CARIBBEAN REGIONAL FISHERIES MECHANISM SECRETARIAT

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A REGIONAL OVERVIEW OF SPINY LOBSTER *PANULIRUS ARGUS*) RESOURCES IN CARICOM / CARIFORUM COUNTRIES

CRFM Secretariat, Belize

2008

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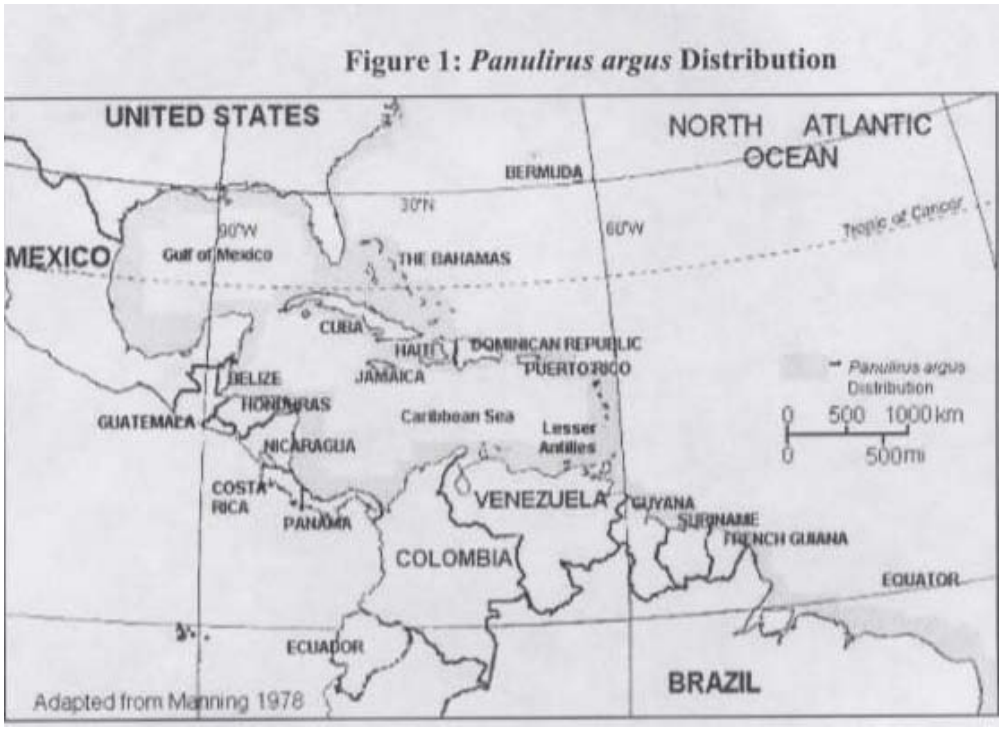
1.0 INTRODUCTION

1.1 Stock Distribution and Life History

Panulirus argus occurs from North Carolina in the United States of America and Bermuda in the north, to Rio de Janeiro, Brazil in the south (Figure 1). In an east-west direction, it occurs from the Antilles islands to the Gulf of Mexico (Manning 1978). It is usually found in coral reefs and rocky areas and is found in depths down to approximately 90 m (Cervignon et al. 1993 In FAO 2001).

Figure 1: *Panulirus argus* Distribution



The larvae of *P. argus* are planktonic in oceanic waters where they spend 6-10 months (Lewis et al. 1952, Baisre 1964, Sims and Ingle 1967. In FAO 2001). The larvae become distributed throughout the Caribbean during their period in the plankton (Alfonso et al. 1991, Baisre et al. 1978 In FAO 2001). This distribution of larvae makes it difficult to identify unit stocks and thus complicates providing effective management

Maximum settlement periods are during August to December (in Cuba, Mexico, Jamaica, Antigua, Costa Rica and Bermuda (FAO 2001). After the pueruli settle on clumps of red macroalgae *Laurencia spp.* (Marx and Hermkind 1985, Herrnkind and Butler 1986, Lalana et al. 1989 In FAO 2001) they moult and become post pueruli with a length of 6 - 15 mm CL (Fao 2001). Ten to fifteen months after settling post-pueruli become juveniles (Cruz et al. 1995, Davis 1978 In FAO 2001).

