mexico Fishery Management Council & South Atlantic Fishery Management Council.

CFRAMP. (2001). Country Report Nevis: Lobster and Conch Data Collection Program and Research Activities. *Lobster and Conch Terminal Workshop*. Santo Domingo: CARICOM Fisheries Resources Assessment and Management Program.

CFRAMP. (1997). Lobster and Conch Subproject Specification and Training Workshop Proceedings. *CARICOM Fishery Research Document No. 19* (p. 290). Kingston: CARICOM Fisheries Unit.

CFRAMP. (2001). The Lobster Fishery of Jamaica: Lobster and Conch Workshop. *Lobster and Conch Terminal Workshop*. Santo Domingo: CARICOM Fisheries Resource Assessment and Management Program.

Chakalall, B., & Cochrane, K. (2007). Regional Cooperation for the Responsible Use of the Caribbean Spiny Lobster Resource. *Proceedings of the 60th Gulf and Caribbean Fisheries Institute*. Punta Cana: GCFI.

Chavez, E. A. (2007). Socio-economic Assessment for the Management of the Caribbean Spiny Lobster. *Proceedings of the 60th Gulf and Caribbean Fisheries Institute*. Punta Cana.

Chavez, E. A. (2009). Socio-economic Harvesting Strategies of the Caribbean Spiny Lobster Fisheries for their Sustainable Exploitation. *unpub.*

Chavez, E. A., & Ley-Cooper, K. (2007). Forecasting Yield in a Spiny Lobster Stock of the Northern Mesoamerican Barrier Reef System. *Proceedings of the 59th Gulf and Caribbean Fisheries Institute*. GCFI.

Chavez, E. (2001). Policy Design for Spiny Lobster (*Panulirus argus*) Management at the Meso-American Barrier Reef System. *Crustaceana*, 74 (10), 1119-1137.

CITES. (2003). *Review of Significant Trade in specimens of Appendix II Species: Strombus gigas*. Geneva: Convention on International Trade in Endangered Species.

Claro, R., Baisre, J. A., Lindeman, K. C., & Garcia-Arteaga, J. P. (2001). Cuban Fisheries: Historical Trends and Current Status. In K. L. R. Claro (Ed.), *Ecology of the Marine Fisheries of Cuba* (pp. 194-218). Washington, DC: Smithsonian Institution Press.

Clerveaux, W., Puga, R., & Medley, P. (2002). *National Report on the Spiny Lobster Fishery of the Turks and Caicos Islands*. Retrieved June 9, 2010 from <http://www.fao.org/docrep/006/y4931b/y4931b0j.htm>

Cochrane, K. L., & Chakalall, B. (2001). The Spiny Lobster Fishery in the WECAFC Region - An Approach to Responsible Fisheries Management. *Marine Freshwater Research*.

CRFM. (2001). *Plan for Managing the Fisheries of Saint Lucia*. FMP, Caribbean Regional Fisheries Mechanism.

CRFM. (2008). Report of the Fourth Annual Scientific Meeting. *Fishery Management Advisory Summaries*. 2, p. 52. Kingstown: CRFM Fishery Report.

CRFM. (2010). *Report of the Multidisciplinary Survey of the Fisheries of Haiti*. Belize City: Caribbean Regional Fisheries Mechanism.

CRFM. (2007). Report of the Third Annual Scientific Meeting. *CRFM Fishery Report - 2007* (p. 183). Kingstown: CRFM.

Crowder, L., Lyman, S. J., Figueira, W. F., & Priddy, J. (2000). Source-sink population dynamics and the problem of siting marine reserves. *Bulletin of Marine Science*, 66, 799-820.

Daves, N., & Noguchi, L. (2007). CITES: A Tool for Regulation of International Trade in Spiny Lobster? *Proceedings of the 60th Gulf and Caribbean Fisheries Institute*. Punta Cana.

Ehrhardt, N. M. (2005). Population Dynamic Characteristics and Sustainability Mechanisms in Key Western Central Atlantic Spiny Lobster, *Panulirus argus*, Fisheries. *Bulletin of Marine Science*, 76 (2), 501-525.

