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May 26 , 2005
Guyana Drilling has Commenced

Toronto, Ontario - CGX Energy Inc. (OYL.U - TSX-V) and its Guyanese subsidiary ON Energy Inc. ("ON") are pleased to report that drilling has commenced on its Yakusari well, located onshore Guyana. The well will be drilled to a depth of approximately 1,000 metres with targets including both Eocene and Paleocene formations. It is anticipated that it will take between 2 to 3 weeks to drill to depth. This is the first well of a four well program.

"ON Energy, a 62% subsidiary of CGX is embarking on a challenging, high risk drilling program based on seismic and geochemical. A successful outcome would have significant impact on both our shareholders and the country of Guyana," stated Warren Workman, Vice President of CGX and President of ON Energy Inc.

Kerry Sully, President of CGX and Chairman of ON Energy stated "It's very exciting to finally be drilling the first of our 4 wildcats – a wildcat being an exploratory oil well drilled on speculation in an area not previously known to produce. The nature of a wildcat is the probability of a commercial success is low, typically no better than 10%. Over the years in Guyana, there's only been 8 wells drilled onshore and 11 wells drilled offshore, all of which were dry and abandoned. However, oil and gas shows were seen in several of those historic wells, evidence of an active hydrocarbon system. If we encounter significant oil and gas shows while drilling, and if our electric well-logging supports the possibility of formations that warrant further testing, we will cement casing in the well, suspending operations on that well until we can mobilize test equipment from Trinidad.""

CGX Energy is a Canadian-based oil and gas exploration company focused on the exploration for oil in the Guyana. CGX is managed by a team of experienced oil and gas and finance professionals from Canada, U.S.A. and the UK. CGX is financed internationally and has thousands of shareholders worldwide. For further information please contact: Kerry Sully, President & CEO at (604) 733-9647, Charlotte May, Investor Relations at (416) 364-3353 or Denis Clement, Director at (416) 364-1909 or visit our website at www.cgxenergy.com.

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June 30, 2005
Drilling of Hermitage Well has Commenced

Toronto, Ontario - CGX Energy Inc. (OYL.U - TSX-V) and its Guyanese subsidiary ON Energy Inc. ("ON") are pleased to report that drilling of the Hermitage well has commenced. The Hermitage well is located onshore Guyana and is the second and deepest well in a four well program. The well is proposed to be drilled to a depth of approximately 6,200 feet with targets in the Eocene, Paleocene and Cretaceous. The Company will report the results when drilling is completed.

Warren Workman, President of ON Energy stated "This well is third ranked of our remaining locations and is being drilled at this time to minimize surface access problems during the remainder of the rainy season in Guyana."

The Company also announces that it has granted, pursuant to its stock option plan, to directors, management and consultants of the Company an aggregate of 950,000 stock options in replacement of same that expired on May 23, 2005. The Company has also granted 100,000 options to a consultant working on the onshore drilling program. Each such stock option entitles the holder to purchase one common share of the Company at a price of US$0.70 until June 30, 2010.

CGX Energy is a Canadian-based oil and gas exploration company focused on the exploration for oil in the Guyana. CGX is managed by a team of experienced oil and gas and finance professionals from Canada, U.S.A. and the UK. CGX is financed internationally and has thousands of shareholders worldwide. For further information please contact: Kerry Sully, President & CEO at (604) 733-9647, Charlotte May, Investor Relations at (416) 364-3353 or Denis Clement, Director at (416) 364-1909 or visit our website at www.cgxenergy.com.

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FAO Fisheries Report No. 600 FIRM/R600

WESTERN CENTRAL ATLANTIC FISHERY COMMISSION

National reports presented and stock assessment reports prepared at the

CFRAMP/FAO/DANIDA STOCK ASSESSMENT WORKSHOP ON THE SHRIMP AND GROUNDFISH FISHERIES ON THE GUIANA-BRAZIL SHELF

Port-of-Spain, Trinidad and Tobago, 7-18 April 1997

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 1999

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The Workshop was held in Port-of-Spain, Trinidad and Tobago, from 7 to 18 April 1997. An administrative report of the Workshop is available as Denmark Funds-in-Trust, FI:GCP/INT/575/DEN, Report on Activity No. 34, FAO, Rome.

This document includes edited national reports presented at the Workshop and stock assessment papers on shrimp and groundfish resources prepared during and after the Workshop.

The bibliographies appended to the technical papers have not been checked for accuracy, but have been edited to follow the FAO Fisheries Department format.

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NATIONAL REPORT OF GUYANA

Shrimp and groundfish fisheries of Guyana

by

Dawn Shepherd[1], Angela Hackett[1] and Reuben Charles[2]

1 INTRODUCTION

1.1 Fisheries and the National Economy

The Fisheries Sub-sector is important to the economy and social well-being in Guyana. The economic contribution of the Sub-sector has grown in recent years. The importance of the Fisheries Sub-sector is evident in five key areas:

(i) Food Supplies
Fish is a major source of animal protein in Guyana, with the per capita annual consumption being approximately 45 kg in 1991.

(ii) Economy
The primary sector of the Sub-sector contributed 7% to the total Gross Domestic Product (GDP) in 1993, while the total value of fish products in Guyana in 1996 was G$ 11.6 billion.

Current production (1996) of the Fisheries Sub-sector was estimated at 61,483 tonnes, of which the Offshore Industrial Fishery landed 22,525 tonnes, the Inshore Artisanal Fishery landed 36,581 tonnes, and the Inland Fishery and Aquaculture 800 tonnes. Sub-sector production is shown in Table 1.

Table 1: Showing Fisheries sub-sector Production (tonnes) for the period 1993 – 1996

Product	Year			
	1993	1994	1995	1996
Prawns (tail weight)	1,821	1,890	1,874	1,260
Seabob & Whitebelly (Unprocessed)	5,614	6,737	9,344	14,501
Seabob & Whitebelly (Processed)	1,640	1,968	3,128	NA
Finfish (Industrial)	1,333	1,589	1,916	NA
Finfish (Artisanal)	35,818	36,533	35,332	34,947
Finfish (Inland) including Aquaculture	800	800	800	800

Source: Guyana Department of Fisheries Report, 1995 & DOF Statistics, 1997)

(iii) Exports
Guyana's 1996 export earnings from the Fisheries Sub-sector were approximately G$ 3.7 billion.

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(iv) Employment and Income
The fishing industry employs some 4,800 people in harvesting and 5,800 in processing and marketing. Also, many people benefit from fishing related occupations such as boat building, requisite supply and repair.

(v) Revenues Derived *from the Fisheries*
The Fisheries Sub-sector is a significant contributor to government revenues in Guyana through export levies and licence fees. Export levies of 10% on the reference value of shrimp, 5% on the reference value of ornamental fish and 1.5% on the reference value of finfish generate substantial revenues for the Government. In 1996, the total revenues earned were G$167 530 349. The export levies have been waived as of February 1997.

2. EXCLUSIVE ECONOMIC ZONE (EEZ)

Guyana has a coastline of 432 km and a continental shelf area of 48,665 sq. km. The average width of the continental shelf is 112.6 km, while the area of the EEZ is 138,240 sq. km. The living marine resources being exploited within the EEZ are mainly the demersal resources (shrimp and groundfish) and to a limited extent, the pelagic resources over the continental shelf and towards the continental slope.

2.1 Description of the Fisheries

The Fisheries Sub-sector of Guyana has three main components, each with further subdivisions as follows:

Marine Fishery
(i) The Offshore Industrial (Trawl) Fishery
(ii) The Inshore Artisanal Fishery

Inland Fishery
(i) Subsistence Fishery
(ii) Ornamental Fish Fishery

Aquaculture
(i) Brackish-water Culture
(ii) Fresh-water Culture

2.1.1 Description of the offshore industrial and inshore artisanal shrimp fisheries

The offshore industrial shrimp trawl fleet exploits mainly penaeids (*Penaeus spp.*) in the case of the penaeid trawl fleet and seabob (*Xiphopenaeus kroyeri*) in the case of the seabob/finfish trawl fleet. The whitebelly shrimp (*Nematopalaemon schmitti*) is also seasonally caught to a much lesser extent as incidental catch in the seabob/finfish fishery.

The Chinese seine vessels of the inshore artisanal fleet exploit both seabob and whitebelly shrimp. Some of the larger penaeid shrimp are occasionally caught in the Chinese seine fishery. Also, various finfish species, including juveniles, are caught.

2.1.2 Offshore industrial fishery

The Offshore Industrial Fishery consists of 127 trawlers (Table 3), 5 fish/shrimp processing plants and numerous wharves and dry docking facilities. The trawlers are 48 percent foreign owned. Foreign trawlers mainly exploit penaeid shrimp *(P. brasiliensis, P. notialis, P. schmitti, and P. subtilis)* with *finfish and small amounts of squid* (*Loligo spp.*) *and lobster* (*Panulirus spp.*) *as by-catch.* The locally owned trawlers mainly exploit seabob (*Xiphopenaeus kroyeri*) and various finfish species (*Macrodon ancylodon, Micropogonias furnieri, Nebris microps, Arius spp., Cynoscion spp.*), with small quantities of penaeid shrimp as by-catch.

2.1.2.1 Vessel Description

The penaeid and seabob/finfish trawlers are the standard Gulf of Mexico type trawlers. The Japanese vessels are 19.81 m (65 ft.) in length. The American and local vessels range from 18.90 to 22.86 m (62-75 ft.) in length, with the American vessels being on the average 20.42 m (67 ft.) in length (Shepherd and Charles, 1996). The local vessels are powered by inboard Caterpillar diesel engines while the American fleet are powered by Cummings engines. The engine horsepower ranges from 365 to 425 HP. The finfish trawlers are Japanese built stern trawls. They are approximately 13.72 m (45 ft) long and are powered by 240 HP Yanmar diesel engines (Shepherd and Charles, 1996). Chinese seine vessels are small flat-bottomed dory type vessels 6.40 to 12.19 m (21 - 40 ft.) in length and are powered by sails or outboard engines (Frame survey, 1994).

2.1.2.2 Fishing gear

Nylon or polyethylene jib trawl nets with 4 to 5 cm (1.6 - 2.0 inches) stretched mesh in the wings and 2.5 - 3.5 cm (1 to 1 ½ inch) stretched mesh in the cod-end are used in both the penaeid and seabob/finfish fleets (DFB, 1994).Turtle Excluder Devices (TED's) are mandatory for the entire shrimp trawl fleet.

The finfish trawlers use stern trawl nets with 10.16 cm (4 inches) mesh size. The Chinese seine vessels use funnel shaped fyke nets with mesh size of 8 cm (3.15 inches) at the mouth and 1 cm (0.39 inches) at the tail end.

2.1.2.3 Fishing Operations

At the beginning of a shrimping operation, a small try-net is towed for 10 - 30 minutes to test the area for abundance of shrimp (DFB, 1994). The American fleet, starting in 1982, (and more recently a few of the local vessels) began using 4 *10.67 m (35 ft) nets at a time ("twin trawling"), while the Japanese and the local fleets tow 2 * 13.72 to 15.85 m (45 - 52 ft) nets at a time. In "twin trawling" a sledge is used between each pair of nets. The penaeid shrimp trawls are equipped with tickler chains which stir up the bottom substrate and cause the shrimp to jump into the nets. The seabob/finfish trawls are fitted with drop chains around the mouth opening of the nets. They tow 2 * 13.72 to 15.85 m (45 - 52 ft) nets at a time.

Table 2: Total Number of Trawlers

Year	Total number of vessels
1986	128
1987	129
1988	119
1989	118
1990	122
1991	115
1992	120
1993	114

(DOF Statistics, 1996 and WECAFC, 1995)

In 1994, 28 local vessels were operative, while in 1995 and 1996, 25 and 27 vessels were operative respectively.

The 1994 census of the Inshore Artisanal Fishery covered 253 Chinese seine vessels. DOF estimates put the number of these vessels at 354 for the year 1996.

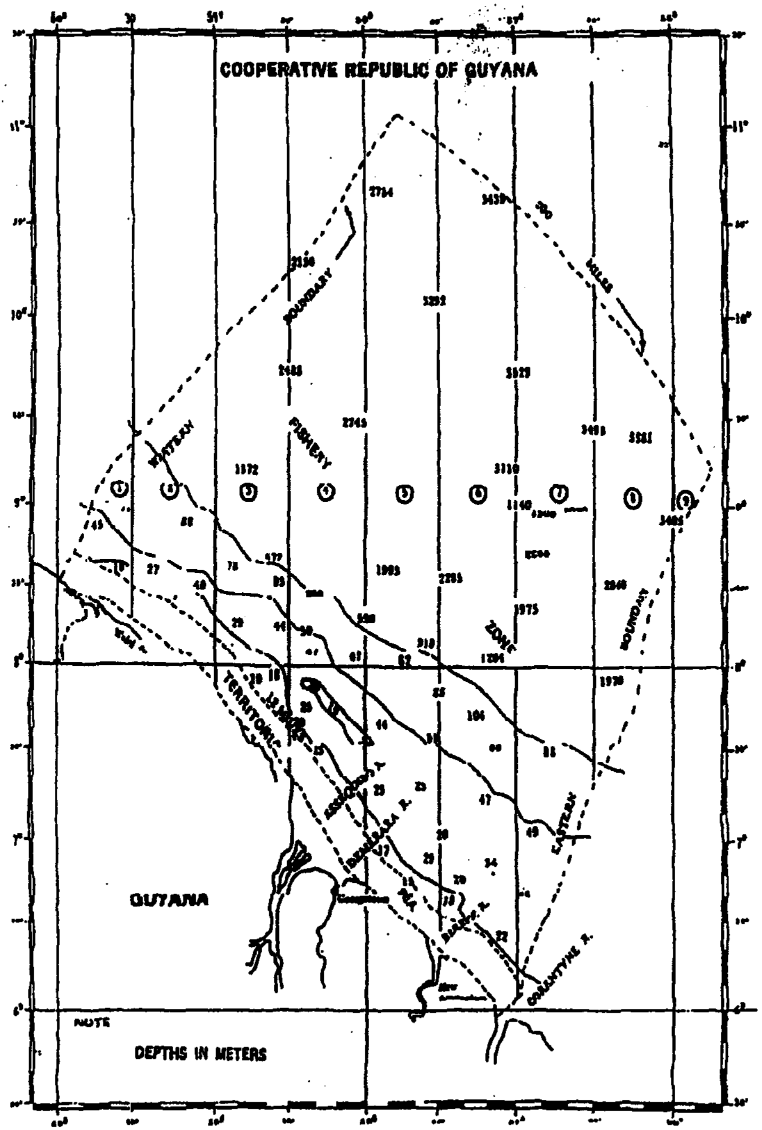

Figure 1: The statistical fishing zones of Guyana

Table 3: Type of Vessel by Year and Fishery Classification

Year	Type of Vessel			Total
	Penaeid Shrimp	Seabob/Finfish	Finfish	
1994	72	45	6	123
1995	72	47	6	125
1996	73	48	6	127

(DOF Statistics, 1996)

2.1.2.4 Crew

Penaeid shrimp trawl vessels normally have a crew of 5 while seabob vessels and finfish vessels carry 5 - 6 and 4 - 5 respectively. Chinese seine vessels carry 2 - 4 crew.

2.1.2.5 Fishing strategy

The EEZ, for statistical purposes, has been divided into Fishing Zones which are defined according to the degrees of longitude within which they lie, with each zone being separated from the other by an interval of 30 degrees (Shepherd and Charles, 1995) See Figure 1 for the Statistical Fishing Zones of Guiana.

Penaeid trawl vessels operate from 40 to 145 km offshore at depths of 18 to 91 m. The Japanese fleet tends to trawl much further offshore than the American and local fleets. The bottom areas are usually mud or a mixture of sand and mud (DFB 1994). Trawlers tend to operate in Fishing Zones 1-6 in January, moving gradually eastward to Zones 4-8 in April, returning to Fishing Zones 1-7 in May. In June, July, and August, the fleet tend to operate in Fishery Zones 1-8, shifting to Fishing Zones 2-6 from September to November and moving to Fishing Zones 3-8 in December. In the early 1980's operations were much more concentrated to the east in Fishery Zones 5-9. Most shrimp are caught at night (DFB 1994).

