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# WESTERN CENTRAL ATLANTIC FISHERY COMMISSION

National reports and selected papers presented at the Third Workshop on the

# BIOLOGICAL AND ECONOMIC MODELLING OF THE SHRIMP RESOURCES OF THE GUYANA-BRAZIL SHELF

Paramaribo, Suriname, 22-25 June 1992

Food and Agriculture Organization of the United Nations

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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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## ABSTRACT

This publication assembles the national reports and technical papers presented at the Third Workshop on the Biological and Economic Modelling of the Shrimp Resources of the Guyana-Brazil Shelf, Paramaribo, Suriname, 22-25 June 1992.

The papers are included in the language in which they were presented.

Nine papers are included dealing with the shrimp fishery of the region; six national reports, and three papers on escape panels, the artisanal shrimp fishery of the northern coast of Venezuela, and a review of the shrimp fisheries and resources of the Guyana-Brazil continental shelf.

# CONTENTS

NATIONAL REPORT OF VENEZUELA

# *Venezuelan Shrimp Fisheries in the Atlantic Margin of Guyana*

by
L. Marcano[1], J. Alió[1], D. Altuve[1], John Celaya[2]

## INTRODUCTION

This report describes the characteristics of the shrimp fisheries made by venezuelan industrial fishermen in the Atlantic zone of the country (from Bocas de Dragon in the Gulf of Paria, the zone encompassed between the South of Trinidad and the Orinoco river delta, until Boca Grande, Fig. 1). Shrimp resources in this zone are exploited by fishermen from Venezuela and Trinidad and Tobago. Information from the latter country has not been included. Information on the artisanal trawling fishery is not included either, because it is not carried out by Venezuelan fishermen, but by Trinidadian fishermen, in a special common area recognised by the two governments. No information is available on their activities. The artisanal shrimp fishery made by Venezuelans in the area, using beach seines, is concentrated in the northern Gulf of Paria; details on this fishery are given in a separate report (Altuve *et al.*, 1992). Only a brief description is presented below.

The industrial exploitation of shrimp resources in this zone is the most recent of Venezuela; its origin has been reported to occur in 1973 (Novoa, 1974; Marcano, 1977). Nevertheless, before the establishment of an industrial fleet, shrimps had been exploited, since around 1960, by small vessels, with little autonomy, using Güiria as their base port (Ewald *et al.*, 1971). At the beginning, these small vessels operated in the northern region of the Gulf, and progressively covered the whole area, stimulated by the results of the MAC-PNUD-FAO project (Marcano, 1977, 82, 85).

The industrial shrimp trawling fishery in the Atlantic zone of Venezuela started as a consequence of the crisis that the exploitation of shrimp resources underwent in the Gulf of Venezuela, towards the end of 1973 (Fig. 2), which originated a massive migration of vessels to the eastern region of the country. Many of these vessels took as their base port Cumaná or Güiria, settling this way a permanent trawling fleet in the area, exploiting the bottom resources between the Boca de Dragones in the Gulf of Paria and the Essequibo river (Marcano, 1977; 1990).

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By 1971, two trawling vessels based in Cumaná made trawls in front of Suriname and French Guiana (Novoa, 1974), although it is in 1974 that the fleet based in Cumaná increased its activities in the Atlantic zone of Venezuela and the surroundings. Nowadays, more than 50% of the fishing effort in the area is performed by vessels from Cumaná, landing the catch in Güiria or Cumaná (Montesinos *et al.*, 1980; Marcano, 1985). More recently, starting in 1988, vessels from Guanta (Punta Meta, near Puerto La Cruz, Fig. 2) have initiated trawling operations in the area, landing their catch in their base port.

At the present moment, the traditional trawling fishing grounds, located in the Gulf of Venezuela, Platform Unare - Píritu, and Northern Margarita Island and Sucre State (Fig. 2), are being exploited intensively. It has been estimated that the effort level applied to the bottom resources, and mainly upon the shrimp resources, is beyond the one required to achieve the Maximum Sustainable Yield.

In lieu of this situation, the Atlantic zone has been considered as an alternative to increase the industrial development of the fishery, because of its lowest level of exploitation, high yields in fish resources, and the highest yields in shrimp resources, in comparison with the other areas exploited by the trawling fleet. At the present moment, a total of 136 to 140 vessels operate in the Atlantic zone of Venezuela, based in Puerto La Cruz, Cumaná and Güiria (Marcano, 1989b).

# I. DESCRIPTION OF THE SHRIMP INDUSTRY

## I.A. SOURCE OF DATA AND METHODS

The basic information used for this report has four sources:

i. The official statistics, conformed monthly with the reports made by all companies owner of trawling vessels. The reports are handed in to the Fishery Authority in the base port, after every trip made by each vessel. These reports include the following information: landings per species or group of species and effort in number of days-at-sea. Information pertaining to shrimps is indicated as commercial categories, white shrimp (*Penaeus schmitti*) or brown shrimp. The latter corresponds to a mixture of three species, the brown shrimp, *P. subtilis*, the pink shrimp, *P. notialis*, and the pink spotted shrimp, *P. brasiliensis*. Usually shrimp catch is reported as animals with head, but occasionally it is reported headless.

ii. The fishing log books filled up by the captains, since 1989 by the fleet based in Güiria and Cumaná, and since 1990 by the fleet based in Guanta. The information reported in these log books include the catch per species in every trawl (in boxes of 10 kg), the duration of the trawl (time it began and ended), the geographic location of the trawl (in FAO squares of 30 x 30 miles$^2$) and the depth of the trawl.

iii. These log books are also filled up by technicians (FONAIAP personnel or persons hired and trained for this purpose) serving as observers on board, who also report data about by-catch, and perform biological samplings of different species in the catch.

iv. The information gathered in the processing plants located at Güiria and Cumaná, consisting in biological sampling of shrimp (date and origin of the catch, sizes, sex and gonadal maturity).

The seasonal analysis by species was performed using only data from the fleet based in Güiria, since these vessels discriminate the shrimp catch among the four shrimp species, and the catch of this fleet represents more than 50% of the total catch in the zone. The monthly data (catch, effort and c.p.u.e.) were standardized by year, subtracting the mean for the respective year and dividing by its standard deviation. The monthly mean for the group of years was then calculated. This procedure prevents high yields during abnormal years from affecting excessively the general seasonal estimate for each month.

Information pertaining to structural characteristics of the vessels and fishing gear, was obtained from the Fishing Information System of the Venezuelan Fisheries and Aquaculture Office, gathered when the boats are registered and the fishing permits are requested.

The analysis of the information by area was performed dividing a map of the Atlantic zone in FAO type squares of 30 x 30 nautical miles$^2$ (Fig. 1).

Because of the large number of companies dedicated to shrimp exploitation in the area, the processing of information by company was difficult. Thus, the analyses in this report include the global information from the entire fleet.

## I.B. FISHING ACTIVITIES

### 1. The fishing zone

The area where the fleet operates is located in the Atlantic zone of Venezuela, between Bocas del Dragón in the North, to the Essequibo river in the South (Fig. 1), covering an area of 71.000 km$^2$. The area receives the discharge of important rivers (Amazon, Esequibo, Orinoco and San Juán), which induces a high level of primary productivity in the water.

The area can be subdivided into two sub-areas, the Gulf of Paria and the Atlantic margin of the Venezuelan Guayana. The first of them represents a body of internal waters of 9.700 km$^2$, enclosed between the coast of Venezuela (Peninsula of Paria, the Guariquén mountains and the San Juan river delta) and the eastern coast of Trinidad. This Gulf connects to the Caribbean Sea through the Bocas de Dragon, while does it with the Atlantic Ocean through the Serpent's Mouth. The rivers Orinoco, in a greater proportion, San Juan and diverse creeks which drain into the Gulf, influence water properties and sediment distribution. Water is mainly turbid (Secchi depth less than 20 cm),

with low salinity (0 to 30 °/oo) and high temperature (> 27°C). Depths in the zone are commonly less than 37 m, with wide zones shallower than 3 m. Bottom is generally silty to silty-sandy (Ginés, 1972; Alió *et al.*, 1990).

The Atlantic margin of Guayana encompasses a coast line of 618 km, from Point Bombeador, in the northern delta of the Orinoco river, until the Esequibo river, covering an area of 60.000 km$^2$. This sub-area receives directly the discharge of the Orinoco river and presents silty bottoms, from the coast to a distance 80 km outwards.

## 2. The fleets

Vessels and enterprises

All industrial fishing vessels operating in the Atlantic margin of Venezuela, use Florida type nets, trawling two similar nets on each side of the vessel. The number of boats operating in the zone reached 136, from three base ports: Güiria, Cumaná and Punta Meta (Table 1).

Due to the large number of enterprises, compared to the number of vessels, it is evident that most enterprises are small. In Güiria and Punta Meta (Puerto La Cruz) the companies have up to 3 vessels, whereas in Cumaná there are companies with up to 11 vessels. All boats carry the venezuelan flag. The venezuelan fishing authorities have not granted any permit to foreign trawlers for operation in the jurisdictional waters.

The evolution of the fleet operating in the zone during the period 1973-91, by base port, is shown in Tables 2, 3 and 4 and Fig. 3. The number of fishing units based in Güiria has shown wide changes from its beginning (Table 2). The maximum number of vessels was reached at the beginning of the industrial operation of the fleet (91 trawlers); this number decreased progressively until 1980, when it reached 21 vessels. Since then the number of vessels has increased, to 56 in 1991. These variations were a consequence of the migration of trawling boats from the fishing grounds in the western part of the country, and the later return of them to their original base port, in addition to the incorporation of new fishing units registered in Güiria (Marcano, 1990).

The fluctuation in the number of fishing units operating in the Atlantic zone from Cumaná, are less notorious than in the previous case (Table 3). The maximum number of trawling vessels was reached in 1989 with 84 units, and stabilized during last years at 70 units. These vessels also operate in the zone of Margarita - North of Sucre State. Nowadays, most vessels operating in the area are based in Cumaná.

Lastly, it can be observed that during the last two years, there have also been vessels from Punta Meta fishing in the Atlantic zone (Table 4).

All trawling vessels are made with steel. The structural characteristics are shown in Table 5, for the last three years and the whole fleet, without consideration of the base port. Most vessels have lengths between 21 - 25 m, engines with a power 400 - 700 hp, and Bulk Reported Tonnage (B.R.T.) 100 - 200 mt. The structural characteristics do not seem to have changed noticeably during

the period considered, whereas the power of the engines has increased. These characteristics confer the fleet a fishing power greater that the one they are performing in the zone.

The units are equipped with compass, radar and echosounder. Thirty per cent of them carry freezer refrigeration systems, while the rest (70%) carry crushed ice to conserve the catch.

Fishing gear

The vessels are equipped to work with Florida type gear (double gear), using a hydraulic winch with two drums. Each drum carries 500 - 600 m of steel cable, with diameter 50.8 - 63.5 mm. This length of cable limits operations to a maximum depth of 70 m. The cable is marked every fathom (18 m) in order to know the amount of dispensed cable.

The doors are rectangular, 2.45 x 1.0 m or 2.70 x 1.10 m, made with wood boards and steel shoes and shoulders. The triangles are made with chains, the front one being 0.8 m long, whereas the rear one is 1.35 m. The legs are made as follows: the one connected to the floatline is made with polypropilene rope and measures 2.0 - 2.5 m; the one connected to the lower line is made with chain and measures 2.9 m. Scissors are made with wire, 12.7 mm in diameter and 4.8 m long.

The nets are semi-flat, with four faces, and a total length of 25 - 35 m. There are three sections in each net : body, tunnel and cod end. The floatline measures 27 m and the footrope 29 m. The nets are made with polyamide ("nylon") netting, with 350 - 420 mesh of 52 mm stretched in the body; side faces have 60 - 80 mesh and the arms 100 - 110. Mesh size in the tunnel is 50 mm, and 42 mm in the cod end. The cod end is additionally protected by an external net, called "shirt", to prevent damage. This latter net is made with coarser netting yarn with a mesh of 76 - 89 mm. The net opening is around 2 m during trawling operation.

The fleet is basically uniform considering the fishing gear, since only small size differences can be found among the nets of the various companies.

## 3. The fishing strategies

Duration of trips in the fleet based in Güiria has decreased in the last five years, from 15 days-at-sea in 1987 to 10 in 1991. The observed tendency is towards a stabilization to an average of 10 days-at-sea (Table 2). However, the number of trips has increased since 1987, from 205 trips during that year to 504 in 1991, which means an increment of 250%. This increment was caused by the larger number of trawling units operating in the zone in later years, whereas the decrease in the duration of trips was a consequence of changes in the selected fishing grounds, since the activity has concentrated closer to Güiria (near Bombeador Point at the northern part of the Orinoco river delta).

The average duration of the trips in the fleet based in Cumaná has stabilized to 15 days-at-sea and 480 trips per year, in spite of the fact that the fleet has also increased in number (Table 3). This apparent reduction in trips per vessel is probably a result of the fact that the units are also operating in the fishing grounds of Margarita Island and North of Sucre State.

The fleet from Punta Meta performed the lowest number of trips in the area. The activity of this fleet in the zone started in 1989 (fishing data from that year is unknown). The number of trips in 1990 reached 109, and only 62 during 1991. This reduction of 60% is most probably a consequence of the fishing in zones other than the Atlantic one (Table 4).

The average trawling parameters estimated for the fleets in the Atlantic zone are:

| | |
|---|---|
| Trawls during the day (06:00 - 18:00): | 3 |
| Trawls during the night (18:00 - 06:00): | 3 |

No monthly variation was observed in this estimates during the year.

Most of the fishing activity took place between the South of Trinidad and Boca Grande, in the southern portion of the Orinoco river delta. The range of selected depth for trawls was between 5 and 40 fathoms (9 - 72 m), concentrating in the range of 11 - 20 fathoms (20 - 36 m).

## 4. The discards

Observers on board of the trawling units, established that there is no discard of Penaeus shrimp species. According to the size of the animals found in the fishing grounds, all shrimps were juvenile to pre-adult (minimum total length about 6 cm, N≈5000), and had commercial value. However, discards of sea bob, *Xyphopenaeus kroyeri*, occurred but the amounts have not been evaluated.

The incidental catch of fish associated to the shrimp fishery accounted for 94% of the total catch in the nets. From this fish, 30% was sold on the local market and the rest (64% of the total catch) was returned, mostly dead, to the sea (Marcano, 1992).

## 5. Artisanal shrimp fishery

Until this moment, no controls are made upon the artisanal shrimp trawling fishery in the zone. There is a subsistence fishery performed by indigenous people in the Orinoco river delta. There is an organized artisanal trawling fishery in the zone, performed by trinidadians under agreement between the Venezuela and the Trinidad and Tobago governments, through which 60 boats are allowed to fish in very shallow waters, along the coast or inside the mouth of the Orinoco river. However, there have not been any reports concerning the catch or effort applied by these fishermen in the zone.

In the northern Gulf of Paria, between Irapa and Güiria, there is an artisanal shrimp fishery using beach seines, practised by about 300 fishermen (see Altuve, 1992). They work in teams of three, two of them walk with the seine along the beach, at depths between 0.5 and 1.5 m; the third one carries a burning light and a bucket, and helps in the pulling of the net out of the water. Fishing is mostly done at night, at mean to high tide. Catches have been estimated at 70 tons of white shrimp, *P. schmitti*, per year. The fishing is seasonal, between September and May. This is one of

the few fisheries in the country where women and children are directly involved in the fishing activity.

## I.C. PROCESSING ACTIVITIES

### 1. Industrial shrimp processing

Shrimps from the industrial fleet arrive either whole or headless. Since 1989, the problem raised with the use of bisulphite as a shrimp preservative, induced some managers to request the removal of the heads on board. Once in the plant, the shrimps are classified by size according to the international market categories, and packed in 5 lb boxes. Headless shrimp are exported to the north-american market, while the whole shrimp are exported to Europe.

There are 4 processing plants in Cumaná, and 4 more in Güiria. Approximately 80% of the shrimp is exported. However, since the shrimp from the Atlantic zone is smaller than the one from other fishing zones, most of it is sold on the venezuelan market. Data on the proportion of processed and exported shrimp from the Atlantic zone are not available.

### 2. Processing of the artisanal catches

The artisanal catch receive very little processing, except for the cleaning of the shrimps with sea water after the seines are brought to the beach. When the proportion of small shrimp (juveniles 7 - 9 cm in total length) is high, the fishermen classify the catch into small and large shrimp. The landings are sold directly at the beach itself, to buyers who access the different beaches with trucks. Shrimps are kept on crushed ice in the trucks. The trucks sell the catch to processing companies, in a similar manner as the catch from the industrial fleet.

The processing plants receiving the catch from artisanal fishermen are located in Güiria. Small shrimp are peeled and frozen, with destination to the domestic market. Larger shrimps are processed in the same way as the landings from the industrial fleet.

# II. RESULTS OF THE EXPLOITATION

## II.A. EFFORT

The participation of the different fleets in the area can be divided in three periods: 1973-77, when vessels from Cumaná initiated the exploitation of the zone and made most of the trawling in the area. The influence of boats from Güiria was more important between 1978-86, when many of the vessels were brought to their original base ports, with a considerable reduction in the effort. During the third period, 1987-91, the fleet based in Cumaná again increased its influence and made most

of the effort in the area, as a consequence of a greater increase in the number of units in comparison with the fleet from Güiria. During this third period, trawling units from Punta Meta started operations in the area, but their contribution to the general effort was still limited (Tables 2, 3 and 4).

The monthly tendency of the effort in the last seven years shows small fluctuations in the average number of vessels operating in the area. However, there is an increase in the number of trawling units during the last four months of every year (Annex 1).

The number of trips made by the trawling units has increased in last years, from 489 in 1987 to 1026 in 1991 (an increase of 112%). The yearly increase rate has been: 13%, 24%, 49% and 2%, between 1987 and 1991, respectively. In 1988 and 1991, most trips corresponded to the fleet based in Güiria.

An evaluation of the average monthly variation in number of trips, shows that the trips increased during the last five months of every year, in the period 1987-91, which agrees with the concentration of vessels in the zone during the same period (Annex 1).

Considering the number of days-at-sea spent by the trawling units in the Atlantic zone, it has been found that the Cumaná and Güiria fleets spent about 100 days-at-sea per vessel, between 1990-91, whereas the vessels with the longest stay are those from Punta Meta, which spend about 200 days-at-sea per vessel.

This relatively low stay of the trawling units in the zone by the two former fleets obeys the fact that most units operate in other fishing grounds different from the Atlantic zone. There are units that have only made a single trip to the zone.

A historic analysis of fishing effort (days-at-sea, d.a.s.) in the period 1973-91, shows that the effort has increased from 8,208 (in 1973) to 13,252 d.a.s. (in 1990, the year of maximum fishing activity in the zone), representing an increase of 60%. However, there have been wide fluctuations in the yearly effort, with values as low as 4,000 d.a.s. (1984 and 85). The tendency during the last two years has been towards a stabilization around 13,000 d.a.s., which is a rather high effort value (52%) in comparison with the 1989 one (Fig. 3).

Considering the geographic distribution of the fishing effort during 1989-91, it can be observed that trawling was mostly performed in 5 from a total of 11 squares that were used by the fleets (Table 6). The effort in these five squares represented between 70 and 83% of the total effort made by the fleets in this three years period. There were some annual variations in the squares with the greater concentration of effort, but all were located in the southern Gulf of Paria and northern Orinoco river delta.

With respect to depth, during 1991 it could be observed that 90% of the effort was made at depths less than 20 fathoms (36 m), with a greater concentration of the effort in the interval 11-20 fathoms (20-36 m) with 67% of the total effort (Table 7). At greater depths, the exploitation is minimal. This situation contrasts with the one reported by Dragovich (1980) in fishing zones of Brazil and

Suriname, where most of the activity of the trawling fleet took place in deeper waters (21-35 fathoms, or 38-63 m).

## II.B. CATCH AND LANDINGS

The data about landings of shrimps (whole) have been registered since 1973, when the industrial trawling fishery started in the Atlantic zone. The landings for that year were the highest ever reported for the fishery in the region (2,000 tons). This amount of shrimp was caught by 136 trawling vessels (the second highest number of vessels operating in the zone). Since 1974, the landings have decreased as the number of fishing units from the fleet based in Güiria also decreased. However, landings from 1975-77 are considered some of the highest in the study period (1973-91) with 1,400 tons per year. From 1977 until 1987, the landings decreased with small annual variations. This situation changed in 1988, and has continued until now, since the landings have had a steady increase, reaching 1,433 tons during 1991. The effort made by the fleets in this latter period has increased (Table 8, Fig. 4), and this is a possible cause of the increase in shrimp catch.

The fleet based in Cumaná had the greatest contribution to the landings of shrimp between 1973 and 1986. Since 1987, the fleet based in Güiria replaced the one based in Cumaná in this respect, landing more than 50% of all the shrimp caught in the Atlantic zone of Venezuela (Table 9). The contribution of the fleet based in Punta Meta was 16 and 14%, during 1990 and 1991, respectively.

Shrimp populations in the northeastern region of South America are integrated by a group of four sympatric species, the white shrimp, *Penaeus schmitti*, a group of species belonging to the subgenus Lithopenaeus, known as the brasiliensis complex, integrated by the brown shrimp, *P. subtilis*, the pink spotted shrimp, *P. brasiliensis*, and the pink shrimp, *P. notialis*, and finally the sea bob, *Xyphopenaeus kroyeri* (Novoa, 1974; Marcano, 1977 and 1985; Jones & Villegas, 1980 a, b). The first four have commercial value, whereas the sea bob is only occasionally commercialized, being most of the time discarded to the sea. The species of the brasiliensis complex is the most abundant in the area, representing more than 60% of the catch, with frequent values as high as 80%. The white shrimp represents the remaining proportion (Annex 2). The average proportion of species presented in the catch are:

| SPECIES | % |
|---|---|
| *P. subtilis* | 58 |
| *P. brasiliensis* | 20 |
| *P. schmitti* | 20 |
| *P. notialis* | 2 |
| **Total** | **100** |

This proportion is affected by the fishing area and the depth.

The seasonal variation of the shrimp catch was evaluated using only information from the fleet based in Güiria, for the period 1986-91 (Annex 2). It was observed that maximum catch occurred during May - June and December - January, while the lowest yields were observed during July -

October and February (Fig. 5). The trend of maximum catch seems to have no direct relation with effort fluctuations, since the latter increases during the last four months of the year, when catch is at its lowest level. Catchability of shrimp populations seems to be lower during the last quarter of the year.

The monthly variation of catch by species indicates that the catch of brown and pink shrimps show similar trends as the general shrimp catch (Figs. 6 and 7). For the catch of white shrimp, the months of greater catch are March, May, June, November and December (Fig. 8). The variation of the catch of white shrimp is strongly associated with the rainfall, as well as with the depth. The farther away from shore, the lower the catch.

The pink spotted shrimp shows a catch pattern similar to the white shrimp, although the yields of the former species are higher, in spite of the fact that it is distributed in deeper waters. Its catch is also affected by the depth of operation of the vessels.

The shrimp species included in the brasiliensis group are considered sub-littoral and mainly marine. They are primarily distributed between 10 and 50 fathoms, from the Amazon river to Venezuela. The white shrimp, is considered eurylittoral and euryhaline, with a distribution range closer to shore, at depths between 5 and 19 fathoms (Bullis & Thompson, 1959; Jones & Dragovich, 1977; Dragovich *et al.*, 1980).

The distribution of shrimp catch by fishing area (squares) in the period 1989-91, shows a high concentration in the same 5 squares that was formerly described for the effort, from a total of 11 squares used by the fleet (Table 6). More than 70% of the landed shrimp is caught in squares 10611, 09613, 09614, 10621 and 10612. In particular, during 1991, the catch from square 09613 was 538 tons (36% of the total landing for that year), in response to the highest value of effort made by the fleet in that square. There was a small annual variation for the geographical distribution of catch.

The analysis of the geographical distribution of catch by shrimp species indicates that, during 1989-90, both brown and white shrimps were most abundant in the five squares mentioned above, particularly in 10611, 09613 and 09614, located between Trinidad and the Orinoco delta. Catches of brown shrimp from these three squares were fairly similar (between 24 and 27%), whereas white shrimp was most abundant in 09614 (32%) than in 09613 and 10611, which showed similar proportions (21 and 18%, respectively). The pattern observed in the catch during 1991 changed, since the greatest catches (73 % and 79% for brown and white shrimp, respectively) were then reported for the Gulf of Paria as well as for the area between Trinidad and the Orinoco delta. The white shrimp was also heavily caught in the south of the Orinoco delta (09601).

Considering de depth at which catch was made, shrimps were mainly fished between 8 and 40 fathoms (Table 7). During 1991, the greatest concentration of shrimps was observed between 11-20 fathoms, with 71% of catch in this range. Catch at greater depths diminished to negligible values (4%), whereas 25% of shrimp was caught at depths lower than 10 fathoms.

As was stated before, depth affects the shrimp composition of the catch. About 60% of the white shrimp comes from areas shallower than 10 fathoms, while only 14% of brown shrimp is caught

in this range. The highest yields of brown shrimp (81%) came from depths between 11 and 20 fathoms. In deeper areas, the white shrimp practically disappears, while the catch of brown shrimp remains important. The landings from this range represent 5% of the total for that species. This vertical distribution of the species agrees with the results presented by Bullis & Thompson (1959) and Bashirullah & Lares (1973), in the region between the Amazon river and Venezuela.

## II.C. CATCH PER UNIT OF EFFORT

In fact, it is difficult to estimate the abundance of exploited populations. However, under certain assumptions discussed by several authors (Ricker, 1940; Marr, 1955), the catch per unit of effort (c.p.u.e.) can be an indicator of the abundance. Thus, changes in the abundance of populations should be reflected by changes in c.p.u.e. For this report, the c.p.u.e. unit used has been kg/day-at-sea, as an index of abundance of the exploited shrimp populations.

The greatest values for the catch rate were obtained in the Atlantic zone of Venezuela at the beginning of the fishery, with a value of 244 kg/day during 1973 (Fig. 9, Table 8). Since then, the index decreased with small fluctuations, until 1981 when the catch rate reached 137 kg/day. The following years (1982-85) were a period of improvement, showing the fishing rate for 1984 a value of 196 kg/day. Since then, there was again a consistent decrease in the catch rate, until 1991 when a c.p.u.e. value of 106 kg/day was obtained, the lowest in the history of the fishery in the zone.

This progressively lower c.p.u.e. in shrimp catch can be associated to several factors, among which can be mentioned : a possible decrease in recruitment rate for the zone in the last five years, jointly with an increase in the fishing effort in the zone, and changes in the selected fishing grounds towards areas less well known by the fishing masters.

The analysis of catch rates by species shows, in the case of the brown shrimp complex, a similar tendency to the general shrimp fishery (Fig. 9). Catch rate for this group varied between 189 and 83 kg/day, in 1984 and 1991, respectively. This fishery has had the lowest catch rates during the last four years.

Catches of the white shrimp are the smallest among all species fished industrially in the zone. Important and irregular annual changes have been observed in the catch trend between 1973-91. After the largest value observed in the fishing rate during 1973 (73 kg/day), there was a sustained decrease in this parameter, reaching a very low value (6 kg/day) between 1977-78. Since then, a recuperation was observed, with fishing rates of 61 and 69 kg/day during 1982-83. Recently (1988-91), the fishing rate of this species has stabilized around 25 kg/day (Fig. 9).

The distribution of the c.p.u.e. for the brown shrimp in the period 1989-91, by fishing area (square), shows that the largest fishing rates were obtained between southern Trinidad and the Orinoco delta (squares 09613, 09614 and 10611), with values of 100 and 98 kg/day for 1989 and 1990, respectively (Table 6). The activity of the fleet in these squares is also more intense than in other areas, which evidences the larger population density of this shrimp species in the sector.

The c.p.u.e for white shrimp shows the largest values along the different river mouths, from the Gulf of Paria, to the southern Orinoco delta (squares 10621, 09614, 09613, 09604, 09602, 09603, 09601), with values around 16 - 25 kg/day, for 1989 -91 (Table 6). The squares with the greatest fishing rates vary somewhat between years, but the tendency of the shrimp species to be most abundant in a certain region remains.

Analyzing the distribution of the fishing rate by depth, it was found that the highest values were obtained for the brown shrimp at depths between 11-20 fathoms, whereas for the white shrimp the depths with highest c.p.u.e.'s were between 1-10 fathoms, supporting the results about distribution of the species obtained with the analyses of the catch (Table 7, Fig. 10).

## III. SECONDARY RESOURCES

During the shrimp trawling operations, great quantities of fish and other organisms are caught incidentally and returned to the sea. Some get to be used commercially. This incidental catch is known as shrimp accompanying fauna (SAF) or by-catch, and it represents about three million metric tons of potential food for human consumption at a world level.

In Venezuela, due to the type of net used in industrial operations (with mesh size 50 mm, stretched), the amount of by-catch is large, since shrimps represent only between 2.5 to 6% of the total caught biomass. In contrast with other countries where this fishery is also practised, a significant proportion of the by-catch is recuperated and commercialized. Approximately 28% of the by-catch is landed in the different base ports of the country, and commercialized as fresh seafood (fish, squid, octopus, crabs) or exported frozen (scallops, squid, octopus). The non commercial shrimp accompanying fauna (NCSAF) accounts for the other 66% of the catch, and is returned, mostly dead, to the sea. The composition of this latter component is: 96% fish, 3% crustaceans, and 1% molluscs and other marine invertebrates. The shrimp catch, as well as the by-catch, vary according to the fishing area, season, depth or time of the day (Valdez, 1983; Penchaszadeh *et al.*, 1984; Marcano *et al.*, 1985, 1989, 1990 and 1992).

The by-catch component recuperated and commercialized by the venezuelan vessels in the Atlantic zone consists exclusively of fin-fish. The main species: croaker (*Micropogonias furnieri*), curbina (*Cynoscion spp.*), dog trout (*Macrodon ancylodon*); lane snapper (*Lutjanus synagris*), catfish (*Bagre bagre*; *Arius spp.*; *Cathorops sp.*), Atlantic moonfish (*Vomer setapinis*), Atlantic cutlassfish (*Trachurus lepturus*), sharks (*Rizhoprionodon sp.*; *Mustelus sp.*). They represent about 80% of the total by-catch landings.