Ehrhardt, N. (2001). Regional Review. In WECAFC, *Report on the FAO/DANIDA/CFRAMP/WECAFC Regional Workshops on the Assessment of the Caribbean Spiny Lobster (Panulirus argus)* (Vol. 619, pp. 12-17). FAO.

Ehrhardt, N., Puga, R., & Butler, M. I. (unpub.). *The Caribbean Spiny Lobster, Panulirus argus, Fisheries*.

Environment Division of Antigua and Barbuda. (2009). Codrington Lagoon National Park Barbuda Management Plan 2009-2019.

FAO. (2005). *Fishery Country Profile - Barbados*. Retrieved Nov 2, 2010 from <http://www.fao.org/fi/oldsite/FCP/en/BRB/profile.htm>

FAO. (2002). *Fishery Country Profile: St. Vincent and the Grenadines*. Retrieved July 1, 2010 from <http://www.fao.org/fi/oldsite/FCP/en/vct/profile.htm>

FAO. (1999). *Information on Fisheries Management in Barbados*. Retrieved September 8, 2010 from <http://www.fao.org/fi/oldsite/FCP/en/BRB/body.htm>

FAO. (2002). *Information on Fisheries Management in St. Vincent and the Grenadines*. Retrieved July 1, 2010 from <http://www.fao.org/fi/oldsite/FCP/en/VCT/body.htm>

FAO. (1993). *Marine Fishery Resources of the Antilles*. Rome: FAO Fisheries Technical Paper No. 326.

FAO. (2006). *Workshop on the Assessment and Management of the Caribbean Spiny Lobster*. Fishery Country Profile – Turks and Caicos Islands No. 826. pg. 59-64.

Fisheries Division. (2010). *Antigua and Barbuda's Plan of action to prevent, deter, and eliminate illegal, unreported and unregulated fishing*. Ministry of Agriculture, Lands, Housing and the Environment.

Fisheries Division. (2004). *Barbados Fisheries Management Plan 2004-2006: Schemes for the Management of Fisheries in the Waters of Barbados*. Ministry of Agriculture and Rural Development.

Gittens, L. (2001). *An Assessment of Recent (1996 - 2000) Biological and Socioeconomic Characteristics of the Jamaican Lobster (Panulirus argus) Fishery, With Implications for Future Management*.

Gittens, L., & Braynen, M. T. (2003). Report on the Spiny Lobster Fisheries of the Bahamas. In *Report of the Second Workshop on the Management of Caribbean Spiny Lobster Fisheries in the WECAFC Area*. Havana: FAO.

Gittens, L., & Haughton, M. O. (unpub). *A Regional Overview of Spiny Lobster (Panulirus argus) Resources in the CARICOM/CARIFORUM Countries*. Caribbean Regional Fisheries Mechanism.

Gongora, M. (2010). *Assessment of the Spiny Lobster (Panulirus argus) of Belize Based on Fishery-Dependent Data*. Belize Fisheries Department. Marine Fisheries Institute.

Gumbs, J. (2010, July 14). Director, Department of Fisheries and Marine Resources. Anguilla.

Headley, M., & Singh-Renton, S. (2009). *Components of the Spiny Lobster (Panulirus argus) Fishery Operations in St. Vincent and the Grenadines and Associated Socio-Economic Characteristics*. CRFM Research Paper Collection.

Headley, M., & Singh-Renton, S. (2008). The Socio-Economic Framework of the Spiny Lobster (*Panulirus argus*) Fishery in St. Vincent and the Grenadines and Associated Socio-economic Fishery Performance Indicators. *Proceedings of the 61st Gulf and Caribbean Fisheries Institute* (pp. 421-432). Gosier: GCFI.

Headley, M., & Singh-Renton, S. (2008). The Socio-Economic Framework of the Spiny Lobster (*Panulirus argus*) Fishery in St. Vincent and the Grenadines and Associated Socio-Economic Fishery Performance Indicators. *Proceedings of the 61st Gulf and Caribbean Fisheries Institute* (pp. 421-432). Guadeloupe: GCFI.