After leaving the settlement habitat juveniles inhabit coral reefs, sponges, caves and soft corals (Herrnkind et al. 1994 In FAO 2001). Juveniles are recruited in the fisheries between 76.0 mm CL and 76.8 mm CL (Davis 1978, Cruz et al. 1986 In FAO 2001). *P. argus* can live in excess of 12 years (Muller et al. 1999), can grow to about 500 mm and weigh 4.5 kg (Mote Marine Laboratory, undated).

A variety of predators feed on *P. argus* during their various life stages. Predators include sharks, rays snappers, groupers, octopus, dolphins and loggerhead turtles (Aiken 1985). *P. argus* feed on a wide variety of organisms including hard-shelled molluscs, starfish, urchins, small Crustacea and algae (Ibid).

Recent attempts to identify the stock/s suggest that no conclusive statements could be made on the existence of discrete stocks (FAO 2001). However, at least four possible sub-stocks were identified based

on the distribution of the species, the nature of the coastal shelf and the prevailing currents within the region. The sub-stocks cross international boundaries, which further complicates management of the *Panulirus argus* resource.

Four possible sub-stocks include:

- Colombia, Nicaragua, Honduras and Jamaica (South Central Stock)
- Brazil, possibly including Venezuela (Southern Stock)
- Mexico, Belize and southern Cuba (North Central Stock)
- Northern Cuba, United States of America (Florida), Bahamas, Turks and Caicos Islands and Bermuda (Northern Stock) (Ibid).

Other lobsters of commercial value in the CARICOM region include *Panulirus guttatus* and *Scyllarides aequinoctialis*. However, these species of lobster are landed on a much smaller scale and are used for local consumption.

1.2 Population Parameters and Stock Assessments

Growth rate estimates are made primarily using length based methods because of inability to age lobsters. Growth rates for *P. argus* range from $K = 0.15\ yr^{-1}$ for females in Bermuda (Evans 1988 In FAO 2001) to $K = 0.44\ yr^{-1}$ for males in the US Virgin Islands (Olsen and Koblic 1975 In FAO 2001). Many estimates of growth rates exist and show that growth rates are sex specific and vary throughout the region. This variation is possibly due to a number of factors including water temperature (Gulf of Mexico and South Atlantic Fishery Management Councils 1982 In Haughton and Shaul 1986), maturation (FAO 2001), availability of food, population density and method of estimation. This makes it difficult to ascertain the accuracy of growth estimates.

Total mortality and fishing mortality estimates show great variation throughout the region. Natural mortality estimates are usually based on empirical formulae and show a degree of variation as well. Recent mortality estimates are seen in Table 1.

Table 1: Recent *Panulirus argus* Mortality Estimates

Location	**Mortality**	**Instantaneous / Actual**		**Author**
	Estimate	Males	Females	
Pedro Bank	Z/A	2.19 / 82%	2.88 / 94%	Haughton and King (1989)
Brazil	Z/A	1 .27 / 72%		Fonteles-Filho In Mateo and Tobias 2001 in press
Mexico	Z/A	0.95 / 61%		Zetina and Rios (1998) In Mateo and Tobias in press
Florida	Z/A	1.19 / 70%	1 .09 / 66%	Muller et al. (1997) In Mateo and Tobias n press

Jamaica's south shelf	F/E	0.67 / 49%	0.72 / 51%	Present study
Mexico	F/E	0.7 / 50%		FAO 2001
Nicaragua	F/E	1.165/68.8%		FAO 2001
Brazil	F/E	-	0.3 / 26%	FAO 2001
Cuba	F/E	0.41 /34%		FAO 2001
St. Croix, USVI	Z/E	1.24-1.91	0.8 - 1.58	Mateo and Tobias in press
Caribbean	M	0.3 - 0.4		FAO 2001

Z = total instantaneous mortality; A = Total actual mortality, M = Natural Mortality
F = instantaneous fishing mortality; E = total actual mortality

The accuracy of mortality estimates are often questionable and are affected by but not limited to questionable growth estimates, migration, actual differences between populations and recruitment of larvae from neighbouring fisheries. The difficulty in accurately determining population parameters complicates assessing the status of a fishery and determination of optimum yield or fishing effort. Nevertheless biological assessments have proven to be a valuable aid to fisheries management and are of great value despite their associated problems. A more common and more reliable practice over the last decade is to use more than one method of estimation as well as sensitivity analysis. Managing a fishery based on the best science available is certainly better than arbitrarily managing a fishery. In addition, the best science available is constantly improving.