Although there are reports of by-catch landings since the beginning of the industrial operations (1973), the data discussed in this report correspond to the most recent period (1987-91; Fig. 11, Table 10). It can be observed that by-catch landings represented 7,000 tons/year during the last two years, with an increasing tendency, in spite of a small decrease during 1991 with respect to 1990. More than 50% of the fish landed belonged to the family Sciaenidae, among which the dog trout (*M. ancylodon*) was the most important during the last three years.

Thanks to the presence of official observers on board of the trawling units during 1991, the catch composition and by-catch could be recorded. From an estimated total of 24,000 tons, shrimps represented 1,433 tons (6%), and the other 22,567 (94%) was by-catch (Fig. 12). From this by-catch, 7,087 tons (30%) were recuperated and landed as fresh fish. The remaining by-catch (15,146 tons, or 64%) was returned to the sea (Table 11).

The geographical analysis of fish catch shows that they were maximal in squares 10612, 10621, 10611 and 09614, with more than 5,000 tons in each of them. The fishing rates were very similar among the different squares, with an average of 500 kg/day (Fig. 13). The non commercial shrimp accompanying fauna had maximal catch in squares 09613, 10621, 09614 and 09604, in which 14,000 tons (92%) were obtained. In particular, square 09613 alone provided 11,000 tons (72% of the total NCSAF). Catch rates for this component were also maximal in the aforementioned squares, with values of 1,100 kg/day, and a maximum of 2,800 kg/day in square 09613 (Table 11).

Total biomass reached the highest values in squares 09613 (13,000 tons), 10612 (2,163 tons), 10621 (2,111 tons) and 09614 (1,600 tons). The largest catch rates for this component were found in squares 09613 (3,436 kg/day), 09604 (1,820 kg/day) and 09614 (1,800 kg/day) (Table 11, Fig. 13).

Fish catch, NCSAF and total biomass, showed variations with depth, with the largest values in the interval 11-20 fathoms (Table 12, Fig. 14). On the other hand, fish catch rates and total biomass rates were also maximal in the interval 11-20 fathoms, while NCSAF had its maximum between 0-10 fathoms (Table 12).

The quotient total biomass/shrimp in the catch was 17:1, whereas NCSAF/shrimp was 11:1. These results indicate that per each kg of shrimp caught in the zone, there were 11 kg of fish discarded to the sea. This amounts to 15,000 tons of fish unused. These proportions varied according to depth and fishing zone (Table 11 and 12). With the aim of reducing the amount of fish discarded in the industrial operations of the trawling fleet, FONAIAP developed trials of modifications in the nets (installing escape panels in the tunnel of the net), which would allow the escape of fish juveniles once entered in the net. The results of using such escape panels have shown reductions in near 50% of by-catch (Alió *et al.*, 1992).

At the beginning of this fishery, fish landings accounted for only a small proportion (approximately 40%) of the actual catch, since most of the catch was returned to the sea because of its low commercial value in the local market (Marcano, 1977). This situation prevented that reliable statistics were obtained from the fishery, which impeded a more precise evaluation of the level of exploitation of fish resources in the zone.

# IV. MANAGEMENT MEASURES

## IV.A. REGULATIONS

Trawling fisheries in Venezuela are regulated by the joint resolutions of Ministry of Agriculture (MAC/DGSPA/N° 46) and Ministry of the Environment (MARNR/DAA/N° 103) of 30 January, 1980, in which the fishing areas allowed for the trawling fleet and the ones reserved to the artisanal fishermen, are specified, both in the coastal zone and in the island territories. A second resolution (MAC/DGSPA/N° 391) of 13 December 1990, regulates the activity of the trawling fleet in the Gulf of Venezuela, establishing a non fishing season between 15 December and 8 January, and from 15 August to 10 September. At the present time, all these resolutions are under study, in order to establish up-to-date norms for this fishery.

In the other hand, as a complementary measure, the Government forbade the construction of new conventional trawling units since 1989, in order to settle the size of the fleet. At the same time, the movement of trawling units towards Güiria has been promoted, in order to increase the effort in Güiria, reducing it in other overexploited areas. Since 1992, this last measure has been reevaluated, concluding that only vessels with base port in Güiria are to be allowed to operate in the Atlantic zone of Venezuela.

## IV.B. FISHING AGREEMENTS

There is an agreement subscribed between the Governments of Venezuela and Trinidad and Tobago in 1986, in which 60 artisanal trawling vessels from this latter country are allowed to fish for shrimp in interior waters of Venezuela. The specific area is delimited by the Venezuelan coast line and a straight line traced between Point Bombeador (Lat. 09° 54,4' N; Lon. 61° 40,12' W) and Point Tolete (Lat. 10° 01,25' N; Lon. 62° 11,87 W).

The conditions under which these vessels operate are:

1. The vessel shall use only one net at a time, operated manually without the aid of electrical or mechanical equipment for the casting or retrieval of the net. The mesh size in the cod end shall be equal or larger than 3.5 cm (stretched).

2. The vessel shall have a maximum crew of four (4) persons, including the captain.

3. No fishing activity is allowed in the tributaries of the delta of the Orinoco river nor in its vicinity.

4. No fishing other than shrimp trawling shall be done. This does not include the by-catch from shrimp trawling.

5. The fishing season shall be between 1st December and 30th June of the following year.

6. Fifty per cent (50%) of the catch shall be sold in Venezuela, to Venezuelan companies authorized by the Government of Venezuela.

7. The sale of this fifty per cent (50%) shall take place in the mutual agreement zone in the immediate proximity to the special fishing area.

8. Non-compliance with what is stipulated herein will result in the cancellation of the present permit, without prejudice to the application of penalties contemplated in the Article 27 of the Fishing Law in force, and other administrative penalties envisaged in the law.

In a reciprocal way, the Government of Trinidad and Tobago will allow the access of Venezuelan vessels to their territorial waters for the exploitation of demersal and pelagic fish, using the lines (hook and line and as longline).

Until this moment no estimates of the shrimp catch by the trinidadian artisanal trawling fleet are available, since no appropriate control system has been established.

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**Table 1**: Distribution of the number of enterprises and trawling vessels operating in the Atlantic zone of Venezuela, by base port, in 1991.

| BASE PORT | NO. ENTERPRISES | NO. VESSELS | % VESSELS |
|---|---|---|---|
| Güiria | 42 | 56 | 40 |
| Cumaná | 48 | 72 | 51 |
| Guanta | 7 | 12 | 9 |
| Total | 97 | 140 | 100 |

**Table 2**: Fishing effort made by the trawling fleet based in Güiria, in the Atlantic zone of Venezuela.

| YEAR | BOAT-YEAR | BOAT-MONTH | NO. TRIPS | DAYS AT SEA | NO. TRIPS/BOAT | DAYS/TRIP |
|---|---|---|---|---|---|---|
| 1973 | 91 | 207 | 211 | 4656 | 1.0 | 22 |
| 1974 | 43 | 64 | 93 | 1130 | 1.5 | 12 |
| 1975 | 62 | 176 | 430 | 3350 | 2.4 | 8 |
| 1976 | 48 | 190 | 300 | 3008 | 1.6 | 10 |
| 1977 | 57 | 208 | 338 | 3189 | 1.6 | 9 |
| 1978 | 25 | 145 | 249 | 2333 | 1.7 | 9 |
| 1979 | 21 | 144 | 296 | 2446 | 2.0 | 8 |
| 1980 | 22 | 179 | 356 | 3588 | 2.0 | 10 |
| 1981 | 30 | 189 | 336 | 3643 | 1.8 | 11 |
| 1982 | 33 | 171 | 259 | 3386 | 1.5 | 13 |
| 1983 | 39 | 213 | 271 | 3722 | 1.3 | 14 |
| 1984 | 28 | - | - | - | - | - |
| 1985 | 34 | - | - | - | - | - |
| 1986 | 28 | 108 | 135 | 1850 | 1.3 | 14 |
| 1987 | 30 | 143 | 205 | 3051 | 1.4 | 15 |
| 1988 | 31 | 276 | 362 | 4501 | 1.3 | 12 |
| 1989 | 35 | 303 | 369 | 3819 | 1.2 | 10 |
| 1990 | 56 | 294 | 415 | 3917 | 1.4 | 9 |
| 1991 | 58 | 359 | 504 | 4995 | 1.4 | 10 |

('-' = data not available)

**Table 3**: Fishing effort made by the trawling fleet based in Cumaná, in the Atlantic zone of Venezuela.

| YEAR | BOAT-YEAR | BOAT-MONTH | NO. TRIPS | DAYS AT SEA | NO. TRIPS/BOAT | DAYS/TRIP |
|---|---|---|---|---|---|---|
| 1973 | 45 | 140 | 245 | 3552 | 1.8 | 15 |
| 1974 | 49 | 194 | 285 | 3422 | 1.5 | 12 |
| 1975 | 43 | 235 | 364 | 4362 | 1.5 | 12 |
| 1976 | 42 | 227 | 332 | 4267 | 1.5 | 13 |
| 1977 | 60 | 304 | 472 | 5767 | 1.6 | 12 |
| 1978 | 33 | 117 | 166 | 1923 | 1.4 | 12 |
| 1979 | 30 | 140 | 235 | 2433 | 1.5 | 10 |
| 1980 | 36 | 110 | 175 | 1799 | 1.6 | 10 |
| 1981 | 38 | 158 | 243 | 3027 | 1.5 | 13 |
| 1982 | 52 | 191 | 239 | 2734 | 1.3 | 11 |
| 1983 | 31 | 115 | 178 | 1752 | 1.5 | 10 |
| 1984 | 36 | - | - | - | - | - |
| 1985 | 32 | - | - | - | - | - |
| 1986 | 47 | - | - | - | - | - |
| 1987 | 64 | 219 | 279 | 3767 | 1.3 | 14 |
| 1988 | 67 | 164 | 183 | 2670 | 1.1 | 15 |
| 1989 | 100 | 242 | 306 | 4891 | 1.3 | 16 |
| 1990 | 72 | 378 | 482 | 6833 | 1.3 | 14 |
| 1991 | 72 | 345 | 460 | 6715 | 1.3 | 15 |

('-' = data not available)

**Table 4**: Fishing effort made by the trawling fleet based in Guanta, in the Atlantic zone of Venezuela.

| YEAR | BOAT-YEAR | BOAT-MONTH | NO. TRIPS | DAYS AT SEA | NO. TRIPS/BOAT | DAYS/TRIP |
|---|---|---|---|---|---|---|
| 1990 | 12 | 105 | 109 | 2502 | 1.0 | 23 |
| 1991 | 6 | 61 | 62 | 1301 | 1.0 | 21 |

**Table 5**: Characteristics of the trawling vessels operating in the Atlantic Zone of Venezuela in the period 1989-91.

| | 1989 | % | 1990 | % | 1991 | % |
|---|---|---|---|---|---|---|
| Length (m) | | | | | | |
| 11-15 | 0 | 0 | 1 | 1 | 0 | 0 |
| 16-20 | 21 | 16 | 13 | 9 | 20 | 15 |
| 21-25 | 78 | 57 | 88 | 63 | 78 | 57 |
| 26-30 | 32 | 24 | 31 | 22 | 30 | 22 |
| 31-35 | 1 | 1 | 1 | 1 | 1 | 1 |
| N/I | 3 | 2 | 6 | 4 | 7 | 5 |
| Power (HP) | | | | | | |
| <250 | 0 | 0 | 1 | 1 | 0 | 0 |
| 251-400 | 17 | 13 | 18 | 13 | 18 | 13 |
| 401-550 | 44 | 33 | 40 | 29 | 30 | 22 |
| 551-700 | 37 | 27 | 42 | 30 | 44 | 32 |
| 701-850 | 32 | 24 | 30 | 21 | 34 | 26 |
| >850 | 2 | 1 | 3 | 2 | 3 | 2 |
| N/I | 3 | 2 | 6 | 4 | 7 | 5 |
| B.R.T. (MT) | | | | | | |
| 50-100 | 31 | 23 | 27 | 19 | 32 | 24 |
| 101-150 | 50 | 37 | 57 | 41 | 50 | 36 |
| 151-200 | 30 | 22 | 30 | 21 | 31 | 23 |
| 201-250 | 16 | 12 | 14 | 10 | 11 | 8 |
| 251-300 | 4 | 3 | 5 | 4 | 4 | 3 |
| 301-350 | 1 | 1 | 1 | 1 | 1 | 1 |
| 351-400 | 0 | 0 | 0 | 0 | 0 | 0 |
| N/I | 3 | 2 | 6 | 4 | 7 | 5 |
| TOTAL | 135 | 140 | 136 | | | |

("N/I" = no information)

**Table 6**: Catch (tm), effort (days-at-sea) and C.P.U.E. (kg/day) for penaeid shrimps (brown and white), by fishing square, reported by the trawling fleet operating in the Atlantic zone of Venezuela during the period 1989-91.

| YEAR | ZONE | 10621 | 10612 | 10611 | 10602 | 09601 | 09602 | 09603 | 09604 | 09613 | 09614 | 10614 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1989 | CATCH | | | | | | | | | | | | |
| | BROWN | 55 | 71 | 234 | 24 | 2 | 7 | 3 | 22 | 203 | 222 | 13 | 859 |
| | WHITE | 15 | 20 | 40 | 11 | - | 5 | - | 7 | 47 | 74 | 8 | 228 |
| | TOTAL | 70 | 91 | 274 | 38 | 2 | 12 | 3 | 29 | 250 | 296 | 21 | 1087 |
| | EFFORT | 492 | 992 | 2200 | 305 | 61 | 771 | 81 | 174 | 1618 | 1653 | 363 | 8701 |
| | CPUE | | | | | | | | | | | | |
| | BROWN | 112 | 71 | 106 | 88 | 33 | 9 | 41 | 124 | 125 | 134 | 37 | 99 |
| | WHITE | 31 | 20 | 18 | 37 | - | 6 | - | 39 | 29 | 45 | 23 | 26 |
| | TOTAL | 143 | 91 | 124 | 125 | 33 | 15 | 41 | 163 | 154 | 179 | 60 | 125 |
| 1990 | CATCH | | | | | | | | | | | | |
| | BROWN | 104 | 38 | 345 | 18 | 23 | 15 | 21 | 55 | 260 | 300 | 13 | 1191 |
| | WHITE | 23 | 10 | 55 | 4 | - | 11 | 6 | 7 | 51 | 54 | 7 | 230 |
| | TOTAL | 127 | 48 | 400 | 22 | 23 | 26 | 27 | 62 | 311 | 354 | 20 | 1421 |
| | EFFORT | 1458 | 663 | 3525 | 271 | 259 | 801 | 289 | 553 | 2120 | 3048 | 265 | 13252 |
| | CPUE | | | | | | | | | | | | |
| | BROWN | 71 | 57 | 98 | 67 | 87 | 18 | 73 | 99 | 123 | 99 | 50 | 90 |
| | WHITE | 16 | 16 | 15 | 15 | - | 14 | 22 | 12 | 24 | 18 | 28 | 17 |
| | TOTAL | 87 | 73 | 113 | 82 | 87 | 32 | 95 | 112 | 147 | 116 | 77 | 107 |
| 1991 | CATCH | | | | | | | | | | | | |
| | BROWN | 140 | 125 | 121 | 27 | 99 | 11 | 23 | 99 | 396 | 39 | - | 1078 |
| | WHITE | 50 | 62 | 17 | 9 | 28 | 3 | 9 | 17 | 142 | 19 | - | 355 |
| | TOTAL | 190 | 187 | 138 | 36 | 127 | 14 | 32 | 116 | 538 | 58 | - | 1433 |
| | EFFORT | 1691 | 2602 | 911 | 390 | 781 | 651 | 390 | 781 | 3903 | 911 | - | 13011 |
| | CPUE | | | | | | | | | | | | |
| | BROWN | 83 | 47 | 133 | 69 | 126 | 16 | 60 | 126 | 102 | 43 | - | 83 |
| | WHITE | 30 | 24 | 19 | 22 | 36 | 4 | 22 | 22 | 36 | 21 | - | 27 |
| | TOTAL | 113 | 72 | 151 | 91 | 162 | 20 | 82 | 148 | 138 | 64 | - | 110 |

**Table 7**: Catch (tm), effort (days-at-sea) and C.P.U.E. (kg/day) of shrimps by depth interval, from the trawling fleet in the Atlantic zone of Venezuela.

| | DEPTH | | | |
|---|---|---|---|---|
| | 01-10 | 11-20 | 21-30 | 31-40 |
| CATCH | | | | |
| BROWN | 153 | 870 | 55 | - |
| WHITE | 211 | 142 | 1 | - |
| TOTAL | 364 | 1012 | 56 | - |
| EFFORT | 3043 | 8717 | 1216 | 35 |
| CPUE | | | | |
| BROWN | 50 | 100 | 45 | |
| WHITE | 69 | 16 | 1 | |
| TOTAL | 120 | 116 | 46 | |

**Table 8**: Catch, effort and C.P.U.E. for brown and white shrimps, from the Atlantic zone of Venezuela.

| YEAR | CATCH (tm) | | | | | EFFORT (days) | C.P.U.E. (tm/day) | | |
|---|---|---|---|---|---|---|---|---|---|
| | BROWN | % | WHITE | % | TOTAL | | BROWN | WHITE | TOTAL |
| 1973 | 1395 | 70 | 605 | 30 | 2000 | 8208 | 170 | 73 | 273 |
| 1974 | 666 | 95 | 35 | 5 | 701 | 4552 | 146 | 8 | 154 |
| 1975 | 1012 | 72 | 386 | 28 | 1398 | 7712 | 131 | 50 | 181 |
| 1976 | 1344 | 91 | 129 | 9 | 1473 | 7275 | 185 | 18 | 202 |
| 1977 | 2022 | 97 | 53 | 3 | 2075 | 6956 | 226 | 6 | 232 |
| 1978 | 792 | 97 | 26 | 3 | 818 | 4256 | 186 | 6 | 192 |
| 1979 | 810 | 86 | 130 | 14 | 940 | 4879 | 167 | 27 | 193 |
| 1980 | 733 | 76 | 227 | 24 | 960 | 5387 | 136 | 43 | 178 |
| 1981 | 853 | 93 | 66 | 7 | 919 | 6670 | 127 | 10 | 137 |
| 1982 | 809 | 69 | 371 | 31 | 1180 | 6120 | 132 | 61 | 193 |
| 1983 | 568 | 60 | 378 | 40 | 946 | 5474 | 104 | 69 | 173 |
| 1984 | 624 | 97 | 22 | 3 | 646 | 3305 | 188 | 7 | 195 |
| 1985 | 445 | 79 | 121 | 21 | 566 | 3223 | 138 | 38 | 179 |
| 1986 | 360 | 87 | 55 | 13 | 415 | 1850 | 195 | 30 | 225 |
| 1987 | 762 | 91 | 74 | 9 | 836 | 6719 | 113 | 11 | 124 |
| 1988 | 714 | 81 | 171 | 19 | 885 | 7175 | 100 | 24 | 124 |
| 1989 | 859 | 79 | 228 | 21 | 1087 | 8710 | 99 | 26 | 125 |
| 1990 | 1191 | 84 | 230 | 16 | 1421 | 13252 | 89 | 17 | 106 |
| 1991 | 1078 | 75 | 355 | 25 | 1433 | 13011 | 83 | 27 | 110 |

**Table 9**: Catch (tm) of shrimps (all species combined), reported by the trawling fleet operating in the Atlantic zone of Venezuela, by base port. The Guanta fleet started operations in the zone during 1990.

| YEAR | BASE PORT | | | |
|---|---|---|---|---|
| | GUIRIA | CUMANA | GUANTA | TOTAL |
| 1987 | 475 | 361 | - | 836 |
| 1988 | 604 | 281 | - | 885 |
| 1989 | 644 | 443 | - | 1087 |
| 1990 | 878 | 322 | 221 | 1421 |
| 1991 | 867 | 318 | 248 | 1433 |

**Table 10**: Catch (tm) of the main fish species landed by the trawling fleet operating in the Atlantic zone of Venezuela. Period 1987-1991.

| SPECIES | YEAR | | | | |
|---|---|---|---|---|---|
| | 1987 | 1988 | 1989 | 1990 | 1991 |
| Croaker | 620 | 922 | 870 | 818 | 745 |
| Curvina | 887 | 567 | 910 | 858 | 974 |
| Dog trout | 446 | 535 | 1363 | 1927 | 2682 |
| Lane snapper | 105 | 155 | 80 | 110 | 148 |
| Catfish | 113 | 165 | 27 | 456 | 519 |
| Atlantic moonfish | 164 | 136 | 195 | 518 | 449 |
| Atlantic cutlassfish | 38 | 20 | 52 | 159 | 140 |
| Shark | 223 | 235 | 314 | 219 | 170 |
| Other | 644 | 591 | 1574 | 2120 | 1165 |
| TOTAL | 3244 | 3569 | 5630 | 7186 | 6987 |

**Table 11**: Catch (tm), C.P.U.E. (kg/day) of fish, NCSAF and total biomass, by fishing statistical square (zone), reported by the trawling fleet operating in the Atlantic zone of Venezuela. Period 1989-91.

| YEAR | ZONE | 10621 | 10612 | 10611 | 10602 | 09601 | 09602 | 09603 | 09604 | 09613 | 09614 | 10614 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1989 | CATCH | | | | | | | | | | | | |
| | FISH | 398 | 499 | 1889 | 161 | 51 | 349 | 80 | 108 | 618 | 1350 | 125 | 5630 |
| | CPUE | 809 | 503 | 859 | 529 | 839 | 453 | 992 | 623 | 382 | 817 | 344 | 646 |
| 1990 | CATCH | | | | | | | | | | | | |
| | FISH | 1623 | 652 | 1673 | 262 | 282 | 392 | 397 | 1462 | 993 | 899 | 227 | 7086 |
| | CPUE | 798 | 983 | 475 | 967 | 1089 | 490 | 1374 | 264 | 468 | 295 | 857 | 535 |
| 1991 | CATCH | | | | | | | | | | | | |
| | FISH | 878 | 1364 | 512 | 341 | 426 | 256 | 426 | 341 | 1960 | 511 | - | 6987 |
| | FACNC | 1063 | 603 | 121 | 106 | 96 | 56 | 182 | 954 | 10905 | 1060 | - | 15146 |
| | TOT. BIO. | 2111 | 2163 | 781 | 493 | 659 | 335 | 650 | 1421 | 13413 | 1640 | | 23566 |
| | CPUE | | | | | | | | | | | | |
| | FISH | 508 | 528 | 573 | 901 | 559 | 409 | 1119 | 450 | 505 | 573 | - | 545 |
| | FACNC | 629 | 232 | 133 | 272 | 123 | 86 | 466 | 1222 | 2794 | 1164 | - | 1164 |
| | TOT. BIO. | 1248 | 831 | 859 | 1263 | 844 | 515 | 1667 | 1820 | 3436 | 1801 | - | 1819 |

**Table 12**: Catch (tm) and C.P.U.E. (kg/day) of fish, NCSAF, total biomass, by depth interval, reported by the trawling fleet in the Atlantic zone of Venezuela during 1991.

| | DEPTH (fathoms) | | | |
|---|---|---|---|---|
| | 01-10 | 11-20 | 21-30 | 31-40 |
| CATCH | | | | |
| FISH | 584 | 5781 | 608 | 13 |
| NCSAF | 4695 | 10299 | 121 | 30 |
| TOT. BIO. | 5667 | 17126 | 819 | 43 |
| CPUE | | | | |
| FISH | 203 | 667 | 528 | 359 |
| FACNC | 1543 | 1183 | 100 | 865 |
| TOT. BIO. | 1866 | 1965 | 674 | 1224 |

**Annex 1**: Effort, reported as boats/month, no. trips and no. days-at-sea, made by the trawling fleet in the Atlantic zone of Venezuela between 1987-91.

| YEAR | EFFORT | MONTH | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | TOTAL |
| 1987 | BOAT/M | 21 | 15 | 17 | 19 | 26 | 35 | 39 | 40 | 37 | 37 | 38 | 38 | 362 |
| | TRIPS | 22 | 16 | 19 | 21 | 36 | 45 | 52 | 51 | 55 | 55 | 61 | 51 | 484 |
| | DAYS | 283 | 247 | 256 | 313 | 425 | 554 | 752 | 776 | 791 | 776 | 796 | 750 | 6719 |
| 1988 | BOAT/M | 38 | 35 | 23 | 37 | 38 | 41 | 27 | 25 | 37 | 46 | 39 | 54 | 440 |
| | TRIPS | 41 | 40 | 28 | 49 | 53 | 46 | 38 | 36 | 51 | 51 | 42 | 70 | 545 |
| | DAYS | 506 | 500 | 401 | 623 | 730 | 600 | 546 | 421 | 640 | 700 | 704 | 804 | 7175 |
| 1989 | BOAT/M | 40 | 42 | 41 | 52 | 42 | 41 | 39 | 46 | 46 | 45 | 46 | 65 | 545 |
| | TRIPS | 44 | 57 | 58 | 66 | 59 | 56 | 48 | 50 | 50 | 54 | 58 | 77 | 675 |
| | DAYS | 560 | 724 | 763 | 793 | 738 | 763 | 728 | 721 | 663 | 720 | 727 | 810 | 8710 |
| 1990 | BOAT/M | 41 | 45 | 70 | 38 | 83 | 79 | 74 | 67 | 74 | 71 | 72 | 64 | 777 |
| | TRIPS | 45 | 51 | 88 | 47 | 115 | 104 | 93 | 81 | 97 | 100 | 110 | 75 | 1006 |
| | DAYS | 379 | 724 | 1089 | 650 | 1496 | 1345 | 1471 | 995 | 1305 | 1266 | 1287 | 885 | 13252 |
| 1991 | BOAT/M | 65 | 53 | 66 | 65 | 73 | 64 | 54 | 55 | 59 | 65 | 64 | 81 | 764 |
| | TRIPS | 81 | 64 | 80 | 88 | 93 | 85 | 87 | 85 | 85 | 86 | 87 | 105 | 1026 |
| | DAYS | 998 | 979 | 1071 | 1075 | 1269 | 963 | 1056 | 966 | 998 | 1072 | 1153 | 1411 | 13011 |

**Annex 2**: Monthly catch (kg) of shrimp and fish in the atlantic zone of Venezuela, by the fleet based in Güiria, during the period 1986-91.

| YEAR | SPECIES | MONTH | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | TOTAL | %SHRIMP | % TOTAL |
| 1987 | PINK SHRIMP | 2370 | 6289 | 1322 | 0 | 17195 | 15437 | 2749 | 3056 | 5660 | 13698 | 6413 | 100 | 74289 | 18 | |
| | WHITE SHRIMP | 2010 | 935 | 9667 | 3977 | 13026 | 4401 | 4339 | 2708 | 4602 | 0 | 6693 | 2865 | 55223 | 13 | |
| | BROWN SHRIMP | 26760 | 9023 | 30362 | 31942 | 21901 | 16662 | 4487 | 14855 | 13002 | 37691 | 41295 | 37167 | 285147 | 69 | |
| | TOTAL SHRIMP | 31140 | 16247 | 41351 | 35919 | 52122 | 36500 | 11575 | 20619 | 23264 | 51389 | 54401 | 40132 | 414659 | | 46 |
| | FISH | 11250 | 21097 | 33033 | 37571 | 48754 | 44962 | 46710 | 46489 | 45694 | 51435 | 48726 | 49177 | 484898 | | 54 |
| | GRAND TOTAL | 42390 | 37344 | 74384 | 73490 | 100876 | 81462 | 58285 | 67108 | 68958 | 102824 | 103127 | 89309 | 899557 | | |
| 1987 | PINK SHRIMP | 4548 | 9604 | 13820 | 10151 | 6996 | 19320 | 20764 | 3620 | 12695 | 8715 | 8812 | 7843 | 126888 | 33 | |
| | WHITE SHRIMP | 0 | 0 | 1500 | 212 | 4706 | 16032 | 5699 | 5630 | 326 | 900 | 3362 | 4802 | 43169 | 9 | |
| | BROWN SHRIMP | 18886 | 22363 | 19470 | 39673 | 59158 | 34740 | 22414 | 18240 | 13944 | 13665 | 27290 | 21009 | 310852 | 58 | |
| | TOTAL SHRIMP | 23434 | 31967 | 34790 | 50036 | 70860 | 70092 | 48877 | 27490 | 26965 | 23280 | 39464 | 33654 | 480909 | | 34 |
| | FISH | 38384 | 78913 | 32060 | 27845 | 55753 | 79260 | 82884 | 137740 | 100925 | 97320 | 123075 | 81255 | 935414 | | 66 |
| | GRAND TOTAL | 61818 | 110880 | 66850 | 77881 | 126613 | 149352 | 131761 | 165230 | 127890 | 120600 | 162539 | 114909 | 416323 | | |
| 1988 | PINK SHRIMP | 14751 | 3257 | 11014 | 5220 | 0 | 20676 | 11657 | 10559 | 3198 | 5463 | 10614 | 0 | 96409 | 16 | |
| | WHITE SHRIMP | 7763 | 8856 | 15286 | 5277 | 14432 | 10292 | 2452 | 2240 | 14583 | 14584 | 11298 | 10556 | 117619 | 19 | |
| | BROWN SHRIMP | 26342 | 19528 | 26629 | 39406 | 52881 | 23920 | 36821 | 24915 | 13410 | 17784 | 26044 | 82434 | 390114 | 65 | |
| | TOTAL SHRIMP | 48856 | 31641 | 52929 | 49903 | 67313 | 54888 | 50930 | 37714 | 31191 | 37831 | 47956 | 92990 | 604142 | | 22 |
| | FISH | 171639 | 126635 | 115385 | 216325 | 284906 | 149779 | 69826 | 95264 | 219037 | 80898 | 160641 | 104506 | 794841 | | 78 |
| | GRAND TOTAL | 220495 | 158276 | 168314 | 266228 | 352219 | 204667 | 120756 | 132978 | 250228 | 118729 | 208597 | 197496 | 398983 | | |
| 1989 | PINK SHRIMP | 18829 | 28256 | 20003 | 19869 | 23666 | 1863 | 838 | 1602 | 3179 | 0 | 9678 | 7228 | 135011 | 21 | |
| | WHITE SHRIMP | 1965 | 28202 | 12522 | 14704 | 7497 | 6281 | 321 | 3180 | 188 | 9860 | 15745 | 34456 | 134921 | 21 | |
| | BROWN SHRIMP | 36771 | 34982 | 38046 | 27258 | 51546 | 42818 | 9334 | 35027 | 19167 | 34045 | 20346 | 24940 | 374280 | 58 | |
| | TOTAL SHRIMP | 57565 | 91440 | 70571 | 61831 | 82709 | 50962 | 10493 | 39809 | 22534 | 43905 | 45769 | 66624 | 644212 | | 20 |
| | FISH | 207251 | 400745 | 131665 | 194928 | 220518 | 223579 | 171897 | 71653 | 67564 | 41124 | 114532 | 431350 | 276806 | | 80 |
| | GRAND TOTAL | 264816 | 492185 | 202236 | 256759 | 303227 | 274541 | 182390 | 111462 | 90098 | 85029 | 160301 | 497974 | 921018 | | |
| 1990 | PINK SHRIMP | 9070 | 8588 | 51487 | 7858 | 16987 | 9749 | 3745 | 20976 | 10288 | 0 | 0 | 0 | 138748 | 16 | |
| | WHITE SHRIMP | 7642 | 3090 | 4875 | 17010 | 5292 | 7483 | 2787 | 29924 | 8646 | 5761 | 25821 | 24889 | 143220 | 16 | |
| | BROWN SHRIMP | 50882 | 14792 | 98895 | 55242 | 17117 | 36155 | 16223 | 45305 | 37716 | 78635 | 26194 | 118894 | 596050 | 68 | |
| | TOTAL SHRIMP | 67594 | 26470 | 155617 | 80110 | 39396 | 53387 | 22755 | 96205 | 56650 | 84396 | 52015 | 143783 | 878018 | | 32 |
| | FISH | 39706 | 34643 | 95455 | 43956 | 169370 | 152814 | 130063 | 200109 | 409220 | 179911 | 186262 | 207994 | 849503 | | 68 |
| | GRAND TOTAL | 107300 | 61113 | 251072 | 124066 | 208766 | 206201 | 152818 | 296314 | 465870 | 264307 | 238277 | 351777 | 727521 | | |
| 1991 | PINK SHRIMP | 0 | 0 | 0 | 6460 | 16145 | 0 | 0 | 0 | 0 | 0 | 14266 | 8242 | 45113 | 5 | |
| | WHITE SHRIMP | 56972 | 36294 | 7123 | 4392 | 3456 | 13330 | 5835 | 2522 | 11442 | 8087 | 13282 | 50895 | 213630 | 25 | |
| | BROWN SHRIMP | 120126 | 73450 | 55491 | 87360 | 32350 | 38567 | 9375 | 29082 | 34400 | 24405 | 51649 | 51894 | 608149 | 70 | |
| | TOTAL SHRIMP | 177098 | 109744 | 62614 | 98212 | 51951 | 51897 | 15210 | 31604 | 45842 | 32492 | 79197 | 111031 | 866892 | | 24 |
| | FISH | 143576 | 127398 | 191106 | 226732 | 163920 | 221496 | 225971 | 207036 | 215074 | 248385 | 462176 | 267349 | 700219 | | 76 |
| | GRAND TOTAL | 320674 | 237142 | 253720 | 324944 | 215871 | 273393 | 241181 | 238640 | 260916 | 280877 | 541373 | 378380 | 567111 | | |