Hernkind, W., & Butler IV, M. J. (1994). Settlement of Spiny Lobsters, *Panulirus argus*, in Florida: Pattern without Predictability. *Crustaceana*, 67, 46-64.

Horsford, I. (1999). *A Socio-economic Survey of the Fishers of Barbuda – Implications for Planning and Development*. Fisheries Division, Ministry of Agriculture, Lands & Fisheries. Antigua.

Horsford, I. (2004). *Vessel Frame Survey 2001: Antigua – Barbuda*. Fisheries Division, Ministry of Agriculture, Lands & Fisheries. Antigua.

Horsford, I. (2006). Globalization Impact on Antigua and Barbuda's Fisheries Sector. *CSME Magazine*. Ministry of Finance and the Economy.

Horsford, I., & Archibald, M. (2006). Status of the Spiny Lobster Fishery of Antigua and Barbuda. *FAO Regional Workshop on the Assessment and Management of the Caribbean Spiny Lobster*, (p. 10). Merida.

Horsford, I., & Lovell, T. (2001). Country Report on Conch and Lobster for Antigua and Barbuda. *CFRAMP Conch and Lobster Terminal Workshop*.

Huitric, M. (2005). Lobster and Conch Fisheries of Belize: A History of Sequential Exploitation. *Ecology and Society*, 10 (1), 21-47.

IOCARIBE. (2007, June). Caribbean Large Marine Ecosystem (CLME) Project: Spiny Lobster Pilot Project. Cartagena, Colombia.

IOCARIBE. (2007). CLME Full Project Component 4: Spiny Lobster Pilot Project.

- Isaac, C. (2001). *Lobster Data Collection Programme and Research Activities: Grenada*. Grenada Fisheries Division.
- Jackson, I. (2007). Northeast Marine Management Area Management Plan. St. John's, Antigua.
- Joseph, A. (2010, August 30). Fisheries Biologist. Point Seraphine, Castries, Saint Lucia.
- Joseph, W. (2003). Report on the Lobster Fisheries of Saint Lucia. In FAO, *Report of the second Workshop on the Management of Caribbean Spiny Lobster Fisheries in the WECAFC Area*. (Vol. 715, p. 289). Havana: FAO Fisheries Report.
- Joseph, W. (2001). *Saint Lucia Country Report*. FAO.
- Kelly, R. (2003). Report on the Spiny Lobster Fisheries of Jamaica. In FAO, *Report of the Second Workshop on the Management of Caribbean Spiny Lobster Fisheries in the WECAFC Area*. Havana: FAO.
- Kimmel, J., & Rueter, J. (2007). Proposed Fisheries Management for Caribbean Spiny Lobster in the US Caribbean: Minimum Size for Imports. *Proceedings of the 60th Gulf and Caribbean Fisheries Institute*, (pp. 222-229). Punta Cana.
- Lipcius, R. N., Stockhausen, W. T., & Eggleston, D. B. (2001). Marine Reserves for Caribbean Spiny Lobster: Empirical Evaluation and Theoretical Metapopulation Recruitment Dynamics. *Marine Freshwater Research*, 52, 1589-1598.
- Lipcius, R., & Cobb, J. (1994). *Introduction*. (B. Phillips, J. Cobb, & J. Kittaka, Eds.) Oxford: Fishing New Books.
- Luckhurst, B., & Marshalleck, S. (1995). Current Status and Assessments of the Fisheries for Spiny Lobster and Conch in the CARICOM Region. *Proceedings of the 48th Gulf and Caribbean Fisheries Institute* (pp. 73-89). GCFI.
- MacDiarmid, & Butler, M. I. (1999). Sperm Economy and Limitation in Spiny Lobster. *Behavioral Ecology and Sociobiology*, 46, 14-24.
- Martinez, S., Monnereau, I., & Fanning, L. (2007). *CLME Full Project Component 4: Spiny Lobster Pilot Project*. Caribbean Large Marine Ecosystem Project.
- Mateo, J., & Haughton, M. (2003). A Review of the Fisheries Sector of Haiti with Recommendations for its Strengthening. *54th Proceedings of the Gulf and Caribbean Fisheries Institute*. 54, pp. 60-71. Belize City: CARICOM Fisheries Unit.
- McConney, P. (2003). *Grenada Case Study: The Lobster Fishery at Sauteurs*. Caribbean Conservation Association.
- McConney, P., & Baldeo, R. (2007). Lessons in Co-management from Beach Seine and Lobster Fisheries in Grenada. *Fisheries Research*, 87, 77-85.
- Mitchell, A. (1993). Notes on the Local Fishery and Import Trade for Spiny Lobsters in Barbados. *Proceedings of the 46th Gulf and Caribbean Fisheries Institute*. GCFI.