Reproductive activity occurs throughout the year but is generally higher in spring and summer months (i.e. March through July) (FAO 2001). There have also been reports of peaks in other months such as September-November for the Nicaraguan shelf (Castano and Cadima 1993 In FAO 2001).

In general, size at first maturity is 78-83 mm CL (FAO 2001). During copulation males deposit a waxy spermatophore on the underside of the females carapace. When the female is ready to incubate she may move several kilometres to the edges of reefs or coastal shelves (Buesa 1965 In FAO 2001). Eggs are extruded and passed over the spermatophore.

Fecundity varies with length and a variety of fecundity-length relationships have been calculated. For example, the following relationship was obtained by the Florida Department of Environmental Protection (Cox et al. 1997 in FAO 2001):

$E = 98.34L_T^2 - 1261651$ ($r^2 = 0.91$, n = 129, for size range 72 -141 mm)

Five percent (5%) of females die if their eggs are not fertilized (Butler et al. in press). The amount of eggs fertilized also depends on the size of the male that produced the spermatophore (Ibid). The eggs are carried for about three weeks before they hatch, producing phyllosome larvae (Stewart 1988). Roughly 99% of those spawned will die {Aiken 1985).

2.0 Objective

The main objective of the present report is to provide a regional overview of lobster resources in CARICOM/CARIFORUM countries for the period 1990 to present to assist the various CARICOM/CARI FORUM country governments in determining what issues need to be addressed in the future.

2.1 Methodology

This involved participating in the Caribbean Fisheries Unit / Caribbean Fisheries Resource Assessment and Management Programme Conch and Lobster terminal workshop and analyses and interpretation of various country reports and previously published literature on *Panulirus argus* fisheries pertaining to: -

- Lobster data collection systems
- Catch, effort, export and import trends by year and or region by species group
- Number of fishers and vessels by country
- Fleet structure by country/region
- The state of knowledge of lobster resources
- Per capita consumption
- Supply, demand, and future demand
- The status of lobster resources in the region
- Management recommendations

3.0 Results

3.1 Data collection

General types of data that can play a significant role in successful sustainable management of lobster fisheries include socio-economic, catch, effort and biological data. Catch and effort constitute the minimum requirements for a simple assessment of a fishery (FAO 1980). These types of data were collected at some point by all of the various governments with the exception of Haiti (Table 2). This was usually as part of national data collection programmes or as part of joint programmes with private or regional organizations.

A number of problems were noted with regards to the collection of data. These included lack of manpower, lack of training, shortage of equipment, uncooperative fishers, lack of transportation and distance of sites. No country cited all of the problems mentioned. In general, the overriding constraints were shortage of staff and / or funding made available by CARICOM / CARIFORUM country governments. This has ultimately resulted in inadequate data collection or no data collection for some periods. This in turn has lead to, in most cases, data sets that may not be representative in addition to rarely done fishery assessments.

In many instances the shortage of staff or funding arose because decision makers either did not fully understand the need to collect data or considered it a relatively low priority when allocating funds. Nevertheless many countries have managed to collect the various types of data at one point or another since 1990. In some instances where relatively good data sets exist (for example, Belize) the resources (such as trained staff, and equipment) to analyze the data unfortunately were not available. However, the majority of this data has been analyzed and has enabled managers to gain insight into various aspects of their fisheries. This should ultimately lead to better management. However, to be ensured of optimal management a lot more needs to be known and continually monitored.

Independent studies have also been carried out from time to time and involved data collected by the government in some cases. Examples of recent research carried out in the region based on government data collection programmes, government funded studies and privately funded studies are seen in Table 3. Table 3 is not exhaustive. One should also bear in mind that in some instances the data on which the studies are based are not accurate enough to draw reliable conclusions. Nevertheless the research is presented to show that governments have been making an attempt to monitor and understand their *P. argus* fisheries.