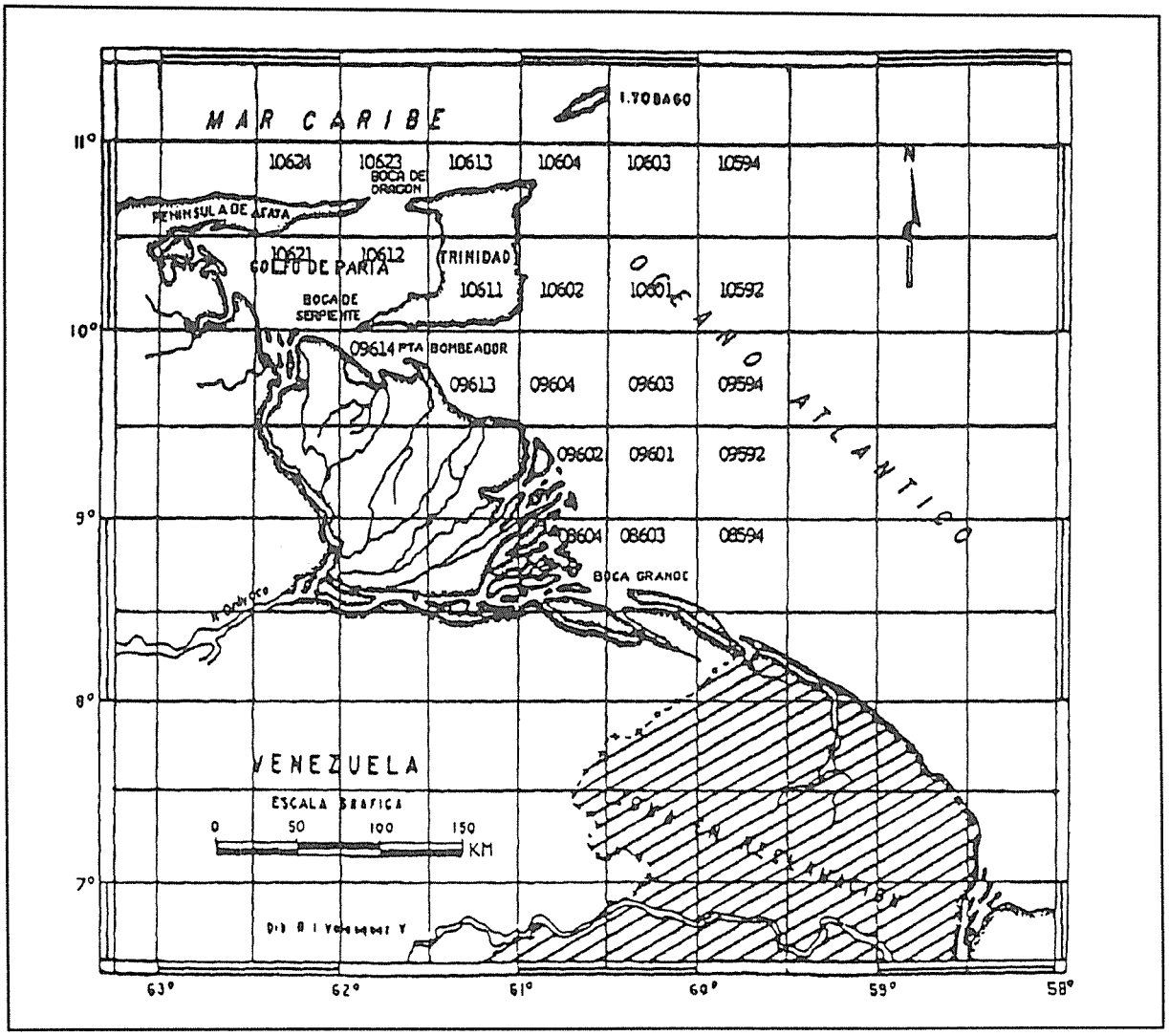


**Figure 1**: Atlantic zone of Venezuela, divided in fishing squares of 30 x 30 miles.

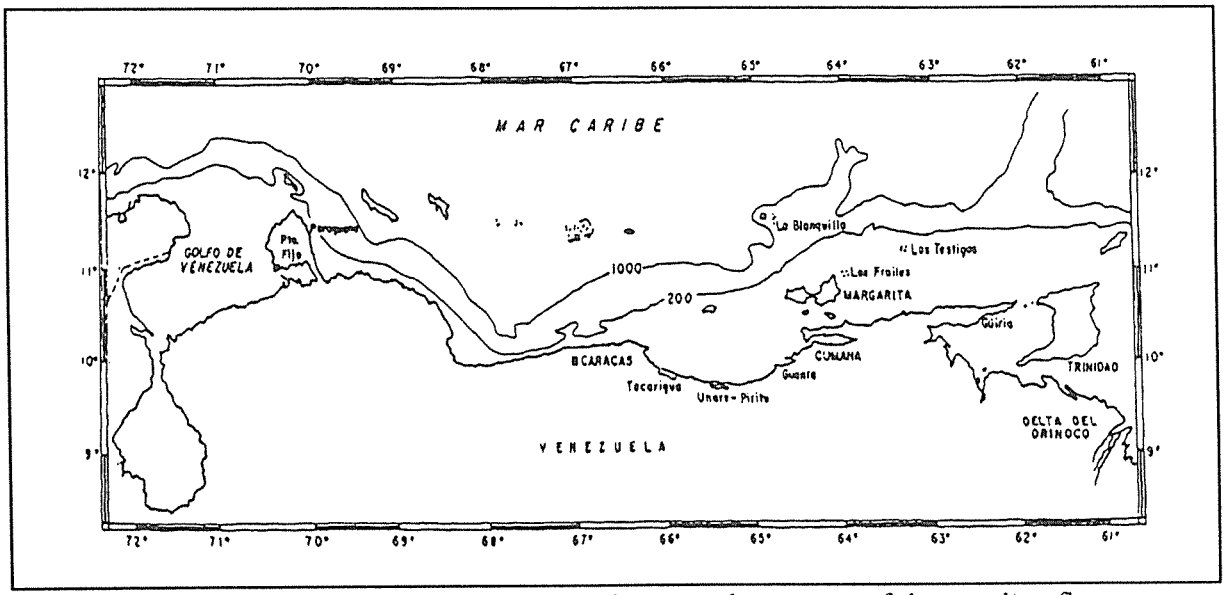


**Figure 2**: Marine coast of Venezuela, showing the major base ports of the trawling fleet.

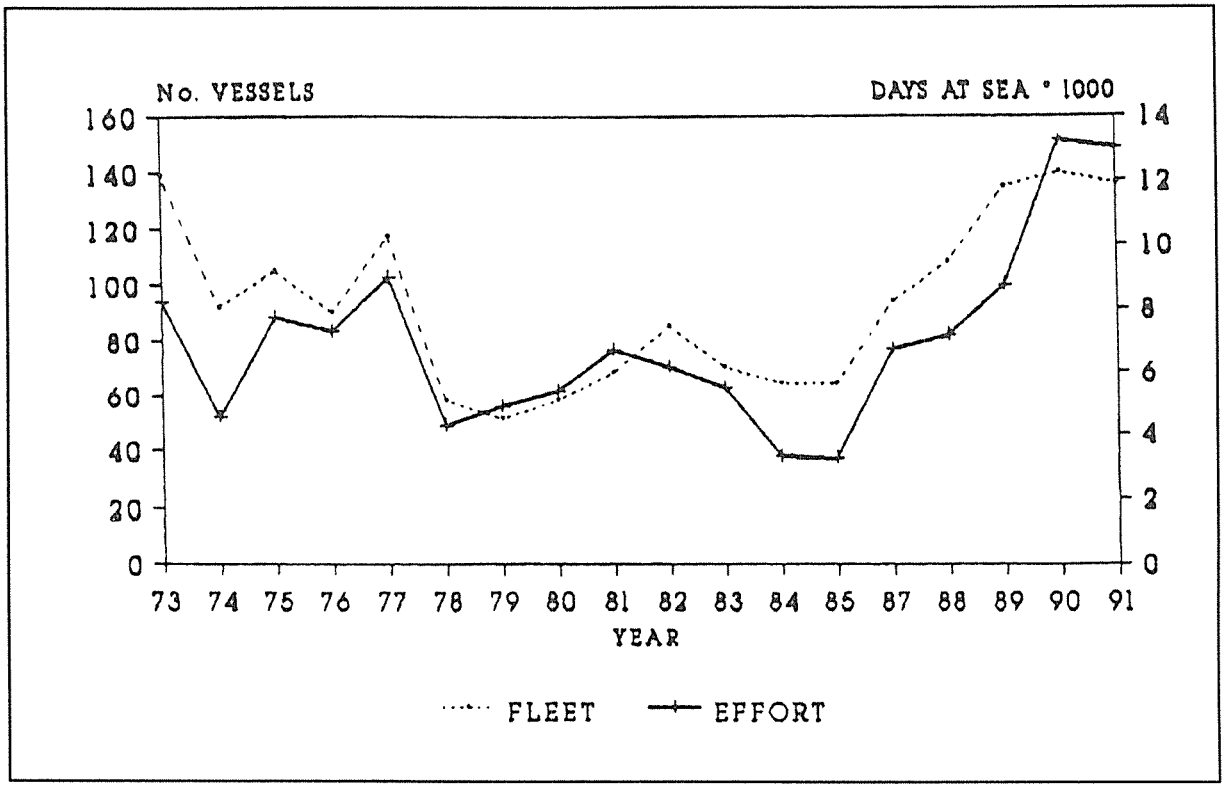


**Figure 3**: Trend in the size of the fleet and fishing effort in the Atlantic zone of Venezuela.

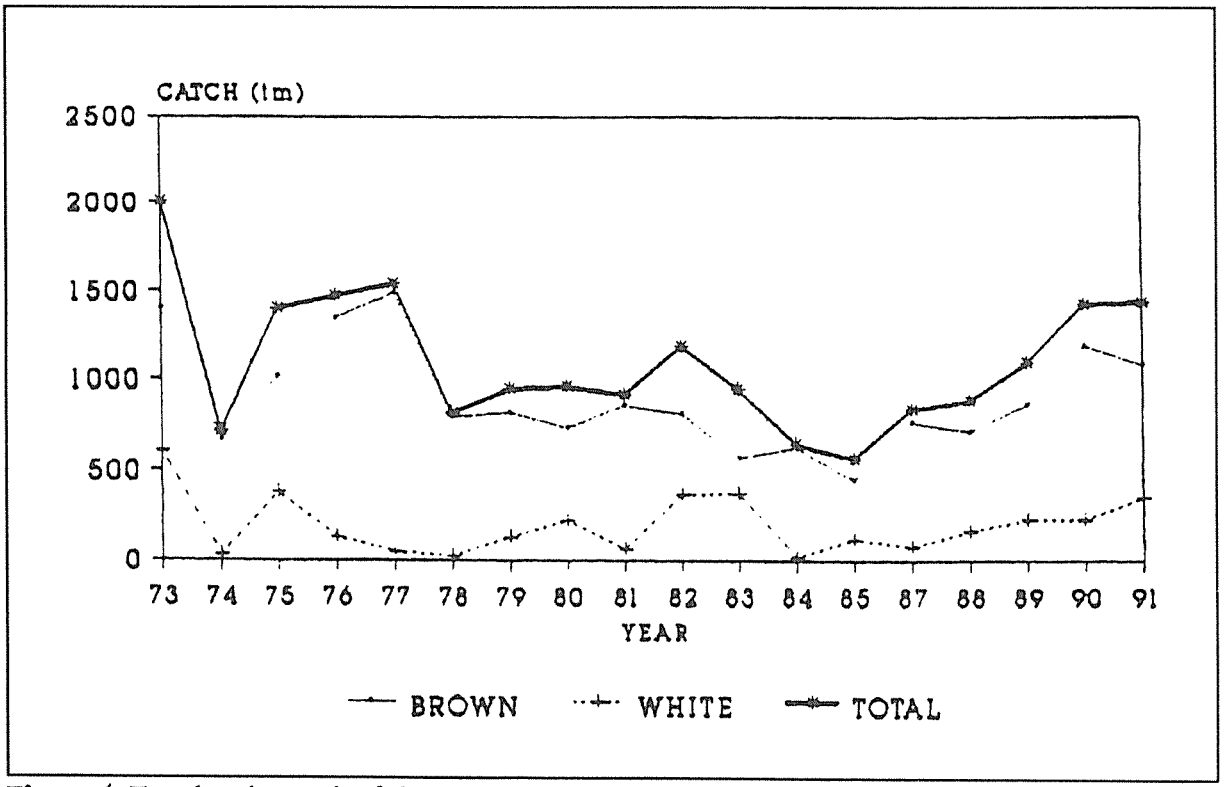


**Figure 4**: Trend in the catch of shrimp reported by the trawling fleet operating in the Atlantic zone of Venezuela.

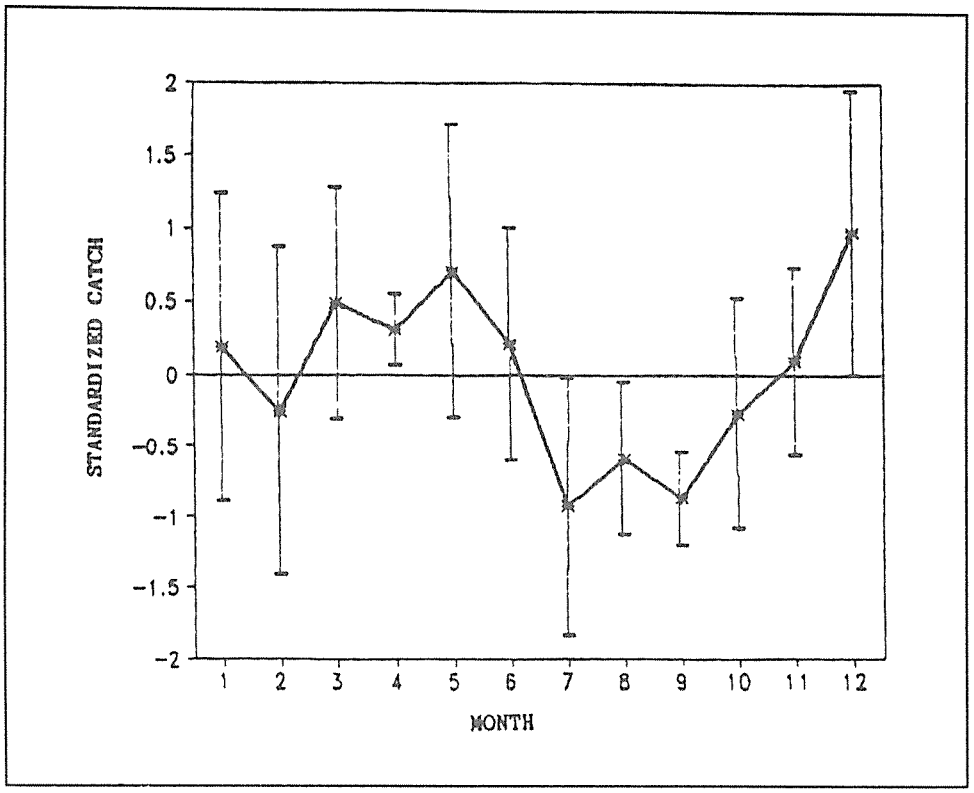


**Figure 5**: Seasonal variation of the catch of shrimps (standardized mean ± SD) in the Atlantic zone of Venezuela, in the period 1986-91.

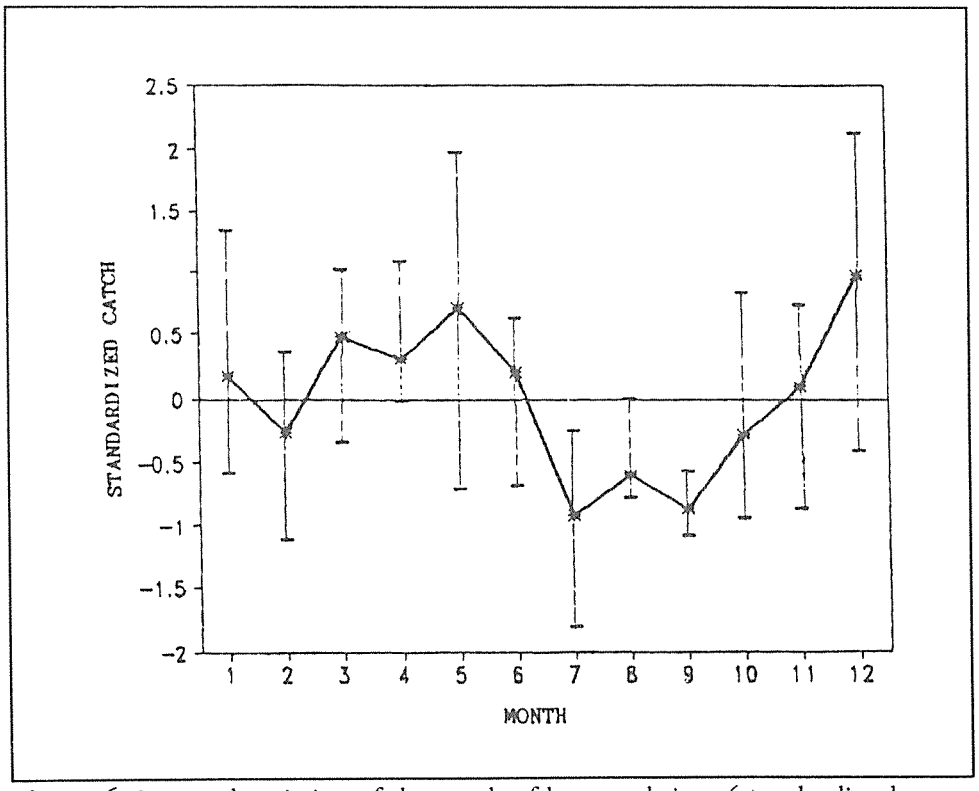


**Figure 6**: Seasonal variation of the catch of brown shrimp (standardized mean ± SD) in the Atlantic zone of Venezuela, between 1986-91.

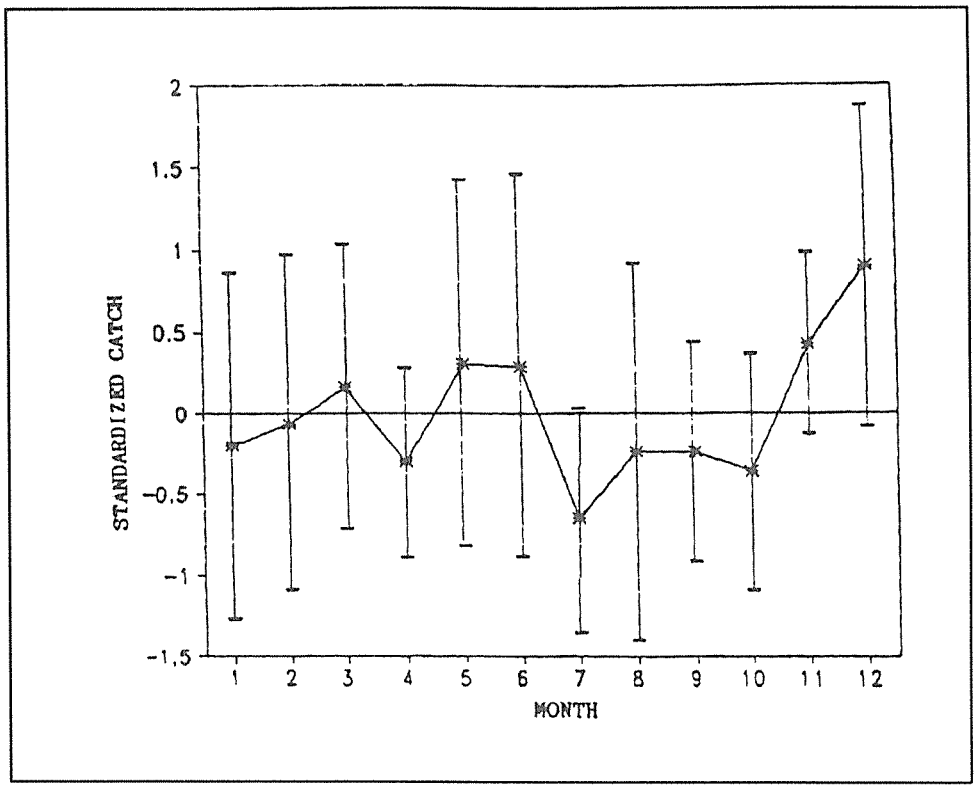


**Figure 7**: Seasonal variation of the catch of white shrimp (standardized mean ± SD) in the Atlantic zone of Venezuela, between 1986-91.

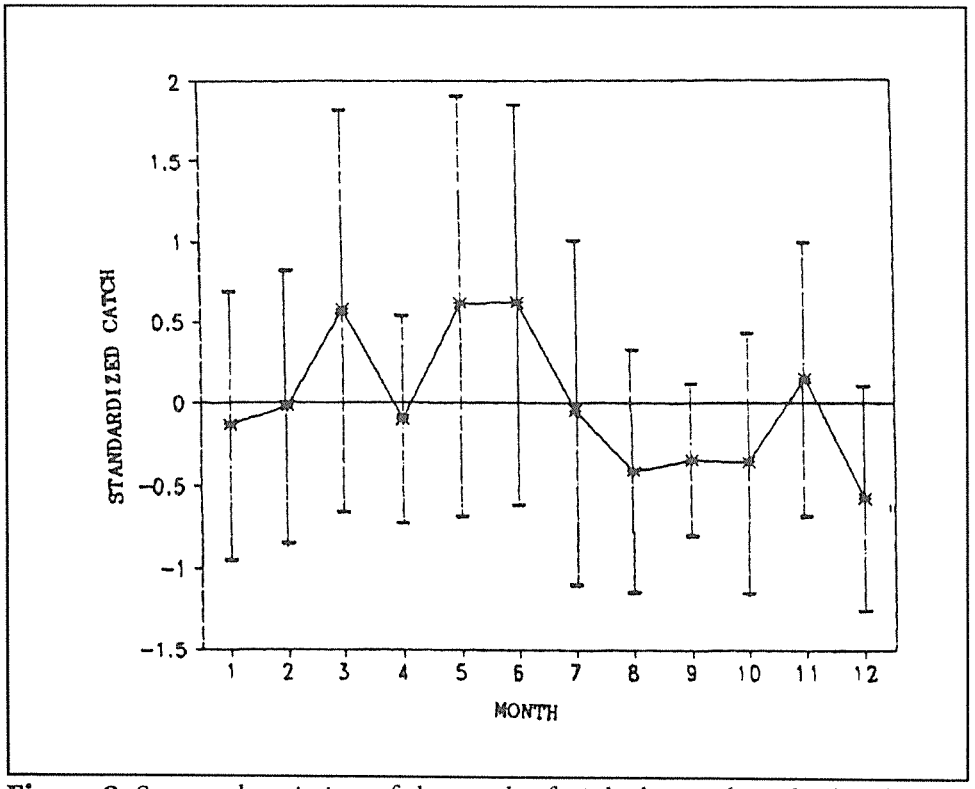


**Figure 8**: Seasonal variation of the catch of pink shrimp (standardized mean ± SD) in the Atlantic zone of Venezuela, between 1986-91.

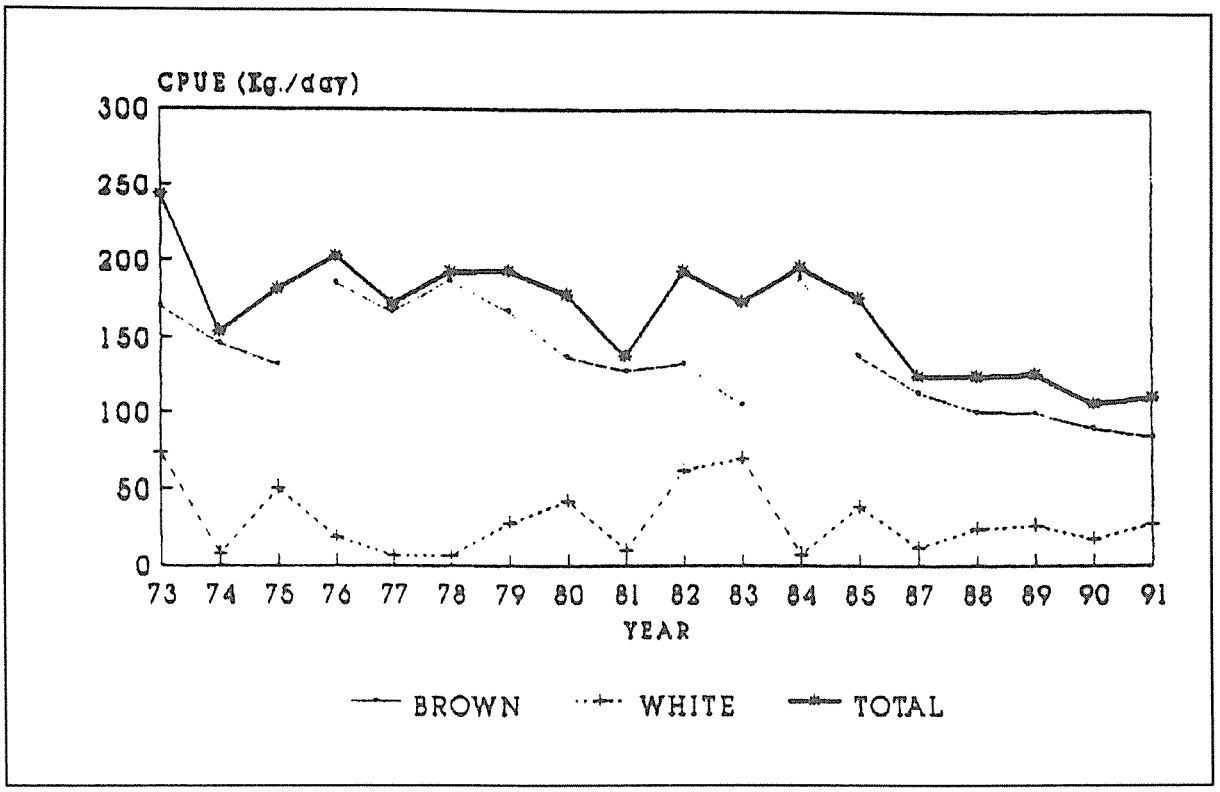


**Figure 9**: Trend of the C.P.U.E. of shrimp reported by the trawling fleet operating in the Atlantic zone of Venezuela.