The industrial seabob fishery began in 1985 (Charles, 1990). Seabob trawlers operate 15-30 km from shore in 13-18 m of water. Fishing operations begin in Fishing Zone 4 in January, gradually moving east to Fishing Zone 5 in March and Fishing Zone 6 in April. The fleet returns to Fishing Zone 4 in May, and fishes there until August, after which the fishing operations cease, except for some effort in Fishing Zone 4 in November. Most seabob are caught by day (DFB 1994).

Chinese seine fishing takes place at or around the mouths of rivers, because the operations are heavily dependent upon the influence of the river currents. The nets are attached to poles set in the river at distances of approximately 1 mile from shore.

The target species caught by the 73 penaeid shrimp trawlers are *P. brasiliensis, P. notialis, P. schmitti, and P. subtilis*, with assorted finfish, small amounts of squid (*Loligo spp.*) and lobster (*Panulirus spp.*) as by-catch.

The 48 local trawlers target seabob (*Xiphopenaeus kroyeri*) and various finfish species (*Macrodon ancylodon, Micropogonias furnieri, Nebris microps, Arius spp., Cynoscion spp.*), with small quantities of *Penaeus spp.* as by-catch. Only 28 of these vessels are currently in operation. The local shrimp vessels tend to shift their operations from seabob to penaied shrimp (*Penaeus spp.*) during the seasons when the seabob resources are scarce. The 6 finfish stem trawlers target *Macrodon*

ancylodon, Micropogonias furnieri, Nebris microps, Arius spp., *Cynoscion spp.* Only 2 of these vessels are currently in operation.

Both American and Japanese trawlers make an average of 3 - 4 hauls per day, with each haul being of 4 - 6 hours duration. The local penaeid shrimp vessels make an average of 3 hauls per day, with each haul being of about 4 hours duration. The American and the local vessels average 8 trips per annum, while the Japanese vessels average 6 trips per annum. The American vessels spend 35 - 42 days at sea, while the Japanese tend to spend much longer times at sea, usually 40 - 50 days. The locally owned penaeid shrimp vessels would spend an average of 30 days at sea. The seabob trawlers spend 5 - 9 days at sea, but an average trip lasts 7 days. A typical seabob vessel makes 2 - 3 trips per month, and an average of 30 trips per annum. The Chinese seine vessels operate with the tide and as such they make 1 or 2 trips per day, with each trip lasting between 6 - 12 hours (Table 4).

Table 4: Fishing Trip Characteristics by Fleet

Vessel Type	Nationality	Average trips/yr	Average trips/month	Average days/trip	Average hauls/day	Average duration of haul (hrs)
Penaeid Shrimp	American	8	NA	35 - 42	3 - 4	4 - 6
	Japanese	6	NA	40 - 50	3 - 4	4 - 6
	Local	8	NA	~ 30	3	4
Seabob/ finfish	Local	30	2 - 3	5 - 9 avg. 7	4	3 - 3.5
Chinese Seine	Local	300	~ 18	0.25 - 0.5	1 set	6 - 12 avg. 9

Source: DOF, 1997

2.1.2.6 Processing

Penaeid shrimp are headed on board and frozen. At the processing plant, the tails are machine graded into commercial size categories. The white shrimp *(P. schmitti)* are graded separately from the other 3 species *(P. brasiliensis, P. notialis,* and *P. subtilis)*. The seabob catch is stored on ice on board vessel. At the processing plants, the catch is machine peeled and graded into commercial size categories. The shrimp catch from the Chinese seine is landed fresh, and is sold to hucksters and to middlemen or representatives of processing plants.

There are 4 major industrial processing plants, namely:

(i) Georgetown Seafoods and Trading Company Ltd. (GS&TCL), an American company which processes the penaeid shrimp catch and more recently the finfish by-catch from its fleet of 55 vessels.

(ii) Marine Food Products Ltd. (MFPL) which processes the penaeid shrimp catch from the Japanese fleet. This plant also processes finfish from the stern trawlers and some amount of fish that is purchased from inshore artisanal vessels.

(iii) Noble House Seafoods (NHS) which processes the seabob catch from its fleet of 16 vessels. This plant also processes finfish that is purchased from inshore artisanal vessels.

(iv) BEV Enterprises which processes the seabob catch from the other local vessels (with the exception of the NHS vessels), and hand grades the penaeid shrimp by-catch brought in by those vessels. This plant also processes seabob and finfish that are purchased from the Chinese seine vessels.

2.1.2.7 Marketing

Upwards of 95 % of the penaeid shrimp are exported, primarily to the USA, and smaller amounts to Japan, Canada and CARICOM countries. For 1996, 1,366 tonnes of penaeid shrimp were exported. Approximately 90 % of the seabob is exported, primarily to the USA, and smaller amounts to CARICOM countries. For 1996, 2,836 tonnes of seabob and whitebelly shrimp were exported (Table 5).

Table 5: Exports of Marine Products (tonnes), 1989-1996

Item	1989	1990	1991	1992	1993	1994	1995	1996
Penaeid Shrimp	1 892	1 665	1 922	1 526	1 630	1 483	1 819	1 366
Seabob & Whitebelly	719	669	1 073	1 238	1 239	1 408	2 408	2 836
Finfish & By-products	943	1 521	2 367	3 151	3 080	3 485	NA	3 632
Crabmeat	4	2	10	16	11	9	27	0.14
Total Exports	3 558	3 857	5 372	5 931	5 960	6 385	4 254	7 834

Source: DFB, 1994, Guyana Department of Fisheries, 1995, and DOF Statistics, 1996)

2.2 Objective for the Management and Development of the Fisheries Sub-sector

The overall objective for the management and development of the Fisheries Sub-sector is to achieve sustainable levels of production, productivity and real incomes of fishery producers and other groups involved in the delivery of products to domestic and export markets, thereby contributing to national production, income and welfare.

Another objective is to substantially improve the functioning of the Fisheries Department of the Ministry of Agriculture and other public sector institutions serving the Fisheries Sub-sector through the provision of adequate legislation, sufficient human resources, modern facilities and improvement in the systems for accountability. Also, one other objective is to ensure that the scientific and technological base of fisheries is improved through adequate funding and organisational improvements to research and extension systems so as to enable the Sub-sector to compete, on an equal footing, in the global economy.

2.2.1 Specific objective

The management objective for penaeid shrimp is to stabilise landings/production, whereas that for seabob and finfish is to increase production. In the case of penaeid shrimp and seabob, the fishery is mainly export oriented (foreign exchange). For finfish, the goal is improved nutrition for the population, increased employment and incomes and aggregate output thereby stimulating growth of the national economy.

The seabob and demersal finfish fisheries would be reserved mainly for Guyanese operators. In the case of the penaeid shrimp fishery which already has foreign participation, in any pull-outs by companies/individuals both foreign and local from the limited entry fleet, the preference for replacement will go to a Guyanese company/ individual. The Chinese seine is the only known means in Guyana of harvesting the whitebelly shrimp (*Nematopalaemon schmitti*). Thus, in addition to the likely socio-economic aspects, there would appear to be some need for the use of the gear.

Regulation will therefore look at first limiting the number of licences to those operators already in the fishery while attempting to reduce support for any new or renewal of Chinese seine operations. Limits on the number of seines per vessel will also be considered.

2.2.2 Current management

The penaeid shrimp resource is either being fished at its optimum sustainable yield or above.

The seabob resource which was relatively under-exploited (mainly by Chinese seines) in the past is now being more fully exploited (Chinese seines and trawlers) with the advent of a number of seabob

processing plants. Until more is known about the seabob resource some caution would have to be exercised in terms of fleet expansion (Phillips, Aiken and Mahon, 1992).
The state of the finfish resource (groundfish, pelagic & deep-slope) taken as by-catch or by directed trawling would have to be determined in relation to the activities of the Inshore Artisanal Fishery and the Snapper/Grouper Fishery.

In keeping with the Fisheries Act 1958 and Maritime Boundaries Act 1977, trawlers are registered and licensed, with the type of licence depending on foreign or local ownership, length of vessel and base of operation. Fishermen are also licensed. Transhipment at sea is prohibited by law.

All shrimp trawlers are required to use TED's when trawling. They are also required to land 32,000 lbs of by-catch per annum as a licencing condition.

The trawler fleet is demarcated in terms of their operations (penaeid shrimp, seabob/ finfish, finfish) and the vessel license indicates this. The penaeid shrimp fleet operate as a limited entry fleet with the upper limit having been set at 100. The seabob/finfishing fleet operates as a limited entry fleet with the upper limit being set at 30. This number is influenced not only by the paucity of information on the seabob resource, but also by the fact that these vessels operate within the nursery grounds of the marine fishery (Phillips, Aiken and Mahon, 1992). The Chinese seine fleet is operated on an open access basis.

Fishing vessels have to be registered and licensed. Crew are also licensed. Chinese seine operators are required to have fish pen permits for each pen set up.

2.2.3 Proposed management of the fishery

2.2.3.1 Penaeid shrimp

Current levels of information indicate that a limited entry fixed fleet approach should be maintained, with consideration being given to:

- prohibition of trawling for penaeid shrimp from 18 fathoms shoreward;
- a closed season for penaeid shrimp.

The limit of 100 vessels currently in use needs to be reviewed (Phillips, Aiken and Mahon, 1992).

Considering the economic importance of shrimp on the Guiana-Brazil shelf, there is need for a regional management approach.

2.2.3.2 Seabob

As a precaution, the limited entry fixed fleet approach should be maintained, with consideration being given to:

- the restriction of trawling for seabob to areas of high adult abundance with a view to reducing conflicts with artisanal fishermen and damage to nursery areas and juveniles.

The limit of 30 vessels should be reviewed.

2.2.3.3 Finfish

In the case of directed trawling for demersal finfish, a limited entry fixed fleet approach may be taken as a precaution, with consideration being given to:

- the restriction of trawling with a view to reducing conflicts with artisanal fishermen and damage to nursery areas and juveniles;
- mesh size regulations and appropriate finfishing trawls;
- adjusting fishing effort to account for by-catch taken in the penaeid shrimp and seabob fisheries.

As these fisheries develop, it may become necessary to apply more complex methods such as fleet quotas, and transferrable quotas which would allow more economically efficient use of the resource. There is need to generate bio-economic data to facilitate bio-economic modeling (Phillips, Aiken and Mahon, 1992).

The issues of illegal foreign fishing, transshipment at sea ("over the side sales at sea") and conflicts with artisanal fishing operations need to be urgently addressed.

2.2.3.4 Environmental considerations

Degradation of coastal habitats (mangroves and other wetlands) which are known to serve as nursery areas for many of the species harvested in the Offshore Industrial Trawl Fishery can be expected to impact negatively on the yields of the Fishery. The interaction with coastal aquaculture (brackishwater culture) both in terms of the destruction of the wetland area and the collection of eggs, fry and juveniles from the sea for culturing would also have to be carefully monitored and controlled as this activity can have adverse effects on the fishery.

The approach to ensuring adequate conservation of these habitats should be an integrated one in keeping with the concepts of coastal zone management.

The environmental impact of the use of sledges in the shrimp trawl fishery needs to be closely examined, especially with respect to possible habitat degradation.

2.3 Description of the Inshore Artisanal Fishery

Guyana is divided into ten (10) administrative regions (Figure 2). Marine fishing occurs off the coast of six (6) of these regions.

The Inshore Artisanal Fishery is made up of an estimated 1 331 boats ranging in size from 6-18 m and powered by sails, outboard, or inboard engines. The 1994 Inshore Artisanal Fishery Census only captured a total of 936 vessels (Table 6). Activity in the inshore artisanal fishery is pursued exclusively by Guyanese. All the boats are made from wood and are manufactured locally. The fishing gear in use includes pin seines, Chinese seines/fyke nets, cadell lines/"demersal longlines", drift nets/gillnets, circle seine and handlines/snapper lines.

A flat-bottom dory powered by sail, paddle, or small outboard engine is used for Chinese seine, cadell lines and a few pin seines to give more manoeuvrability over shallow, muddy and sandy bottom areas. These boats which operate close to shore are not equipped with ice boxes.

A V-bottom boat, ranging in size from 7.63 -9.15m (25 - 30 ft) and with no cabin but with an ice-box and powered by an outboard engine is used by smaller gillnet (gillnet nylon) fishermen. A larger V-bottom vessel size 12.2 - 15.25 m (40 – 50 ft), with an inboard engine and cabin is used for larger gillnet and handline operations. Physical characteristics of the boats, their method of propulsion, length of the fishing trip, crew size, catch composition and the principal fishing grounds of the Guyana Artisanal fleet are provided in Table 7.

There are about 4 500 artisanal fishermen and of these about 1,000 are boat owners. Sixty to seventy percent of the boat owners are members of Fishermen's Cooperatives which acquire and sell fishing requisites to their members (DFB, 1994).

There is onshore infrastructure (wharves, ramps, workshops, fuel depots, requisite shops, ice machines and storage bins, and fish storage bins) at eight sites along the coast for this Fishery. Five (5) of these complexes have been leased to the fishermen's cooperatives within whose boundaries they fall for management and operations. Joint-venture arrangements have been proposed for the remaining three (3) complexes.

Figure 2: Administrative regions

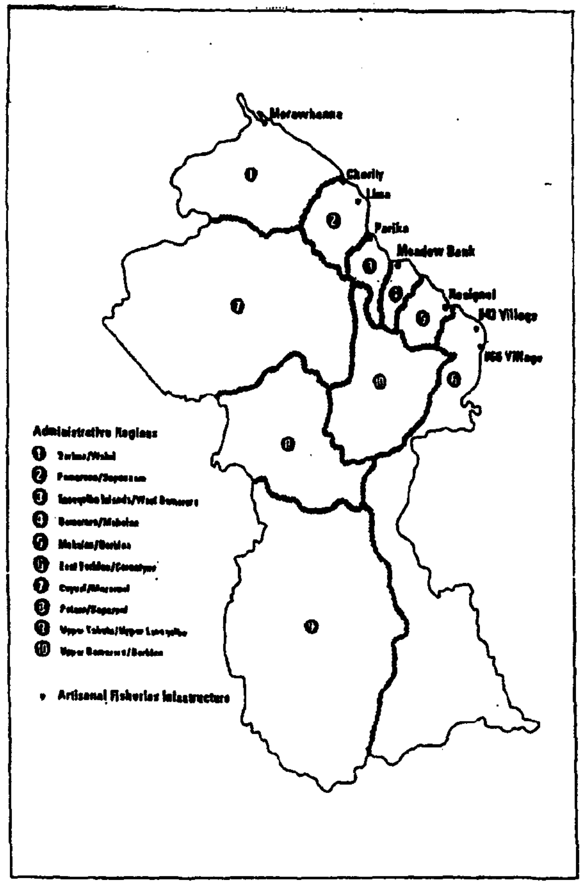

Table 6: Inshore Artisanal Fleet

REGION	Number of Vessels by Gear Type by Region				TOTAL
	Chinese Seine	Pin Seine	Cadell	Gill net	
2	20	7	9	52	88
3	69	5	14	51	133
4	86	6	27	250	368
5	38	7	18	64	127
6	40	21	11	121	193
7	0	0	0	20	20
TOTALS	253	46	79	558	936

Source: DOF, 1994

2.3.1 Fishing area

The EEZ, for statistical purposes, has been divided longitudinally into nine (9) Fishing Zones, each separated by 30 degree intervals (Shepherd and Charles, 1996; Figure 1). Artisanal fishers operate on the continental shelf at distances up to 56 km (30 miles) from the shore, all along the coast.

2.3.2 Seasonality

The most productive period generally runs from March through October which is the period when most of the common species (*X. kroyeri, N. schmitti, Macrodon ancylodon, Cynoscion virescens, Micropogonias spp.*, etc.) are available to the fishery. Most Scombrid species (*Scomberomorus brasiliensis, Scomberomorus cavalla*, etc) are abundant from May to September. During the months of November to February, most finfish species are relatively scarce and the fishing effort has to be increased to obtain a reasonable catch. This coincides with the period when the winds are high and the seas rough (Shepherd and Charles, 1996).

2.3.3 Gear types in the inshore artisanal fishery

There are six types of artisanal fishing gear, namely: (i) Chinese seine/fyke net, (ii) pin seine, (iii) cadell, (iv) gillnet (nylon and polyethylene), (v) handline, (vi) circle seine. Handlines and circle seines are very few in number.