Table 2: Data Collected by CARICOM / CARIFORUM Countries Since 1990

3ata Collected	Antigua and Barb.	The Bahamas	Belize	Dominican Republic	Grenada	Haiti	Jamaica	Nevis	St. Lucia	St. Vincent and the Grenad.
SOCIO-	xy	xy	xy	y	xy		xy	xy	xy	xy
ECONOMIC										
Export quantity	xy	xy	xy		xy		xy	xy		xy
Export Value	xy	xy	xy		xy		xy	xy		xy

Work status of fishers	y	y						y		
investment in fishery			y							
Income of fishers				y						
CATCH	y	xy	xy	y	y		xy	xy	y	xy
Weight	y	xy	xy	y	y		xy	xy	y	xy
Numbers per trip			xy				xy			
EFFORT	*y*	xy	xy	y	y		xy	y	y	xy
Hours fishing							xy			
Number of fishers		y		y			y	y		
number of vessels		y		y			y	y		
Days at sea	y		xy				xy			
Number of traps				y			xy		y	
BIOLOGICAL	*y*		xy	*y*	y		xy	xy	y	*y*
Tail width			xy							
Length measurement	*y*		xy	*y*			xy	xy		*y*
Spawning state of females	y				y		xy		y	*y*
Puerulus monitoring			*y*							

x- Data currently (July 2001) being collected y - Data collected at some point between 1990 and July 2001

NB: Empty spaces indicate that data was not collected or was not reported to be collected in country reports.

Table 3: Spiny Lobster Research in CARICOM/CARIFORUM Countries in the 1990s

Country	Research
Antigua and Barbuda	Analysis of catch per unit effort trends, mean size trends, level of compliance, sex ratios, size at maturity, landings trends, seasonably of reproduction and export trends
The Bahamas	Population abundance trends, fishing mortality trends, landings trends, export trends, and structure of the fishery
Belize	"PUE trends, landing trends, determination of maximum yield, puerulus monitoring
Dominican Republic	Exploratory study of the status of the stocks
Jamaica	Structure of the lobster fishery, landing trends, CPUE trends, sex ratio, mean size [rends, seasonality of reproduction, maximum yield estimates, spawning stock biomass estimates, socioeconomic analysis
Nevis	Landing trends, export trends, mean size trends, structure of the fishery
St. Lucia	Seasonality of reproduction, size at maturity, CPUE trends
St. Vincent and the Grenadines	Structure of the fishery, landing trends, export trends, size at maturity

Note: This table is not exhaustive and is presented merely to give examples of research recently done

3.2 Landing Trends

Landings records in CARICOM/CARIFORUM countries have shown no overall trend when visually inspected (Figure 2; Table 4). There have been sharp declines (e.g. Haiti (1996-1996) and Dominican Republic (1994 -1996)) and increases (e.g. Antigua and Barbuda (1997-1998)) in some years and some fisheries while some fisheries appear to show little fluctuation in landings (e,g. Grenada).

Some governments have explained the changes in landings of their lobster fisheries. For example, in Antigua the increase in landings between 1995 and 1999 was attributed to an increase in the number of fishing vessels from 132 to 473. Likewise, in the Bahamas the increase in landings in recent times is said to be due to increased fishing effort in addition to changes in fishing techniques and an increase in resources applied to the fishery.

However, statistical analysis is needed to arrive at a more reliable conclusion with regards to an overall trend or individual trends. Further, the reliability of landings estimates in most countries is called into question (Section 3.1).

Comparison of landing trends are also confounded by weather patterns, natural disasters (e.g. Two hurricanes in Antigua and Barbuda in 1999 reducing landings), fluctuation in level of enforcement, omissions in reports (e.g.- whether whole weight, live weight, frozen weight or frozen tails were reported), changes in fishing effort and changes in gear.