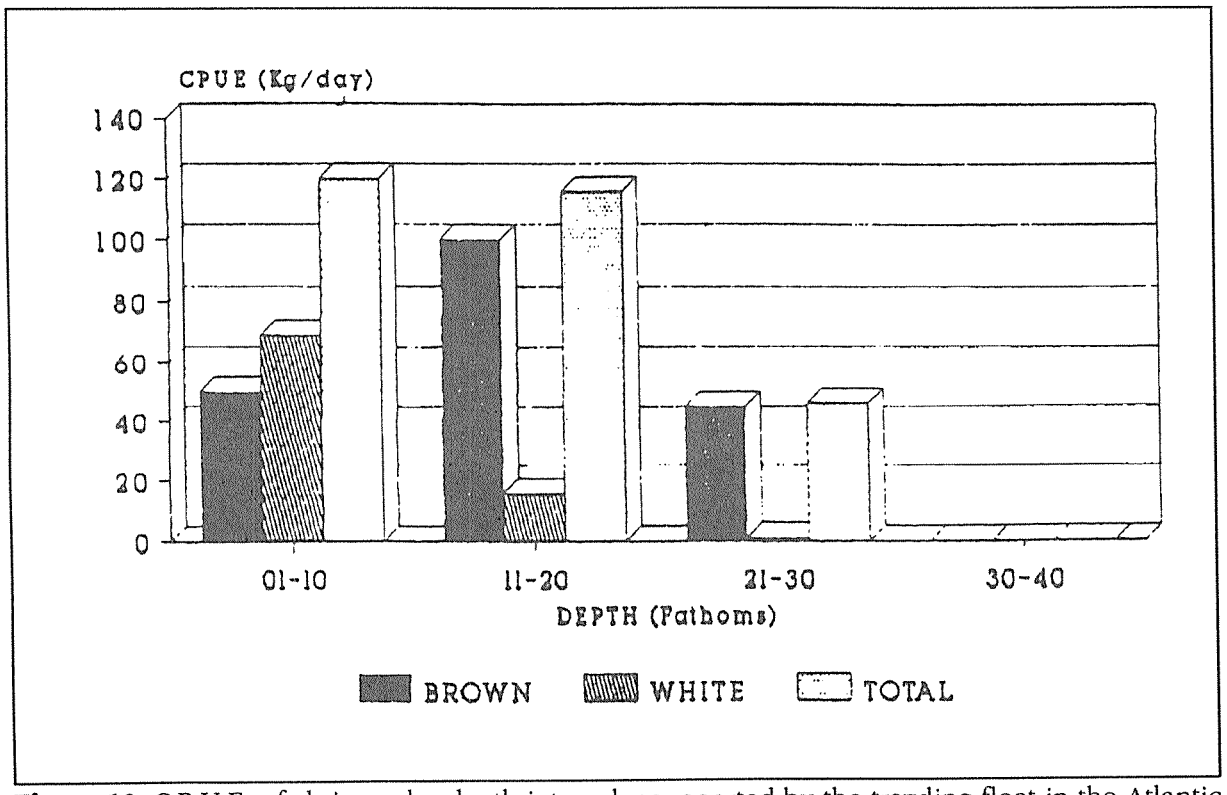


**Figure 10**: C.P.U.E. of shrimps, by depth interval, as reported by the trawling fleet in the Atlantic zone of Venezuela.

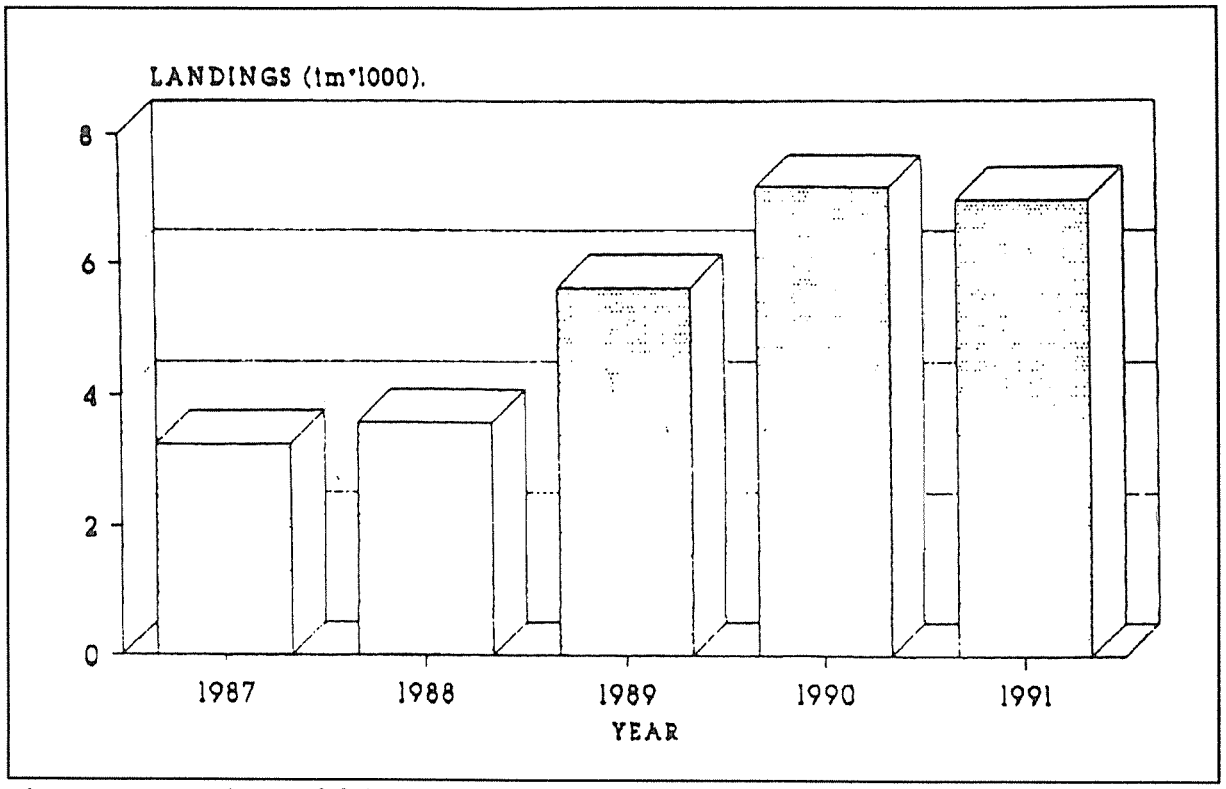


**Figure 11**: Landings of fish reported by the trawling fleet operating in the Atlantic zone of Venezuela.

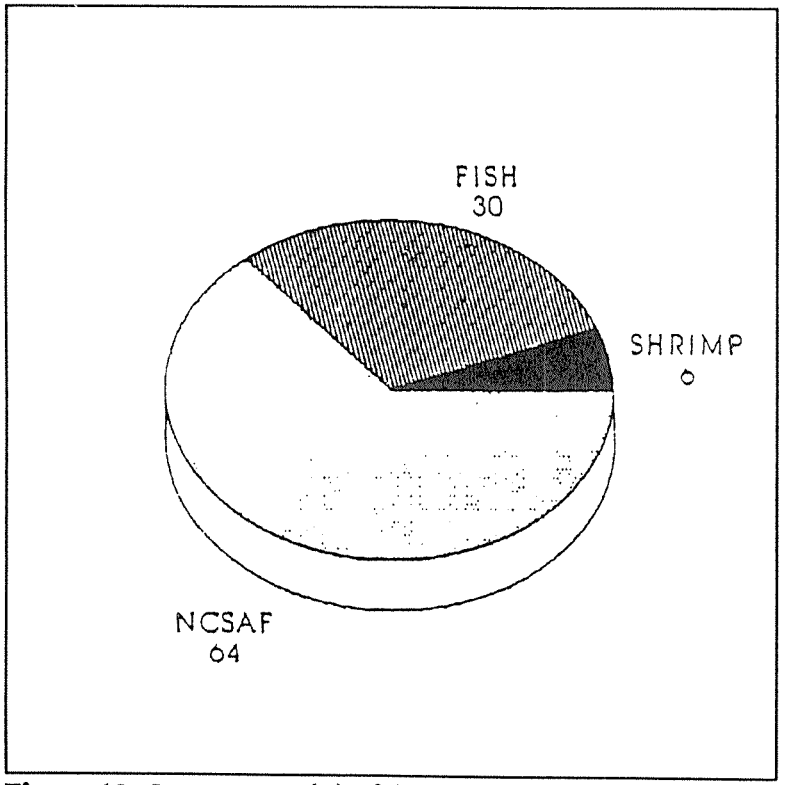


**Figure 12**: Composition (%) of the catch from the trawling fleet operating in the Atlantic zone of Venezuela, 1991.

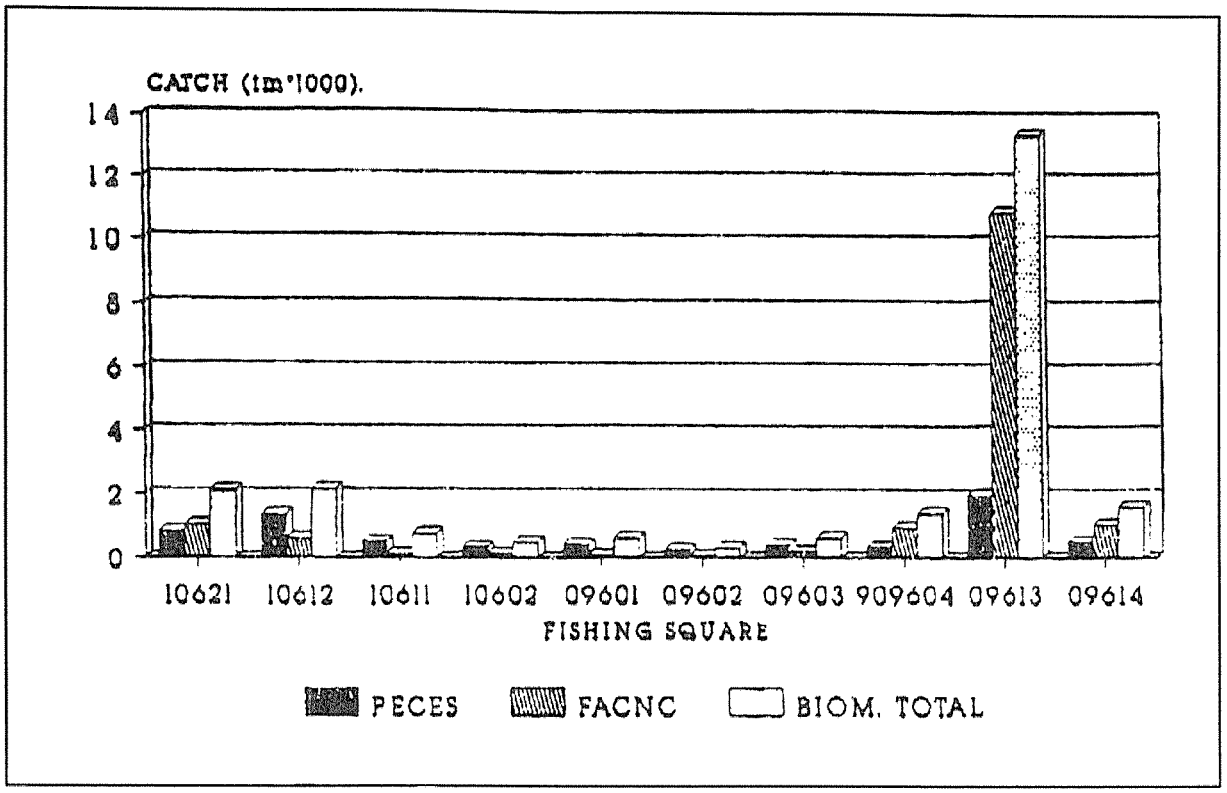


**Figure 13**: Catch of FISH, NCSAP, and TOTAL BIOMASS, by fishing square, for the trawling fleet in the Atlantic zone of Venezuela.

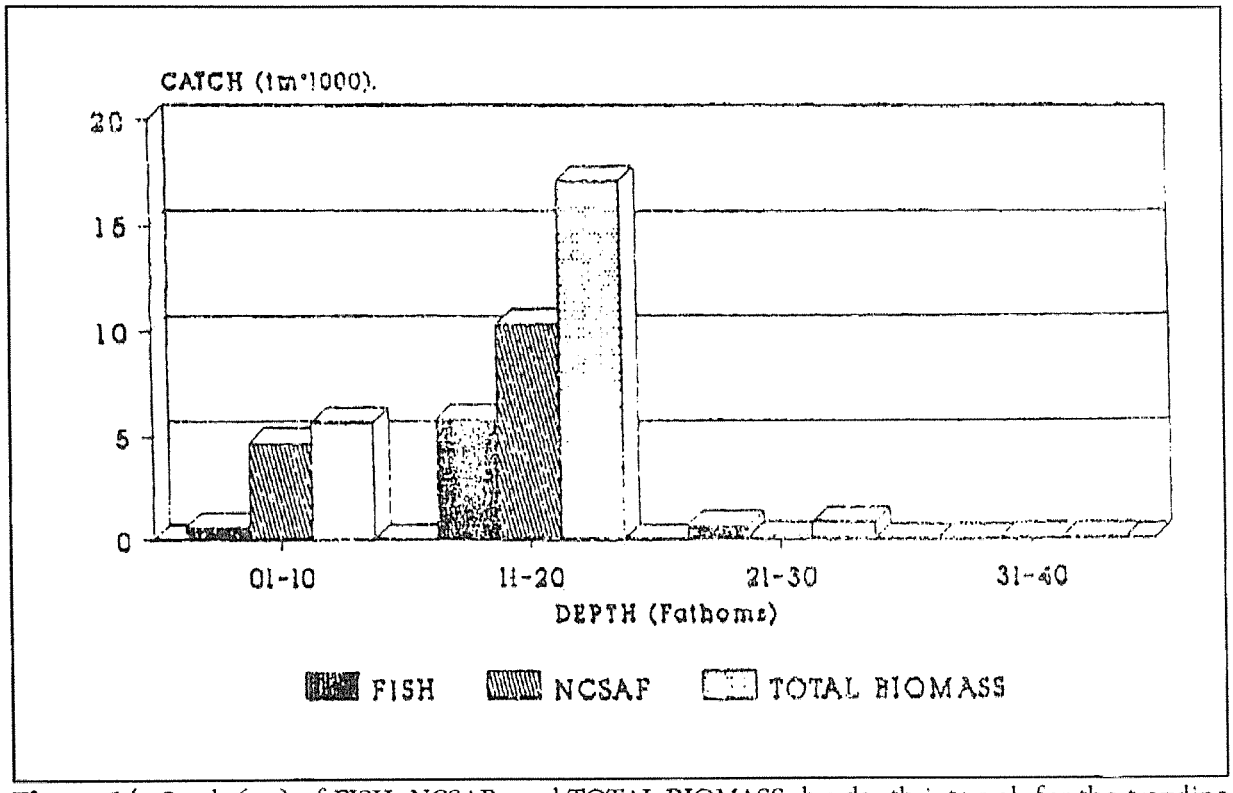


**Figure 14**: Catch (tm) of FISH, NCSAP, and TOTAL BIOMASS, by depth interval, for the trawling fleet in the Atlantic zone of Venezuela.

NATIONAL REPORT OF TRINIDAD AND TOBAGO

# *The Shrimp Fishery of Trinidad and Tobago*

by
B. Fabres[1], L. Maharaj[1] and L. Ferreira[1]

## INTRODUCTION

This report presents an overview of the shrimp trawl fisheries of Trinidad and Tobago, including developments since 1988, when the second workshop on the biological and economic modelling of shrimp resources on the Guianas-Brazil shelf was held in Cayenne, French Guiana. At present, the Fisheries Division is engaged in a biological sampling programme of the trawl fishery, for stock assessment purposes. Existing catch/effort data are being analyzed and a logbook programme for the country's industrial and semi-industrial trawlers has been introduced.

The demersal trawl fishery is the country's most valuable fishery, in terms of landings, dollar value and foreign exchange earnings. The principal exploited species are the Penaeids (*Penaeus brasiliensis, P. notialis, P. schmitti, P. subtilis* and *Xiphopenaeus kroyeri*). Apart from the demersal trawl fishery, there also exists a seasonal beach seine shrimp fishery on the island's south - western peninsula and a cast net fishery in river mouths and mangrove areas for harvesting shrimp (Fabres, 1989).

## I. DESCRIPTION OF THE SHRIMP INDUSTRY

### I.A. FISHING ZONES, FLEET DESCRIPTION, AREAS OF OPERATION AND FISHING STRATEGIES

The demersal trawl fishery of Trinidad and Tobago consists of two (2) inshore, artisanal fleets, an offshore, semi-industrial and an offshore industrial fleet. Trawling occurs mainly in the Gulf of Paria on the island's west coast, the Columbus Channel in the south, off the north coast and in the Orinoco Delta under the Trinidad and Tobago/Venezuela Fishing Agreement. The characteristics and exploited areas of each region are given in Table 1.

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[1] Fisheries Division, Ministry of Agriculture, Land and Marine Resources, Port-of-Spain.

**Table 1**: Characteristics and areas of each fishing zone.

| REGION FISHED | SUBSTRATE TYPE | TOTAL EXPLOITED AREA ($km^2$) |
|---|---|---|
| North Coast | Fine mud and sand with some coral communities | 235 |
| Gulf of Paria | Fine mud with occasional patches of shell debris and sand | 1,957 |
| Columbus Channel | Soft mud with some areas of rock | 826 |
| Orinoco Delta | Mud and sand | 394 |

There has been expansion of both the artisanal and industrial trawl fleets over the years. In a overview of the shrimp industry, Jordan (1969) identified one hundred and sixty-six (166) locally registered (artisanal type) trawlers, ninety-five percent (95%) of which were active, and eighty-five (85) foreign-registered industrial trawlers fishing off the coast of Northeast South America (Guiana - Brazil Area) but landing their catch in Trinidad for processing and export. Chin Yuen Kee (1984), described the local trawl fishery as comprising of some two hundred and fifty (250) artisanal vessels, twenty-two (22) Gulf of Mexico type trawlers, three (3) combination fish/shrimp trawlers and eight (8) mini-stern trawlers. In addition to these, the state owned National Fisheries Company Limited (NFC), had access to ten (10) Barbadian-owned Gulf of Mexico type trawlers. In all, twenty (20) of the Gulf of Mexico type trawlers and the three (3) combined shrimp/fish trawlers were operated by the NFC Limited. Ten (10) of these vessels had access to Brazilian waters under a joint venture agreement with the Company. Other vessels, along with privately owned trawlers, operated within the twelve (12) nautical mile territorial waters of Trinidad & Tobago.

A census of fishing vessels conducted in November 1991, has identified some two hundred and nine (209) active, locally registered trawlers. These vessels have been categorised into four (4) types according to their lengths, engine horsepower and degree of mechanisation (Table 2).

**Table 2**: Trawler categories.

| TRAWLER CATEGORY | ENGINE TYPE | AVERAGE HORSEPOWER | VESSEL LENGTH (m) | GEAR TYPE | AVERAGE HEADROPE LENGTH | # TRAWLERS IN CATEGORY |
|---|---|---|---|---|---|---|
| I (artisanal) | Outboard | 2 x 56 | 6.7-9.8 | 1 stern trawl, manually retrieved | 10.4 m | 113 |
| II (artisanal) | Inboard or Inboard/ Outboard | 137 | 7.9-11.6 | 1 stern trawl, manually retrieved | 10.6 | 66 |
| III (semi- industrial) | Inboard diesel | 176 | 10.4-12.2 | 1 stern trawl hydraulic winch | 11.6 m | 9 |
| IV (industrial) | Inboard diesel | 356 | 17.1-22.0 | 2 nets on outriggers, hydraulic winch | 13.7 m (*2) | 21 |
| Source: Fisheries Division Vessel Census, 1991. Fisheries Division Trawl Gear Survey, 1991. | | | | | | |

Landings of Shrimp and Finfish By-Catch takes place exclusively along the Gulf of Paria and the south-western peninsula (Figure 1). There are four (4) major landing sites: the NFC Limited which is the main landing site for industrial (Type IV) vessels, the Orange Valley Fish Market where the semi-industrial (Type III) fleet is based, and the San Fernando and Otaheite Fish Markets, which are mainly Type II landing sites. The number of vessels operating at each landing site is given in Table 3. In addition, there are ten (10) lesser landing sites.

**Table 3**: Number of trawlers per landing site

| LANDING SITE | # TYPE I TRAWLERS | # TYPE II TRAWLERS | # TYPE III TRAWLERS | # TYPE IV TRAWLERS | TOTAL # TRAWLERS |
|---|---|---|---|---|---|
| Port of Spain | 1 | | 1 | 2 | 4 |
| National Fisheries Company Limited | | | | 15 | 15 |
| Blue River | 2 | | | | 2 |
| Cacandee Sluice | 4 | 3 | | | 7 |
| Waterloo | 1 | 11 | | | 12 |
| Orange Valley | 4 | 12 | 8 | 4 | 28 |
| Carli Bay | 3 | | | | 3 |
| San Fernando | 1 | 17 | | | 18 |
| Otaheite | 3 | 23 | | | 26 |
| Bonasse | 25 | | | | 25 |
| Fullerton | 25 | | | | 25 |
| Icacos | 44 | | | | 44 |
| TOTAL | 113 | 66 | 9 | 20 | 209 |
| Source: Fisheries Division Vessel Census, 1991. | | | | | |

Vessels operating from Bonasse, Fullerton and Icacos are all Type I and trawl in the Gulf of Paria, however, seventy (70) of these vessels are allowed to trawl in the Orinoco Delta between the months of December to June. These vessels normally operate at depths of 1.2 to 3.6m.

Type II and III vessels operate exclusively in the Gulf of Paria at depths of 1.8 - 18.0m and 9.0 - 41.4m respectively. Type IV vessels fish all year round in the Gulf of Paria (between 18 - 41.4m) and in the Columbus Channel (between 9.0 - 57.6m). These vessels also fish on the North Coast during the months of October to January at depths of 37-58m. The depth fished and areas of operation of each vessel type were determined from interviews with trawl fishermen by staff of the Fisheries Division during January 1992 - April 1992. These areas are given in Figure 2.

Vessels operating in the coastal waters of Trinidad trawl both day and night, while Type I vessels trawling in the Orinoco Delta usually trawl only during day-light hours. When catch rates are favourable for Type II vessels, two crews may operate the same vessel sequentially. Table 4 gives an indication of the fishing patterns of the different vessel types.

**Table 4**: Fishing pattern of each trawler type.

| TRAWLER CATEGORY | AVERAGE DURATION OF TRIP | AVERAGE NUMBER OF FISHING DAYS/MONTH/VESSEL | AVERAGE NUMBER OF HAULS/DAY | AVERAGE DURATION OF HAUL (hours) | AVERAGE VESSEL SPEED (knots) |
|---|---|---|---|---|---|
| I | 12 hrs | 8 | 6 | 1.5 | 1 |
| II | 12 hrs | 13 | 5 | 2 | 1 |
| III | 15 hrs | 16 | 4 | 4 | 2 |
| IV | 17 days | 17 | 4 | 4 | 3 |
| Source: Interviews with Type I and Type II Fishermen. Extrapolation from Trawler Logbooks. | | | | | |

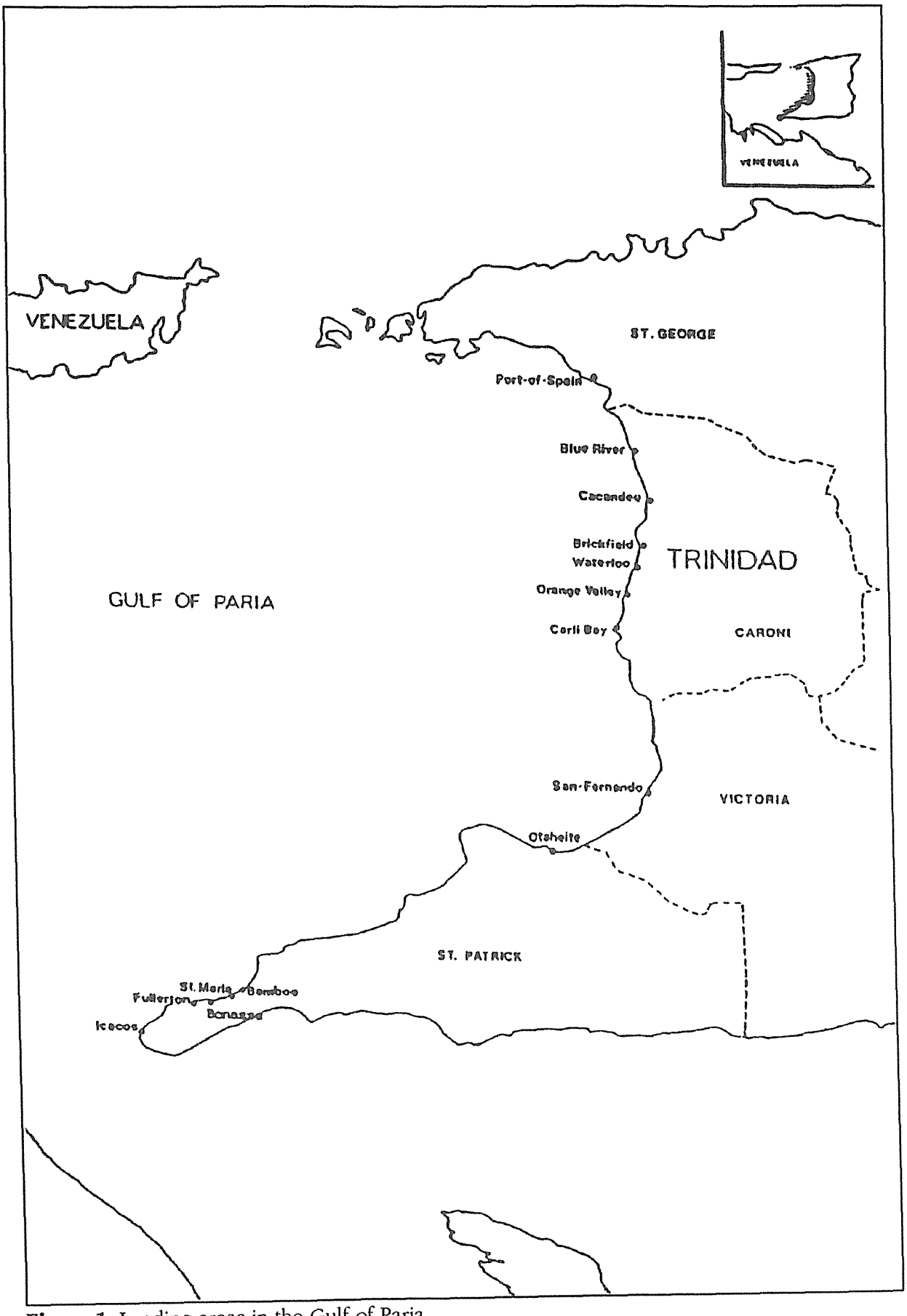


**Figure 1**: Landing areas in the Gulf of Paria.

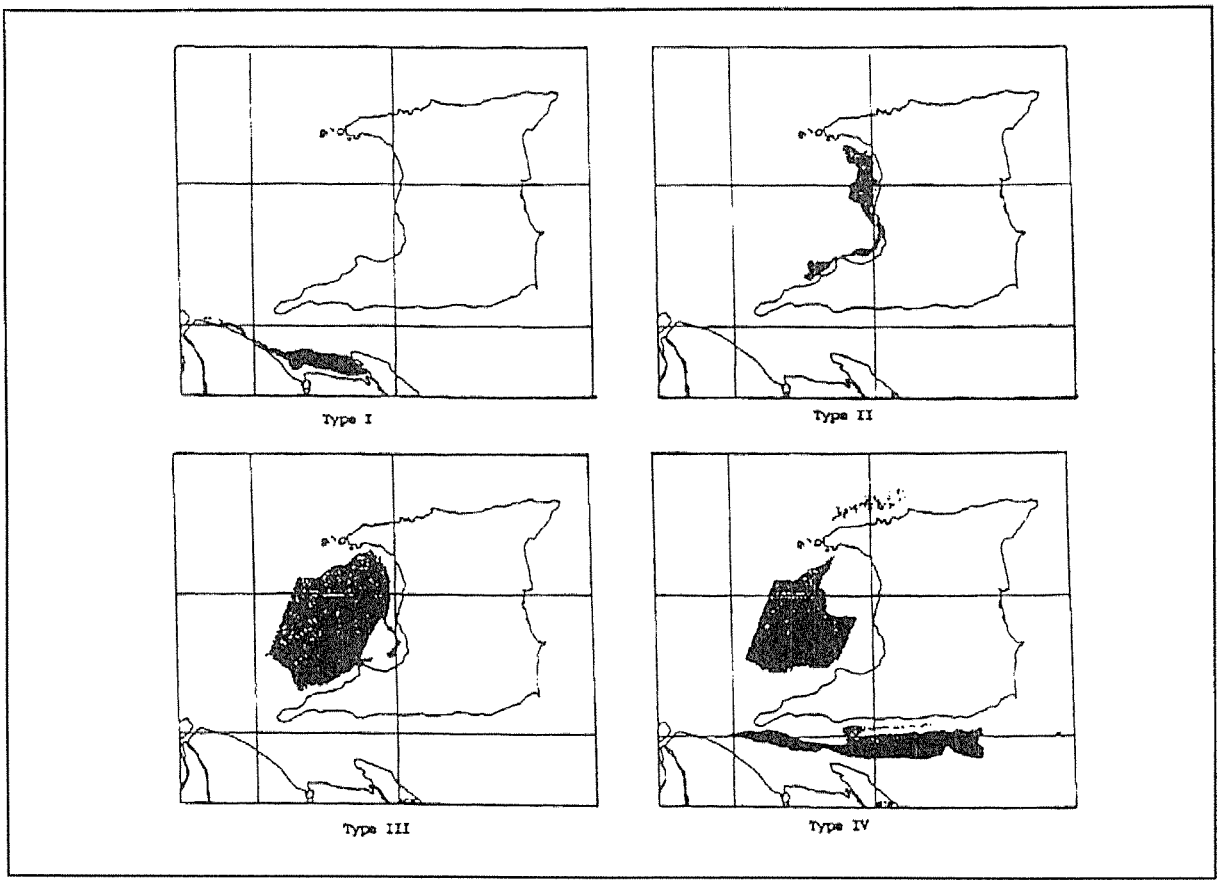


**Figure 2**: Areas of operation of each trawler type.

## I.B. PROCESSING AND MARKETING ACTIVITIES

The National Fisheries Company (NFC) is the country's major shrimp and finfish processing company and represents the main landing site for the industrial (Type IV) trawlers. The company has docking facilities, provides bunkering services and is a trans-shipment point for foreign vessels. Total production capacity is estimated at 6.8 million kg shrimp/fish annually, and there are facilities for de-heading and peeling shrimp. Shrimp and finfish by-catch are purchased either directly from vessels offloading at the Company, or from private individuals who buy shrimp/fish from other parts.