The description of each gear type/fishery is as follows:

2.3.3.1 Chinese Seine

This is the only gear type used in the Inshore Artisanal Shrimp Fishery of Guyana. Chinese seines are funnel-shaped nets, 16 m (52 ft) long and 4-6 m (13.1-19.6 ft) wide at the mouth. The mesh size gradually tapers from 8 cm at the mouth to 1 cm at the funnel. A flat-bottom dory vessel powered by sail, paddle, or small outboard engine is used in the fishing operations. Based on the 1994 Inshore Artisanal Fishery Census, there were 253 Chinese seine vessels, accounting for 27% of the artisanal fleet (Table 6).

(i) Fishing strategy

These fishing operations work in relation to the tide and involve between 6 to 12 hours per day fishing. Some operators fish both tides per day. The seines are attached to poles and set on mud banks, mainly in the river mouths, where tidal currents sweep the fish and shrimp into them. The seines are set at depths between 2 and 6 fathoms, at a distance of about one mile from the shore. The crew size on these vessels ranges between 2 and 4.

(ii) Catch

The catch consists primarily of *N. schmitti* (whitebelly shrimp), *Xiphopenaeus kroyeri* (seabob), *Macrodon ancylodon* (bangamary), *Nebris microps* (butterfish). An undetermined amount of juvenile fish is caught in the Chinese seine fishery and is discarded or used to produce "fish meal".

(iii) Processing

The whitebelly shrimp is landed whole. It is then dried and the shell removed. The shell or shrimp meal is used as livestock feed. The dried shrimp is sold either locally or exported. The fish is landed whole and sold fresh.

(iv) Marketing

The marketing of shrimp and fish by the Chinese seine operators is done by several channels depending on the landing site.

Shrimp/fish is sold as follows:

- directly to processing plants (Cottage Industry) where it is dried and marketed locally or exported to countries such as USA and Holland. This is one of the major marketing channels for Chinese seine operators in Region 3;
- by fishers to consumers;
- by fishers to vendors who retail it to the public from market stalls, roadside tables or from door to door.

2.3.3.2 *Cadell line*

The cadell or demersal longline fishing vessels range in size from 6.71-9.15 m (22 – 30 ft). During the 1994 Inshore Artisanal Fisheries Census, 79 vessels were counted. This accounted for 8% of the total artisanal fleet. A flat-bottom dory vessel powered by sail, paddle or small outboard engine is used for cadell line.

A cadell line consists of a horizontal/ground line anchored at each end, with a series of about 800 dangling/vertical lines, set with baited hooks at 2 m. outwards. Each vessel carries between 4-5 wooden trays with each tray having from 2-6 main lines.

(i) Fishing strategy

Before each trip, the hooks are baited and stored in the trays. Keybrand hooks are normally used. Bait includes bangamary, mullet and shrimp. These vessels operate on a daily basis with each fishing trip lasting for approximately 12 hrs. Most of the fishing activities occur at night and sometimes during the day. Fishing occurs between 10-12 miles from the coast in waters approximately 5 - 10 fathoms deep. Crew size on a cadell vessel ranges from 2 to 4.

(ii) Catch

The catch consists mainly of *Arius parkieri* (gillbacker), *Bagre bagre* (catfish), *Arius proops* (cuirass), (*Arius phrygiatus*) kwakwari and various species of shark which are landed headless and gutted.

(iii) Processing

The catch is landed either sorted or unsorted depending on the landing sites. Most fish caught by this gear type are landed whole with the exception of the various shark spp. These vessels are not equipped with iceboxes. Shark is processed into dried shark, the fins of the shark are removed along with the bones. These processed products are exported but some dried shark is consumed locally.

(iv) Marketing

Fresh fish is sold directly from the wharves and landing site to processing plants and retailers. Fresh fish is also sold directly to exporters from the landing sites.

2.3.3.3 *Gillnet fishery*

The gillnet is the most productive gear in the artisanal fishery of Guyana. More than half of the total catch is caught with gillnets. Based on the results of the 1994 Artisanal Frame Survey, it was estimated that there is a total of 921 artisanal fishing vessels, of which 586 (64 %) are equipped with gillnets.

There are several types of gillnet operations. These are as follows:

- gillnet polyethylene inboard engine
- gillnet polyethylene outboard engine
- gillnet nylon outboard engine
- circle seine -modified gillnet nylon outboard
- tangle seine -modified gillnet nylon outboard

The gillnet vessels of Guyana can be conveniently grouped into two size categories, large 12-16 m (38.4-52.5 ft) and small 8-10 m (26.2-32.8 ft). Large gillnet vessels, using gillnet polyethylene (GNP) are diesel-powered inboard engine vessels with insulated ice boxes capable of carrying up to 5 tonnes of ice. Most of these vessels are equipped with compasses. The length of their trip is 10-12 days. Typically and a gillnet (polyethylene) vessel will have a crew size ranging between 4-6 which consists of a captain and workmen.

There are also gillnet polyethylene outboard engine vessels known as "cabin cruisers". These vessels are equipped with ice boxes and fish for 5-6 days. Crew size ranges from 4-6.

Small gillnet vessels using gillnet nylon (GNN) are equipped with outboard motors up to 48 horsepower, and fish and land their catches along the entire coast of Guyana (Table 8). These vessels with small ice boxes remain at sea for 2-3 days at a time, while others without ice boxes land their catches about every 12 hours. A gillnet (nylon) vessel will have a crew size of 4 consisting of a captain and three workmen (Chakalall and Dragovich, 1979). Both types of gillnets are called "drift seine".

A circle seine is a modified nylon gillnet used in the Corentyne River. Fishermen have developed circle seines of different types and sizes to catch schooling fish when they are abundant.

Gillnets polyethylene (inboard and outboard) vary in length from 1 000 to 1 600 m and are 4 m deep with a stretched mesh size of 20 cm (6 – 8 inches). Polyethylene nets are preferred by the fishermen because the nets last longer and tangle less than those made of nylon. Gillnet (nylon), a modified version of the gillnet gear type, measure about 300 m in length and have smaller mesh sizes 8 cm (2.5-4 inches). These are being used by some fishermen near the inshore area. Gillnets are very selective, catching only fish of a distinct size.

(i) Fishing strategy

The structure of a gillnet is very simple. It is a single wall of net which comprises several sheets of netting joined together. It has floats for buoyancy as well as sinkers to enable it to expand vertically when submerged under the water. The depth of the net is determined according to the density of fish schools and the depth of the swimming layer of fishes to be

Table 7: Characteristics of the Artisanal Fishing Fleet of Guyana

No. of Vessels		Method of propulsion	Length of Vessels (m/ft)	Gear Type	Trip length	Catch Composition	Crew Size	Method of preser-vation	Estimated annual landings (1996) (tonnes)	Principal Fishing Area
Frame Survey	1996 Estimate									
	11	Inboard Diesel	14/45	Handlines	12-18 days	snappers, groupers	8	Ice	299	Edge of continental shelf, rocky areas (areas between 10 and 20 fathoms)
558	78	Inboard Diesel Lister Piter, Perkins 210 hp	12-15/40-50	Gillnet polyethylene (inboard)	10-12 days	grey snapper, sea-trout, gillbacker, tarpon, Spanish-mackerel, croaker, snook, shark spp.	4-6	Ice	1,137	Area between 10 and 20 fathoms.
	469	Outboard engine 48 hp	8-11/35	Gillnet polyethylene (cabin-cruiser)	8 days	grey snapper, sea trout, pagee, tarpon, croaker, gillbacker, Spanish mackerel.	4-6	Ice	9,114	Area between 10 and 20 fathoms
	244	Outboard engine 25 hp	30m	Gillnet nylon	1 day	bangamary, sea-trout, butterfish.	4	Ice	7,951	Area between 10 and 15 fathoms
253	354	Sail, outboard engine 6 - 9 hp	6.40-12.19 m (21-40ft.)	Chinese seine	6 – 12h	whitebelly, seabob, immature fish, bangamary, butter-fish, catfish	2-4	Fresh	finfish-7,951 seabob-1,460 whitebelly-1,749	Estuaries, river mouths and banks on the coast.
79	111	Outboard engine 6 - 9 hp	6 - 9/15 - 30	Cadell	12h	catfishes, sharks spp.	2-4	Fresh	6,355	Areas between 5 and 10 fathoms.
46	64	Sail, outboard engine	6 - 9/15 - 30	Pin Seine	12h	mullet, snook, queriman, catfish, croaker, bangamary	2	Fresh	299	Intertidal zones

Modified from Chakalall, 1979

caught. The net can be made to rest on the bottom layer, to hang in midwater, or to float in the surface layer. The ease of handling the gear is also to be taken into account. A gillnet catches fish that swim into it. The fish is usually caught by its gill. When the fish swims up to the net it sticks its head right into one of the meshes. When the fish tries to pull its head out of the mesh the thin twine cuts into its skin; its gills and fins get caught in the mesh. The fish stays in the net until it is pulled up.

Fish are also caught when the net wraps around them as in the case of the tangle seine. Drift gillnets are not secured by anchors, but are allowed to drift at the mercy of the winds and/ or currents. They are by and large operated at the surface or mid-layer of the water. Since the gear is not anchored, fishing places are considerably extensive. It is possible to set the net chasing a school of fish.

With a circle seine, the net is lowered into the water from the back of the vessels in such a way that it will surround the fish school. The fish encircled will try to escape out of the net and become entangled as well as gilled.

(ii) Fishing area

Drift seining is practiced along the coast in deep waters 31-39 km (19-24 miles) offshore in areas between the 18-36 m (10-20 fathoms) isobaths. Circle seine and tangle seine operations are usually practiced in the Corentyne area.

There is a large concentration of gillnet vessels in Region 4 followed by Regions 6, 5 and 2 (Table 8).

Table 8: Breakdown of Gillnet Vessels by Region

Region	No. of Gillnet Vessels
2	52
3	51
4	300
5	64
6	119
Total	586

(iii) Catch

The gillnet fishery accounts for approximately 60% of the artisanal landings. For the gillnet polyethylene (inboard and cabin cruiser), the catch consists mainly of *Cynoscion acoupa* (grey snapper), *Centropomus spp.* (snook), *Scomberomus brasiliensis* (spanish mackerel), *Caranx hippos* (cavalli), *Arius parkeri* (gillbacker), *Carcharhinus limbatus* (blacktip shark), *Rhizioprionodon porosus* (Caribbean sharpnose sharks) *Micropogonias furnieri* (bashaw), *Megalops atlanticus* (cuffum), *Cynoscion virescens* (sea trout), *Lobates surinamensis* (pagi), *Epinephelus spp.*(jew fish). Swim bladders (fish glue) are landed either fresh or dried. Some GNP vessels practice direct fishing for shark.

For the gillnet (nylon), the catch consists mainly of *Macrodon ancylodon* (bangamary), *Nebris microps* (butterfish) and *Cynoscion virescens* (sea trout).

For the circle seine, the catch consists of *Micropogonias furnieri* (bashaw), *Hypophthalmus edentatus* (highwater), *Aridae spp.* (lau lau and bringle) and *Macrodon ancylodon* (bangamary).

(iv) Processing

Fish from the gillnet vessels are landed either whole, gutted or headless. Shark spp. are landed headless and gutted, grey snapper and sometimes snook and sea trout are landed gutted. Gillbacker is landed whole. Since these vessels are equipped with iceboxes the fish are stored on ice at sea.

(v) Marketing

Price is the main determinant of the choice of the marketing channels but convenience is also an important factor. The marketing of fish caught by the gillnet vessels is carried out through several channels
Fish are sold as follows:

- directly by the fisher to the consumer;
- by the fisher to a vendor or huckster who retails it to the public from market stalls, roadside trays or peddles from door to door;
- by the fisher to processing plants (Cottage Industries and BEV Enterprise Ltd) which may sell in the domestic market but more typically export the fish. The fish is cleaned and frozen. Sometimes it is dried (as in the case of shark spp.). The processing plants tend to buy the large fish leaving the smaller fish to the hucksters.

A small percentage of fishermen/owners retail on their own. The major exporters in the Cottage Industry are F. Jhumman, K. Seepersaud, E. Lord, Jhasshri and A.A Shakoor.

2.3.3.4 Pin seine fishery

Pin seine fishing is practised mainly in Regions 2 and 6. Pin seine or beach seine comprises the smallest number of vessels of the artisanal fleet. According to the results of the 1994 Artisanal Frame Survey there are 46 pin seine vessels which accounts for 5% of the artisanal fleet of Guyana (Table 5). They are usually 2 m in depth and 2 000 m in length, with a stretch mesh size of 9 cm or less.These vessels are mainly between 6.40 to 12.19 m (21-40 ft) in length and are driven by outboard engine or sail.

(i) Fishing strategy

The net is set at high tide in the intertidal zone. A row of stakes arranged in a semicircle holds the net in a vertical position. During the ebbing tide the fish are trapped and then retrieved from the mud flats by the use of a "catamarang", which is an upward-curved mud-riding board of about 2 m (6.6 ft) in length and 60 cm (23.6 inches) wide fitted with a fin underneath and a box for storing fish. The fishermen pick up their catch from a kneeling position on their catamarangs.

(ii) Catch

Their catch includes *Mugil spp.* (mullet), *Mugil sp.* (queriman), *Centropomus sp.* (snook), *Macrodon ancylodon* (bangamary), *Micropogonias furnieri* (croaker), and catfishes of the family *Ariidae*. There are also discards of juvenile fishes of which the species and amounts are not known.

2.3.3.5 Handline fishery

Fishing boats known as handliners are 18 m in length and fish between 18-36 m (10-20 fathoms) near the edge of the continental shelf. Handliners are equipped with insulated ice boxes which hold up to 5 tonnes of ice. Each fishing trip is 12-15 days. Each boat is equipped with eight polyethylene handlines, one handline per fisherman. Each line carries 16 hooks, size 4 or 5.

(i) Catch

Their catch consists mainly of *Lutjanus spp.* (snappers) and *Epinephelus spp.* (groupers).

(ii) Marketing

The fish landed from handline vessels are sold directly to the processing plant (BEV Enterprise). Most of the fish is exported, with a small amount being sold locally mainly to hotels and restaurants.

2.4 Management Objective for the Inshore Artisanal Fishery

The management objective for the artisanal fishery is to increase the landings to a sustainable level which would enable the fishery to contribute to improve nutrition for the population, export earnings, increase employment and aggregate output thereby stimulating growth of the national economy.

The strategy would be to initiate management actions that would lead to rationalisation in the development of the fleet so as to exploit the resources more effectively while seeking to put in place onshore infrastructure and equipment and ensuring their effective utilisation.

2.4.1 <u>Management Options</u>

Priorities would be given to the identification and elimination and/or reduction of destructive gear while developing an effective gillnet (polyethylene) fleet.

2.4.1.1 Chinese seine fishery

The Chinese seine is the only known means in Guyana of harvesting the whitebelly *(N.schmitti)*. Thus, in addition to the likely socio-economic aspect, there would appear to be some need for the use of the gear (Phillips, Aiken and Mahon, 1992).

Regulation could therefore look at first limiting the number of licences to those operators already in the fishery while attempting to reduce support (finaacial and other requisites) for any new or renewal of Chinese seine operations. Limits on the number of seines per vessel could also be considered.
Later, by means of survey/investigations the areas of high shrimp concentrations can be identified and mapped as well as the seasons determined. Operations could then be restricted to these locations and seasons of abundance.

2.4.1.2 Cadell Line Fishery

Cadell line fishing should be encouraged but hook size regulations could be looked into as a means of ensuring only larger sizes of the species caught are targeted.

2.4.1.3 Nylon nearshore gillnet fishery

More indepth study of this situation would be required. If found to be necessary then regulations on mesh size and length of seine could be put in place. Also, the number of licences issued can be restricted.

2.4.1.4 Polyethylene gillnet/driftnet fishery

Regulations on mesh size should be addressed as a means of conserving the resource because of likely good economic returns and because of the ease of implementing mesh size regulation. Later, limitations on effort could also be addressed.

2.4.1.5 Shark Fishery

This resource should be carefully examined since it is likely that it can be exploited through specific targeting by different gear types. Reducing of targeting by imposing limits on the proposition of landed catch or limiting the number of processing plants utilizing shark licences could be considered.