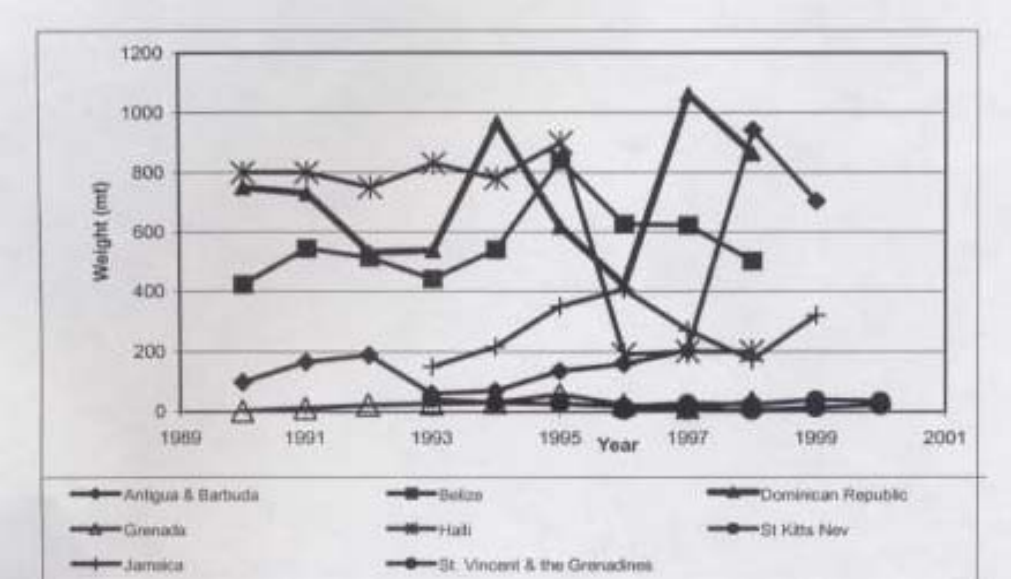


Table 4: *Panulirus argus* Landings in CARIFORU M Countries between 1990 and 2000

Country	**Weight (tonnes) / Year**										
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Antigua & Barbuda	97	165	188	60	69	134.7	10108	202.9	941.9	704.3	
Belize	424	544	513	442	541	842	626	623	502		
Dominican Republic	750	730	532	537	967	619	420	1,061	863		
Grenada	2	10	22	26	30	57	23	14	31		
Haiti	800	800	750	830	780	900	190	200	200		
SI Kitts Nevis							5.35	3.95	4.35	14.2	20.7
Jamaica				150	215	350	406	270	170	320	
The		7575	8156	7855	7587	7788	8262	7949	7552	8224	9023

Bahamas											
St. Vincent & tie Grenadines				41.3	29.49	26.54	16.87	27.24	22.59	39.47	34.9
Total	2073	9826	10161	9941	10218	10717	20057	10351	10287	9302	9079

Source; Government reports and an FAO database NB: Blank spaces Indicate data was unavailable

3.3 Catch Per Unit Effort Trends

Due to limitations of data collection systems in the various countries, only Belize, Jamaica and Antigua were able to report CPUE. Consequently, CPUE trends representing the entire CARICOM region were unobtainable. Due to variability in units of measurement and inability to standardize these units, CPUE comparisons between reporting countries were stifled and are thus considered individually. This further demonstrates the need for improved data collection as a region.

In Antigua CPUE was reported for the period 1995 to 1999 (Figure 3). There is an apparent increase in CPUE between 1997 and 1999. Reasons for the increase as well as other fluctuations are unclear. In Belize catch rates were fairly stable in the 1990s (Figure 4) and indicate a fully exploited resource (Maria Estela de Leon Gonzalez In Marin 2001). Jamaica (Figure 5) showed no obvious declines or increases in CPUE although fluctuations were observed for free diving and SCUBA.

Figure 3: Catch per Unit Effort for *Panulirus argus* in Antigua's (1995 – 1999) Trap Fishery