Shrimp is purchased either heads-on or heads-off from the fishermen and graded into the following categories according to the number of individuals per pound (count per lb).

**Table 5**: Shrimp categories utilised by the NFC limited.

| CATEGORY | SMALL (count per lb) | MEDIUM (count per lb) | LARGE (count per lb) | EXTRA LARGE (count per lb) |
|---|---|---|---|---|
| Heads on | 66 - 90 | 41 - 65 | 16 - 40 | 0 - 15 |
| Heads off | | 42 - 67 | 26 - 41 | 0 - 25 |

The prices for each category are fixed.

Finished products include tails, peeled and breaded shrimp. These are sold to restaurants, hotels and fast food outlets or directly to the consumer via a series of outlets under franchise from the company and also from its own outlet at the plant (Chin Yuen Kee, 1985).

There are four (4) small, privately owned shrimp and fish processing plants located in Bonasse and Icacos in the South Coast. These plants purchase shrimp mainly from Type I vessels fishing in the Orinoco Delta and Type IV vessels. However, at the end of the Orinoco Delta fishing season these plants will purchase shrimp from other vessel types or from other landing sites. There is one other privately owned processing plant located in Laventille, near Port-of-Spain, in North-West Trinidad. This plant purchases shrimp from Type IV vessels or from different landing sites.

Shrimp caught by Type II and Type III vessels are offloaded at markets located in Orange Valley, Waterloo, San Fernando and Otaheite. The Orange Valley fish market is the main landing site for Type II vessels. Shrimp and finfish by-catch are usually auctioned to the highest wholesale bidder. Vessels landing at Waterloo, San Fernando and Otaheite are mainly Type II. At these ports, shrimp is usually sold retail, although some shrimp may be sold wholesale to representatives of restaurants or fast food outlets.

Figures obtained from the Export Development Cooperation indicate that shrimp exports in 1989, 1990 and 1991 totalled 342,725 kg, 292,219 kg and 360,837 kg respectively. These exports were valued at TT $6.2, $4.9 and $7.2 million respectively.

# II. RESULTS OF EXPLOITATION

## II.A. CATCH/EFFORT STATISTICS, ECONOMIC ASPECTS

Landings and effort data are collected by the Fisheries Division for the following landing sites: Orange Valley, San Fernando, Otaheite, Bonasse, Fullerton and Icacos. Estimates of total shrimp catch for Type I, II and III vessels, along with the number of trips and catch per unit effort (CPUE) values are given in Table 6 for the years 1987 - 1991.

**Table 6**: Catch weights, fishing efforts, cpue, prices and total revenue for trawlers (1987-1991).

| YEAR | ITEM | TYPE I | TYPE II | TYPE III |
|---|---|---|---|---|
| 1990/91 | Catch (tonnes) | 255.9 | 345.8 | 167.2 |
| | Effort (Trips) | 4,701 | 11,550 | 3,999 |
| | CPUE (kg/trip) | 54.4 | 31.1 | 41.8 |
| | Trip time (hr/trip) | 9.9 | 8.5 | 16.4 |
| | Manning (men/boat) | 3.0 | 2.0 | 2.4 |
| | Average Price (TT $) | 17.08 | 6.84 | 12.67 |
| | Total Revenue (TT $) | 3,904,443 | 2,246,138 | 1,951,542 |
| 1989/90 | Catch (tonnes) | 344.1 | 324.8 | 158.1 |
| | Effort (Trips) | 6,325 | 12,242 | 4,328 |
| | CPUE (kg/trip) | 54.4 | 26.5 | 37.3 |
| | Trip time (hr/trip) | 10.1 | 8.5 | 17.0 |
| | Manning (men/boat) | 3.0 | 2.1 | 2.5 |
| | Average Price (TT $) | 15.67 | 7.54 | 12.20 |
| | Total Revenue (TT $) | 5,288,232 | 2,427,852 | 1,902,994 |

**Table 6**: (continued)

| YEAR | ITEM | TYPE I | TYPE II | TYPE III |
|---|---|---|---|---|
| 1988/89 | Catch (tonnes) | 149.5 | 159.1 | 198.3 |
| | Effort (Trips) | 4,327 | 8,114 | 3,403 |
| | CPUE (kg/trip) | 34.5 | 19.5 | 29.9 |
| | Trip time (hr/trip) | 10.2 | 7.4 | 17.7 |
| | Manning (men/boat) | 3.0 | 2.0 | 2.6 |
| | Average Price (TT $) | 22.4 | 8.72 | 11.67 |
| | Total Revenue (TT $) | 3,224,871 | 1,365,972 | 1,215,990 |
| 1987/88 | Catch (tonnes) | 440.1 | 229.2 | 188.7 |
| | Effort (Trips) | 9,896 | 9,882 | 3,896 |
| | CPUE (kg/trip) | 44.5 | 23.0 | 47.3 |
| | Trip time (hr/trip) | 10.0 | 5.7 | 19.5 |
| | Manning (men/boat) | 2.9 | 1.8 | 2.7 |
| | Average Price (TT $) | 18.89 | 7.32 | 10.51 |
| | Total Revenue (TT $) | 6,753,765 | 1,492,876 | 1,937,266 |
| 1986/87 | Catch (tonnes) | 324.7 | 278.4 | 353.3 |
| | Effort (Trips) | 6,081 | 9,645 | 4,300 |
| | CPUE (kg/trip) | 53.4 | 28.7 | 77.8 |
| | Trip time (hr/trip) | 10.2 | 5.6 | 17.8 |
| | Manning (men/boat) | 3.0 | 1.8 | 2.3 |
| | Average Price (TT $) | 11.53 | 7.19 | 9.14 |
| | Total Revenue (TT $) | 3,525,445 | 2,044,446 | 3,308,809 |

No comparative catch/effort data for the industrial (Type IV) fleet is available. Landings of shrimp and finfish by-catch at the NFC by the Type IV fleet are available from the company, however Type IV vessels may sell parts of their catch at other ports or tranship shrimp at sea. A logbook programme for these vessels and for the semi-industrial (Type III) fleet was introduced in November 1991, in an attempt to obtain more accurate catch/effort data. Extrapolations from the data collected so far for Type IV vessels indicate an annual catch of 1,000 tonnes of shrimp and 300 tonnes finfish by-catch from an average of 300 trips per year, giving a CPUE of 3.3 tonnes shrimp/trip and 1 tonne by-catch/trip.

The average wholesale prices for shrimp and the revenues earned by fishermen operating Type I, II, III trawlers are also given in Table 6. For Type IV vessels, the annual revenue earned is estimated at TT $13.8 million.

# III. ASSESSMENT OF THE RESOURCES

## III.A. THE SAMPLING PROGRAMME OF THE TRAWL FISHERY

The Sampling Programme of the trawl fishery commenced in March 1991 under the Government of the Republic of Trinidad and Tobago (GORTT)/Food and Agriculture Organization of the United Nations (FAO)/United Nations Development Program (UNDP) Project TRI/91/001, entitled "Establishment of Data Collection Systems and Assessment of Fisheries Resources". This on-going Sampling Programme has been documented by Lum Young and Maharaj (1992).

As part of the Sampling Programme, shrimp from the different trawler fleets are being sampled for length frequencies on a weekly basis at specific sites in the Gulf of Paria. The landing sites/beaches covered are the National Fisheries Company Limited (NFC), Waterloo, the Orange Valley Wholesale

Fish Market, the San Fernando Fish Market, the Otaheite Fish Market, Bonasse, Fullerton and Icacos at a target rate of two (2) vessels per beach per week.

### 1. The Industrial Trawl Fishery

Type IV vessels are sampled at the NFC. The sample size for each of the categories "medium", "large", "extra large", "headless (large)" and "headless (extra large)" is 10 lbs while that for the "small (hoppers)" and "small (mixed)" categories is 2 - 3 lbs.

The samples in each category are sorted by species and sex. For whole shrimp, the carapace length of each shrimp is measured (to the nearest millimetre). For headless individuals, tail lengths are measured. These measurements, in addition to the sample weights and catch weights for each category are recorded on voice-activated tape recorders and later transcribed on to tally forms.

### 2. The Semi-industrial Trawl Fishery

Type III vessels are sampled at the Orange Valley Wholesale Fish Market. As far as possible, unsorted catches are sampled from which a random sample of 10 lbs is taken. If catches are sorted (usually two (2) commercial categories - medium and large browns), random samples of 10 lbs of each category are obtained. Samples are sorted by species and sex and carapace lengths are measured and recorded on voice-activated recorders.

### 3. The Artisanal Trawl Fishery

Type I and Type II vessels are sampled at San Fernando and Otaheite. Type II vessels are also sampled at Waterloo while the Type I vessels fishing in the Orinoco Delta are sampled at Bonasse, Fullerton and Icacos. Shrimp may be landed unsorted or in categories of "small", "medium" and "cork" (large). Sampling of sorted and unsorted catches is carried out as described for the Type III vessels. Only 3 lbs of the "small" category are sampled. If "medium" on a particular beach is comparable to "small" at the NFC, then 5 lbs of shrimp are sampled.

## III.B. TREATMENT OF LENGTH-FREQUENCY DATA

The length-frequency data collected at the NFC, the semi-industrial and the artisanal beaches are transcribed onto tally forms as indicated and filed by trawler type and fishing area. All data are converted into carapace lengths using conversion factors worked out by the Trawl Fishery Assessment Team. Tally data are added and summarised into monthly length frequencies.

## 1. Unsorted Catches

For unsorted catches, the length frequencies are simply added across the weekly sampling frequencies to give a monthly length-frequency distribution.

## 2. Sorted Catches

The length-frequency distributions for each category of a sorted catch are first raised to the total landing of the particular category. The length-frequencies for the different categories are then combined to provide a complete profile for the catch sampled. Complete (raised) profiles may then be added to the profiles of samples of unsorted catches for the month to give a monthly length-frequency distribution.

At present, all the monthly length frequencies are entered into COMPLEAT ELEFAN (Gayanilo et al., 1989) files to be used in subsequent analyses. Table 7 gives the months for which length frequency distributions by species and sex were obtained.

**Table 7**: Monthly length frequency distributions obtained by fleet and by area.

| VESSEL TYPE | AREA | MONTH/ YEAR | NO OF SAMPLES | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | SORTED | | | | |
| | | | UNSORTED | SMALL (HOPPERS) | SMALL (MIXED) | MEDIUM | LARGE | EXTRA LARGE |
| I | 10 | Mar 91 | 4 | | | | | |
| | | Jun 91 | 4 | | | | | |
| | | Aug 91 | 4 | | | | | |
| | | Sept 91 | 1 | | | | | |
| | | Oct 91 | 1 | | | | | |
| | | Nov 91 | 1 | | | | | |
| | | Dec 91 | 1 | | | | | |
| | | Jan 92 | 1 | | | | | |
| | Special Area | Mar 91 | 1 | | | | | |
| | | Apr 91 | 4 | | | | | |
| | | May 91 | 9 | | | | | |
| | | Jun 91 | 4 | | | | | |
| | | Jul 91 | 1 | | | | | |
| | | Jan 92 | 2 | | | | | |
| II | 10 | Mar 91 | 4 | | | | | |
| | | Apr 91 | 7 | | | | | |
| | | May 91 | 6 | | | | | |
| | | Jun 91 | 11 | | | | | |
| | | Jul 91 | 6 | | | | | |
| | | Aug 91 | 1 | | | | | |
| | | Sept 91 | 8 | | | | | |
| | | Oct 91 | 7 | | | | | |
| | | Nov 91 | 3 | | | | | |
| | | Dec 91 | 2 | | | | | |
| | | Jan 92 | 7 | | | | | |
| | | Feb 92 | 6 | | | | | |
| | | Mar 92 | 2 | | | | | |

**Table 7**: (continued)

| VESSEL TYPE | AREA | MONTH/ YEAR | NO OF SAMPLES | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | UNSORTED | SORTED | | | | |
| | | | | SMALL (HOPPERS) | SMALL (MIXED) | MEDIUM | LARGE | EXTRA LARGE |
| II cont'd | 11 | Mar 91 | 8 | | | | | |
| | | Apr 91 | 11 | | | | | |
| | | May 91 | 2 | | | | | |
| | | Jun 91 | 2 | | | | | |
| | | Jul 91 | 1 | | | | | |
| | | Sept 91 | 5 | | | | | |
| | | Nov 91 | 4 | | | | | |
| | | Dec 91 | 1 | | | | | |
| | | Jan 92 | 4 | | | | | |
| | | Feb 92 | 1 | | | | | |
| | | Mar 92 | 2 | | | | | |
| | | Apr 92 | 3 | | | | | |
| III | 10 & 11 | Mar 91 | 3 | | | | | |
| | | Apr 91 | 11 | | | | | |
| | | Jun 91 | 4 | | | | | |
| | | Jul 91 | 4 | | | | | |
| | | Oct 91 | 4 | | | | | |
| | | Nov 91 | 3 | | | | | |
| | | Dec 91 | 3 | | | | | |
| | | Jan 92 | 4 | | | | | |
| | | Feb 92 | 2 | | | | | |
| | | Mar 92 | 3 | | | | | |
| | | Apr 92 | 4 | | | | | |
| IV | 8 & 9 | Apr 91 | | 5 | 5 | 5 | 5 | 5 |
| | | May 91 | | 2 | | 2 | 2 | 2 |
| | | Jun 91 | | | 4 | 4 | 4 | 4 |
| | | Jul 91 | | | 4 | 4 | 4 | 4 |
| | | Aug 91 | | | | 4 | 4 | 4 |
| | | Nov 91 | | | 6 | 6 | 6 | |
| | | Dec 91 | | | 5 | 5 | 5 | |
| | | Jan 92 | | | 8 | 8 | 8 | 8 |
| | | Feb 92 | | 1 | 9 | 9 | 9 | 9 |
| | 10 & 11 | May 91 | | 5 | 5 | 5 | 5 | 5 |
| | | Jun 91 | | | 3 | 3 | 3 | 3 |
| | | Jul 91 | | | | 1 | 1 | 1 |
| | | Nov 91 | | | | 1 | 1 | |
| | | Feb 92 | | | | 2 | 2 | |

## III.C. SPECIES AND SEX COMPOSITION AND DISTRIBUTION IN COMMERCIAL (SIZE) CATEGORIES

Sample weight estimations were done for all monthly length frequencies using COMPLEAT ELEFAN. Monthly and annual species and sex composition (as a percentage by weight) are available by fleet and by area. The annual results obtained from the 1991 and 1992 data are shown in Table 8. In general, the sex ratio (male:female) is 1:3 for *P. notialis* and 1:1.5 for the other four (4) penaeid shrimp species. Observations on the species composition and distribution in commercial (size) categories is given below for each of the industrial, semi-industrial and artisanal trawl fisheries.

## 1. The Industrial Trawl Fishery

The Type IV vessels operating offshore in the Columbus Channel (Areas 8 and 9) land approximately 51% *P. subtilis*. *P. brasiliensis* is also abundant in the catches with some *P. notialis* also being landed. No *X. kroyeri* is landed.

The Type IV vessels operating offshore in the Gulf of Paria (Areas 10 and 11) land approximately 60% *P. notialis* and 31% *P. subtilis*, these species occurring in the medium, large and extra large categories. Small amounts of *P. brasiliensis* occur in all categories. *P. schmitti* is rare and *X. kroyeri* is absent from the catches.

## 2. The Semi-industrial Trawl Fishery

The Type III vessels operating near shore in the Gulf of Paria land approximately 63% *P. notialis* and lesser quantities of *P. subtilis* and *P. schmitti*. All sizes of these species are landed, although only *P. schmitti* occurs in the extra large category. Neither *P. brasiliensis* nor *X. kroyeri* is landed.

## 3. The Artisanal Trawl Fishery

The Type II vessels operating inshore of the southern Gulf of Paria (Area 10) land mainly *P. schmitti* with negligible quantities of *P. notialis*, *P. subtilis* and *X. kroyeri*. The Type II vessels operating in the northern Gulf of Paria (Area 11) land approximately 50% *P. notialis*, with *P. schmitti* also being abundant. Some *P. subtilis* and negligible quantities of *X. kroyeri* are also landed.

The Type I vessels operating inshore of the southern Gulf of Paria (Area 10) land more or less equal quantities of *P. notialis*, *P. subtilis* and *P. schmitti* with lesser amounts of *X. kroyeri*. The Type I vessels operating in the Orinoco Delta ("Special Area") land approximately 69% *P. schmitti* and 31% *P. subtilis*.

The artisanal fleet lands juveniles of *P. notialis* and *P. subtilis* and all sizes of *P. schmitti*. *P. brasiliensis* rarely occurs in the landings.

**Table 8**: Annual species and sex composition (% by weight) by fleet and by area (from 1991 and 1992 data).

| | | TYPE I | | TYPE II | | TYPE III | TYPE IV | |
|---|---|---|---|---|---|---|---|---|
| SPECIES | SEX | AREA 10 | SPECIAL AREA | AREA 10 | AREA 11 | AREA 10 & 11 | AREA 8 & 9 | AREA 10 & 11 |
| *P. notialis* | ♂ | 6 | | 1 | 13 | 15 | 6 | 16 |
| | ♀ | 19 | | 3 | 37 | 47 | 11 | 45 |
| | ♂ and ♀ | 25 | | 5 | 50 | 63 | 16 | 60 |
| *P. subtilis* | ♂ | 13 | 9 | 1 | 6 | 10 | 19 | 12 |
| | ♀ | 20 | 21 | 1 | 7 | 17 | 32 | 19 |
| | ♂ and ♀ | 34 | 31 | 2 | 13 | 27 | 51 | 31 |

**Table 8**: (continued)

| SPECIES | SEX | TYPE I | | TYPE II | | TYPE III | TYPE IV | |
|---|---|---|---|---|---|---|---|---|
| | | AREA 10 | SPECIAL AREA | AREA 10 | AREA 11 | AREA 10 & 11 | AREA 8 & 9 | AREA 10 & 11 |
| *P. schmitti* | ♂ | 12 | 35 | 38 | 13 | 5 | | |
| | ♀ | 17 | 34 | 53 | 21 | 6 | | |
| | ♂ and ♀ | 29 | 69 | 91 | 33 | 10 | | |
| *P. brasiliensis* | ♂ | | | | | | 10 | 3 |
| | ♀ | | | | | | 22 | 5 |
| | ♂ and ♀ | | | | | | 32 | 8 |
| *X. kroyeri* | ♂ | 4 | | 1 | 2 | | | |
| | ♀ | 9 | | 1 | 3 | | | |
| | ♂ and ♀ | 13 | | 2 | 4 | | | |
| TOTALS | | 101 | 100 | 100 | 100 | 100 | 99 | 99 |

## III.C. KNOWLEDGE OF THE RESOURCE (RECRUITMENT, NURSERIES, POPULATION DYNAMICS)

Not much work has been done locally with regard to the recruitment nurseries, and population dynamics of the penaeid shrimp species. Table 9 shows the information obtained about the shrimp resources from surveys carried out locally. Stock assessment parameters for *P. schmitti*, *P. notialis*, *P. brasiliensis*, *P. subtilis* and *X. kroyeri* have been compiled from a literature search (Lum Young, P., L. Maharaj and L. Ferreira, 1992).

**Table 9**: Information obtained about the shrimp resources from surveys carried out locally.

| STUDY AREA | TIME PERIOD | HEADING | INFORMATION OBTAINED | REFERENCE |
|---|---|---|---|---|
| Inshore waters of Gulf of Paria, Trinidad | Oct 1984 - May 1986 | Spawning | *X. kroyeri* mates all year round.<br><br>Spawning is expected to coincide with or follow the periods when the number of mature females in the catch is highest, i.e., between July and September and March/April. | Henry, C. (1987) |
| | | Length at First Maturity | *X. kroyeri* females: 8.1 - 8.5 cm (total length)<br><br>Smallest mature male was 6.3 cm. | |
| | | Impact of Environmental Factors | *X. kroyeri* is highest in the catch when salinities are about 32%.<br><br>Reduction in total numbers of *X. kroyeri* in the rainy season may be the result of environmental conditions acting to trigger short lateral migrations of the population within its depth range to perhaps facilitate spawning.<br><br>Temperature did not appear to influence the distribution or abundance of shrimps generally or the catch of *X. kroyeri*. | |
| Inshore waters of the Gulf of Paria, Trinidad | Nov 1984 - Feb 1986 | Life Cycle | It is suggested that both male and female *Penaeus subtilis* enter the coastal (nursery) areas as approximately one-month old postlarvae (at < 13 mm carapace length) in June, the beginning of the rainy season in Trinidad. October/November marks the emigration out of the coastal (nursery) areas to offshore, deeper waters.<br><br>A second spawning was not evident from the data set. | Fabres, B. (1988) |
| Oropouche Bank adjacent to mangroves of South Oropouche Swamp | 1983 - 1984 | Species Composition | *X. kroyeri* dominates between September and April.<br><br>*P. schmitti* is the most common species during the period of peak rainfall and river discharge, i.e., June and July.<br><br>*P. notialis* and *P. subtilis* are present in lesser quantities. | Ramcharan, E.K. (1989) |

**Table 9**: (continued)

| STUDY AREA | TIME PERIOD | HEADING | INFORMATION OBTAINED | REFERENCE |
|---|---|---|---|---|
| Oropouche Bank adjacent to mangroves of South Oropouche Swamp (cont'd) | 1983 - 1984 | Impact of Environmental Factors | The dependence of *X. kroyeri* on both mangrove and phytoplankton carbon is apparent.<br><br>*P. schmitti* is dependent upon the freshwater pulse, low salinity regime and mangrove carbon which is generated at the onset of the rainy season. | Ramcharan, E.K. (1989) |
| Inshore Gulf of Paria, Trinidad near Orange Valley | Aug 1986 - May 1987 | Species Composition | *P. schmitti*, *P. notialis* and *P. subtilis* dominated the shrimp catches.<br><br>*P. schmitti* was most abundant from September to October and very low from November to May.<br><br>*P. notialis* was highest in the catch from January to May and lowest from October to January.<br><br>The quantity of *P. subtilis* in the catch fluctuated with highest levels occurring from November to May.<br><br>*X. kroyeri* appears sporadically in the catches being highest from August to January and almost absent from mid January to May. | Maharaj, V. (1989) |
| | | Impact of Environmental Factors | There was an increase in shrimp catches in the dry season. | |
| Nearshore Gulf of Paria, Trinidad | Jun 27 - Jul 27 1990 | Minimum and Maximum Lengths | Length frequency analysis of *P. subtilis* catches indicates smaller sized individuals for the northern Gulf of Paria than for the southern, with smallest individuals being 18 mm (carapace length) in the northern Gulf and 19 mm in the southern Gulf.<br><br>The maximum length in the northern Gulf of Paria was 41 mm and 59 mm in the south.<br><br>The large size of *P. subtilis* in the southern Gulf possibly reflects a faster growing population in this area due to enhanced nutrient content or a "micro-cohort" flushed out earlier from coastal nursery areas. | Amos, M. (1990) |
| | | Catch Rates | There is no marked difference between mean day and night CPUE (kg/hr) for shrimp in both the northern and southern Gulf of Paria.<br><br>(kg/hr) (kg/hr)<br>Northern Gulf of Paria: Day 2.29 Night 2.47<br>Southern Gulf of Paria: Day 4.41 Night 4.50 | |
| | | Species Composition | *P. notialis* and *P. subtilis* are the 2 most dominant Penaeid shrimp species.<br><br>*P. brasiliensis* is caught in minimal quantities in the Gulf of Paria.<br><br>*X. kroyeri* does not appear at all in the Type III catches; this species is usually caught close inshore by the Type I and Type II trawlers.<br><br>Relative Contribution by Weight of Penaeid Shrimp Species<br><br>Species — Mean % (wt): N Gulf of Paria / S Gulf of Paria / Total<br>*P. brasiliensis* 3.64 5.01 4.46<br>*P. notialis* 30.19 39.35 35.69<br>*P. schmitti* 36.37 10.80 21.03<br>*P. subtilis* 29.99 44.85 38.92 | |

**Table 9**: (continued)

| STUDY AREA | TIME PERIOD | HEADING | INFORMATION OBTAINED | REFERENCE |
|---|---|---|---|---|
| Nearshore Gulf of Paria, Trinidad cont.d | Jun 27 - Jul 27 1990 | Impact of Environmental Factors | The higher commercial productivity in the southern Gulf of Paria may be correlated to a higher nutrient content of the marine environment of the southern Gulf and/or the negative impacts of human settlement patterns and pollution (pesticides and industrial effluent) on the nursery grounds and inshore waters of the northern Gulf and the negative impacts of the significant inshore trawl fishery of Type I and Type II vessels operating mainly out of the Orange Valley region near the northern Gulf.<br><br>*P. brasiliensis* prefers a more saline and deeper water environment and substrate of high sand composition as is found on the south portion of the Gulf and along the south coast of Trinidad.<br><br>The apparent higher percentage occurrence of *P. schmitti* in the northern Gulf is due to the fact that this species is characterised as being an inshore species with a preference for areas of muddy substrate and high organic content.<br><br>The dominance of *P. subtilis* and *P. notialis* in the Gulf of Paria reflects their euryhaline preferences. | Amos, M. (1990) |

# IV. ECONOMIC ASPECTS

Refer to Section II.

# V. SECONDARY RESOURCES

## V.A. SEA-BOB

There are approximately twenty (20) inshore (Type I) vessels that trawl for bait for the long-line fishery. These vessels target the sea-bob, *Xiphopenaeus kroyeri.* Type I trawlers fishing in the Orinoco Delta land very little by-catch and indications are that small shrimp (mainly sea-bob) are discarded by these vessels.

## V.B. DEEP WATER SHRIMP

Information on this resource was obtained through the surveys of the RV Dr. Fridtjof Nansen in 1988 (Inst. Marine Research, 1989). The following is the report made:

In all surveys some test hauls with bottom trawl were made for deep sea shrimp on the slope which in the southern part extends 30 - 40 nm outside the edge of the shelf before 700 - 800 m is reached. The results of these fishing experiments are summarized in Table 10 showing total catch rates and by species for the forms judged to be of commercial interest. There were some minor by-catches of non-commercial species mostly *Nematocarcinus* and *Glyphocrangon* species. The most important species are scarlet shrimp *Plesiopenaeus edwardsianus* and royal red shrimp *Pleoticus robustus*, the latter caught together with other commercial sized species of Solenoceridae.

The mean catch rates are low, but there are a few higher individual catch rates which may indicate patchiness or seasonal aggregations. One should note the variation of depth ranges for some of these species. A trawl fishery was not recommended, based on the relatively low catch rates.

**Table 10**: Trinidad, East coast. Tests for deep water shrimp, 20 hauls (190-800 m). Catch rates in kg/hr and main depth (m).

| SPECIES | MEAN CATCH | HIGHEST | INCIDENCE | DEPTH |
|---|---|---|---|---|
| All commercial shrimp | 9 | 39, 16, 12 | 20/20 | |
| *Plesiopenaeus edwardsianus* | 2 | 6, 5, 5 | 11/20 | 600-700 |
| *Pleoticus robustus* a.o. | 3 | 27, 8, 7 | 11/20 | 300-500 |
| *Penaeopsis serrata* | 3 | 13, 12, 8 | 11/20 | 300-500 |
| *Acanthephyra sp.* | 0.6 | 5, 3, 3 | 5/20 | 700-800 |

## V.C. FINFISH

Significant quantities of finfish and crabs are exploited incidentally in the demersal trawl fishery. However, some authors (Manickchand-Dass and Julien, 1983; Fabres, 1989) claim that certain species of fish may be targeted according to market demand, or during the wet season when shrimp abundance decreases.

A survey of the Type II fishery was carried out by Maharaj (1989) between August 1986 to May 1987. Some seventy (70) species of finfish by-catch from forty (40) families and several species of Portunid crabs were identified. Approximately eighty percent (80%) of the finfish by-catch was composed of sub-adults and juveniles of the following families: Ariidae, Carangidae, Clupeidae, Engraulidae, Gerreidae and Sciaenidae. Species of commercial importance (i.e. marketable for consumption) Carangids, Sciaenids and Lutjanids accounted for only 15-33 % of the total finfish catch. Length ranges of the most abundant and commercially important species of by-catch caught during this survey are given in Table 11. It was estimated that in 1986, 94.13 % of the total By-Catch of Type II vessels were discarded.

In a one (1) month study of the commercial Type III trawl fishery, Amos (1990) reported twenty-five (25) species of finfish by-catch from fourteen (14) families. A list of the more abundant and commercially important By-Catch sp. recorded is given in Table 12. The percentage by weight of discards to the total finfish catch was calculated as 59.67 % (SD 11.67).

Length frequency analyses for two of the most commercially important and abundant species, *Micropogonias furnieri* and *Cynoscion jamaicensis*, indicate that for both species 95 % of the individuals caught were immature.

**Table 11**: Length ranges of the most abundant and commercially important finfish species (Type II trawl survey).

| FAMILY | SPECIES | LENGTH MIN (cm) | LENGTH MAX (cm) |
|---|---|---|---|
| Ariidae | *Arius sp* | 26 | 122 |
| Bothidae | *Cyclopsetta sp* | 39 | 113 |
| Carangidae | *Caranx sp*<br>*Chloroscombrus chrysurus* | 40<br>38 | 120<br>142 |
| Centropomidae | *Centropomus ensiferus* | 141 | 190 |
| Clupeidae | *Harengula sp* | 59 | 140 |
| Cynoglossidae | *Symphurus sp* | 100 | 160 |
| Engraulidae | *Anchoa sp*<br>*Cetengraulis edentulus* | 40<br>75 | 95<br>150 |
| Gerreidae | *Diapterus rhombeus*<br>*Eucinostomus sp* | 25<br>30 | 120<br>135 |
| Lutjanidae | *Lutjanus sp* | 52 | 200 |
| Portunidae | *Callinectes sp* | 25 | 102 |
| Sciaenidae | *Cynoscion sp*<br>*Macrodon ancylodon*<br>*Micropogonias furnieri* | 60<br>117<br>90 | 260<br>190<br>275 |
| Trichiuridae | *Trichiurus lepturus* | 250 | 796 |
| Source: Maharaj, 1989. | | | |

**Table 12**: % contribution by weight of the most abundant and commercially important finfish (Type II trawl survey).

| FAMILY | SPECIES | % CONTRIBUTION BY WEIGHT |
|---|---|---|
| Carangidae | *Caranx hippos*<br>*Chloroscombrus chrysurus*<br>*Trachinotus carolinus* | 2.7<br>10.0<br>6.8 |
| Clupeidae | *Harengula clupeola*<br>*Opisthonema oglinum* | 2.2<br>1.6 |
| Cynoglossidae | *Cyclopsetta sp*<br>*Symphurus sp* | 1.7<br>1.5 |
| Gerreidae | *Diapterus rhombeus*<br>*Eucinostomus argenteus* | 15.9<br>8.5 |
| Lutjanidae | *Lutjanus sp* | 7.0 |
| Polynemidae | *Polydactylus virginicus* | 1.2 |
| Sciaenidae | *Cynoscion jamicensis*<br>*Micropogonias furnieri* | 12.6<br>5.4 |
| Trichiuridae | *Trichiurus lepturus* | 1.4 |
| Triglidae | *Prionotos punctatus* | 9.7 |
| Portunidae | | 8.9 |
| Source: Amos, 1990. | | |

Analysis of logbook data collected from Type IV vessels for the period November 1991 - April 1992 indicate that of the total by-catch 64.8 % was discarded. The percentage contribution by weight of the different species of by-catch landed is given in Table 13.