2.4.1.6 Mackerel

This fishery may be targeted since there is an increased demand for the species. This resource should be monitored to obtain more information.

3. DATA COLLECTION PROGRAMME

The objective of the programme is to consolidate and expand the existing programs of data collection and information gathering for assessment and updating of the Fisheries Management Plans for the Offshore Industrial and Inshore Artisanal Fisheries for Shrimp and Groundfish.

3.1 Offshore Industrial Fishery

A species identification/composition exercise is to be started shortly to identify and determine the species composition of shrimp and finfish being caught and landed by gear type.

Catch and effort data are collected using vessel and plant logbooks. An observer programme is being developed for the trawl fleet which would serve to verify the logbook data as well as collect biological data on the catch.

An in-plant biological data collection program (BDC) for three penaeid shrimp species (*P. notialis, P. subtilis* and *P. brasiliensis*) is currently underway (Table 9). A biological data collection program for selected finfish species and seabob will be implemented in the near future.

The processing plants submit data on fish and shrimp prices per commercial size category. Data on price per species for finfish are collected from the markets and landing sites.

Basic economic and social data were collected during the Census of the Inshore Artisanal Fishery in 1994 and the Survey of Women in the Fisheries Sub-sector in 1994. Some social and economic data on fishers are stored in the Licensing and Registration System (LRS).

3.1.1 Sampling methodology of in-plant BDC for *P. brasiliensis, P. notialis*, and *P. subtilis*

Biological data (see Table 9) are being collected to enable us to apply Crustacean Stock Assessment Techniques Incorporating Uncertainty (Ehrhardt and Legault, 1996).

Table 9: Showing the types of Biological data available

Years	Months	Length & weight frequencies by commercial size category		Source of Data
		Pink Shrimp	White Shrimp	
1996	Oct.	✓	No	In-plant shrimp BDC
	Nov.	✓	No	In-plant shrimp BDC
	Dec.	✓	No	In-plant shrimp BDC
1997	Jan.	✓	No	In-plant shrimp BDC
	Feb.	✓	No	In-plant shrimp BDC

There are several years of historical shrimp landings data (1981-1997) (Table 10) which are recorded in pounds of tails per commercial size category. Those landings are recorded in two species groupings: (i) Pink shrimp, which are really three species (*P. brasiliensis, P. notialis*, and *P. subtilis*), and (ii) white shrimp (*P. schmitti*).

The current in-plant shrimp biological data collection programme is aimed at generating (i) species composition and species/gender composition within each commercial size category and (ii) tail length frequencies and individual tail weights for each species/gender composition within each commercial size category. These sampling activities are carried out each week at the processing plant.

For the commercial size categories U-12 to 26/30, the recommended sample size is 4 boxes (5 lbs each) per commercial size category. For the commercial size categories 31/40 to 71/90, the

Table 10: Showing the types of catch & effort data available

Year	Months	Types of Data Available				
		Effort			Catch	
		Number of vessels	Number of trips	Number of Landings	Landings/Catch of shrimp tails (tonnes) by commercial size category	
					Pink Shrimp[1]	White Shrimp[2]
1981	Jan. - Dec.			✓	✓	✓
1982	Jan. - Dec.			✓	✓	✓
1983	Jan. - Dec.			✓	✓	✓
1984	Jan. - Dec.			✓	✓	✓
1985	Jan. - Dec.			✓	✓	✓
1986	Jan. - Dec.	✓		✓	✓	✓
1987	Jan. - Dec.	✓		✓	✓	✓
1988	Jan. - Dec.	✓		✓	✓	✓
1989	Jan. – Dec	✓		✓	✓	✓
1990	Jan. – Dec	✓		✓	✓	✓
1991	Jan. – Dec	✓	✓	✓	✓	✓
1992	Jan. - Dec.	✓		✓	✓	✓
1993	Jan. – Dec	✓		✓	✓	✓
1994	Jan. – Dec	✓		✓	✓	✓
1995	Jan. – Dec	✓		✓	✓	✓
1996	Jan. – Dec	✓		✓	✓	✓
1997	Jan. - Dec.	✓		✓	✓	✓

NB. Pink Shrimp[1] = combination of *P. brasiliensis, P. notialis*, and *P. subtilis*
White Shrimp[2] = *P. schmitti*

recommended sample size is 2 boxes (5 lbs each) per commercial size category. The contents of each box (shrimp tails) is weighed, and the tails are then separated into species ; each species is then further separated by sex.

After separation of the tails into species and sex, both individual tail lengths and individual tail weights are taken for the first box (box #1) sampled in each commercial size category, while for boxes 2, 3 and 4, only individual tail lengths are taken.

3.2 Inshore Artisanal Fishery Data Collection Program

A species identification/composition exercise is to be done shortly to identify and determine the species composition of shrimp and finfish being caught and landed by gear type.

Catch and effort data are collected using vessel logbooks and a stratified random sampling which serves to verify the logbook data as well as to estimate the landings (Table 12). A biological data collection program (BDC) for selected finfish species is also underway (Table 11).

Basic economic and social data were collected during the Census of the Inshore Artisanal Fishery in 1994 and the Survey of Women in the Fisheries Sub-sector in 1994. Some social and economic data on fishers are stored in the Licensing and Registration System (LRS). Data on ex-vessel and retail prices are being collected at landing sites and markets.

3.2.1 Description of the Stratified Random Sampling

Using data on landing sites (primary fishing units), vessel/fishing gear (secondary fishing units) and related information from the June-September 1994 Census of the inshore artisanal fishery, a stratified random sampling program was devised using the RANCLUS software. Landing sites were stratified as primary, secondary or tertiary sites, with the criteria for stratification being based on the number of gear types and number of vessel by gear types at a landing site. In regions 5, 4 and 3, primary sites are sampled 12 days per month, secondary sites 8 days per month and tertiary sites 4 days per month. In Regions 6 and 2, each stratum is sampled 4 days per month. Sampling is based on both space and time. The program was implemented in August 1995.

Sampling in Regions 6 and 2 is being done by the fisheries personnel based in these Regions, with supervision being done by the Data Collection Supervisor/Data Manager, Angela Hackett, based at headquarters. Sampling in Region 5,4 and 3 is being done by fisheries personnel from headquarters, under the overall supervision of Ms. Hackett.

Selection of vessels for sampling is not always done at random and the most available vessel is sampled because of:

(i) resistance of fishers to sample their catch;
(ii) competition between vendors and data collectors.

The Division hopes to solve these problems through its Community Awareness and Involvement Programme.

Biological data (length data) are being collected for the following species bangamary (*Macrodon ancylodon*), grey snapper (*Cynoscion acoupa*), gillbacker (*Arius parkieri*), butterfish (*Nebris microps*), sea trout (*Cynoscion virescens*) and snook (*Centropomus pectinatus*).

The Department is working towards a more decentralised approach to its sampling , whereby Regions 2 and 6 will function as subunits, with each subunit being responsible for data collection, entry and storage. Disk copies of data will be submitted to headquarters at the end of each month.

3.3 Data Storage and Management

The data collected in the field are being entered into three software applications:

(i) Trip Interview Program (TIP) - catch and effort (artisanal and industrial) and biological data;
(ii) Licencing and Registration System (LRS) - licence and registration, social and economic data;
(iii) EXCEL - biological data from the shrimp sampling in the processing plants.

The objective of data management is to ensure that the data collected and computerized are available whenever needed. The data collected are used to generate monthly and annual production reports as well as for use in stock assessment models.

3.4 Resources (Personnel, Equipment)

The Data Collection Program is staffed by:
1 Data Manager
2 Data Entry Clerks
5 Data Collection Supervisors
2 Fisheries Officers
7 Data Collectors

The office and field equipment includes:
5 Computers
2 Vehicles

Table 11: Showing the types of biological data available

Year	Month	Length frequency by species					Source of data
		M. ancylodon	*N. microps*	*C. virescens*	*C. acoupa*	*C. pectinatus*	
1995	May	✓	✓			✓	Stratified Random Sampling for Artisanal Fishery
	Jun		✓	✓			
	Jul	✓	✓	✓	✓	✓	
	Aug	✓	✓			✓	
	Sep.						
	Oct.						
	Nov.	✓	✓	✓	✓	✓	
	Dec.			✓	✓		
1996	Jan.	✓	✓				
	Feb.	✓	✓	✓	✓	✓	
	Mar.	✓	✓	✓	✓	✓	
	Apr.	✓	✓	✓	✓	✓	
	May	✓	✓	✓	✓	✓	
	Jun.	✓	✓	✓	✓	✓	
	Jul.	✓		✓	✓	✓	
	Aug.	✓	✓	✓	✓	✓	
	Sep.	✓	✓	✓	✓	✓	
	Oct.	✓		✓	✓	✓	
	Nov.	✓	✓	✓		✓	
	Dec.			✓			

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Table 12: Showing the types of catch & effort data available

Year	Types of data available		
	Effort	Catch	
	Number of Vessels	Landings/Catch data for Finfish	
		Artisanal logbook	Sampling Programme
1981	✓		
1982	✓	✓	
1983	✓	✓	
1984	✓	✓	
1985	✓	✓	
1986	✓	✓	
1987	✓		
1988	✓		
1989	✓		
1990	✓		
1991			
1992	✓		
1993			
1994	✓		
1995		✓	✓
1996	✓	✓	✓
1997			✓

NATIONAL REPORT ON THE SHRIMP FISHERY IN SURINAME

by

Pierre Charlier and Yolanda Babb-Echteld[1]

1. PRESENT SITUATION OF THE SHRIMP FISHERY

The description prepared in January 1996 for the "CFRAMP Shrimp and Groundfish Subproject Specification Workshop & Fourth Meeting of the WECAFC ad hoc Shrimp and Groundfish Working Group on the Guiana-Brazil Continental Shelf" (Charlier et al, 1996), remains in general valid. The main features of the shrimp fishery in Suriname are:

- It is an all-industrial fishery, without a small-scale component in the exploitation.
- Two shrimp species (*Penaeus subtilis and P. brasiliensis*) make up most of the catch, complemented by two secondary species (*P. notialis and P. schmitti*).
- Extraction is carried out by a fairly stable fleet of 100 to 120 trawlers of the classic double rigged type. They belong to a number (20 to 25) of foreign owned fishing companies.
- Two main components can be distinguished in the fleet : a Korean fleet and a Japanese fleet. Numbers fluctuate from year to year, but the Korean fleet totals 70 to 90 trawlers, and the Japanese fleet remains at approximately 30 vessels. There is also a small fleet sailing under the Surinamese flag, which can be considered part of the Korean fleet, since it is operated by Korean fishing companies under chartering agreements.
- The differences between the fleets lie mainly in the fishing grounds. The Japanese fleet operates in deeper waters than the Korean fleet, and mostly at night. It targets one shrimp species (*P. brasiliensis*), while the Korean fleet does not show such a preference and exploits all species.
- Shrimp is processed at two plants, SAIL and SUJAFI. A new processing company has been established in 1996 (Guiana Seafoods). This plant processes finfish, sea bob and shrimp. The relative importance of shrimp in the landings, or their approximate volume, are not known as data collection by the Fisheries Department at the plant has not been arranged yet.

Besides the shrimp fleet, there is a growing number of trawlers operating mainly on finfish. Part of this fleet consists of former shrimp trawlers where the fishing gear has been modified in order to increase the finfish catch. The fleet also includes larger vessels (stern trawlers), with engine power generally higher between 500 and 1 000 HP. Finfish trawlers of the first type (former shrimp trawlers) deliver catches at SAIL and, recently, at Guiana Seafoods, while other types of finfish trawlers use other landing places.

2. RESULTS OF THE EXPLOITATION

The data available on effort include the number of boats licensed, the number of trips (deliveries) and the number of days at sea (Table 1). The number of days at sea has been obtained for the vessels landing at SAIL since 1983, but is not available for the vessels landing at SUJAFI. More accurate effort units, like *the number of hauls or of trawling hours, could be extracted from logbooks submitted by part* of the fleets (not done currently).

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Table 1: Annual fishing effort by fleet

Year	Number of deliveries				Number of days at sea (SAIL)
	SAIL	SUJAFI Korean	SUJAFI Japanese	TOTAL	
1977		145	248		
1978	610	53	231	894	
1979	506	57	230	793	
1980	387	128	209	724	
1981	561	125	285	971	
1982	584	226	253	1,063	
1983	474	281	199	954	22,245
1984	485	291	182	958	23,646
1985	384	122	208	714	20,673
1986	388	49	215	652	23,416
1987	410	81	178	669	28,227
1988	425	113	167	705	27,273
1989	420	103	223	746	23,813
1990	381	104	227	712	21,797
1991	268	110	233	611	18,179
1992	298	119	242	659	20,651
1993	254	103	209	566	17,829
1994	235	105	231	571	17,786
1995	214	115	228	557	15,691

Effort is evenly distributed over the months, as shown in the next table, as an example, for 1994 (Table 2). A slight peak is generally observed in April-May, corresponding to the best yields in the year.

Table 2: Distribution of fishing effort by month in 1994

Month	Number of deliveries				Number of days at sea (SAIL)
	SAIL	SUJAFI Korean	SUJAFI Japanese	Total	
January	18	10	20	48	1,574
February	18	8	22	48	1,236
March	19	9	15	43	1,418
April	18	8	20	46	1,648
May	22	6	20	48	1,762
June	21	7	19	47	1,735
July	18	7	17	42	1,108
August	26	13	19	58	1,961
September	23	8	21	52	1,555
October	18	8	20	46	1,359
November	18	10	18	46	1,378
December	16	11	20	47	1,052

The data on landings for each fleet, since 1973, have been compiled at the Fisheries Department. All figures presented in Table 3 are expressed in head-off equivalents (tail weight). Landings data prior to 1973 could not be located in Suriname, but global figures (annual production) can be found in the literature.

The annual production shows important fluctuations, with series of good years alternating with series of less favorable ones. After the last series of good years in 1986-1987, however, the production has not reached the level of 3,000 tonnes per year again. The production of the peak year of 1991 (2,828 tonnes) remained well below the level observed in earlier peak years, which was around 3,500 tonnes.

The best catch (landing) per unit of effort (cpue) data available for the entire fleet is the landing per delivery. Landings per day at sea are only available for the vessels landing at SAIL. Table 4 gives the average cpue for each component of the shrimp trawler fleet between 1977 and 1994. It demonstrates that the average landing per day at sea of the vessels landing at SAIL follows the same trend as the average landing per trip (for the whole fleet). The cpue's of all components of the fleet (Korean fleet landing at SAIL, Korean fleet landing at SUJAFI, Japanese fleet) also appear to follow parallel courses over the years.