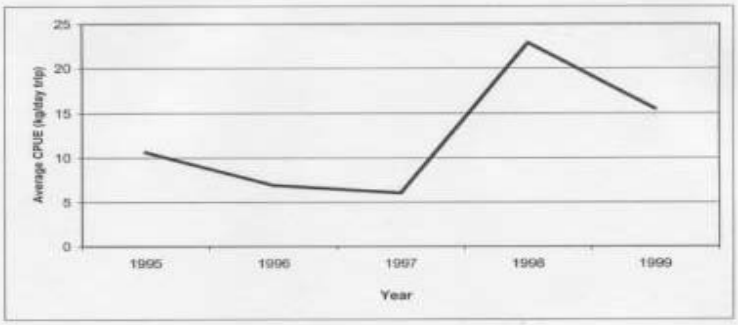
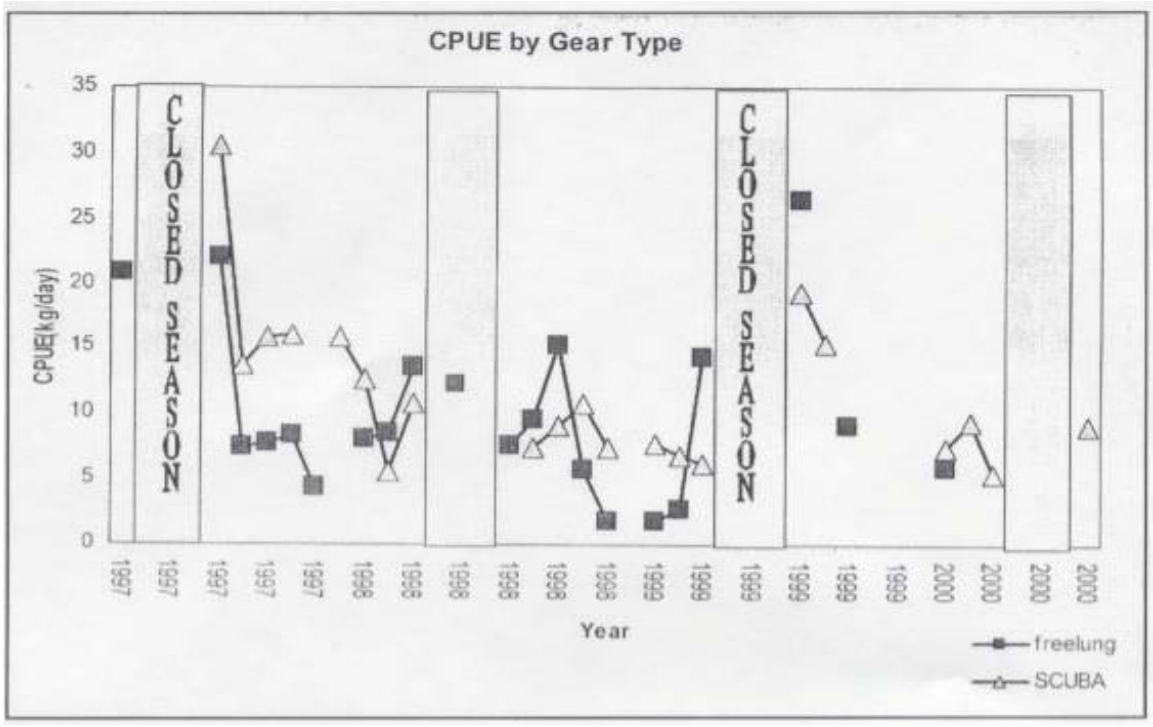


Figure 4: Catch per Unit Effort for *Panulirus argus* in Belize's (1965 – 1997) Trap Fishery

Figure 5: Catch per Unit Effort for *Panulirus argus* in Jamaica's (1997 – 2000) Freedive and SCUBA Fisheries