**Table 13**: % contribution by weight of by-catch species landed by Type IV vessels.

| FAMILY | SPECIES | % CONTRIBUTION BY WEIGHT |
|---|---|---|
| Ariidae | *Arius sp* | 0.2 |
| Carcharhinidae | | 1.6 |
| Carangidae | *Caranx hippos*<br>*Chloroscombrus chrysurus*<br>*Selene sp* | 0.02<br>0.5<br>0.2 |
| Ephippidae | *Chaetodipterus faber* | 0.7 |
| Gerreidae | *Diapterus rhombeus* | 3.0 |
| Haemulidae | *Haemulon sp* | 0.2 |
| Lutjanidae | *Lutjanus sp* | 6.3 |
| Pomatomidae | *Pomatomus saltator* | 0.08 |
| Sciaenidae | *Cynoscion sp*<br>*Ophioscion sp* | 36.8<br>37.0 |
| Scombridae | *Scomberomorus brasiliensis* | 0.2 |
| Source: Logbook returns for Type IV vessels (November 1991 - April 1992). | | |

# VI. SURVEYS ON SHRIMP AND RELATED RESOURCES

## VI.A. PAST SURVEYS

A number of trawl surveys have been implemented in the coastal waters of Trinidad and Tobago since 1944. The surveys resulted from a variety of objectives- exploratory fishing, gear trials, simulated production fishing and formal systematic sampling. During these surveys, a variety of trawl designs (with variations in gear rigging) were utilised. The fishing power of vessels varied significantly. These surveys are listed in Table 14, with the relevant references.

**Table 14**: Past trawl surveys in the area of Trinidad and Tobago (1944 - 1988).

| SURVEY YEAR | VESSEL | REFERENCE |
|---|---|---|
| 1944 | No. 305 | Whiteleather & Brown (1945) |
| 1951 | Assault | Richards (1958) |
| 1956-57 | Bonny Ethel | Salmon (1958) |
| 1962-64 | Nereid | Cervigon (1965) |
| 1963 | Obraztsovo | Salnikov (1969) |
| 1963 | SRTR-9075 | Alvarez Perez (1969) |
| 1981 | MV Provider | Manickchand-Heileman & Julien-Flus (1990) |
| 1988 | R/V Dr. Fridtjof Nansen | Inst. Marine Research (1989) |

From 1957-1976, the United States (Bureau of Commercial Fisheries and National Marine Fisheries Service) research vessels OREGON and OREGON II also made a number of monitoring surveys in North-east South America, from Trinidad and Tobago to Brazil. These are listed in Table 15.

**Table 15**: Summary of Oregon I and Oregon II cruises (1957 - 1977).

| NUMBER | CRUISE PERIOD | SURVEY AREA | | | | | SHRIMP | | FINFISH |
|---|---|---|---|---|---|---|---|---|---|
| | | Trinidad/ Venezuela | Guyana | Suriname | French Guiana | North Brazil | Exploratory | Production | Exploratory |
| OREGON | | | | | | | | | |
| 47 | 3 November - 19 November (1957) | X | X | X | X | X | O | | |
| 53 | 26 August - 25 September (1958) | X | X | X | X | | O | | |
| 84 | 18 February - 25 March (1963) | X | X | X | X | | O | | O |
| 87 | 17 September - 4 November (1963) | X | | | | | O | | |
| 94 | 24 August - 8 October (1964) | X | | | | | O | | |
| 107 | 15 February - 1 April (1966) | X | | | | | O | | |
| OREGON II | | | | | | | | | |
| 8 | 25 April - 17 March (1969) | X | X | X | X | | O | O[1] | O |
| 13 | 15 November - 27 November (1969) | | | | X | | O | O[1] | |
| 38 | 21 June - 4 July (1972) | | X | X | X | | O | | |
| 49 | 26 June - 13 February (1974) | | X | X | X | | O | O[1] | |
| 58 | 5 May - 18 May (1975) | | | | X | X | O | | |
| 66 | 15 May - 28 May (1976) | X | X | X | X | X | O | O | |
| 84 | 14 November - 2 December (1977) | | X | X | X | X | O | | O |

[1] Continental slope surveyed.

## VI.B. PRESENT AND PLANNED SURVEYS

No trawl surveys are being undertaken at present. There are, however, plans for the introduction of an Observer Programme to validate Logbook returns, and from 1993, monitoring trawl surveys with the MV PROVIDER (79 ft. training/research vessel of the Ministry of Agriculture, Land and Marine Resources) which will be re-fitted with stern trawling gear. Trinidad and Tobago will also be head-quarters for the Resource Assessment Unit of the trawl fishery component of the regional CFRAMP Programme (CARICOM Fisheries Resource Assessment and Management Programme). This is sponsored by the CARICOM countries and CIDA (Canadian International Development Agency) and is an eight (8) year programme. The trawl fishery component will be for three and a half (3.5) years. The Fisheries Division has also submitted for consideration a technical co-operation project entitled "Bio-Economic Modelling, Resource Survey and Management Plan Formulation", to be implemented through the UNDP/FAO. Economic aspects of the trawl fishery will be developed during this project.

# VII. MANAGEMENT

The Government's declared objectives are full utilisation of the resource consistent with adequate conservation and minimal conflict between the artisanal and non-artisanal components of the fishery. For the vessels operating in the waters under national jurisdiction, these objectives have been translated into actions to prevent increase in the number of trawlers, a definition of the areas in which the trawlers may operate, and the specification of minimum cod-end and mesh sizes. The actions were proposed for a two year period, to be followed by a re-evaluation. For vessels that operate in the coastal waters of the Orinoco Delta under the Trinidad and Tobago/Venezuela Fishing Agreement, there are additional limitations to operations.

A draft management plan for the shrimp trawl fishery has been developed. It includes a number of provisions to administer the fishery, for licensing, and for participation of the industry in management. The plan will be submitted for discussion, amendment and introduction. The government will involve the Food and Agriculture Organization of the United Nations (FAO) in this exercise and in the development of an appropriate legal basis.

## VII.A. LICENSING POLICY

There is a system of registration of all commercial fishing vessels, renewable every two (2) years. For trawlers, Government has further mandated that no additional vessels be registered i.e. that the existing fleet fishing power/size be maintained as a maximum. There is, however, no formal system of licensing for the national vessels that operate in the waters under the jurisdiction of Trinidad and Tobago. In the coastal waters of the Orinoco Delta (Venezuela), under the terms of the bilateral Fishing Agreement, the Government of Venezuela grants licenses to the Trinidad and Tobago (Type I) vessels, based on a recommended list of applicants. These licenses are granted annually for each fishing season.

## VII.B. REGULATIONS

Regulations exist for the control of trawling in waters under the jurisdiction of Trinidad and Tobago. These relate to Depth and Areal Restrictions, and Mesh Regulations. These Regulations entitled "Fisheries Control of Demersal (Bottom) Trawling Activities) Regulations, 1991" were adopted under the Fisheries Act, (Chapter 67:51).

These regulations specify the following in relation to where trawling may be permitted:

(a) within territorial waters outside two (2) nautical miles off each of the north and south coasts of Trinidad.

(b) within the Gulf of Paria
- outside the one (1) fathom depth contour for the artisanal (ie. Type I and Type II trawlers)
- outside the four (4) fathom contour for the non-artisanal trawlers of 180 horsepower of less (ie. Type III trawlers) and,
- outside the eight (8) fathom contour for the non-artisanal trawlers of greater than 180 horse power (ie. Type IV trawlers).

No demersal trawling is permitted off the East Coast of Trinidad, nor twelve (12) nautical miles off Tobago.

The Regulations are to remain in force until mid-1993, unless extended by the Minister for a further period not exceeding more than two (2) years.

The Regulations also specify the minimum mesh sizes permitted in the cod-ends of the trawl nets. Stretched mesh sizes must not be less than 7.5 cm (3 in) when trawling for fish, or 3.5 cm (1.5 in) when trawling for shrimp.

When chafing gear is used, it is required that it be of netting material of stretched mesh size not smaller than specified for cod-ends. The chafing gear must also cover no more than twenty-five (25) percent of the cod-end.

Under the terms of the Trinidad and Tobago/Venezuela Fishing Agreement, a maximum of seventy (70) Type I trawlers are permitted to fish in the coastal waters of the Orinoco Delta. Under this agreement, it is specified that the vessels be constructed of wood or fibreglass, not exceeding twelve (12) metres in length, and have engines whose combined horsepower is not greater than 110 HP. No outboard engine may exceed 60 HP. The fishing period is confined to December 1st to June 30th.

The maximum storage capacity of the vessels is specified as 500 kg (net). The trawl nets must be of the artisanal type, with the headrope lengths not exceeding fifteen (15) meters, and have a cod-end minimum mesh size 1.75 centimetres (between knots). Only one (1) net may be used at any time. The maximum crew size is four (4) persons including the skipper.

Resulting from the requirement to export shrimp to the USA, the 1990 enactment by the US Congress (at the request of the United States shrimping industry), the adoption of Turtle Excluder Devices (TEDS) was accepted by the Trinidad and Tobago Government. As a result all Type III and Type IV trawlers will be required to use TEDS on a permanent basis.

## VII.C. ENFORCEMENT

The responsibility for enforcement of national vessels in waters under the jurisdiction of Trinidad and Tobago lies with the Trinidad and Tobago Coast Guard. There is also an Environmental Lobby within the country, growing in importance, that monitors the operations of commercial fisheries, particularly trawling. Reports of alleged contraventions are reported to the Fisheries Division, the Coast Guard, and frequently to the media. In the coastal waters of the Orinoco Delta, the Venezuelan National Guard is the main enforcement agent. Contraventions are mainly for trawling in the areas not legally designated.

## VII.D. REVISION OF FISHERIES LEGISLATION

Trinidad and Tobago is presently undertaking a review and revision of the legal statutes relating to the fishing industry, particularly aspects of legislation that pertain to fisheries management, data collection, licensing and registration. The objective is also to consolidate existing legislation to facilitate administration, management and enforcement.

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# NATIONAL REPORT OF GUYANA

by
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## I. GENERAL BACKGROUND INFORMATION

Guyana, bordered by the Atlantic Ocean on the north, Suriname to the east, Brazil to the south and Venezuela to the west, is the only English speaking country in South America. Its total area is 215,000 square kilometres and with a population of approximately 754,844 has one of the lowest population densities (3 - 7 persons per square kilometre) in the world.

Physically, Guyana is divided into four natural regions:

1. The Low Coastal Plain
2. The Hilly Sand & Clay Belt
3. The Highland Region
4. The Interior Savannahs.

Most of the population live and work on the coastal plains. Guyana has an equatorial climate, the main features of which are high but variable rainfall, high humidity and relatively narrow variation in temperature.

It has an extensive system of rivers and creeks, most of which have sources in the great mountain ranges of the south and west then flow north easterly to the Atlantic Ocean meandering through virgin forests.

Administratively, Guyana is divided into ten (10) Regions (see fig. 1). Guyana declared a 200 mile EEZ on 91-02-23 but a Fishery Zone of 200 miles was in existence since 1977.

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[1] Fisheries Division, Ministry of Agriculture

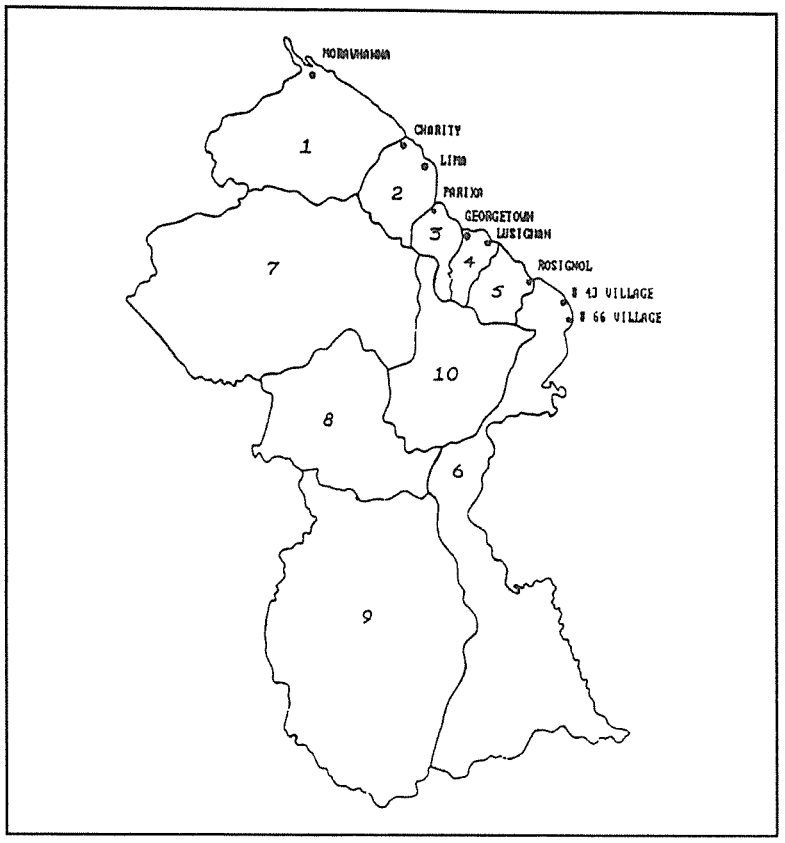


**Figure 1**: Administrative regions of Guyana.

## II. DESCRIPTION OF THE SHRIMP INDUSTRY

Shrimp is caught by both the industrial/trawl and artisanal fleet with the industrial/trawl fleet catching mainly *Penaeus species* (Prawns) and *Xiphopenaeus kroyeri* (seabob) and the artisanal fleet catching *Palaemon schmitti* (white belly) and *Xiphopenaeus kroyeri.*

### II.A. FISHING ACTIVITIES - INDUSTRIAL/TRAWL FLEET

#### 1. Fishing zones

Trawlers catching prawns operate in areas ranging from 40 to 145 kilometres from the shorelines over the continental shelf with depth ranging from 18 to 91 meters. During the year 1991 the vessels would appear to operate mainly in zones 1-6 in January ; 2-6 in February; 3-8 in March ; 4-8 in April ; 1-7 in May ; 1-8 in June, July and August ; 2-6 in September to November ; and 3-8 in December (fig. 2). This situation differs to that of the early 80's when trawling activities were more concentrated in the south eastern and central zones (5-9).

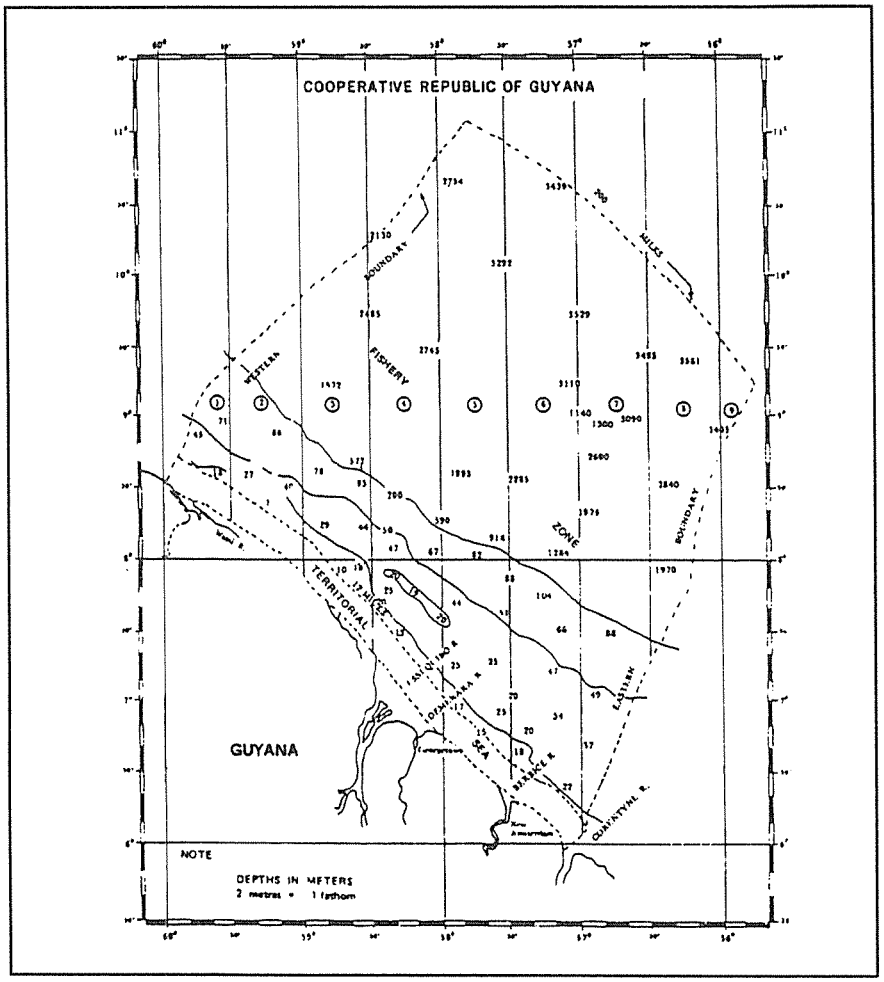


**Figure 2**: Fishing zones of the trawl fleet.

Trawlers catching seabobs operate in areas ranging from 15 to 30 kilometres from the shore over the continental shelf - with depths ranging from 13 to 18 meters. The bottom areas tend to be mud, gravel or sand with about the same for prawns. During the year the vessels would appear to operate mainly in zones 4 to 6 with zone 4 being fished in January, February, May, June, July, August and November. Zone 5 being fished in February and March and zone 6 in April. There is very little fishing in September, October and December.

## 2. Fleet

At the end of 1991 the industrial shrimp fisheries (prawns and seabob) was made up of 115 trawlers owned by some 25 companies, two of which were foreign [Georgetown Seafoods and Trading Company Limited (American), and Nisshin Suisan KK (Japanese)], four shrimp/fish processing plants [Georgetown Seafoods and Trading Company Limited, Marine Food Products Limited (local/foreign joint venture company), BEV Enterprise (local private) and Noble House Seafoods (local private)], and numerous wharves and dry docking facilities. Ice and freezing facilities servicing these fisheries were owned and operated by participants within and outside the fisheries.

Table 1 provides information on the trawl fleet development from 1986 to 1991. The foreign fleet caught mainly prawns during the period while the local fleet caught mainly seabob (and finfish) with a limited number catching prawns. For example, in 1991 only 8 local trawlers were catching prawns directly.

**Table 1**: Information on trawlers.

| YEAR | NUMBER OF FOREIGN TRAWLERS | | NUMBER OF LOCAL TRAWLERS | TOTAL NUMBER OF TRAWLERS |
|---|---|---|---|---|
| | AMERICAN FLAG | JAPANESE FLAG | | |
| 1986 | 61 | 12 | 55 | 128 |
| 1987 | 61 | 12 | 56 | 129 |
| 1988 | 61 | 12 | 46 | 119 |
| 1989 | 61 | 9 | 48 | 118 |
| 1990 | 61 | 9 | 52 | 122 |
| 1991 | 61 | 6 | 48 | 115 |
| N.B.: Information relates to trawlers taking part in the prawns and seabob/fin-fishing operations. | | | | |

The trawlers catching prawns and seabobs measure about 21 meters in length and use double outrigger shrimp trawlnets (Tampa, Florida model). The American fleet tows four rather than two nets at a time (twin trawling). The prawns and seabob trawl nets are basically the same with 4 - 5 cm stretched mesh in the wings and 2.5 - 3.5 cm. stretched mesh in the cod end.

Of the four processing companies, the American and Joint venture companies machine process prawns as graded tails while the other two local companies machine process seabob and white belly into peeled product and hand process prawns as graded tails.

## 3. Fishing strategies

A local prawns trawler averages 8 trips per year with each trip averaging 30 days. It makes about 3 hauls per day with each haul lasting about 4 hours.

An American trawler averages 8 trips per year with each trip lasting about 36 days, while a Japanese trawler averages 6 trips per year with each trip lasting about 42 days. Both types make about 3 - 4 hauls per day with each haul lasting about 4 - 6 hours. The Japanese supposedly shrimp the greatest distance from the shore.

Most prawns catching is done at night while dragging for seabob is done mainly during the day.

## 4. Discards

No prawns are discarded at sea. The same goes for seabob. All prawns vessels are required to land 15 mt of by-catch each year. Species such as banga mary, butter fish, seatrout, croaker dominate the landing and only the medium to larger sizes of these species are brought in.

Table 2 shows fish landed by the industrial trawlers for the period 1986 to 1991.

**Table 2**: Fin-fish production (MT).

| DESCRIPTION | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|---|
| By-Catch resulting from Prawns Operation | 2720 | 2736 | 2545 | 1178 | 817 | 1546 |
| By-Catch resulting from Seabob Operation | 1943 | 1314 | 1189 | 444 | 514 | 716 |
| Catch resulting from Straight Fishing Operation | | | | 863 | 753 | 465 |
| TOTAL | 4663 | 4050 | 3734 | 2485 | 2084 | 2727 |
| N.B.: Prior to 1989 fin-fish resulting from the seabob operation and the straight fishing operation was not separated hence separate figures could not be given for these types of operation for the period 1986-88. | | | | | | |

## 5. Artisanal fishery

In the artisanal fishery, the chinese seine is the fishing gear used for catching whitebelly and seabob in addition to fish. Chinese seines (fyke nets) are funnel shaped nets 16 m long and 4 -6 m wide at the mouth and, their mesh seize gradually tapers from the mouth end (8cm) toward the bag end (1 cm or less). The net is attached to poles and set on round barks along the coast, in rivers and particularly in river mouths. Shrimp and fish are swept into the bag of the net by the tidal currents. Each vessel which range in length from 6 - 8 m, operates between 3 to 10 nets.

Table 3 shows the development of the chinese seine fleet from 1986 to 1991.

**Table 3**: Seabob and whitebelly production (MT).

| ITEM | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|---|
| Seabob - (Industrial) | 884 | 773 | 1566 | 1831 | 1864 | 2746 |
| Seabob and Whitebelly - (Artisanal)<br>(No. of Chinese Seine Vessels) | 1612<br>(412) | 1560<br>(398) | 1591<br>(406) | 1623<br>(414) | 1646<br>(422) | 1728<br>(443) |
| Seabob and Whitebelly - Total (Whole Wt.) | 2496 | 2333 | 3157 | 3454 | 3510 | 4474 |

## 6. Brackish water shrimp culture

Brackish water culture in Guyana is an extensive culture operation whereby shrimp and fish eggs, larvae and fry are let into empoldered areas along the coastlines, mainly in the Berbice area and allowed to grow out.

At the end of 1991 there were 135 farms in operation with an estimated 1641 acres under cultivation. Through a mixed culture it is estimated that about 500 lbs (227 kg) of shrimp per acre per year is harvested.

Table 4 shows the development of this mixed culture activity over the period 1986 to 1991 in terms of number of farms, acres and shrimp production.

**Table 4**: Shrimp culture.

| ITEM | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|---|
| Number of Farms | 16 | 20 | 50 | 85 | 125 | 135 |
| Total Acreage | 592 | 671 | 810 | 950 | 1021 | 1641 |
| Shrimp Production (Mt) | 134 | 152 | 184 | 216 | 232 | 372 |
| N.B. Shrimp is done within a mixed culture system. Yields average approximately 500 lbs/acre/year. Some 300 lbs of fish/acre/year is harvested from this same operation. | | | | | | |

## II.B. PROCESSING ACTIVITIES

### 1. Industrial shrimp processing

In 1991 the American owned company (GS & TC) processed prawns from its own fleet of 61 vessels while MFPL processed from the 6 Japanese vessels and the local 8 prawns vessels. The 40 local seabob vessels processed their catch at BEV Enterprises (30 vessels) and Noble House Seafoods (10 vessels). The prawns landed as by-catch by these vessels were processed at the said plants. MFPL and GS & TC each has one (1) shrimp grading line while BEV Enterprises and Noble House Seafoods each has two (2) peelers.

BEV Enterprises owned no vessels but purchased fish and shrimp from the local private operators. They assisted the operators by providing spares and other inputs at reasonable prices.

Noble House Seafoods owned 6 of the 10 vessels landing at its plant and operated the other 4 under management contract.

Tables 3 and 4 give data on prawns (main catch and by-catch) production and seabob and whitebelly production (industrial and artisanal) for 1986 to 1991. Total prawns production has decreased by 19% since 1986 while seabob and whitebelly production has increased by 79%.

In most recent cases the prawns were landed as tails and graded by size categories at the plants. Some of the Japanese production was processed as heads-on at sea. In 1991, heads-on represented 0.13% of the total national (Local and foreign) production. Seabobs were landed whole and were then peeled at the plants.

### 2. Processing of the artisanal catch and aquaculture harvesting

In 1991 approximately 50% of the artisanal catches of seabob and whitebelly was processed into dried shrimp by the cottage industry, 5% was processed into peeled shrimp by the processing plants and the remainder sold in fresh form.

The shrimp from the brackish water farms were sold fresh and unprocessed.

## II.C. MARKETING ACTIVITIES

### 1. Local market

Shrimp landed by the artisanal chinese seines were either processed into dried shrimps, sold fresh to consumers or sold to the processing plants.

The dried shrimp was either sold locally or exported while the fresh shrimp sold to the plants was peeled and vastly exported.

Cultured shrimp were sold locally in the fresh state.

### 2. Export market

In 1991, 1921 mt of prawns (tails) were exported compared to 1055 mt of peeled seabob and whitebelly. Most of the prawns and peeled shrimp were exported to the USA, Japan and CARICOM countries.

Eighteen (18) tonnes of dried shrimp were exported to Holland and CARICOM countries.

Table 5 shows the total exports and estimated values for shrimp, fish and fish products from 1987 to 1991.

**Table 5**: Export information (period 1987 - 1991).

| ITEMS | 1987 | | 1988 | | 1989 | | 1990 | | 1991 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | VOLUME (MT) | VALUE (US$) | VOLUME (MT) | VALUE (US$) | VOLUME (MT) | VALUE (US$) | VOLUME (MT) | VALUE (US$) | VOLUME (MT) | VALUE (US$) |
| Prawns (frozen) | 2,286.23 | 25,194,272 | 1,928.87 | 21,256,147 | 1,891.98 | 20,849,620 | 1,664.59 | 13,055,720 | 1,921.67 | 13,976,723 |
| Seabob and Whitebelly (frozen/processed) | 292.06 | 1,391,293 | 620.86 | 2,052,563 | 716.30 | 2,368,088 | 661.70 | 1,869,860 | 1,054.94 | 2,906,360 |
| Seabob and Whitebelly (Dried) | n.a. | n.a. | 14.25 | 59,143 | 2.96 | 8,338 | 7.50 | 42,487 | 18.26 | 73,474 |
| Fin-fish (frozen) | 765.90 | 1,678,845 | 726.95 | 1,602,1970 | 930.65 | 2,051,153 | 1,320.01 | 2,909,302 | 1,978.97 | 4,361,650 |
| Salted Fish | n.a. | n.a. | 10.00 | 18,873 | 5.94 | 9,332 | 137.77 | 323,537 | 336.72 | 523,786 |
| Smoked Fish | n.a. | n.a. | 0.05 | 100 | - | - | 45.16 | 96,620 | 31.19 | 48,972 |
| Frozen Crab meat | n.a. | n.a. | 0.77 | 3,273 | 4.15 | 6,435 | 1.94 | 10,857 | 10.42 | 25,003 |
| Shark Fins | n.a. | n.a. | 0.82 | 4,094 | 2,365 | 24,350 | 7.75 | 135,674 | 13.17 | 181,455 |
| Fish Glue | n.a. | n.a. | 0.095 | 635 | 4.00 | 22,120 | 10.28 | 116,930 | 6.89 | 40,662 |

n.a. = not available.

# III. RESULTS OF THE EXPLOITATION

Table 1 provides data on number of vessels (foreign and local) operated each year from 1986 to 1991. In 1991, an average 54 foreign (49 American and 5 Japanese) trawlers caught prawns per month while 5 local trawlers caught prawns per month. The range for foreign vessels was from 34 (29 American and 6 Japanese) to 61 (57 American and 4 Japanese) per month.

Of the local seabob trawlers an average of 21 operated each month. The range being from 18 to 23 vessels per month.

## III.A. CATCH/LANDING

Table 6 provides data on the number of landings for prawns trawlers per year for the period 1986 to 1991. The number of landings are given in terms of local and foreign (American and Japanese Flags). Table 7 provides the annual production, during the period 1986-91.