Table 3: Annual landings at SAIL and SUJAFI (in kgs of tails)

Year	Head-off landings				Head-on landings	TOTAL landings (head-off + head-on)
	SAIL	SUJAFI Korean	SUJAFI Japanese	Total	SUJAFI (Japanese)	
1973	1,581,211					1,791,000
1974	1,425,290					2,022,000
1975	2,166,278					3,167,000
1976	2,771,022			3,613,588	168,030	3,781,618
1977	2,730,876	383,942	570,106	3,684,924	280,373	3,965,297
1978	1,916,555	150,676	496,350	2,563,581	187,461	2,751,043
1979	2,424,671	149,340	385,976	2,959,987	268,507	3,228,495
1980	1,793,858	546,667	403,160	2,743,685	327,155	3,070,840
1981	2,340,816	638,830	514,904	3,494,550	352,183	3,846,733
1982	1,645,442	991,264	306,948	2,943,654	484,092	3,427,746
1983	1,613,907	1,159,622	151,294	2,924,823	378,934	3,303,758
1984	1,516,090	874,262	72,558	2,462,910	294,700	2,757,610
1985	1,479,790	391,912	79,706	1,951,408	481,109	2,432,516
1986	2,196,969	238,172	313,976	2,749,117	562,758	3,311,876
1987	2,447,690	472,056	256,550	3,176,296	312,690	3,488,986
1988	1,903,630	423,198	117,046	2,443,874	311,009	2,754,883
1989	1,398,167	313,274	80,330	1,791,771	381,843	2,173,614
1990	1,671,362	337,290	67,128	2,075,780	490,442	2,566,222
1991	1,691,050	512,792	198,798	2,402,840	425,585	2,828,225
1992	1,549 tonnes	544 tonnes	317 tonnes	2,410 tonnes	262 tonnes	2,672 tonnes
1993	1,486 tonnes	431 tonnes	171 tonnes	2,088 tonnes	346 tonnes	2,434 tonnes
1994	1,410 tonnes	444 tonnes	125 tonnes	1,979 tonnes	455 tonnes	2,434 tonnes
1995	1,428,197	540,658	228,358	2,197,213	414,501	2,611,714

Table 4: Annual CPUE per fleet

Year	Landings per delivery (kg tails)				Landings (kg tails) per day at sea (SAIL)
	SAIL	SUJAFI		TOTAL	
		Korean	Japanese		
1977		2,648	3,429		
1978	3,142	2,843	2,960	3,077	
1979	4,792	2,620	2,846	4,071	
1980	4,635	4,271	3,494	4,241	
1981	4,029	5,111	3,272	3,962	
1982	2,818	4,386	3,127	3,225	
1983	3,405	4,127	2,664	3,483	72.5
1984	3,126	3,004	2,018	2,878	64.1
1985	3,654	3,212	2,696	3,407	71.6
1986	5,662	4,861	4,078	5,080	93.8
1987	5,970	5,828	3,198	5,215	93.3
1988	4,479	3,745	2,563	3,908	69.8
1989	3,329	3,041	2,073	2,914	58.7
1990	4,387	3,243	2,456	3,604	76.7
1991	6,310	4,662	2,680	4,629	93.0
1992	5,198	4,571	2,395	4,055	75.0
1993	5,850	4,585	2,474	4,300	83.3
1994	6,000	4,150	2,511	4,263	79.3
1995	6,674	4,701	2,783	4,689	91.0

The monthly cpue values are shown for 1994 hereunder (Table 5). The first part of the year has the highest yields, and the lowest yields are obtained from June to August, for both indexes (kg per day at sea and kg per delivery).

Table 5: CPUE per month, 1994

Month	Landings per delivery (kg)				Landings per day at sea (SAIL)
	SAIL	SUJAFI		Total	
		Korean	Japanese		
January	8,511	2,920	2,780	5,014	97.3
February	6,917	4,379	2,673	4,411	100.7
March	6,925	5,007	4,051	5,442	92.8
April	8,915	4,927	3,026	6,348	97.4
May	6,307	4,241	2,179	4,430	78.7
June	5,698	3,201	1,761	3,734	69.0
July	3,569	2,887	1,771	2,434	58.0
August	4,471	3,994	2,068	3,237	59.3
September	4,809	4,390	2,404	4,040	71.1
October	5,970	5,117	2,495	4,270	79.1
November	6,063	3,561	2,985	4,379	79.2
December	4,609	4,248	2,723	3,607	70.1

Table 6 presents the global parameters of the fishery since 1973 (total landing, total effort and average cpue per year). These data are also available by month.

Table 6: Annual landings, fishing effort and CPUE

Year	Total landings (kg of tails)	Total effort (number of deliveries)	CPUE	
			kg per delivery	kg per day at sea (SAIL)
1973	1,791,000			
1974	2,022,000			
1975	3,167,000			
1976	3,781,618			
1977	3,965,297			
1978	2,751,043	894	3,077	
1979	3,228,495	793	4,071	
1980	3,070,840	724	4,241	
1981	3,846,733	971	3,962	
1982	3,427,748	1,063	3,225	
1983	3,303,758	954	3,463	72.6
1984	2,757,610	958	2,879	64.1
1985	2,432,518	714	3,407	71.6
1986	3,311,876	652	5,080	93.8
1987	3,486,986	669	5,215	93.3
1988	2,754,883	705	3,908	69.8
1989	2,173,614	746	2,914	58.7
1990	2,566,222	712	3,604	76.7
1991	2,828,225	611	4,629	93.0
1992	2,672 tonnes	659	4,055	75.0
1993	2,434 tonnes	566	4,300	83.3
1994	2,434 tonnes	571	4,263	79.3
1995	2,611,714	557	4,689	91.0

3. ASSESSMENT OF THE RESOURCES

3.1 Production modelling

Despite known limitations of this approach for the assessment of shrimp stocks, this exercise has been carried out several times in the region, and in Suriname, especially when only partial, non differentiated data were available. Table 7 shows an overview of results of the analyses performed before 1990, based on regional data, and based on data specific to Suriname.

The results of regional modelling have been used to estimate roughly the maximum sustainable yield and corresponding fishing effort in Suriname, based on the respective surfaces of the fishing grounds. Figures obtained in this way oscillated, for MSY, between 3,800 and 4,400 tonnes (tail weight). The fishing effort required would be of more than 200 boats. From the results of an earlier assessment by Venaille (1979), based on a shorter time series, comparable MSY estimates were obtained, with a corresponding fishing effort of little more than 35,000 days at sea. Assuming an average of 250 to 300 days at sea per boat, a "MSY fleet" of 117 to 142 boats was calculated (Charlier, 1989).

Using data on the fishery in Suriname only, lower MSY estimates were obtained (3,200 tonnes), but the corresponding effort was substantially higher. There were also years where MSY could not be achieved, whatever the effort. An attempt to apply production models to selected time series (separated into good and bad years) is also mentioned in the table.

From these results it was concluded that production keeps increasing with increasing effort, without a readable maximum. It is clear that there are annual factors influencing production, which are not accounted for by these models. One of them is certainly recruitment.

Table 7: Evaluation of potential by production models

[illegible]								
Schaefer	65-85	# boats	11,600	570 boats	4,200			203
Fox	65-85	# boats	12,300	744 boats	4,400			265
[illegible]								
Schaefer	64-78	# days	11,600	99,500 days	4,200		35,422	118 (1)
Fox	64-78	# days	10,700	98,000 days	3,800		35,173	117 (1)
[illegible]								
Schaefer	78-87	# trips			3,200	900	58,600	195
Fox	78-87	# trips			3,200	890	64,350	214
Schaefer	79, 81, 86, 87 (good years)	# trips			3,700	974	63,310	211
Schaefer	78,80,82-85 (bad years)	# trips			3,100	1,106	71,890	240

= number of
(1) considering an average of 300 days at sea/boat/year
(2) considering an average of 65 days at sea/trip (SAIL, 1987)

3.2 Bio-economic modelling

Since no clear maximum is to be found on surplus production curves, it is difficult to recommend a MSY. What is wanted as a matter of fact is maximum benefit, that is maximum difference between production value and costs, rather than a maximum yield. Bio-economic models like those of the BEAM family investigate this. The BEAM I model was used in Suriname in 1983 (Willman and Garcia, 1985) and 1989 (Charlier, 1989). The following main conclusions were reached (see also Figure I) :

- The total net benefit drawn from the shrimp exploitation (fishing + processing) would not increase after the fleet had exceeded about 50 vessels; beyond 100 vessels it would actually start decreasing. The number of boats was remaining high as a result of competition between the fishing companies (overcapitalisation).
- At the current high levels of fishing effort, the impact of recruitment (variability) is such that the same fleet (level of effort) can operate profitably one year and lose money the next year.
- It was therefore recommended to use the following paths towards stock assessment and management :
    - understand shrimp recruitment variability, and its relation with production and cpue variability, requiring data which are differentiated by species, and these can only be obtained through sampling;
    - cohort analysis approach; (similar type of data required);
    - investigate further the economic factors of the exploitation, apply the different BEAM models now available, and consider management in accordance with bio-economic rather than purely biological criteria.

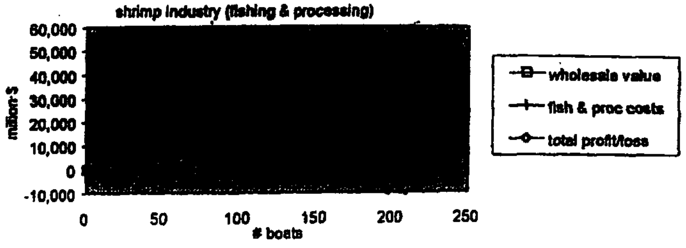

Figure 1: Total revenues and costs shrimp industry (fishing & processing)

3.3 Sampling the landings for species and size composition

After a few months of experimentation in 1984, systematic sampling of the landings at the plants started in 1985. This programme made use of the existing commercial size categories and aimed at establishing:

- the breakdown by species and sex in each commercial category ;
- the size distribution of each species/sex within each commercial category ;
- the size distribution of each species/sex, in the total landings, by combining the results of the two earlier analyses.

The sampling programme was therefore carried out in two steps. The first operation was counting tails of each species/sex, and the second one was measuring the tail length of a sample of each species/sex in each category. While counting required little time and was repeated several times a week, measuring was much more lengthy, and length frequencies resulting from measurements taken in different weeks or months were pooled and used over extended periods. An assumption was made here that the size distribution of a given species/sex within a given commercial category is better described by averages based on repeated samplings than by measurements specific to one particular sample.

Most of the sampling programme took place at SAIL. Scattered samplings were also carried at SUJAFI and should be used to test whether extrapolation of the SAIL results to the total landings may be valid. The head-on landings at SUJAFI have been sampled on only two occasions. The form shown in Table 8 was used to record the results of individual first step samplings (countings), as well as the monthly averages, expressed in number of tails (of each species/sex) per kg of a given category. These figures are easily extrapolated to the number of tails present in the total landings (of a boat, a week, a month), by multiplying by the corresponding weight landed.

For the transformation of the numbers of tails by commercial categories into the numbers of tails by length intervals (second step), conversion tables have been calculated for each commercial category and each species/sex. An example is shown graphically in Figure 2, for *P. subtilis* females.

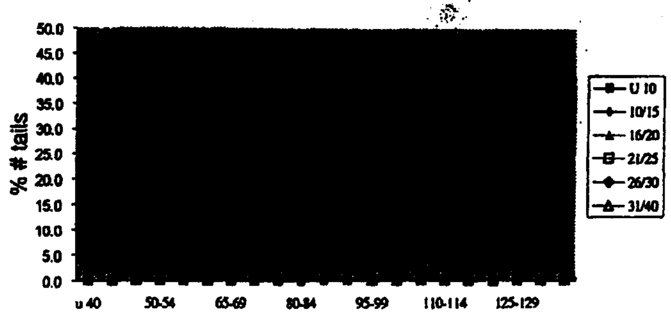

Figure 2: Relationship between commercial categories and tail length

Table 8: Form for sampling programme (see text for explanation)

	u 10	10-15	16-20	21-25	26-30	31-40	31-35	36-40	41-50	51-60	61-70	over 70	L P/O	M P/O	S P/O	culls	broken
Bf																	
Bm																	
Bo																	
Hf																	
Hm																	
Ho																	
Pf																	
Pm																	
Po																	
Wf																	
Wm																	
Wo																	

B = Brown shrimp (*P. subtilis*) ; H = Hopper (*P. brasiliensis*) ; P = Pink shrimp (*P. notialis*) ; W = White shrimp (*P. schmitti*)
f =female ; m = male ; o = sex undetermined.

The sampling programme was discontinued in 1992, as a result of lack of manpower. Data on landings by species remain necessary, however, for (almost) any future stock assessment attempt. Before the sampling programme can be resumed, several problems have to be solved and, in particular, the sampling scheme needs to be optimized. The optimal number of samples to be taken in the first step of the sampling programme (breakdown of the landings by species and sex) needs to be calculated, in accordance with the variance of the number of tails per kg. This variance depends on the species/sex as well as on the commercial category.

Figure 3 presents the coefficients of variation calculated from all data of the years 1986 and 1987, and shows that the same sampling intensity will not be required for all commercial categories. On the other hand, different species/sex show their highest coefficient of variation in different commercial categories.

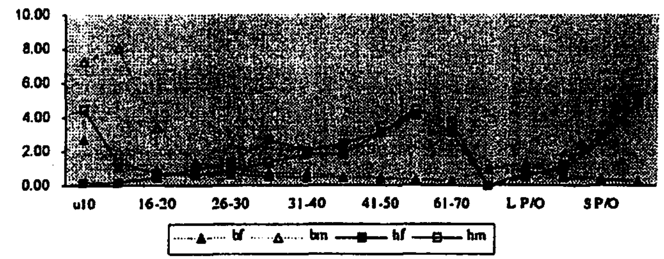

Figure 3: Coefficient of variation of numbers of tails/kg, by species/sex and categories (1986-87)

Figure 4 suggests a way to select an optimal sample size for a particular species/sex in a given commercial category, by bringing the maximum relative error to an acceptable level.

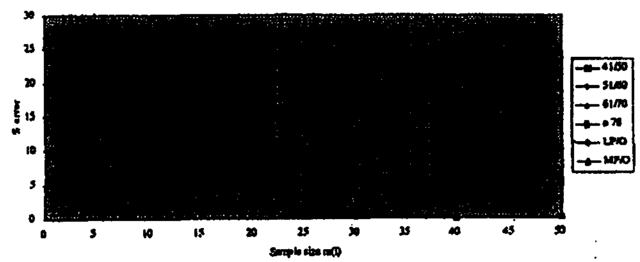

Figure 4: Maximum relative error (90%) of the average number of tails/kg brown shrimp, female;
M: 32 boats landing per month

The conversion tables (commercial categories to tail length categories) used in the second step of the programme should be recalculated at regular intervals. In practice, it is difficult (time consuming) to obtain satisfactory length frequency distributions for all species/sex/categories, especially where the numbers of a given species/sex are small. Consequently, the same set of tables, derived from all available measurements, has been used from 1985 to 1992. The validity of these length frequency distributions over longer periods of time should be investigated, and the optimal interval between two rounds of measurements should be established.

This is an important point, since step 1 (counting tails by species and sex) is much faster than step 2 (measuring them). The time/effort necessary to perform more frequent measurements would have to be deducted from the effort/time dedicated to sampling more landings.

3.4 Cohort analysis

Length-based cohort analyses have been carried out on female brown shrimp data over the years 1985 to 1991. It should be quickly mentioned that the data used did not represent the totality of the landings, since the landings at SUJAFI were not included. The results are therefore nothing but indicative, even though SAIL is considered to account for at least 65% of the total brown shrimp landings (see Table 3).

The exercise was carried out on the annual landings, on the total landings during the life-span of annual cohorts (as identified by eye), and on the average landings over the years 1985-1991. The average length frequency distribution over the period considered is shown in Figure 5.

The mortality and growth parameters used were those recommended during the workshop held in 1988 in Cayenne:

- M = 0.20 per month
- K = 0.190
- L_∞ = 129 mm

Results were series of fishing mortalities by size, for different assumptions on the final F/Z. Figure 6 gives as an example outputs of the cohort analysis on the data illustrated above (average 1985-1991). The curves resulting from the different assumptions appear very similar. The size suffering the highest fishing mortality remains 95-100 mm, beyond which fishing mortality smoothly decreases, for final F/Z lower than 0.4. A higher assumed final F/Z would produce a relative jump in the fishing mortality of the largest sizes.

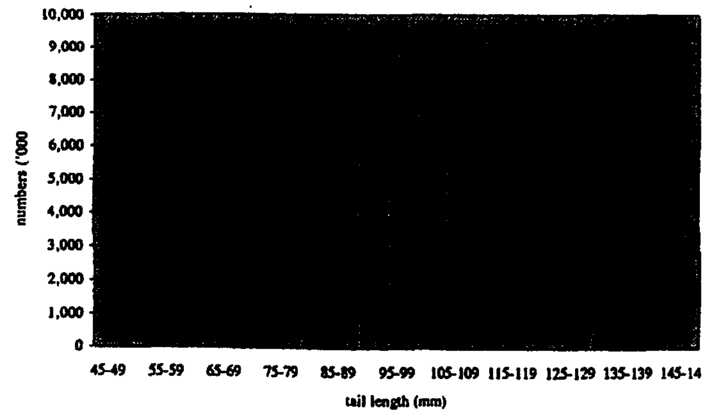

Figure 5: Average length frequency distribution, brown shrimp female, 1985-91

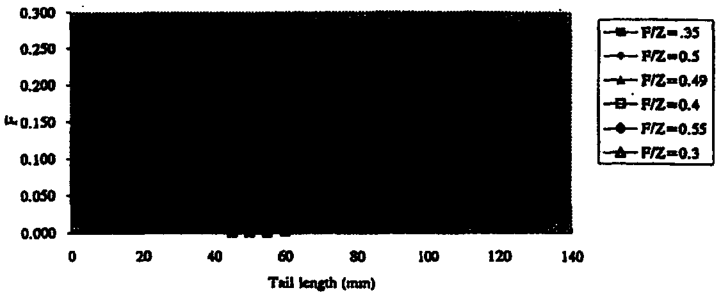

Figure 6: Fishing mortality by size, for various final F/Z

These results can be used to attempt catch predictions for various levels of fishing mortality, with results shown in Figure 7. While the catch, expressed in numbers of individuals or in weight, seems to keep increasing for fishing mortalities up to three times higher, its value soon reaches a maximum, and starts decreasing if F increases further than 1.5.