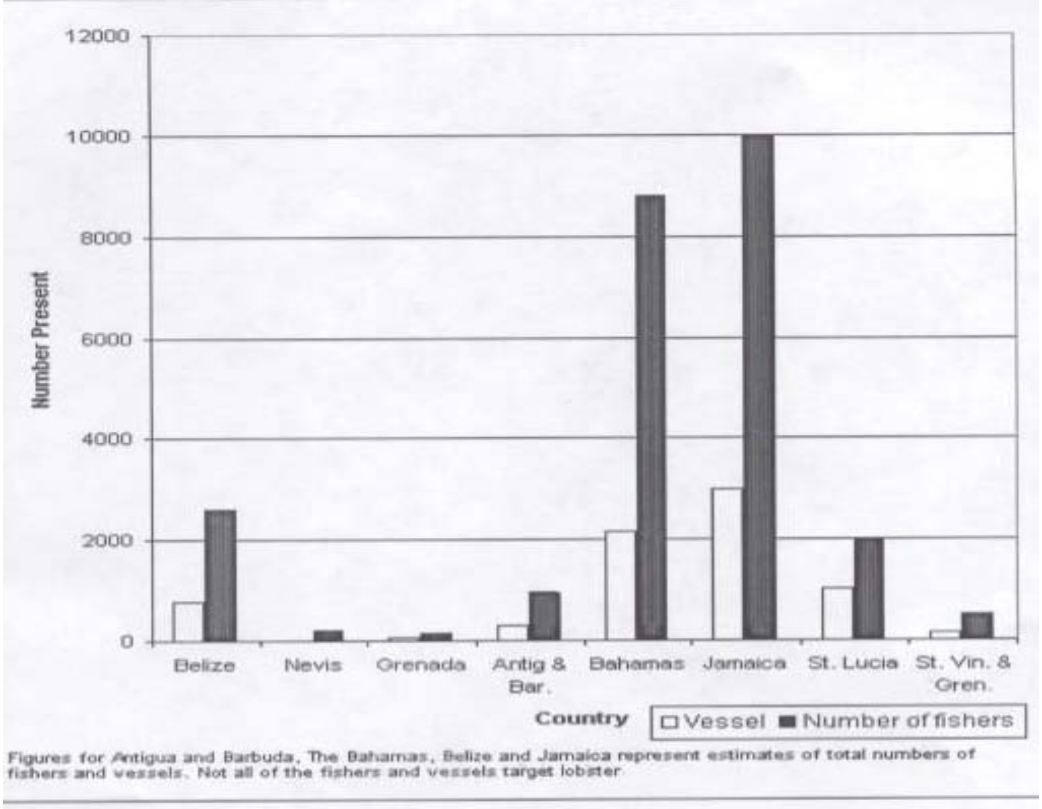
3.4 Fishing effort and gear

A crude estimate of fishing effort has shown that among CARICOM/ CARIFORUM countries the Bahamas and Jamaica appear to have the greatest fishing effort in terms of number of persons and number of vessels fishing (Figure 5). However, in both countries not all fishers target lobster. Grenada and Nevis had the least amount of fishers targeting lobster. The total area of viable lobster fishing grounds and distance to fishing grounds would also affect the number of fishers and vessels that fish for lobsters.

For comparative purposes, more accurate estimates of fishing effort including numbers of a given gear type and hours fishing are also needed due to differences in efficiency of fishing methods. It should also be noted that while accurate records of fishing effort were often not available, many countries reported an increase in fishing effort.

A range of fishing methods / gear types are used 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. No single country uses all gear types.

Figure 5: Estimates of Fishing Effort for *P. argus* in CARICOM/CARIFORUM Countries



3.5 Landings

As a result of an increase in demand for lobsters in more developed countries, fisheries for lobsters started mainly in the 1960s (Ehrhardt in FAO 2001). Among CARICOM / CARIFORUM countries the Bahamas has the greatest export earnings from its spiny lobster fishery, earning up to US$87 million (Table 5). Over 90% of landings were exported from the Bahamas. However, *P. argus* fisheries are not only of significant value in terms of exports. Many countries from the region have valuable *P. argus* fisheries despite exporting relatively little lobster and only a small portion of landings. The percentage of landings exported varies greatly between countries. For example, The Bahamas and Barbuda export over 90% of lobster landings, whereas St. Vincent and the Grenadines, Antigua and Nevis export 84.8%, 17% and 19.1-36.8% respectively. Much of the lobster that is not exported is used in hotels and restaurants. The fishery also helps to provide employment throughout the region, including, in some instances, fishers and vendors that would otherwise not be able to obtain gainful employment. The ex-vessel price for *P. argus* ranges from US$4 to US$15 per kg depending on the fishery/location and attracts many small scale fishers (Ehrhardt In FAO in press). There is a relatively high return on low capital investment (Ibid).

Table 5: Export Earnings in CAR1COM/CARIFORUM Countries

Year	Antigua & Barbuda		Bahamas		Belize		Jamaica		Nevis		St. Vincent and the Gren.	
	Qty	Val	Qty	Val	Qty	Val	Qty	Val	Qty	Val	Qty	Val
1990					197.91		76	0.70				
1991					213.49		112	1.75				
1992					196.24		179	3.15				
1993					190.63			0.00			32.72	0.19
1994					205.26		174	3.92			23.84	0.20
1995					216.05		243	6.1			21.46	0.18
1996	87.2	0.76			188.19		167		1.02	0.01	12.03	0.10
1997	95.4	0.8			235.11		86				23.99	0.20
1998	45.1	0.38			217.41		106		1.46	0.02	17.32	0.14
1999			2547	72	256.69		286	6.3	5.22	0.06	35.75	0.32
2000			2872	87	293.02				3.81	0.04	34.85	0.28

NB; Qty - Metric tonnes exported; Val - Value of exports in $US millions
Source: Various government reports. Empty spaces indicate data was unavailable

3.6 Regulations and Enforcement

A variety of fishing regulations specific to *P. argus* fisheries exist in the region (Table 6). Very common restrictions include an annual closed season of 3-4 months {usually in the spring and or summer months and coinciding with peak spawning; Table 7), a minimum size limit, prohibition against landing molting lobsters, prohibition against landing lobsters carrying eggs (and removal of eggs) and prohibition against certain types of fishing methods (Table 6). There are also fairly unique regulations instituted in some countries, for example, fishing for lobster on the fore reef in Belize is banned.