**Table 6**: Number of landings of prawns trawlers.

| YEAR | NUMBER OF FOREIGN LANDINGS | | NUMBER OF LOCAL LANDINGS | TOTAL NUMBER OF LANDINGS |
|---|---|---|---|---|
| | AMERICAN FLAGS | JAPANESE FLAGS | | |
| 1986 | 469 | 74 | 164 | 707 |
| 1987 | 496 | 87 | 164 | 747 |
| 1988 | 466 | 59 | 181 | 706 |
| 1989 | 441 | 55 | 147 | 643 |
| 1990 | 302 | 71 | 97 | 470 |
| 1991 | 533 | 58 | 23 | 614 |

**Table 7**: Annual prawns production.

| ITEM | 1986 | 1987 | 1988 | 1989 | 1990 | 191 |
|---|---|---|---|---|---|---|
| Main Catch (Tails) | | | | | | |
| (lbs) | 5245247.7 | 5298509.5 | 4126446.7 | 3988358.4 | 3396842.2 | 411637 |
| (mt) | 2379.88 | 2404.04 | 1872.25 | 1809.60 | 1541.22 | 1867 |
| By-Catch (Tails) | | | | | | |
| (lbs) | - | - | - | - | 51822.8 | 11157.8 |
| (mt) | - | - | - | - | 23.51 | 50.6 |
| Total Catch (Tails) | | | | | | |
| (lbs) | 5245247.7 | 5298509.5 | 4126446.7 | 3988358.4 | 3448665.0 | 422795 |
| (mt) | 2379.88 | 2404.04 | 1872.25 | 1809.60 | 1564.73 | 1918 |

## III.B. CATCH PER UNIT OF EFFORT

Data collected provides the number of vessels operated and the production by flag for prawns and seabob for each month, quarter and year.

In 1988, 1989, 1990 and 1991 an American prawns trawlers landed an estimated 31 mt per year for 1988, 1989 and 1991 with 29 mt being landed in 1990.

For the years 1988, 1990 and 1991 a Japanese prawn trawler averaged 33 mt, 37 mt, 49 mt and 42 mt per year respectively.

In 1988, 1989, 1990 and 1991 a local prawns trawler landed an estimated 16 mt, 10 mt, 10 mt and 9 mt per year respectively.

Table 8 shows the quarterly production levels by Flag Vessels.

**Table 8**: Quarterly production level.

| | 1988 | | | | 1989 | | | | 1990 | | | | 1991 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | QUARTERS | | | | QUARTERS | | | | QUARTERS | | | | QUARTERS | | | |
| FLAG VESSELS | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 |
| American | H | H | L | H | H | H | L | H | H | H | L | L | L | H | H | H |
| Japanese | H | H | L | H | H | L | L | H | H | L | L | H | H | L | H | H |
| Local | H | L | L | H | H | L | L | H | H | H | L | H | L | H | H | L |
| N.B. H = High ; L = Low. | | | | | | | | | | | | | | | | |

For the years 1988, 1989, 1990 and 1991 a seabob trawler averaged 104 MT, 128 MT, 101 MT and 125 MT per year respectively.

## III.C. ARTISANAL FISHERY

It is estimated that a chinese seine vessel lands approximately 4 MT of shrimp per year.

# IV. THE EXPLOITED RESOURCES

The landings by size categories by month are available, split into national and foreign fleets.

# V. ECONOMIC ASPECTS

The Fisheries Department, Agriculture Planning Unit and the State Planning Secretariat in the first and second quarter of 1992 designed a format to collect economic data from the shrimping industry in response to calls from the industry that it was facing serious financial problems due to falling prices for shrimp exports and increasing costs of production.

The Cost of Production Survey was designed to obtain economic data that would have enabled an objective analysis of the situation as well as facilitate the establishment of an economic data base on the shrimping industry (prawns and seabob). The format is provided in Appendix 1.

The forms were passed to the shrimp/fish processing plants and a sample of the trawler operators. Their submissions are being awaited.

## VI. SURVEYS ON SHRIMP AND RELATED RESOURCES

Guyana in the past participated in the Oregon II Cruises of 1975, 1976 and 1977. Also, we participated in the WECAFC Shrimp tagging Survey of 1982-3.

From 1976 to 1978, Guyana was involved in the "Biological sampling of the landings of the Guianas Shrimp Fisheries" project funded by the NMFS (Dragovich and Tashiro, 1979).

In 1981-83, a study on "The Shrimp and Fish Resources of the Cooperative Republic of Guyana" was done by Aquatic Biological Consultancy Services Limited.

Guyana hopes to be part of the shrimp tagging programme proposed and accepted at the WECAFC Meeting in St. Vincent in 1990, and will be participating in the CFRAMP group to assess the shrimp and other demersal resources in the CARICOM region. It is hoped that some of the initiatives taken at these meetings can be developed within the context of or provide guidelines for the CFRAMP workshop group.

## VII. MANAGEMENT

Looking at penaeid shrimp production over the year it is observed that from 1978, with the exception of slight fluctuation in 1979 and 1982, production has been declining at a significant rate. This reduced level of catches followed a period when the size of the fleet fishing on the Guianas Banks numbered over 700 vessels and in the view of most fishery scientists, represented excessive fishing effort for this fishery.

Reduced landings also followed the era when all the countries established Fishery Zones or Exclusive Economic Zones thus ending the practice of vessels moving along with the high concentration of shrimp off the coast of the countries.

It should be noted that all analysis is based on the official landings statistics and that there is no consideration of over the side sales at sea which could be at the level of 20 to 30% of landings.

In its efforts to stem the decline in catches and bring about some stability in shrimp production Guyana from the mid-eighties sought to manage the resources by the following methods:

(i) Gradually reduce the prawn fleet to 100 vessels;

(ii) License trawlers in keeping with their fishing activity (prawns, seabob/finfish, fin fish);

(iii) Implement an annual closed season from November of one year to January of the other;

(iv) Protect the nursery areas by restricting fishing vessels from operating 18 fathoms and shorewards.

In addition to management initiatives directed at the industrial/trawl fishery to conserve the shrimp resources, attention was also directed at the use of the chinese seines which destroy large quantities of juvenile fish and crustaceans.

Of the four initiatives to manage the shrimp resources only (i) and (ii) have been accepted by the policy makers. As such prawns catching trawlers are now below the 100 limit. Trawlers are now classified in terms of prawns, seabob/fin fish and fin fish with the seabob/fin fish level being set at 34 vessels. However, vessels do not always adhere to their classifications due to the seasonality of shrimping/fishing activities and the fact that they all use basically the same type of vessel and trawl gear.

In the case of the application of a closed season it was felt that enough information was not available to justify the period selected. Also, the enforcement of such mechanism was felt to be beyond the existing capacity of the Coast Guard.

In the case of restricting the area of operation of the trawlers to protect the nursery grounds, this is still being debated with the industry. There is a situation where trawlers that have been taken out of catching prawns and are now catching seabob and/or fin fish which required them to fish closer in shore.

In the case of the chinese seine, the initiative to regulate their use may become a socio-economic issue as large numbers of artisanal fishermen all along the coast use the chinese seine. One idea may be to keep this operation at present level by means of more rigid licensing requirements and diversion of credit opportunities to other gear types.

NATIONAL REPORT OF SURINAME

by
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# I. PRESENT SITUATION OF THE SHRIMP INDUSTRY

## I.A. FISHING ACTIVITIES

### 1. The fishing grounds

Suriname has proclaimed a 200-miles Exclusive Economic Zone (EEZ) in 1978. Shrimp is exploited over the entire zone in the depth range from about 20 to 90 meters. The fishermen recognize the following main fishing grounds (see figure 1):

- the "Western grounds", between 40 and 90 meters in the western part of the EEZ;
- the "Middle grounds", between 25 and 40 meters off the central part of Suriname;
- the "Puw patch", between 30 and 80 meters in the eastern part of the EEZ.

Depth is very important for the distribution of shrimp, and a distinction is usually made between "deep fishing grounds" (more than 50 meters depth) and "shallow fishing grounds" (less than 50 meters depth). The EEZ is divided in six longitudinal zones, each corresponding to 30' longitude, as shown in figure 1. The areas by depth and longitudinal zone have been estimated, based on the marine charts.

**Table 1**: Area of fishing grounds by depth and longitudinal zones (km$^2$).

| | I | II | III | IV | V | VI | TOTAL |
|---|---|---|---|---|---|---|---|
| LONGITUDE (W) | 56.30-57.00 | 56.00-56.30 | 55.30-56.00 | 55.00-55.30 | 54.30-55.00 | 54.00-54.30 | |
| DEPTH ZONE (m) | | | | | | | |
| 10-20 | 494 | 487 | 355 | 626 | 610 | 943 | 3,515 |
| 20-30 | 2,264 | 2,125 | 1,761 | 1,190 | 749 | 2,186 | 10,275 |
| 30-40 | 2,349 | 2,372 | 1,452 | 1,236 | 1,159 | 1,754 | 10,322 |
| 40-50 | 494 | 881 | 1,360 | 1,553 | 1,337 | 2,240 | 7,865 |
| 50-60 | 695 | 888 | 641 | 904 | 966 | 943 | 5,037 |
| 60-70 | 286 | 394 | 448 | 487 | 633 | 1,190 | 3,438 |
| 70-80 | 433 | 533 | 402 | 417 | 533 | 711 | 3,029 |
| 80-90 | 309 | 564 | 657 | 572 | 657 | 1939 | 4,698 |
| 90-100 | 85 | 216 | 193 | 247 | 425 | 502 | 1,668 |

[1] Fisheries Department, Ministry of Agriculture, Livestock and Fisheries.

Bottom is muddy in the shallower parts and sandy in the deeper grounds. Area by type of bottom has not been estimated.

According to fishermen, the deeper grounds are exploited at night, shallower grounds are generally fished by day. Fishing in shallow waters is more intensive in the second half of the year, with a maximum in July-August, and there is more fishing in deep water in the first half, with a maximum in February-March.

## 2. The fleet

The shrimp trawler fleet was owned, in 1991, by 23 fishing companies, listed in the following table. The fleet can be divided into:

- a Japanese fleet: 2 companies operating under Japanese flag;
- a Korean fleet: hoist a number of different flags;
- a Surinamese fleet: the SUGAM. Most boats belonging to this company are either rented, operated and/or manned by Korean companies, so that the strategy of this fleet is comparable to the Korean fleet.

**Table 2**: List of fishing companies and average characteristics of the vessels in 1991.

| | # BOATS | AVERAGE HP | AVERAGE LENGTH (m) | FLAG | # NETS |
|---|---|---|---|---|---|
| Landing at SAIL | | | | | |
| Dong hee | 8 | 425 | 20.88 | Korea | 4 |
| Marine Enterprises | 7 | 425 | 20.79 | " | 4 |
| Seoyang | 7 | 365 | 20.42 | " | 4 |
| Woojin | 6 | 385 | 20.59 | " | 4 |
| Young Jin | 5 | 365 | 20.65 | " | 4 |
| Bogo Fisheries | 2 | 425 | 20.36 | " | 4 |
| Jin Min | 3 | 385 | 20.03 | Vanuatu | 4 |
| Atlantic Star | 1 | 365 | 19.63 | " | 4 |
| Atlanta Shrimp Company | 1 | 365 | 19.65 | " | 4 |
| Kaya Fisheries | 3 | 375 | 20.55 | Korea | 4 |
| Mona Fisheries | 4 | 395 | 20.25 | " | 4 |
| Sung Ha Fisheries | 5 | 365 | 19.63 | Panama | 4 |
| Se Won | 3 | 425 | 20.42 | Korea | 4 |
| Sae Woo | 4 | 375 | 20.42 | " | 4 |
| Sugam | 17 | 418 | 19.21 | Suriname | 4 & 2 |
| Silla Trading | 11 | 425 | 20.88 | Korea | 4 |
| Landing at SUJAFI | | | | | |
| Hakodate Kokai | 16 | 383 | 19.79 | Japan | 4 |
| Nisshin Maru | 18 | 474 | 21.95 | Japan | 4 |
| Dong Jo | 3 | 365 | 20.85 | Korea | 4 |
| June enterprise | 6 | 425 | 19.92 | Vanuatu | 4 |
| Dong Nam | 2 | 425 | 20.87 | Korea | 4 |
| Estemar | 1 | 425 | 19.96 | Honduras | 4 |
| WooRi | 6 | 276 | 20.07 | Honduras & Japan | 4 |
| Other landing places | | | | | |
| Caribbean Seafoods | 1 | 1,250 | 34.98 | Curaçao | |
| Sadhoe | 1 | 430 | 21.90 | Spain | |
| Weibolt | 1 | 330 | 21.88 | Suriname | |
| Jahafish | 1 | 425 | 22.86 | U.S.A. | |

All companies use the same type of boat, the traditional double-rigged "Florida" or "Gulf of Mexico" trawler type. Differences exist in the gear (number of nets), the engine power, the age of the fleets. A study of their respective fishing power has not been carried out yet.

The number of trawlers with a fishing license, over the last 5 years, is shown in table 3, for each company.

**Table 3**: Number of registered trawlers (shrimp, fin-fish) by year.

| | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|
| Shrimp trawlers landing at SAIL | | | | | |
| Seoyang | 8 | 8 | 7 | 7 | 7 |
| Seu Fisheries | 10 | 10 | 7 | - | - |
| Woo Jin | 7 | 7 | 7 | 7 | 7 |
| Atlanta Shrimp Company | 1 | 1 | 1 | 1 | 1 |
| Atlantic Star | 1 | 1 | 1 | 1 | 1 |
| Shindong Fisheries | 3 | 3 | 3 | - | - |
| Jin Min | 3 | 3 | 3 | 3 | 3 |
| Marine Enterprises | 10 | 7 | 7 | 7 | 7 |
| Jinam | 9 | 7 | 7 | 5 | - |
| Silla Trading | 20 | 20 | 20 | 10 | 11 |
| Sugam | 14 | 13 | - | 14 | 14 |
| Weibolt | 2 | 2 | 2 | 2 | 2 |
| Young Jin | - | 5 | 5 | 5 | 5 |
| Kosac | - | 3 | 3 | - | - |
| Mona Fisheries | - | 2 | 2 | 4 | 4 |
| Kaya Fisheries | - | - | 3 | 3 | 3 |
| Dong Hee | - | - | - | 8 | 8 |
| Sae Woo | - | - | - | 7 | 4 |
| Bogo Fisheries | - | - | - | 3 | 2 |
| Sung Ha Fisheries | - | - | - | - | 5 |
| Se Won | - | - | - | - | 3 |
| Total | 88 | 92 | 78 | 87 | 87 |
| Shrimp trawlers landing at SUJAFI | | | | | |
| Nisshin Gyogyo | 23 | 23 | 20 | 20 | 18 |
| Hakodate Kokai | 13 | 13 | 13 | 15 | 16 |
| Dong Jo | 5 | 5 | 5 | 3 | 3 |
| June | 6 | 6 | 6 | 6 | 6 |
| Dong Nam | 2 | 2 | 2 | 2 | 2 |
| Estemar | - | - | 4 | 4 | 1 |
| WooRi | - | - | - | 3 | 6 |
| Total | 49 | 49 | 53 | 53 | 53 |
| Fin-fish trawlers | | | | | |
| Sugam | 1 | 1 | 1 | 2 | 5 |
| ASW | - | 1 | 1 | - | - |
| Weibolt | - | - | 1 | 1 | 1 |
| STIVI | - | - | - | 1 | - |
| Sufico | - | - | 1 | 1 | - |
| Total | 1 | 2 | 4 | 5 | 6 |

## 3. The fishing strategies

The strategies of the two main components of the fleet (Japanese and Korean) are fundamentally different. The Japanese companies specialize in the exploitation of the deeper grounds, targeting the species *Penaeus brasiliensis*. Fishing is almost exclusively done at night. During a particular season, around July-August, these vessels fish day and night, switching between shallower and

deeper grounds. The Korean fleet, as well as the trawlers operating under the Suriname flag, exploit more the shallower fishing grounds. There is a great deal of overlapping between the fishing grounds exploited by both fleets, however.

Trawlers of both fleets carry out long trips of 50 to 100 days. The average was 68 days at sea per trip for the Korean vessels (SAIL, 1991), and somewhat lower for the Japanese vessels. The Japanese vessels make two hauls of 5½ hours in a night. According to Korean fishermen, hauls are shorter during the day (4 hours).

### 4. The discards

Fishermen claim that they are not discarding any shrimp. There are indications, however, that small shrimp is discarded when it forms a large part of the catch. This is a consequence of a policy of the processing industry (SAIL) not to accept landings with more than a given percentage of small shrimp. It is believed that discarded penaeid shrimp, are mainly small *Penaeus subtilis*. Sea-bob is systematically discarded.

It is believed that the largest part of the fish by-catch is generally discarded, except for the larger specimens of a few species. Towards the end of the trip, the boats interested in fin-fish make a few hauls especially for fish The bulk of the fin-fish landed by shrimp trawlers seems to be in fact caught during the last few days of the trip (and is no real by-catch).

### 5. Artisanal fishery

There is no artisanal fishery targeting Penaeus species. Small-scale fishermen use funnel nets, or "fyke-nets" (locally called "fuiknet") in the tidal zones and in estuaries to catch smaller shrimp species (sea-bob and white-belly). In certain seasons their catch includes small amounts of juvenile *Penaeus subtilis*.

Besides this incidental catch, *P. subtilis* is occasionally caught by hand-seines in brackish-water lagoons between May and July, in certain years.

## II.B. PROCESSING ACTIVITIES

### 1. Industrial shrimp processing

Almost the totality of the shrimp caught by trawlers is processed at the two main plants:

S.A.I.L. (Suriname American Industries Limited) has been founded in 1957 with US capital. It was bought up by the Suriname State in 1985.

SUJAFI (Suriname Japanese Fisheries) was created in 1973, and is in hands of Japanese (49%) and Surinamese (51%) private capital.

Their respective share of the shrimp volumes is approximately 60% for SAIL and 40% for SUJAFI. The SAIL is diversifying her operations since 1986 and is currently processing some 1,000 tons a year of fin-fish. Sea-bob is not used by the industry.

**Table 4**: Production by processing plant in 1991.

| | |
|---|---|
| SAIL | |
| Shrimp (head-off weight) | 1,691,050 kgs |
| Fin-fish | 1,092,894 kgs |
| SUJAFI | |
| Shrimp (head-off weight) | |
| Korean fleet | 512,792 kgs |
| Japanese fleet | 624,383 kgs |

Each fishing company is under contract with one of the processing companies and delivers exclusively there. Currently 7 companies, of which 2 Japanese and 5 Korean deliver to SUJAFI, and 16 companies, of which 15 Korean (different flags) and 1 Surinamese are bound by contract to SAIL. The total number of vessels landing at SAIL is 87 and 52 for SUJAFI.

The two processing companies operate in a different way. SAIL buys all the shrimp landed, processes it and markets it for her own account. SUJAFI only sells her services (processing and storage of the head off shrimp, storage only for the head on shrimp). The Japanese fishing companies export under their own brands.

The shrimp delivered at SAIL have been headed on board. The processing on-shore includes thawing, grading (grading machine) into counts/pound commercial categories, and freezing in two kg boxes (in a block of ice). The commercial size categories are shown in table 18. The shrimp, graded by size, is also classified into several quality categories.

Species are generally not sorted. When the catch includes an important proportion of *Penaeus schmitti* is landed, however, this species is packed and marketed separately.

SAIL has been processing a part of her production head-on (for the European Market) in the years 1989 to 1990. The proportion always remained modest (around 50 tons whole weight, annually).

At SUJAFI a distinction needs to be made between the Korean vessels, which deliver the entire production head-off, and the Japanese vessels, which process the major part of the catch on board. Processing of head-off shrimp (totality of the Korean landings and part of the production by Japanese vessels) on shore is similar to this of SAIL, except that small shrimp is classified into different secondary categories (see table 18). Processing on board Japanese vessels includes the grading of shrimp (head-on) manually, and freezing in boxes of 2 kgs (in a block of ice). The product is delivered at Sujafi packed and ready for export. It is stored at Sujafi till the next shipment. The proportion head-on/head-off in the production of the Japanese fleet varies around 70%/30%.

### 2. Processing of the artisanal shrimp catch

The artisanal shrimp production (sea-bob, white-belly) is marketed locally, in fresh or dried condition. No part of it is sold to the processing factories. Juvenile *Penaeus subtilis* caught in the lagoons is sold fresh, and is salted and dried when catch is abundant.

## II.C. MARKETING ACTIVITIES

Both processing companies sell a part of the production locally (table 5). The local sales by SAIL includes mainly lower quality products (classified as "picked out"). Volumes remain relatively modest : 200 to 400 tons a year for SAIL, less than 100 tons for SUJAFI.

**Table 5**: Local shrimp and fin-fish sales by the shrimp processing companies.

| | | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|---|
| SAIL | | | | | | |
| shrimp | amounts (tons) | 304 | 397 | 138 | 261 | 349 |
| | value (1000 Sf) | 8,594 | 7,463 | 5,593 | 16,207 | 15,860 |
| fish | amounts (tons) | - | - | - | 930 | 931 |
| | value (1,000 Sf) | | | | 3,239 | 4,029 |
| SUJAFI | | | | | | |
| shrimp | amounts (tons) | 36 | 70 | 82 | 80 | 130 |
| | value (1,000 Sf) | 1,348 | 2,932 | 4,628 | 4,305 | 7,730 |

The bulk of the shrimp production is exported. Table 6 shows the volumes exported, from each of the processing plants, in the last years. The export values are calculated from price information by category of size and quality, provided by SAIL.

**Table 6**: Shrimp exports.

| | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|
| SAIL | | | | | |
| Amounts (tons, head-off weight) | 2,098 | 1,664 | 1,294 | 1,446 | 1,300 |
| Value (1,000 US$) | 27,905 | 21,696 | 20,585 | 20,198 | 17,604 |
| SUJAFI | | | | | |
| Amounts of : | | | | | |
| Shrimp head-off (tons) | 700 | 483 | 231 | 373 | 397 |
| Shrimp head-on (tons, head-off weight) | 338 | 308 | 262 | 557 | 418 |

The main destination is Japan. The exports towards the European have been increasing in the last years, but remain largely below the Japanese share. Only small amounts are marketed on the Caribbean market (see figure 2).

**Table 7**: Shrimp exports by destination in 1991.

| | COUNTRY OF DESTINATION | QUANTITY (kg) | VALUE (US $) |
|---|---|---|---|
| SAIL | Curaçao | 4,000 | 47,803 |
| | Japan | 1,029,896 | 14,763,789 |
| | France | 257,420 | 2,795,289 |
| | Total | 1,291,316 | 17,606,881 |
| SUJAPI | Japan | 100% | |

# II. RESULTS OF THE EXPLOITATION

## II.A. EFFORT

The data available on effort include the number of boats licensed, the number of trips (deliveries) and the number of days at sea. The number of days at sea is currently obtained only for the vessels landing at SAIL. More accurate effort units, like the number of hauls or of trawling hours could be extracted from the logbooks. This is not done currently, mostly by lack of manpower.

Standardization of the effort data has not been carried out yet.

**Table 8**: Annual effort by fleet.

| YEAR | NUMBER OF DELIVERIES | | | | NUMBER OF DAYS AT SEA |
|---|---|---|---|---|---|
| | SAIL | SUJAFI | | TOTAL | SAIL |
| | | Korean | Japanese | | |
| 1977 | | 145 | 248 | | |
| 1978 | 610 | 53 | 231 | 894 | |
| 1979 | 506 | 57 | 230 | 793 | |
| 1980 | 387 | 128 | 209 | 724 | |
| 1981 | 581 | 125 | 265 | 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 | 23,415 |
| 1987 | 410 | 81 | 178 | 669 | 26,227 |
| 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 |

Tables 9 and 10 show the average pattern of effort from January to December. The level of effort does not vary much from month to month. There is a slight peak in April-May (usually the best yields), and a minimum in September-October (maintenance work is generally carried out in that season of lower yields). There is also an apparent higher level of effort in January than in December, due to closure of the processing plants during the end of the year.

**Table 9**: Average pattern of the distribution of effort (# deliveries) over the year.

| MONTH | AVERAGE 1987-1991 | | | | 1991 | | | |
|---|---|---|---|---|---|---|---|---|
| | | SUJAFI | | | | SUJAFI | | |
| | SAIL | Korean | Japanese | TOTAL | SAIL | Korean | Japanese | TOTAL |
| January | 37.6 | 7.2 | 20.8 | 65.6 | 33 | 9 | 24 | 66 |
| February | 28.4 | 8.0 | 17.4 | 53.8 | 16 | 4 | 8 | 28 |
| March | 30.4 | 8.6 | 18.6 | 57.6 | 19 | 12 | 23 | 54 |
| April | 32.8 | 8.6 | 18.6 | 60.0 | 23 | 11 | 19 | 53 |
| May | 36.2 | 10.4 | 16.0 | 62.6 | 27 | 18 | 27 | 72 |
| June | 32.6 | 9.2 | 16.0 | 57.8 | 23 | 9 | 13 | 45 |
| July | 33.6 | 7.8 | 16.8 | 58.2 | 25 | 12 | 22 | 59 |
| August | 29.0 | 9.0 | 17.2 | 55.2 | 23 | 6 | 20 | 49 |
| September | 29.6 | 7.8 | 14.2 | 51.6 | 18 | 5 | 19 | 42 |
| October | 32.8 | 9.4 | 13.4 | 55.6 | 24 | 8 | 10 | 42 |
| November | 28.0 | 8.6 | 20.2 | 56.8 | 22 | 5 | 30 | 57 |
| December | 29.8 | 7.6 | 16.4 | 53.8 | 15 | 11 | 18 | 44 |

The geographical distribution of effort, by zone and depth, and the seasonal trends (variations in the fishing grounds exploited), have not been investigated. This type of information should be obtained from the logbook system. Although logbooks are requested from all trawlers, these could not be analyzed yet, by lack of manpower.

**Table 10**: Average pattern of the distribution of effort (# days at sea, SAIL) over the year.

| | 1987-1991 | 1991 |
|---|---|---|
| January | 2,531 | 2,208 |
| February | 1,783 | 939 |
| March | 1,935 | 1,457 |
| April | 2,130 | 1,530 |
| May | 2,283 | 1,872 |
| June | 1,879 | 1,614 |
| July | 2,001 | 1,659 |
| August | 1,729 | 1,370 |
| September | 1,758 | 1,165 |
| October | 2,042 | 1,761 |
| November | 1,657 | 1,554 |
| December | 1,730 | 1,050 |

## II.B. CATCH / LANDINGS

Table 11 and figure 3 present the landings of each fleet for the years 1973-1991. All figures are expressed in head-off equivalents (tail weight).

The yearly production shows important variations, with series of good years alternating with series of less favourable ones. The last "maximum" year has been 1987. The landings afterwards reached a minimum in 1989. An increasing trend was observed again in 1990 and 1991.

**Table 11**: Total landings by year and by fleet (in kgs of tails).

| YEAR | HEAD OFF LANDINGS | | | | HEAD ON | TOTAL (head-off + head-on) |
|---|---|---|---|---|---|---|
| | SAIL | SUJAFI | | Total | SUJAFI | |
| | | Korean | Japanese | | 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 | 2,432,518 |
| 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 | 2,402,640 | 425,585 | 2,828,225 |

The monthly pattern is shown in table 12, based on the averages of the monthly landings during the period 1987-1991. Table 13 gives the monthly landings in the last year.

**Table 12**: Average pattern of the monthly landings over the year (1987-1991).

| MONTH | SAIL | SUJAFI (head-off) | | SUJAFI (head-on) | TOTAL |
|---|---|---|---|---|---|
| | | Korean | Japanese | | |
| January | 205,226 | 33,981 | 17,212 | 51,442 | 307,861 |
| February | 144,897 | 36,674 | 17,520 | 32,954 | 232,045 |
| March | 159,785 | 35,701 | 15,602 | 34,452 | 245,540 |
| April | 162,934 | 38,210 | 11,794 | 37,988 | 250,926 |
| May | 159,819 | 32,520 | 9,947 | 24,902 | 227,189 |
| June | 130,392 | 28,602 | 8,920 | 29,911 | 197,825 |
| July | 138,191 | 26,186 | 10,791 | 29,546 | 204,713 |
| August | 118,674 | 33,000 | 9,198 | 34,534 | 195,406 |
| September | 138,146 | 28,825 | 8,554 | 25,668 | 201,192 |
| October | 171,963 | 43,235 | 9,050 | 27,159 | 251,407 |
| November | 145,662 | 41,793 | 14,188 | 38,334 | 239,976 |
| December | 146,690 | 32,995 | 11,196 | 17,424 | 208,305 |

**Table 13**: Monthly landings in 1991.

| MONTH | SAIL | SUJAFI (head-off) | | SUJAFI (head-on) | TOTAL |
|---|---|---|---|---|---|
| | | Korean | Japanese | | |
| January | 188,608 | 35,054 | 13,124 | 56,214 | 293,000 |
| February | 76,878 | 23,344 | 7,862 | 35,438 | 143,522 |
| March | 141,844 | 57,886 | 11,940 | 34,483 | 246,153 |
| April | 157,934 | 56,890 | 15,436 | 32,938 | 263,198 |
| May | 180,703 | 65,532 | 18,498 | 41,125 | 305,858 |
| June | 130,394 | 19,630 | 8,708 | 22,820 | 181,552 |
| July | 122,567 | 39,158 | 19,038 | 42,651 | 223,414 |
| August | 112,349 | 24,714 | 16,436 | 42,571 | 196,070 |
| September | 109,579 | 23,144 | 17,832 | 41,590 | 192,145 |
| October | 193,537 | 66,356 | 8,346 | 39,571 | 307,810 |
| November | 172,552 | 43,960 | 33,140 | 27,903 | 277,555 |
| December | 104,105 | 57,124 | 28,438 | 8,282 | 197,949 |

## II.C. CATCH PER UNIT OF EFFORT

The best cpue data available for the entire fleet is the landing per delivery. The landing per day at sea is only available for the vessels landing at SAIL.

**Table 14**: Annual catch per unit of effort, per fleet.

| YEAR | LANDING (kg tails) PER DELIVERY | | | | LANDING (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 | 3,463 | 72.5 |
| 1984 | 3,126 | 3,004 | 2,018 | 2,878 | 64.1 |
| 1985 | 3,854 | 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 |

Table 14 gives the average value of each of these cpue units for each component of the trawler fleet between 1977 and 1991. Figure 4 demonstrates that the average landing per day at sea of the vessels landing at SAIL follow the same trend as the average landing per trip (for the whole fleet). The cpue's of all components of the fleet (Korean/SAIL, Korean/SUJAFI, Japanese) also display similar evolution.

In table 15 the average monthly cpue values have been calculated over the last five years. The monthly cpue's for 1991 are also shown (table 16) for comparison. It can be seen that the yields per day as well as per trip tend to be higher from October to March and lower between April and September (figure 5). In 1991 however two maxima are observed, one in April and the second one in October-November.