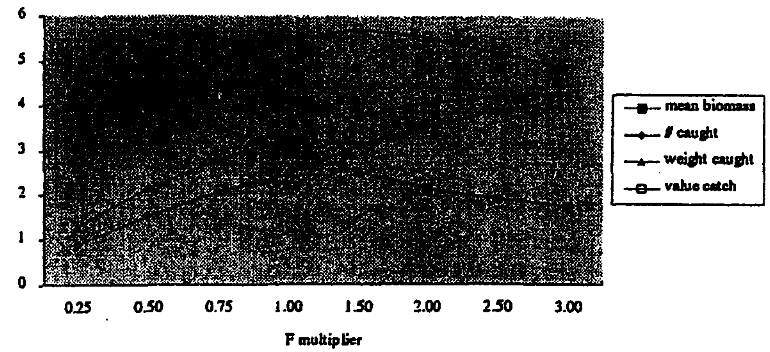

Figure 7: Catch production for different levels of fishing mortality

This analysis has not been further developed, because it was felt that the results were very dependent on input parameters (growth and mortality). Since there are no reliable, locally determined parameters available, it was necessary to select from a rather wide range of values calculated in the region, or even outside the region. On the other hand, the impact of the variations in recruitment is so important, that it is difficult to provide and substantiate advice on optimal levels of fishing mortality or effort, as long as this factor (recruitment) has not been taken into account in the predictions.

4. CONCLUSIONS

A comprehensive data base is being built up on the shrimp fishery in Suriname. Landing and effort information covers the totality of the fleet. Biological information (essentially the size structure of the landings by species) has been collected from 1985 to 1991 and, even though part of the production could not be included in the sampling programmes, the available material seems suitable for various stock assessment approaches. Several of these approaches have already been experimented with, and the results as well as the procedures used could be worked out at this workshop.

- Sampling methodology : the problems associated with the sampling programme at landing have been presented in 3.3. A methodology should be proposed to assess the value of results obtained until now by this programme, specifically :
  - optimization of the first step of the sampling system (number, size and distribution of the samples);
  - validity through time of the conversion tables (commercial categories to tail length categories) ;
  - *determination of an optimal periodicity* for the reassessment of these tables.
- The possibility (usefulness) of resuming a sampling programme (on a new basis) should then be discussed.
- Cohort analysis : results should be compared with those obtained elsewhere in the region. A discussion should take place on how to select input parameters from the wide range of values proposed in the literature. Further interpretation and application of cohort analysis techniques, with their limitations, should be debated.
- Analysis at regional level : as far as national data and results allow.

On the longer term, studies oriented towards the variations in recruitment, including the linkages with environmental parameters, should give the most useful keys for the management of the shrimp resources. It is also considered that bio-economic approaches should receive more attention in Suriname as well as, probably, in the rest of the region.

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NATIONAL REPORT OF TRINIDAD AND TOBAGO

The shrimp and groundfish fisheries of Trinidad and Tobago

by

Fisheries Division, Ministry of Agriculture, Land and Marine Resources Trinidad and Tobago[1]

1. DESCRIPTION OF THE SHRIMP TRAWL FISHERY

The demersal trawl fishery has been described as the country's most valuable fishery in terms of landings, dollar value and foreign exchange earnings (Fabres, 1989; Amos, 1990). The principal exploited species are the Penaeids: *Penaeus brasiliensis* (hoppers), *P. notialis* (pink shrimp), *P. schmitti* (white/cork shrimp), *P. subtilis* (brown shrimp) and *Xiphopenaeus kroyeri* (honey/jinga shrimp). The latter species is also targeted by bait trawlers. A significant quantity of finfish, crabs and squid are landed as by-catch.

There are four trawler fleets: two inshore, artisanal fleets; an offshore, semi-industrial fleet; and an offshore industrial fleet. Major trawling activities are centered around the Gulf of Paria in the west, the Columbus Channel in the south and seasonally in areas off the north coast.

Several species of groundfish exploited incidentally in the demersal trawl fishery are also targeted by an inshore gillnet fishery. The most commercially important and abundant species are *Micropogonias furnieri* and *Cynoscion jamaicensis.*

1.1 Fleet Description and Fishing Zones

A census of fishing vessels conducted in November 1991 identified some two hundred and nine (209) active, locally registered trawlers. These vessels are categorised into four (4) types (Types I - IV) according to their lengths, engine horsepower and degree of mechanisation (Maharaj *et al.*, 1993). Nine (9) trawlers currently comprise the semi-industrial fleet (Type III) and twenty one (21) the industrial (Type IV) fleet. The exact numbers of artisanal vessels (Type I and II) currently operating have been estimated as 113 and 66 respectively. Vessel type and characteristics are presented in Table 1.

Table 1: Trawler categories

Trawler category	Engine type	Avg Hp	Vessel length (m)	Gear type	# Trawlers in category
I (artisanal)	Outboard	2 x 56	6.7 - 9.8	1 stern trawl, manually retrieved	113
II (artisanal)	Inboard or Inboard/ Outboard	137	7.9 - 11.6	1 stern trawl, manually retrieved	66
III (semi-industrial)	Inboard diesel	176	10.4 - 12.2	1 stern trawl, retrieved by hydraulic winch	9*
IV (industrial)	Inboard diesel	> 365*	21.6 - 22.5*	2 nets on outriggers, retrieved by hydraulic winch	21*

Source: Fisheries Division Vessel Census, 1991. Fisheries Division Trawl Gear Survey, 1991. *B. Maharaj, pers. comm (1995).

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7. ACKNOWLEDGEMENTS

Sincere thanks are extended to the members of the in-plant shrimp sampling team (Messrs R. Adams, B. Dey, S. David, D. Harris, E. Thom, and Ms. D. Maison) without whose data collection efforts and fortitude in the face of great adversity the analyses presented here would not have been possible. Special thanks to the Data Input Clerks (Ms. R. De Florimonte and Ms. D. James) for their assistance in the preparation of the data. We are indebted to Dr. K. Cochrane, FAO Fishery Resources Officer, for his very valuable suggestions and assistance in editing this document. The Caricom Fisheries Resource Assessment and Management Program (CFRAMP), for their financial, technical and administrative support of this programme, is greatly acknowledged.

STOCK ASSESSMENT OF BROWN SHRIMP (*Penaeus subtilis*) IN SURINAME

by

Pierre Charlier[1]

1. INTRODUCTION

The shrimp fishery started in Suriname in 1958, and developed, together with other fleets based along the Guyana-Brazil shelf, through the mid-1970's, when the maximum number of vessels was reached. Since the establishment of the 200 miles Exclusive Economic Zone by the countries of the region, around 1978, the size of the fleet based in Paramaribo has generally tended to decrease, and fluctuated in the last ten years between 100 and 120 vessels.

More than 95% of the trawlers are foreign owned, and operated by Korean and Japanese fishing companies. With the exception of a few small local operators using their own facilities, all shrimp is landed at two large plants called "Sali" (government owned) and "Sujafi" (private owned, 49% Japanese capital). Three fleets can be distinguished, in accordance with their fishing strategy : a Korean fleet landing at Sali, a Korean fleet landing at Sujafi and the Japanese fleet, also landing at Sujafi. There is no artisanal fishery.

Landings include 2 main species (*Penaeus subtilis* and *P. brasiliensis*) in comparable proportions, and two secondary species (*P. schmitti* and *P. notialis*) representing together less than 5 % of the total landings.

The shrimp fishery is the most important of the country in terms of output value and sustains a very profitable processing and export industry. Efforts have therefore been made, since the eighties, to collect data suitable for assessment of the exploited stocks. Several attempts to understand and assess the resource, and the difficulties that were met, are outlined in the national report included in this volume. It was, among other things, concluded that a priority should be given to studying the recruitment mechanisms of the different shrimp species, since recruitment variations appear to be the major factor directly affecting the performance of the fishery.

The brown shrimp, *Penaeus subtilis*, is caught throughout the region and accounts, depending on the year, for around 60% of the shrimp production in Surinamee. Since only negligible quantities of shrimp are caught by fishing gear other than shrimp trawls, it can be considered that data obtained on the landings by the industrial shrimp fleet correspond, in first approximation, to the total production. This further justifies the selection of the brown shrimp as a priority species for stock assessment.

2. DATA AND METHODS

2.1 Data Available

The larger part of the shrimp is landed head-off at one of the two processing plants mentioned above, where it is sorted into the prevalent count-per-lb commercial categories, in accordance with individual weight. A significant part (10 to 20%) is landed at one of the plants (Sujafi) head-on, already graded, packed, frozen and ready for shipping. The commercial categories used for head-on shrimp differ from those of the head-off products. Monthly Figures on landings by commercial categories have been obtained from the industry since the year 1978, while partial information could be retrieved from different reports at the Fisheries Department for the period 1971-1977. From the information provided be the industry, fishing effort can also be calculated, in number of vessels and number of trips. Partial information on the number of days at sea is also available.

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As the species are not segregated in the processing, the data describe the global landings. Data by species can only be obtained through sampling. As explained in some detail in the national report, a sampling program has been carried out at one of the plants (Sail) from 1985 to 1991, in order to monitor the species, gender and length composition of the landings. The first output of this program is the average species and gender composition of the landings by commercial category for every month, based on samples of each category taken from 8 to 10 vessels (each month).

In a second step, monthly landings by species, gender and length (by 5 mm tail length ranges) are generated, using a set of length frequency distributions for each species/gender inside each commercial category. A single set of distributions has been established for the entire period considered, by combining all measurements taken for a given category over a number of months. These distributions could not be monitored through time, due to lack of staff, and they were assumed to remain sufficiently stable through the period considered. The validity of this assumption needs to be assessed. All calculations and extrapolations have been carried out on spreadsheets (Lotus 123 at the time).

Sampling of the head-off landings at Sujafi has been less intensive, because of practical constraints (distance from the Fisheries Department, lower frequency and total volume of landings). As a result, separate matrices for the two transformations of the landings data from this plant could not be generated. Whether, or to what extent, parameters obtained at Sail could be extrapolated to Sujafi remains to be established. For the time being, however, the Sujafi head-off landings by commercial categories have been broken down by species, gender and 5 mm length range, using the results of the samplings at Sail.

The head-on landings, also from Sujafi, have been re-distributed into corresponding head-off categories, in accordance with their respective number of counts per pound, and added to the head-off landings. Since it is presumed that the species composition of these head-on landings might differ from that of the former, a specific sampling program has been designed to monitor the occurrence of the different species in all head-on categories. This program could not yet be carried out with the required intensity, however, mainly due to the reluctance of the fishing companies to provide samples. Sampling head-on landings means thawing a number of already packed and ready-for-export 2 kg boxes, which involves a loss for the company (thawed head-on shrimp can only be processed, after sampling, as head-off shrimp).

2.2 Analytical Methods

The method used in this study is the length-based cohort analysis, from Jones (1984). A review of this method as well as practical guidelines can be found in Sparre and Venema (1992. The calculations were carried out using a spreadsheet template designed by Ehrhardt and Legault (1996). This spreadsheet also allows for tuning the analysis in such a way that the length specific fishing mortality rates obtained are in closest possible agreement with the weighed average fishing mortality rate obtained independently, for a similar range of lengths, from for example a catch curve analysis. This approach, called tuned length-based cohort analysis, is further explained in other chapters of this volume dealing with assessment of shrimp.

2.3 Input Parameters

Population parameters necessary to start a length-based cohort analysis include natural mortality rate (M), and growth parameters K and L_∞. In accordance with estimates available in the literature, which are discussed in the meeting report (this volume), the following parameters were adopted by the workshop, and were also used in this analysis :

	Female	Male
L_∞ (mm, tail length)	135.5	109.59
K ($month^{-1}$)	0.0885	0.0974
m ($month^{-1}$)	0.146	0.146

3. RESULTS

The outputs of the tuned length cohort analysis are monthly estimates, by size range, of the total and fishing mortalities and of the population size (both in biomass and in number of individuals). These results constitute a powerful data base from which trends can be traced for example in the abundance of recruits, or of spawners, or of any other size component, and relationships can be investigated between these different components, or between their abundance and external parameters, like environmental or fishery-driven parameters. The preliminary analysis hereunder proposes an interpretation of the global trends in fishing mortality, abundance and recruitment, and will be carried further in connection with environmental information, results on other target species of this fishery, more refined data on longer time series and locally determined population dynamics parameters (when they become available).

3.1 Fishing mortalities

The fishing mortalities for both sexes, plotted in Figure 1, follow each other closely. The fishing mortality of males appears to be always substantially lower than that of females. This may be caused, at least partly, by the choice of input parameters. In particular, the same natural mortality (M=0.146) has been assumed for both genders, while some sources suggest that males may bear a higher natural mortality rate than females (Isaac *et al.*, 1992).

For both genders, the average fishing mortality shows, in the entire period considered, a clear annual periodicity where a maximum is reached in the middle of the second half of each year. It then decreases gradually until February, and the minimum values are generally observed between February and April. The annual pattern seems fairly reproducible. In 1989, however, lower levels of fishing mortality were reached in the second half of the year than was the case in other years. The same could be said, to a lesser extent, of the year 1991. The period characterised by lower fishing mortalities, in the first months of the year, was more extended (6 to 7 months) than usual (4 months) in both 1989 and 1991.

There has been no apparent long term change in the mortality levels, and the fishing mortality estimates obtained by this analysis remain always, for both sexes, below the value postulated for the natural mortality.

3.2 Stock Abundance

Stock abundance is reflected by the average numbers of shrimp at sea, and by the corresponding biomass. Figure 2 shows that brown shrimp males consistently had a lower biomass than females. The trends for both genders are very similar, however. Abundance appears to have changed widely from month to month, with maxima situated in the first half of the year. Abundance estimates may increase or decrease, in a matter of a few months, by a factor of 3 or 4. On the other hand, no increasing or decreasing long term trend is observed over the years considered. After a low in 1989, biomass recuperated quickly and was back at its previous level in 1991.

Catch (shown in tonnes) represents a relatively small fraction of the biomass (Figures 3, 12 and 13). This proportion varies following a recurrent annual pattern, with higher values towards the end of the year, corresponding to the higher fishing mortalities. The contribution of males in the catch is about half that of the females, and the proportion of males seems to decrease in the periods when catch and biomass are higher (Figure 3). It is notable that the catch has a very constant relation to the recruitment (Figures 12 and 13), which underscores the role that recruitment may play in the variations in shrimp production.

3.3 Catch per Unit of Effort

The catch per unit of effort (CPUE), expressed in number of individuals caught in an average trip, is given in Figure 4. Maxima are generally observed in the second half of the year, and a second, less conspicuous peak is visible in the first months of most years. The year 1988 exhibits only the main peak (September to November), and no CPUE peak is discerned at all in 1989. The catch per unit of effort for males is lower than for females, and this difference is accentuated in the second half of the year.

Figures 5 and 6 illustrate, respectively for females and males, the relationship between abundance, catch and CPUE, all expressed in numbers. It can be seen that the three curves follow the same evolution, but also that the numbers caught seem to match the changes in the abundance more accurately than does the CPUE. It is useful to mention here that the unit of effort used in the CPUE calculations (number of trips) is not very precise, and that using, for example, the number of days at sea, might lead to a different interpretation. Plotting respectively the numbers caught per trip and the numbers caught against the abundance (Figures 7 and 9 for the females, 8 and 10 for the males) confirms that the catch apparently has a closer relationship to abundance than does the CPUE.