As with national data collection systems, enforcement of lobster fishing regulations is generally inadequate. Common examples include the landing of undersized or berried lobsters, the landing of lobsters during the closed season and poaching. Poor enforcement is partly due to lack of funding and/or staff. However, it should also be mentioned that there are instances where strict enforcement takes place, for example Belize and St. Vincent and the Grenadines. In St. Vincent and the Grenadines persons found in possession of berried females or females that have been stripped of eggs are often prosecuted. Also, in Belize the lobster fishery is vigilantly monitored with the aid of the military.

Table 6: *Panulirus argus* Fishing Regulations in CAR1COM/CAR1FORUM Countries

Country	Regulation					
	Closed Season	**Minimum Size**	**Molting State**	**Berried Females**	**Tar Spot**	**Other Lobster Fishing Restrictions**
Antigua & Barbuda	X	9.5 cm CL		?	?	3.81 cm mesh minimum for traps
The Bahamas		825 cm CL 14 cm TL	X		X	wooden slat traps 91 .4 cm x 61 cm к 61 cm with slats not less than 2.54 cm apart, no SCUBA
Belize		7.62 cm CL 4oz TW			X	10 fishing in forereef. no SCUBA
Dominican Republic		24 cm LT 12.5 cm TL	X			?
Grenada	X	9.0 cm CL	?	?	?	?
Haiti		?	?	?	?	?
Jamaica		7.62 cm CL	?		X	limited entry for industrial fishery
Nevis	X	9.5 cm CL	X	X	X	not available
St. Vincent & the Grenadines		22.86 cm LT 24oz WT			X	can only be caught by hand loop, pot. or trap
St. Lucia		9.5 cm CL			X	no SCUBA or spears, trap mesh 30.1mm limited entry

X - does not have the given regulation; - has the given regulation; ? - unclear if given regulation exists

Table 7: Duration and Time *ofPanulirus argus* Closed Seasons

COUNTRY	J	F		M	A	M	J		J	A	S	O	N	D
Antigua and Barbuda	No closed season													
The Bahamas														
Belize														
Dominican Republic														
Grenada	No closed season													
Haiti														
Jamaica														
Nevis	No closed season													
St. Vincent and the Grenadines														
St. Lucia														

3.7 Current Status

Panulirus argus is being fully or over-exploited throughout much of its range although the status could not be reliably estimated in some areas due to insufficient data (FAO 2001).

3.8 Management Recommendations

At the CFU/CFRAMP Conch and Lobster Terminal Workshop country representatives agreed that the overall objective of management of P. *argus* fisheries was to ensure the sustainability of the livelihood of resource users and other stakeholders. A number of major issues that needed to be addressed were identified and include the collection and analysis of data, compliance and enforcement of regulations, conducting research and strategies to be adopted by governments.

Conducting research is critical for monitoring and providing the best management possible for *P. argus* resources. This includes collection and analysis of data including socioeconomic, landing trends, CPUE trends and biological data such as trends in mean size, size at spawning, spawning season, mortality, population abundance, growth rates and recruitment patterns. As mentioned earlier, data collection and monitoring systems for lobster fisheries in the region are inadequate. It is felt by country representatives that regional resources need to be identified to improve or begin data collection programmes. Representatives were also of the opinion that a regional approach for conducting research is needed since the *P. argus* stock is shared regionally. A regional approach would also be more cost effective than governments funding research on an individual basis and would help to facilitate regional management of the fisheries.

Compliance with and enforcement of regulations needs to be improved significantly in the region. An increase in awareness of key compliance and enforcement agents such as magistrates and other adjudicators are needed to advance this cause. It is also felt that harmonization of regulations would also improve compliance and enforcement, in particular, harmonization of closed seasons in neighbouring

countries. Harmonization of closed seasons would help to simplify regional approaches to monitoring, control and surveillance. During the terminal workshop it was highlighted that some fishers would continue to land lobster during the closed season and claim that the lobster was actually caught in neighbouring waters where the season was still open when in fact the lobsters were not caught elsewhere. Some fishers also resort to poaching from neighbouring waters during the closed season. Where current closed seasons exist, they are believed to coincide with peak spawning and are generally during spring and summer months but seems to vary slightly from country to country possibly due to environmental variations. Harmonizing closed seasons could therefore result in the regional closed seasons not completely coinciding with peak spawning in some instances. However, the benefits to be gained from improved enforcement may outweigh any associated problems.

With regards to regional management of P. *argus* fisheries, representatives recognized that there was a need for regional planning and were of the opinion that a standing working group should be established as a means of advancing the process of sustaining a regional stock of lobster.

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