- Monnereau, I. and A.H.J. Helmsing. (2010). "Local Embedding and Economic Crisis: Comparing Lobster Chains in Belize, Jamaica and Nicaragua" in A.H.J. Helmsing and S. Vellema (eds) *Value Chains, Inclusion and Endogenous Development: Contrasting Theories and Realities*. Routledge Publishing Company. Abingdon.
- Monnereau, I. (2007). Social Impact on Human Well-Being of Different Governance Arrangements of Lobster Fisheries in the Caribbean. *Proceedings of the 60th Gulf and Caribbean Fisheries Institute* (pp. 230-232). Punta Cana: GCFI.
- Munoz-Nunez, D. (2009). *The Caribbean Spiny Lobster Fishery in Cuba: An Approach to Sustainable Fishery Management*. M.Sc., Duke University, Nicholas School of the Environment.
- Murray, A. (unpub). *The Use of Production Models and Length Frequency Data in Stock Assessments in Jamaica Fisheries, Building on the Caribbean Spiny Lobster Observations*. Jamaica Fisheries Division.
- Ninnes, C., & Medley, P. (1995). Fisheries Assessment and Management in the Turks and Caicos Islands. *Conch and Lobster Subproject Specification and Training Workshop*. Kingston: CFRAMP.
- Phillips, B., Cobb, J. S., & Kittaka, J. (1994). *Spiny Lobster Management*. Fishing News Books.
- Rennie, J. (2010, September 15). Chief Fisheries Officer. St. George's, Grenada.
- Riclet, E. (2001). Alarming Overexploitation of the Caribbean Spiny Lobster Stock in Martinique: Ecological Point of View and Recommendations. *Proceedings of the 52nd Gulf and Caribbean Fisheries Institute* (pp. 204-211). GCFI.
- Saul, S. (2004). *A Review of the Literature and Life History Study of the Caribbean Spiny Lobster, Panulirus argus*. National Marine Fisheries Service, Miami.
- Stanley, S. (2003). *Marine Region 7, The Wider Caribbean Region: A Global Representative System of Marine Protected Areas*. Retrieved June 17, 2010 from <http://www.deh.gov.au/coasts/mpa/nrsmmpa/global/volume2/chapter7.html>.
- Stockhausen, W., & Lipcius, R. N. (2001). Single large or several small marine reserves for Caribbean spiny lobster? *Marine and Freshwater Research*, 52, 1605-1614.
- Stoute, C. (2010, July 13). Dominica Fisheries Department.
- Toller, W. (2003). *Spiny Lobster (Panulirus argus) Fact Sheet*. Retrieved June 15, 2010 from http://bcrc.bio.umass.edu/vifishandwildlife/Education/FactSheet/PDF_Docs/14Lobster.pdf
- WECAFC. (2007). *Report of the Fifth Regional Workshop on the Assessment and Management of the Caribbean Spiny Lobster*. Western Central Atlantic Fisheries Commission. Merida: FAO Fisheries Report # 826.
- World Wildlife Fund. (2010). Retrieved June 24, 2010 from http://wwf.panda.org/about_our_earth/blue_planet/news/?uNewsID=189983
- WWF & PROARCA. (2004). *Spiny Lobster Marketing Chain*. Central American Commission for Environment and Development.

Wynne, S. (2009). *Size at Maturity, Breeding Seasons and Fishery Selectivity of Panulirus guttatus in Anguilla, British West Indies*. Government of Anguilla. Department of Fisheries and Marine Resources.