3.4 Recruitment

Recruitment as expressed by the biomass of individuals smaller than 70 mm (females) or 65 mm (males), tail length, is given in Figure 11. For each gender, Figures 12 and 13 compare the recruitment curve with the curve of the biomass and the curve of the catch. All three have very similar patterns, and recruitment seems to follow exactly the biomass, except that the clear biomass peaks translate into lesser conspicuous recruitment peaks, particularly at the beginning of the year. As a result, recruitment appears more or less continuous through the year, with only lows in the middle of certain years (1986, 1988, 1989, 1991).

If the quotient recruitment/biomass is plotted, however, as in Figures 14 and 15, a very clear monomodal recruitment pattern comes forward, with a major peak situated between September and November. Only in the years 1985 and 1989 does this recruitment period appear less predominant (though still clearly visible). This pattern is matched perfectly by another recruitment index, the CPUE of small sizes. Remembering that shrimp is recruited to the trawl fishery from an age of about three months, and that there is a time lag of one to two months between catch and landing time, it follows that the shrimp making up the recruitment peak has been hatched in April - June. These months coincide with the main rainy season in Suriname. This confirms earlier findings on the impact of rainfall on shrimp recruitment in the region (for example Garcia *et al.*, 1984, for French Guiana ; Charlier *et al.*, 1995, for Suriname).

3.5 Fishing Mortality and Fishing Effort

There is no apparent relationship between the fishing effort and the resulting fishing mortality, as demonstrated by the plots in Figures 16 (females) and 17 (males). This translates into, or may be caused by, an important variability of the catchability coefficient (q), which is the quotient between these two variables, from month to month. On the other hand, this coefficient exhibits a seasonal pattern, as higher values are found in the second half of the year (Figure 18), corresponding also to higher values of the fishing mortalities. How all this should be interpreted is not clear at this time. Different elements like the behaviour of the shrimp, the strategy of the fleets, and environmental factors, have to be taken into account. It is interesting to observe that the catchability coefficient seems to be negatively related to the fishing effort (Figures 19 and 20).

3.6 Importance of input parameters

In order to understand the impact of the assumptions made on initial F/Z and other input parameters on the results of the tuned length cohort analysis, several values of F/Z, L_∞ K and M were tested. For this exercise, the average annual length frequency distribution of *P. subtilis* females, for the years 1985-1991, was used. The values tested ranged within the results that have been reported in the literature (Lum Young *et al.*, 1992 ; Charlier, 1995).

The results obtained with varying values of the input parameters are illustrated in Figures 21 to 28. The values given to initial F/Z (in the range 0.1 to 0.7) do not seem to affect the estimated number of survivors (thus the abundance) by size (Figure 25). The fishing mortality estimates obtained by this analysis do not appear to depend very much either on the initial F/Z value (Figure 21). On the contrary, the assumptions made on natural mortality and growth parameters have a significant impact on the results, particularly on the estimated numbers of survivors in the small sizes (Figures 26 to 28). These observations suggest that efforts should be made to verify these parameters in the different countries of the region, in order to obtain more reliable abundance and recruitment estimates. They also underline the need for the countries to cooperate, in common methods and assumptions, and to share the results of their analyses.

4. CONCLUSIONS

a) Length-based cohort analysis offers a way to calculate monthly abundance indices of brown shrimp by size (age), and to quantify recruitment. Preliminary results covering the period January 1985 to December 1991 indicate that abundance varies widely (by a factor 3 to 4) through the year, and in Suriname follows an average annual pattern with maxima at the beginning of the year. Fishing mortality exhibits a very reproducible annual trend with higher values in the second half of the year. In the long term, both variables show notable stability, which would suggest that the level of exploitation, in the period considered, was not excessive.

b) Catch varies in accordance with biomass, which in its turn appears very dependent on recruitment. This confirms that recruitment, and particularly its variability from year to year, is a major factor to be taken into account in the management of the fishery. Understanding the relationship between recruitment and environmental conditions could open the way to yield predictions, and allow for a better adjustment of levels of effort, and economic optimisation.

c) Recruitment to the fishery is year-round, with one conspicuous mode at the time of the year that precisely corresponds to a larval recruitment during the main rainy season in Suriname, from April to June.

d) Catchability was estimated to exhibit seasonal variations, with higher values observed in the periods of maximal fishing mortality, and an apparent negative relationship to fishing effort. The possible impact of a number of factors that may be related to this variability should be investigated.

e) It should be kept in mind that, since the level of fishing effort applied does not appear to be the major factor governing yield, which appears more influenced by abundance fluctuations, economic overexploitation is likely to occur before shrimp stocks become threatened. Economic issues therefore play a particularly important role in the management of shrimp fisheries. On the other hand, shrimp trawling strongly affects the stocks of all fish species included in its by-catch, and the status of these stocks might to some extent constrain shrimp fisheries management.

f) From the considerations above, it is possible to draw some guidelines for future investigations:

- Given their impact on the results of length-based cohort analysis, population parameters, particularly growth, should be investigated based on local data.
- Sampling on a continuous basis is required to keep track of the composition of the landings. An optimised sampling scheme, making the best possible use of available manpower, should be worked out and implemented.
- The current database should be further analysed, in connection with factors of recognised importance, like environmental factors and a more accurate description of fishing effort (including standardisation and integration of technical innovations). The information contained in the seven years 1985-1991 should be sufficient for a reliable extrapolation to other years.
- Similar analyses should be undertaken on the other shrimp species exploited by the trawlers fleets. Data should be collected on different aspects that are important to the management of the fishery, particularly on the economic aspects, and on the by-catch.

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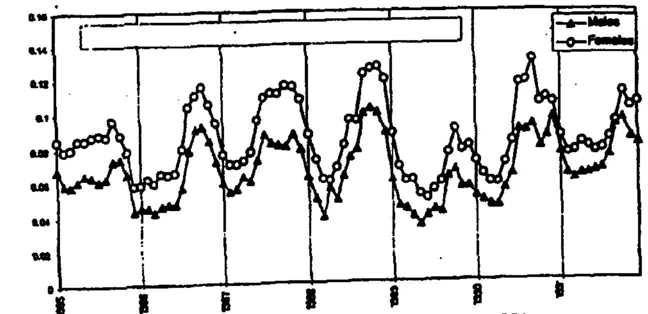

Figure 1: Monthly fishing mortalities, *P. subtilis*, Suriname, 1985-1991

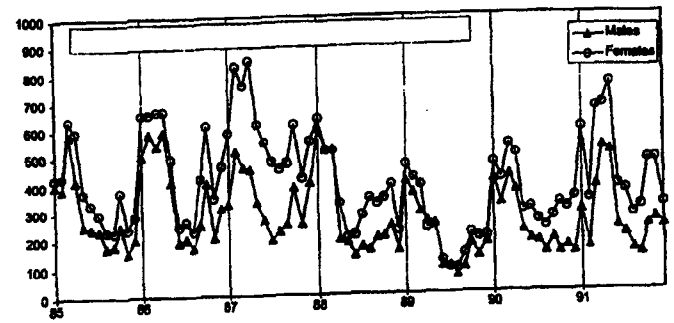

Figure 2: Monthly average biomass, *P. subtilis*, Suriname, 1985-1991

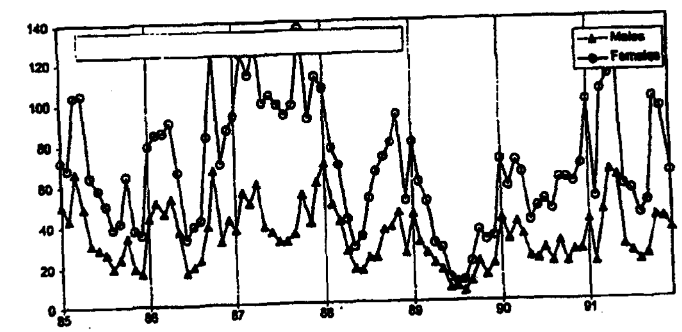

Figure 3: Monthly catch, *P. subtilis*, Suriname, 1985-1991

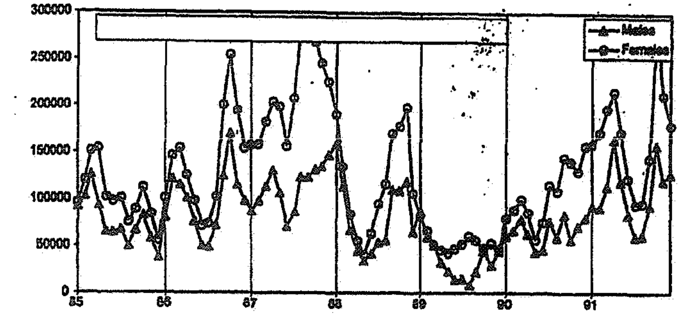

Figure 4: Monthly cpue (# caught/trip), *P. subtilis*, Suriname, 1985-1991

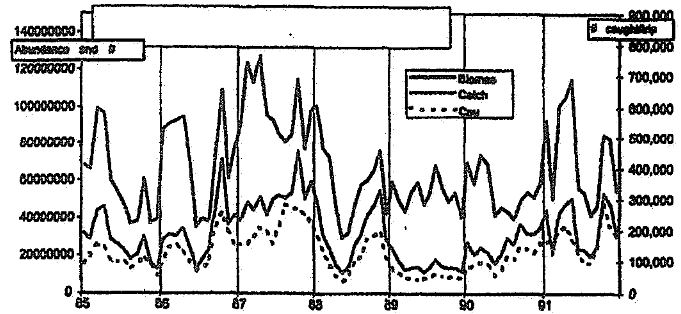

Figure 5: Monthly abundance, catch and cpue in numbers, *P. subtilis* female, Suriname, 1985-1991

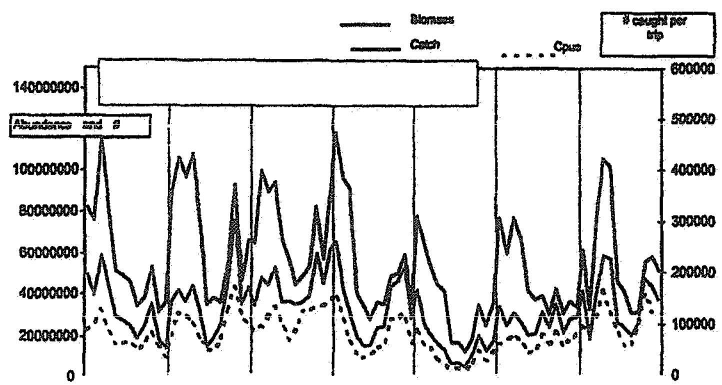

Figure 6: Monthly abundance, catch and cpue in numbers, *P. subtilis* male, Suriname, 1985-1991

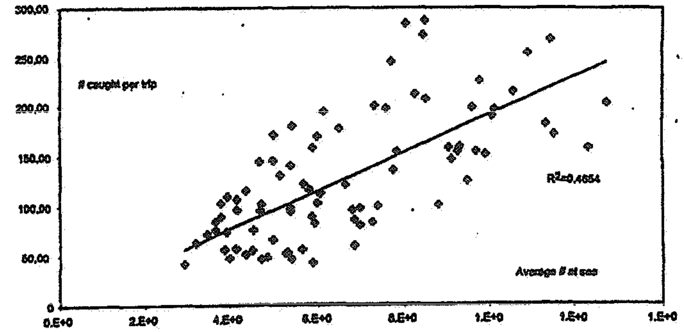

Figure 7: Cpue (# caught/trip) vs abundance, *P. subtilis*, female, Suriname, 1985-1991

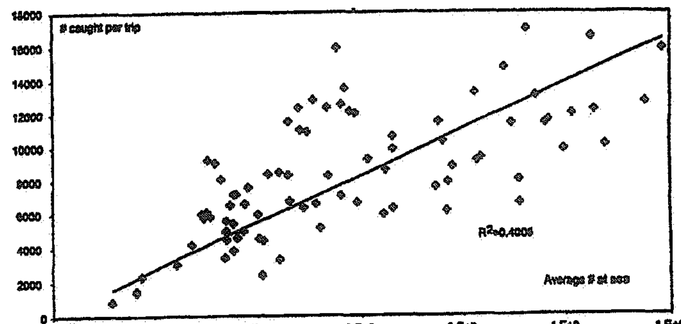

Figure 8: Cpue (# caught/trip) vs abundance, *P. subtilis*, male, Suriname, 1985-1991

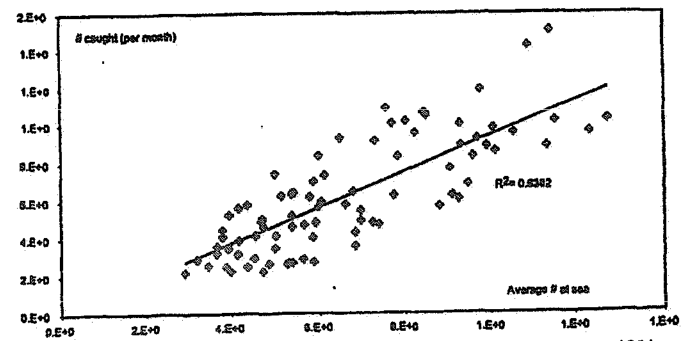

Figure 9: Catch in numbers vs abundance, *P. subtilis*, female, Suriname, 1985-1991

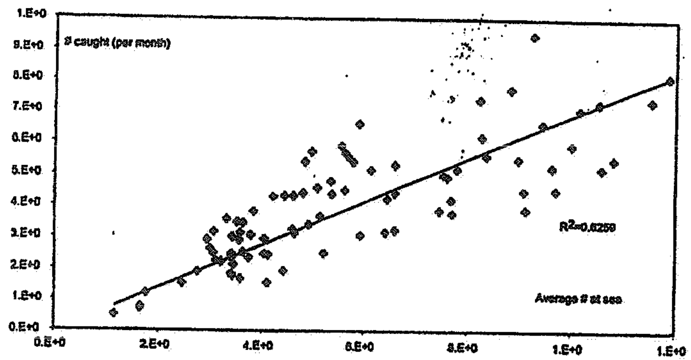

Figure 10: Catch in numbers vs abundance, *P. subtilis*, male, Suriname, 1985-1991

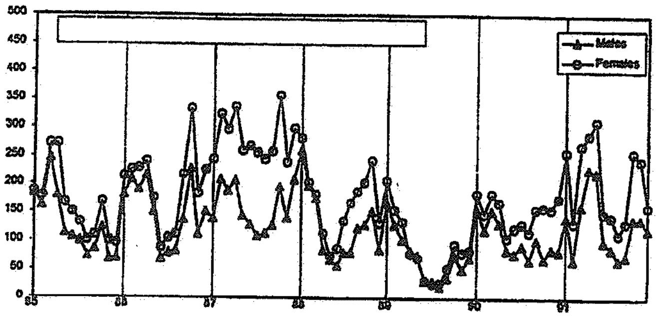

Figure 11: Monthly recruitment, *P. subtilis*, female, Suriname, 1985-1991

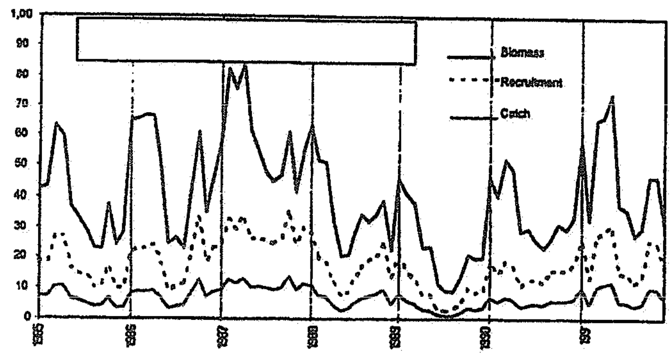

Figure 12: Monthly biomass, recruitment and catch (tonnes), *P. subtilis*, female, Suriname, 1985-1991

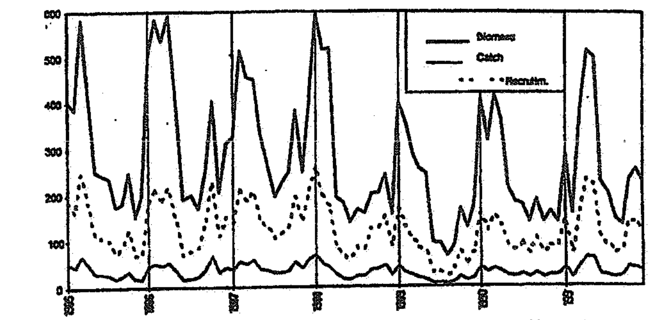

Figure 13: Monthly biomass, recruitment and catch (tonnes), *P. subtilis*, male, Suriname, 1985-1991

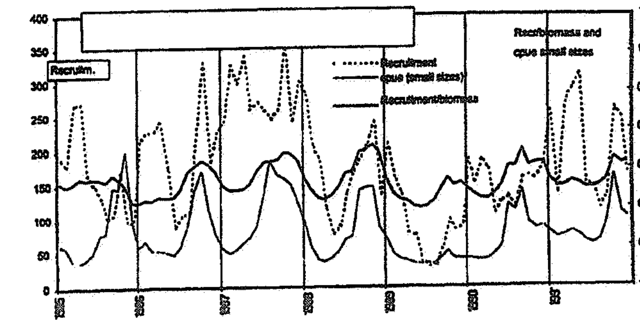

Figure 14: Monthly recruitment and recruitment indicators, *P. subtilis*, female, Suriname, 1985-1991

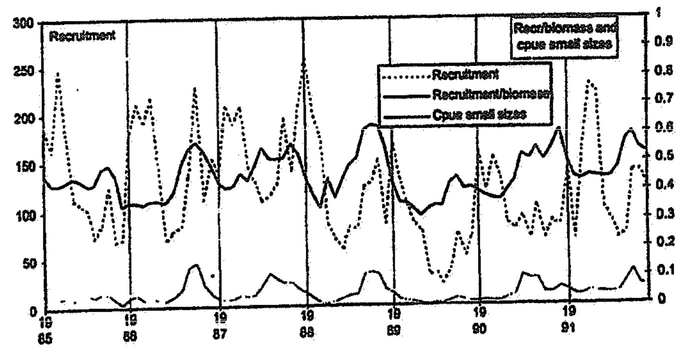

Figure 15: Monthly recruitment and recruitment indicators, *P. subtilis*, male, Suriname, 1985-1991

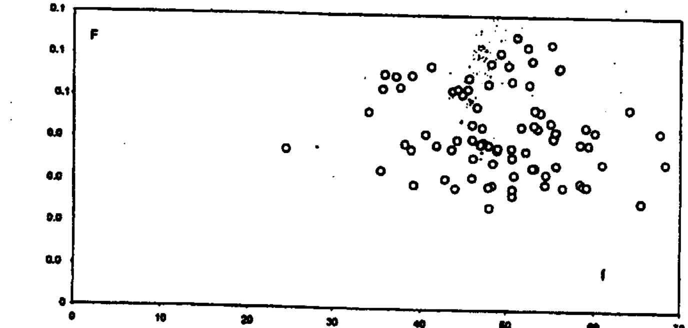

Figure 16: Fishing mortality vs effort (# trips), *P. subtilis*, female, Suriname, 1985-1991

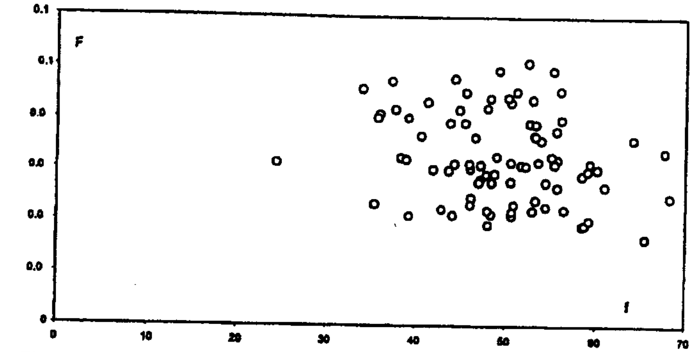

Figure 17: Fishing mortality vs effort (# trips), *P. subtilis*, male, Suriname, 1985-1991

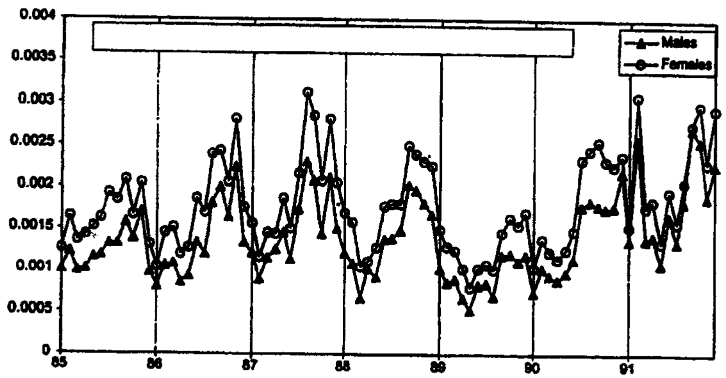

Figure 18: Monthly catchability coefficient, *P. subtilis*, Suriname, 1985-1991

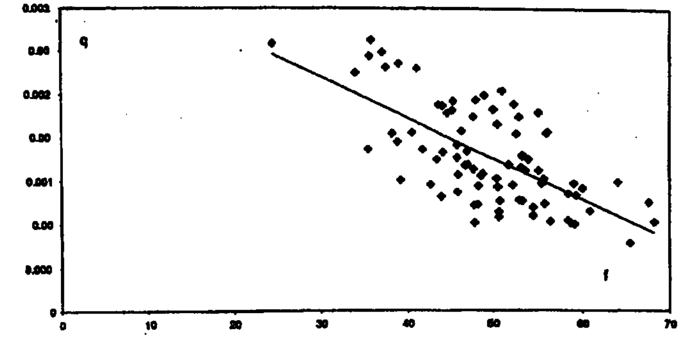

Figure 19: Catchability coefficient vs fishing effort, *P. subtilis*, female, Suriname, 1985-1991

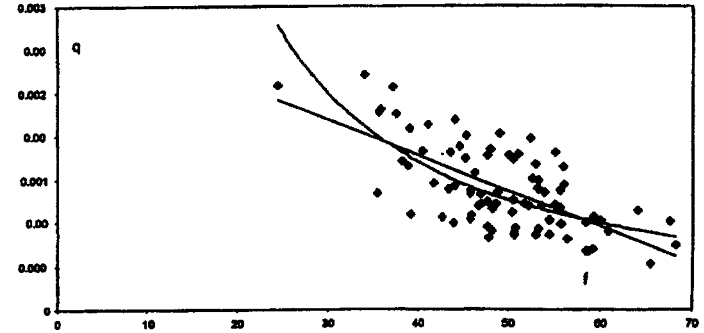

Figure 20: Catchability coefficient vs fishing effort, *P. subtilis*, male, Suriname, 1985-1991

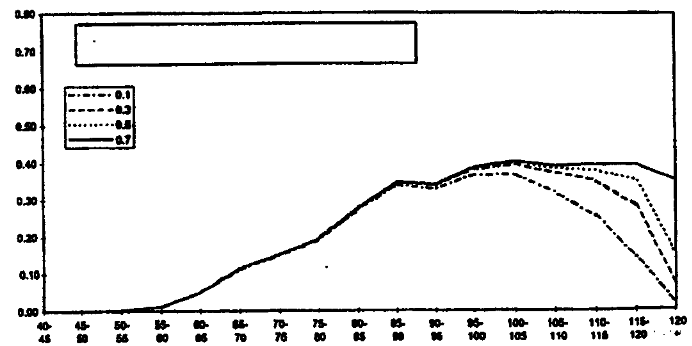

Figure 21: Impact of initial F/Z on fishing mortality by size, *P. subtilis*, female, Suriname, average 1985-1991

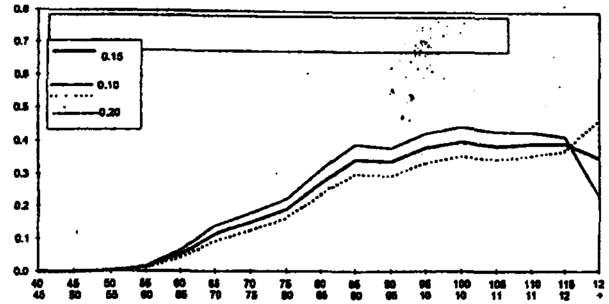

Figure 22: Impact of assumed natural mortality on estimated fishing mortality by size, *P. subtilis*, female, Suriname, average 1985-1991

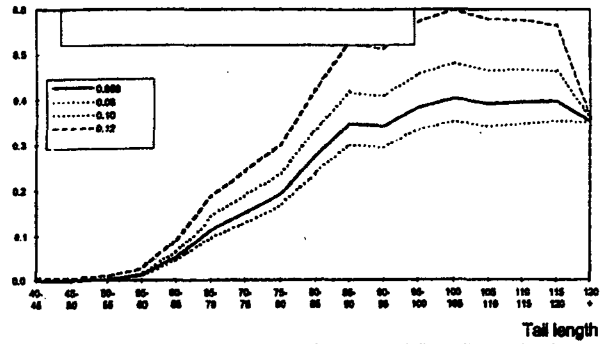

Figure 23: Impact of assumed K on estimated fishing mortality estimates by size, *P. subtilis*, female, Suriname, average 1985-1991

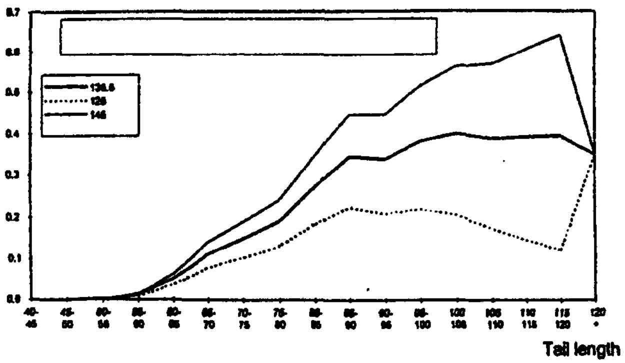

Figure 24: Impact of assumed L_∞ on estimated fishing mortality estimates by size, *P. subtilis*, female, Suriname, average 1985-1991

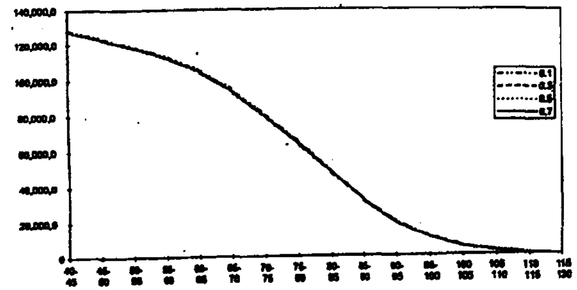

Figure 25: Impact of initial F/Z on abundance estimates by size, *P. subtilis*, female, Suriname, average 1985-1991

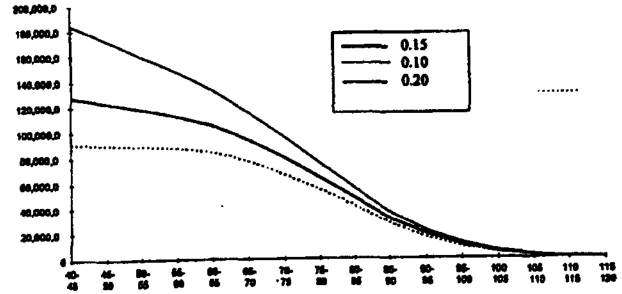

Figure 26: Impact of assumed natural mortality on abundance estimates by size, *P. subtilis*, female, Suriname, average 1985-1991

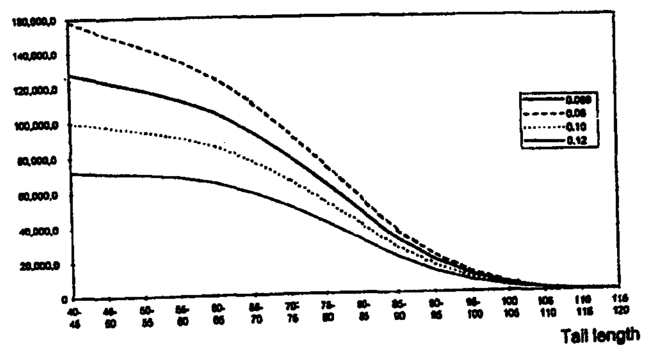

Figure 27: Impact of assumed K on abundance estimates by size, *P. subtilis*, female, Suriname, average 1985-1991

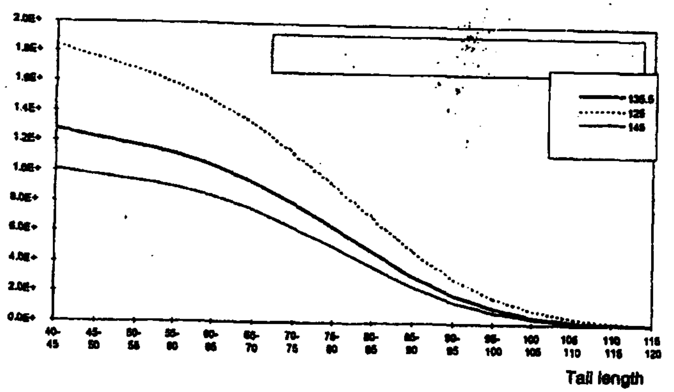

Figure 28: Impact of assumed L_∞ on abundance estimates by size, *P. subtilis*, female, Suriname, average 1985-1991

EVALUATION OF THE WHITE SHRIMP (*Penaeus schmitti*) STOCK WITHIN THE ORINOCO DELTA AND GULF OF PARIA REGION

by

José J. Alió[1], Luis A. Marcano[2], Juan Páez Costa[3], Douglas E. Altuve[4], Nelson M. Ehrhardt[5]

1. JUSTIFICATION

A common approach for evaluating shrimp resources in areas where information is scant, usually having only data on catch and effort, has been the use of surplus production models (e.g. Fox, 1970). Notwithstanding their valuable contribution to management of marine shrimp fisheries, these types of models make gross assumptions about the dynamics of the population under analysis. Since they treat all individuals in a similar way, they are unsuitable for evaluating, for instance, the variations undergone by different stages within the life cycle of a shrimp species. The information currently available on the shrimp species within the region of the Guyana – Brazil shelf has improved significantly in recent years. In addition to the catch and effort data already available in most countries, processing plants within the region can provide a large amount of information on catch received by *month, and how it was converted to catch per size class. Furthermore, there have been numerous* studies on the regional species of shrimp covering aspects of growth, reproduction and maturation, morphometry, distribution of *life* stages, recruitment, natural mortality and stock assessment (see review by Lum Young *et al.*, 1992).

Considering the available, albeit still limited, information the working group on *Penaeus schmitti* decided to perform a first assessment of this species using virtual population analysis (VPA). It is expected to serve as an introduction of this methodology in the progressive evaluation of other regional shrimp resources, which may become possible in the near future as more information accrues.

2. DESCRIPTION OF STOCK AND FISHERIES

The white shrimp, *Penaeus schmitti*, occurs in shallow waters throughout the Gulf of Paria and the marine border of the Orinoco delta. Its distribution encompasses the Caribbean Sea and the eastern coast of South America, to southern Brazil (Holthuis, 1980). It seems that within the Trinidad - Brazil shelf region, important landings of this species are only made from Venezuelan waters.

Catches of juvenile *P. schmitti* are made by artisanal fishermen in shallow areas within the Gulf of Paria and in the mouths of the rivers throughout the Orinoco delta region (Figure 1). There is an artisanal fishery for this species in the northern coast of the Gulf of Paria (Irapa to Soro), in which fishermen use beach seines in very shallow water (Altuve *et al.* 1995; Altuve 1997). There is also an artisanal trawl fishery, composed of fishers from Venezuela and Trinidad-Tobago, who operate in the mouths of the rivers of the northern Orinoco delta. Venezuelan fishers operate in the northern sector *of Point Bombeador, whereas Trinidad fishers do it in the southern sector, near Cocuina Island. P. schmitti* represents most of the landings from the Venezuelan fleet, but only 69% of the Trinidad landings; the other 31% in the latter landings are made up of *P. subtilis* (Trinidad and Tobago Fisheries Division, 1996).

Adult *P. schmitti* are trawled in offshore waters close to the mouths of major rivers in the Gulf of Paria and the Orinoco River. The Venezuelan industrial fleet harvests *P. schmitti* in the Gulf of Paria and the *Columbus Channel (statistical areas 10621, 10612, 09614, 09613, 09604, 09601, 08594 and 08593;* Marcano *et al.*, 1996) while the Trinidad industrial fleet does not make large landings of this species.

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