**Table 15**: Average pattern of CPUE per month (1987-1991).

| MONTH | LANDING PER DELIVERY (kg) | | | | LANDING PER DAY AT SEA (SAIL) |
|---|---|---|---|---|---|
| | SAIL | SUJAFI | | TOTAL | |
| | | Korean | Japanese | | |
| January | 5,458 | 4,720 | 3,301 | 4,693 | 81.1 |
| February | 5,102 | 4,584 | 2,901 | 4,313 | 81.3 |
| March | 5,256 | 4,151 | 2,691 | 4,263 | 82.6 |
| April | 4,967 | 4,443 | 2,676 | 4,182 | 76.5 |
| May | 4,415 | 3,127 | 2,178 | 3,629 | 70.0 |
| June | 4,000 | 3,109 | 2,427 | 3,423 | 69.4 |
| July | 4,113 | 3,357 | 2,401 | 3,517 | 69.1 |
| August | 4,092 | 3,667 | 2,543 | 3,540 | 68.7 |
| September | 4,667 | 3,695 | 2,410 | 3,899 | 78.6 |
| October | 5,243 | 4,599 | 2,702 | 4,522 | 84.2 |
| November | 5,202 | 4,860 | 2,600 | 4,225 | 87.9 |
| December | 4,922 | 4,341 | 1,745 | 3,872 | 84.8 |

**Table 16**: CPUE per month in 1991.

| MONTH | LANDING PER DELIVERY (kg) | | | | LANDING PER DAY AT SEA (SAIL) |
|---|---|---|---|---|---|
| | SAIL | SUJAFI | | TOTAL | |
| | | Korean | Japanese | | |
| January | 5,715 | 3,895 | 2,889 | 4,439 | 85.4 |
| February | 4,805 | 5,836 | 5,412 | 5,126 | 81.9 |
| March | 7,465 | 4,824 | 2,018 | 4,558 | 97.4 |
| April | 6,867 | 5,172 | 2,546 | 4,966 | 103.2 |
| May | 6,693 | 3,641 | 2,208 | 4,248 | 96.5 |
| June | 5,669 | 2,181 | 2,425 | 4,034 | 80.8 |
| July | 4,903 | 3,263 | 2,804 | 3,787 | 73.9 |
| August | 4,885 | 4,119 | 2,950 | 4,001 | 82.0 |
| September | 6,088 | 4,629 | 3,127 | 4,575 | 94.1 |
| October | 8,064 | 8,294 | 4,792 | 7,329 | 109.9 |
| November | 7,843 | 8,792 | 2,035 | 4,869 | 111.0 |
| December | 6,940 | 5,193 | 2,040 | 4,499 | 99.1 |

The general pattern of the geographical distribution of cpue, by zone and depth, is poorly known, since the logbooks are not analyzed. In general terms, it is known that the yields are higher on the deeper grounds in the beginning of the year, where they decrease markedly towards June. The yields in shallower grounds are higher in the second half of the year, corresponding to the recruitment of juvenile *Penaeus subtilis*.

Table 17 presents the global parameters of the fishery since 1973, and figure 6 demonstrates the evolution of total landing, total effort and average cpue per year.

**Table 17.** Annual landings, effort and cpue.

| YEAR | TOTAL LANDINGS (tons of tails) | TOTAL EFFORT (number of deliveries) | CPUE | |
|---|---|---|---|---|
| | | | Landing per delivery | Landing 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 | 3,427,746 | 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 | 3,488,986 | 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 |

## II.D. ARTISANAL FISHERY

No data is collected on the catch, effort, or cpue of Penaeus shrimp by artisanal fishermen. It is known that juvenile *Penaeus subtilis* is caught in the lagoons in certain years during the months May to July. Amounts, though not recorded, are estimated at maximum 50 tons.

# III. ASSESSMENT OF THE RESOURCES

A comprehensive assessment of the shrimp resource in Suriname has not been achieved until now, by lack of sufficient detailed data. Preliminary analyses have been carried out, using surplus production models and the Thompson and Bell model. The application of surplus production models, with global (all species together) catch and effort data, generally led to the conclusion that the catch would keep increasing as fishing effort was increased, without reaching an discernible maximum. The Maximum Sustainable Yield, and the corresponding level of effort, could therefore not be determined with accuracy. Charlier (1989) made use of the bio-economic model BEAM 1, developed by FAO (Willmann and Garcia, 1985) with updated global data on catch and effort, and the (limited) economic information available. According to this analysis, the Maximum Economic Yield would be reached with a fishing effort of between 75 and 100 trawlers of the current type, for a year with an average level of recruitment.

The Fisheries Department has started the collection of the detailed data necessary for the application of more accurate stock assessment methodologies. These data are based on the information supplied by the processing industry, supplemented by the results of samplings carried out on the landings, at the processing plants.

**Table 18**: Annual head-off landings per commercial category (tons).

| YEAR | u10 | 10/15 | 16/20 | 21/25 | 26/30 | 31/40 | 41/50 | 51/60 | 61/70 | 71/85 | P/O L | P/O M | P/O S | CULLS | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SAIL | | | | | | | | | | | | | | | |
| 1987 | 39 | 224 | 258 | 300 | 385 | 361 | 364 | 224 | 85 | 2 | 59 | 67 | 25 | 56 | 2,448 |
| 1988 | 25 | 205 | 245 | 251 | 293 | 215 | 213 | 147 | 69 | 0 | 74 | 65 | 35 | 66 | 1,904 |
| 1989 | 15 | 199 | 271 | 241 | 223 | 145 | 82 | 39 | 11 | 0 | 81 | 56 | 14 | 22 | 1,398 |
| 1990 | 16 | 169 | 272 | 237 | 271 | 215 | 133 | 107 | 61 | 12 | 63 | 52 | 19 | 44 | 1,671 |
| 1991 | 8 | 137 | 176 | 196 | 317 | 283 | 203 | 149 | 52 | 1 | 52 | 51 | 27 | 39 | 1,691 |
| SUJAFI Koreans | | | | | | | | | | | | | | | |
| 1987 | 5 | 27 | 43 | 47 | 53 | 99 | 72 | 50 | 36 | 13 | 27 | 0 | 0 | 0 | 472 |
| 1988 | 6 | 37 | 58 | 43 | 36 | 61 | 45 | 56 | 37 | 21 | 23 | 0 | 0 | 0 | 423 |
| 1989 | 4 | 33 | 67 | 52 | 39 | 45 | 22 | 24 | 10 | 2 | 15 | 0 | 0 | 0 | 313 |
| 1990 | 3 | 16 | 58 | 39 | 74 | 54 | 33 | 23 | 23 | 2 | 13 | 0 | 0 | 0 | 337 |
| 1991 | 5 | 44 | 55 | 54 | 81 | 90 | 74 | 46 | 22 | 7 | 34 | 0 | 0 | 0 | 513 |
| SUJAFI Japanese (head-on not included) | | | | | | | | | | | | | | | |
| 1987 | 5 | 30 | 55 | 54 | 58 | 37 | 5 | 0 | 0 | 0 | 13 | 0 | 0 | 0 | 257 |
| 1988 | 1 | 15 | 26 | 17 | 25 | 16 | 3 | 2 | 1 | 0 | 10 | 0 | 0 | 0 | 117 |
| 1989 | 0 | 6 | 13 | 10 | 14 | 18 | 6 | 1 | 0 | 0 | 11 | 0 | 0 | 0 | 80 |
| 1990 | 0 | 3 | 7 | 8 | 17 | 15 | 6 | 1 | 0 | 0 | 9 | 0 | 0 | 0 | 67 |
| 1991 | 1 | 20 | 44 | 34 | 61 | 23 | 2 | 1 | 0 | 0 | 12 | 0 | 0 | 0 | 199 |

## 1. Distribution of the landings by size categories

The largest part of the landings is processed on shore and graded into the traditional categories (in # tails per pound). The information on the shrimp production in each of these categories is kindly provided by the industry. Table 18 shows the annual results, from 1987 to 1991, for each component of the fleet. The part of the Japanese landings which is processed on board (head-on) in not included in these figures, because the classification used is different.

## 2. Species and sex composition

As the shrimp species are not separated by the industry, a sampling programme has been initiated in 1985 in order to determine species and sex composition of the landings. Samplings are conducted monthly (ten samples a month) in each commercial category, based on which the composition of each category is calculated. The results are then summed to obtain the global species and sex composition of the landings. Although both processing facilities are covered by the sampling programme, only the results at SAIL have been partly worked out yet.

The species composition (SAIL only) for the year 1987 is given in table 19, and shown in figure 7. The species *Penaeus subtilis* is the most important in the total landings, representing 67% of the total shrimp production. The second species is *P. brasiliensis*, with 31%. *P. schmitti* and *P. notialis* are present in small quantities (about 2%).

The species composition varies markedly with the commercial category, corresponding to differences in sizes of the different species. *P. brasiliensis* makes up most of the large shrimp (categories U-10 to 16/20) and is almost absent from the landings of the small categories. The categories 26/30 and smaller consist mainly of the brown shrimp *P. subtilis*. The 2 less important species (the pink and the white shrimps) are represented in the large categories.

**Table 19**: Species composition by commercial categories. Landings at SAIL (tons) 1987.

| | *P. subtilis* | | *P. brasiliensis* | | *P. notialis* | | *P. schmitti* | |
|---|---|---|---|---|---|---|---|---|
| | F | M | F | M | F | M | F | M |
| U 10 | 2.1 | ---- | 34.4 | ---- | 2.1 | ---- | ---- | ---- |
| 10-15 | 22.5 | 1.3 | 173.2 | 4.4 | 22.7 | 0.4 | 0.1 | ---- |
| 16-20 | 76.0 | 3.1 | 118.0 | 43.7 | 15.4 | 2.2 | ---- | ---- |
| 21-25 | 162.8 | 7.2 | 55.6 | 69.0 | 1.2 | 4.1 | ---- | ---- |
| 26-30 | 225.4 | 41.1 | 41.4 | 72.0 | 0.9 | 3.7 | ---- | ---- |
| 31-40 | 207.1 | 102.7 | 12.3 | 37.9 | ---- | 0.6 | ---- | ---- |
| 41-50 | 203.3 | 130.4 | 7.7 | 22.0 | ---- | ---- | ---- | ---- |
| 51-60 | 114.6 | 102.4 | 2.7 | 4.6 | ---- | ---- | ---- | ---- |
| 61-70 | 41.4 | 43.1 | 0.1 | 0.4 | ---- | ---- | ---- | ---- |
| >70 | 31.1 | 26.5 | 0.1 | 0.2 | ---- | ---- | ---- | ---- |
| P/O/L | 18.5 | 2.3 | 23.1 | 11.1 | 2.0 | 0.5 | 0.5 | 0.6 |
| P/O/M | 31.8 | 12.4 | 7.7 | 14.7 | 0.1 | 0.1 | ---- | ---- |
| P/O/S | 14.1 | 9.4 | 0.5 | 1.1 | ---- | ---- | ---- | ---- |
| Total | 1,150.7 | 481.9 | 476.8 | 281.1 | 44.4 | 11.6 | 0.6 | 0.6 |
| % | 47.0 | 19.7 | 19.5 | 11.5 | 1.8 | 0.5 | ---- | ---- |

## 3. Length frequency distributions

Length and weight measurements are carried out twice a year. Length frequency distributions are determined for each species/sex in each category, and conversion tables between size categories and tail length are worked out. The number of tails of each length is calculated, and summed across the categories, to obtain the overall length composition of the landings of species/sex, per month.

The average distributions (in number of tails) calculated over the years 1985-1991 for the main components of the landings, *P. subtilis* (♀ and ♂) and *P. brasiliensis* (♀ and ♂) are shown in table 20.

**Table 20**: Length frequency distributions per year, in thousands of tails. (SAIL, average 1985-1991).

| | *Penaeus subtilis* | | *Penaeus brasiliensis* | |
|---|---|---|---|---|
| TAIL LENGTH (mm) | ♀ | ♂ | ♀ | ♂ |
| u 40 | 0 | 0 | 0 | 0 |
| 40-44 | 1 | 1 | 0 | 0 |
| 45-49 | 22 | 14 | 0 | 0 |
| 50-54 | 176 | 129 | 1 | 2 |
| 55-59 | 903 | 722 | 10 | 24 |
| 60-64 | 3,600 | 3,049 | 67 | 134 |
| 65-69 | 7,040 | 7,011 | 200 | 436 |
| 70-74 | 7,935 | 8,125 | 517 | 830 |
| 75-79 | 8,027 | 6,016 | 486 | 1,082 |
| 80-84 | 8,467 | 4,301 | 881 | 1,849 |
| 85-89 | 7,043 | 2,556 | 1,992 | 3,213 |
| 90-94 | 4,143 | 822 | 2,201 | 3,830 |
| 95-99 | 2,578 | 270 | 2,561 | 2,940 |
| 100-104 | 1,295 | 111 | 2,913 | 1,351 |
| 105-109 | 520 | 18 | 2,839 | 348 |
| 110-114 | 183 | 8 | 2,359 | 67 |
| 115-119 | 47 | 2 | 1,208 | 11 |
| 120-124 | 6 | 0 | 397 | 1 |
| 125-129 | 0 | 0 | 91 | 0 |
| 130-134 | 0 | 0 | 10 | 0 |
| 135-139 | 0 | 0 | 0 | 0 |

## 4. Indexes of recruitment

In order to assess and monitor recruitment, several indexes can be selected, based on the amounts of small shrimp present in the landings. The following indexes are proposed:

- cpue (landings per delivery), all fleets together, of the categories 51/60, + 61/70 + ≥71 + culls + broken + P/O S.
- cpue (landings per day at sea), SAIL only, of the categories 51/60 + 61/70 + ≥71 + culls P/O S.

Table 21 gives the average value per year of these indexes of recruitment from 1983 to 1991 (see also figure 8). It can be appreciated that both indexes follow similar trends. A cyclic evolution is observed, a few years of high recruitment alternating with a few years of low values of the recruitment indices. The figures presented here are affected by the recruitment of several species, even though the brown shrimp makes up most of the small sizes. It is also possible, however, to calculate recruitment indexes by species (and by sex), for the years covered by the samplings mentioned above.

**Table 21**: Annual recruitment indices.

| YEAR | CPUE (51/60 and smaller) | |
|---|---|---|
| | per day at sea (SAIL) | per delivery (all fleets) |
| 1983 | 9.86 | 479.4 |
| 1984 | 8.92 | 445.8 |
| 1985 | 7.32 | 320.8 |
| 1986 | 11.36 | 524.3 |
| 1987 | 14.95 | 794.7 |
| 1988 | 11.63 | 664.0 |
| 1989 | 3.60 | 200.2 |
| 1990 | 11.12 | 439.6 |
| 1991 | 14.72 | 639.4 |

The average seasonal pattern of recruitment has been calculated over the last five years, using the same indexes computed by month. Table 22 and figure 9 reveal that recruitment takes place year round. A marked difference is observed, however, between the first and the second halves of the year. The months September to December (maximum in October) represent the season of maximum recruitment. No second recruitment period is detected. When the same indexes are computed for a single year, however, a minor recruitment peak may be observed in the course of the first half of the year. In 1991 for example, there was apparently a slight recruitment season in March-May. It must be pointed out that, due to the length of the fishing trips, the real period of recruitment to the fishing grounds is some 60 days ahead of the maxima detected at the level of the processing plant, i.e. between July and September, with possibly a secondary (much lower) season in February-March.

**Table 22**: Seasonal recruitment pattern (cpue 51/60 and smaller).

| MONTH | PER DAY AT SEA (SAIL) | | PER DELIVERY (all fleets) | |
|---|---|---|---|---|
| | average 1987-1991 | 1991 | average 1987-1991 | 1991 |
| January | 8.99 | 14.45 | 636.5 | 1,180.8 |
| February | 5.27 | 7.89 | 433.4 | 813.1 |
| March | 4.31 | 9.00 | 356.7 | 1,298.9 |
| April | 5.15 | 12.90 | 408.1 | 1,333.6 |
| May | 5.86 | 11.39 | 449.8 | 1,359.3 |
| June | 6.57 | 9.21 | 411.8 | 841.0 |
| July | 10.95 | 8.21 | 606.0 | 864.9 |
| August | 12.32 | 10.63 | 740.2 | 876.7 |
| September | 19.78 | 19.54 | 932.5 | 1,627.7 |
| October | 20.63 | 26.66 | 1,268.0 | 2,714.5 |
| November | 19.93 | 24.01 | 1,442.4 | 2,363.1 |
| December | 17.43 | 22.89 | 1,294.4 | 2,606.7 |

## 5. Identification of nurseries

Two brackish-water areas have been identified as potentially important for the production of juveniles *P. subtilis*. They are situated between the right bank of the Nickerie river and the sea, and between the right bank of the Commewijne river and the sea shore. The contribution of these areas to the recruitment of Penaeus shrimp has not been quantified, but is not believed to explain the total recruitment. Mud banks may play an important role in the early stages of this species. Samplings of juveniles carried out in the lagoons behind the shoreline and in the creeks between the lagoons and the sea have revealed the presence of *P. subtilis* only.

## 6. Population dynamics

No population dynamics parameters have been determined locally yet.

Biometric relationships are currently being established. Preliminary results based on recent measurements of shrimp landed head-on at Sujafi are presented in table 23.

**Table 23**: Preliminary biometric relations for *Penaeus brasiliensis* (measurements in 1991).

| | FEMALE | | | MALE | | |
|---|---|---|---|---|---|---|
| Y - X | a | b | r^2 | a | b | r^2 |
| Y = a+bX | | | | | | |
| TL - CL | 2.06 | 0.96 | 0.91 | 6.41 | 0.67 | 0.63 |
| AL - CL | 1.74 | 0.52 | 0.91 | 3.52 | 0.43 | 0.51 |
| TL - PL | 6.62 | 2.21 | 0.83 | 14.33 | 0.29 | 0.61 |
| AL - PL | 4.23 | 1.26 | 0.79 | 8.62 | 0.18 | 0.05 |
| TL - AL | 0.34 | 1.65 | 0.93 | 6.27 | 0.99 | |
| PL - AL | 1.61 | 0.63 | 0.79 | 1.64 | 0.049 | |
| AL - TL | 0.57 | 0.56 | 0.93 | 1.64 | 0.49 | [illegible] |
| TW - AW | 1.07 | 1.61 | 0.94 | 1.90 | 1.42 | 0.93 |
| AW - TW | 2.55 | 0.58 | 0.94 | 0.15 | 0.66 | 0.93 |

T=total, A=abdominal, C=Cuban, P=cephalothorax, L=length (mm), W=weight (gr)

# IV. ECONOMIC ASPECTS

Information on the economic aspects of the shrimp fisheries have never been collected in a routine way. Only in the last few years, have data on the value of shrimp exports been requested from the processing companies. The value of each shipment, broken down by size category, is now recorded together with the amounts exported by size category.

The totals for the year 1991, as well as the average prices by size category, are given in table 24 for each destination.

No data on costs are currently collected. This type of information can be extracted from the annual reports of the national enterprises (SAIL and SUGAM). The same information is not accessible for the foreign fishing and processing companies.

**Table 24**: Amounts exported and average prices for head-off shrimp in 1991 (SAIL).

| | TOTAL AMOUNT (in kg) | | | TOTAL VALUE (US $) | | | PRICE (US $ per kg) | | |
|---|---|---|---|---|---|---|---|---|---|
| | JAPAN | FRANCE | CURACAO | JAPAN | FRANCE | CURACAO | JAPAN | FRANCE | CURACAO |
| U -10 | 7,660 | | | 195,904 | | | 25.58 | | |
| 10-15 | 103,680 | 5,420 | 160 | 2,360,297 | 115,806 | 3,394 | 22.27 | 21.37 | 21.21 |
| 16-20 | 134,116 | 8,820 | 400 | 2,550,757 | 160,765 | 7,230 | 19.02 | 18.23 | 18.08 |
| 21-25 | 152,640 | 16,960 | 200 | 2,492,207 | 266,767 | 3,255 | 16.33 | 15.38 | 16.28 |
| 26-30 | 243,772 | 29,300 | | 3,430,098 | 404,754 | | 14.07 | 13.81 | |
| 31-40 | 189,380 | 59,560 | | 2,008,887 | 685,576 | | 10.61 | 11.50 | |
| 41-50 | 115,604 | 60,580 | 3,240 | 1,049,353 | 588,701 | 33,924 | 9.08 | 9.72 | 10.47 |
| 51-60 | 63,088 | 51,340 | | 502,920 | 427,819 | | 7.97 | 8.33 | |
| 61-70 | 19,956 | 23,240 | | 145,797 | 168,744 | | 7.31 | 7.26 | |
| 71-85 | | 3,540 | | | 22,290 | | | 6.35 | |
| P/OL | | 740 | | | 11,063 | | | 14.95 | |
| P/OM | | 7,100 | | | 72,065 | | | 10.15 | |
| TOTAL | 1,029,896 | 266,660 | 4,000 | 14,736,220 | 2,924,352 | 47,803 | | | |

## V. SECONDARY RESOURCES

Other demersal (trawlable) resources have been very marginally exploited until recently in Suriname. Small amounts of fish use to be landed at SAIL by the shrimp trawlers, sold to middlemen and retailed at the Central Market of Paramaribo. This fish is not seen as shrimp by-catch, as it is believed to be caught by special fishing operations, in special (shallow) areas, during the last days of the fishing trips, instead of being collected from the by-catch of the hauls made on the shrimp fishing grounds.

In the last years, however, a number trawlers have started exploiting specifically fin-fish (see table 3). No accurate information is available on their production, nor on the by-catch of the shrimp trawlers. Total recorded landings at SAIL amount to about 1,000 tons. The total fish catch by trawlers, including discards, is certainly several times higher.

A resource of deep-sea shrimp was identified by the Japanese investigation carried out by R/V Nisshin Maru 201 in 1980-83. The species are the scarlet shrimp (*Plesiopenaeus edwardsianus*), found at a depth of 800-900 meters, the spider shrimp (*Nematocarcinus rotundus*), which density is maximum between 700 and 900 meters depth, and the megalops shrimp (*Penaeopsis megalops*), which is abundant in the depth range of 300 to 400 meters (JAMARC, 1984). Although the investigators concluded that the three species have a commercial potential, no application for a licence to exploit this resource has been received.

Sea-bob (*Xyphopenaeus kroyeri*) is discarded by the trawlers. There is, however, an exploitation of this species by small-scale fishermen. The gear used is called "fuiknet", or chinese seine, and is set in the estuaries. Annual production may be around 500 tons.

# VI. SURVEYS ON SHRIMP AND RELATED RESOURCES

Surveys of shrimp or other marine resources are not carried out by national institutions. Suriname participates, whenever possible, in surveys organised at regional level and financed, coordinated and/or carried out by external agencies. In the last ten years the following investigations on shrimp and related resources have been completed:

- R/V Nisshin Maru 201 has carried out surveys of deep sea shrimp resources for the Japan Marine Fishery Resource Centre (JAMARC), from 1979 to 1983. Besides deep sea operations aimed at the assessment of deep sea shrimp resources, the vessel conducted a series of cruises in the zone between 20 and 100 meters depth, and provided estimates of the biomass of penaeid shrimp and of the demersal fish available in this depth range.

- Shrimp-tagging operations were carried out in 1982, in the EEZ of Suriname and French Guiana, under the coordination of FAO. Participants included scientists from French Guyana and Brazil.

- The German International Development Agency GTZ conducted surveys, with R/V Bonito, in 1981 and 1982. This investigation focused on the demersal fin-fish resources in the depth range 10-50 meters of the Suriname EEZ, and did not produce information on the shrimp resources.

- R/V Fridtjof Nansen carried out acoustic and trawl surveys in 1988, covering the northern coast of South America, from Suriname to Colombia. The executing agency was NORAD (Norwegian International Development Agency). Although this investigation was primarily aimed the assessment of pelagic and demersal fin-fish resources, the bottom trawl operations yielded also some information on shrimp distribution and abundance.

There is a program of investigations planned for the near future. The purpose is to study the recruitment mechanisms, particularly of *P. subtilis*. In addition, information will be collected on the abundance and composition of by-catch, biological data will be recorded on the main fish species, and the incidence of turtle catch will be investigated. Surveys will be carried out in 1993 and 1994, in collaboration with the "Institut Français de Recherche pour l'Exploration de la Mer" (IFREMER), and will cover the depth range between 10 and 50 meters in Suriname and in French Guyana. Two surveys will be undertaken each year, at periods corresponding with the recruitment peaks of the brown shrimp. This study is financed by institutes of the EEC, France and Suriname.

# VII. MANAGEMENT

## VII.A. LEGISLATION

Fisheries in Suriname are currently regulated by the Decree on Marine Fishery (Decree C-14), operational since 1 January 1981. The legislation is being revised and a new fisheries law is expected to be promulgated in the course of 1993. For the time being, the provisions concerning the shrimp trawling fishery can be summarised as follows:

- Registration. Compulsory registration of the boats, which are classified into three categories, according to their nationality status.

- Annual fees. The annual fishing rights amount to 10,000 guilders for vessels belonging to a foreign company/owner which is not established in Suriname ; to 7,500 guilders if the foreign company/owner is established in Suriname ; and to 5,000 guilders for vessels belonging to a national owner. Since 1986 licence fees of foreign vessels are cashed in US$.

- Reporting. Each vessel has to report his position daily to his base. In addition, a logbook has to be filled out and submitted to the Fisheries Department within three days after completion of each trip. A landing report has to be prepared and delivered to the Fisheries Department within supplied three days after delivering the catch.

- Closed areas. Shrimp trawling is forbidden in areas shallower than:
  - 12 fathoms from January to June;
  - 15 fathoms from July to December

- Destination of the catch. The entire catch has to be landed in Suriname. Transshipment at sea is prohibited.

## VII.B. LICENSING POLICY

There has been no attempt to limit the size of the fleet until 1986, when a maximum number of boats to be licensed was established (120 vessels) by the State Commission for the Fishery. This regulation was not enforced, however, and the situation remains one of open access, as applications for licences are never turned down.

## VII.C. ENFORCEMENT

Regulations on registration and licence fees are effectively enforced, even though payment of the fee does not occur at the beginning of the year in all cases. Enforcement of regulations at sea is very poor, as Suriname does not possess the means necessary to effectively control the fishery

zones. For the same reason, control of transshipment and poaching is not possible. The responsibility for enforcement of fishery regulations lies with the Ministry of Defence.

The fishing companies in their majority supply the requested information (logbooks and landing reports) with months of delay, which makes this information difficult to use in the practice. The statistical information used and regularly updated by the Fisheries Department is based on data obtained from the processing industry.

## VIII. REFERENCES

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Willmann, R. and S.M. Garcia, 1985. A bio-economic model for the analysis of sequential artisanal and industrial fisheries for tropical shrimp (with a case study of Suriname shrimp fisheries). FAO Fish.Tech.Pap.,(270):49p.

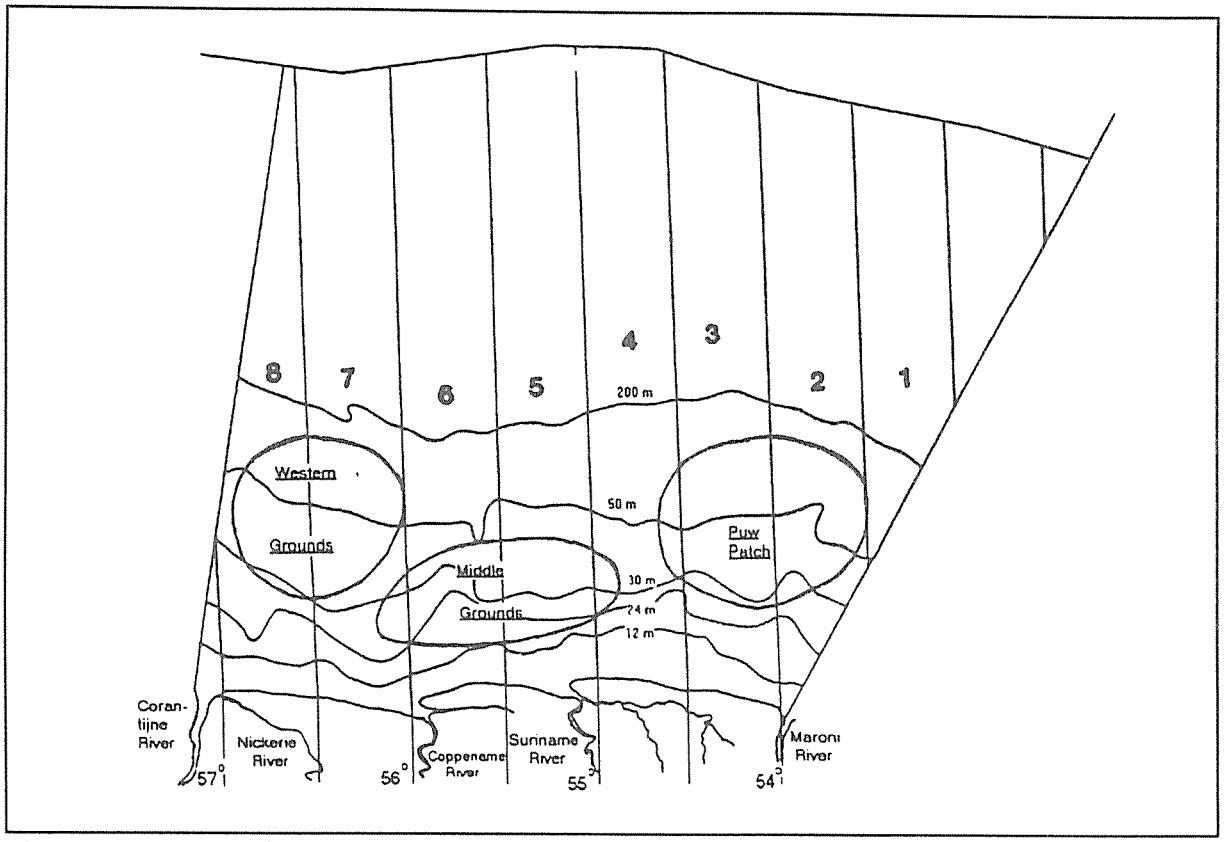



**Figure 1**: Statistical fishing zones for shrimp trawling.

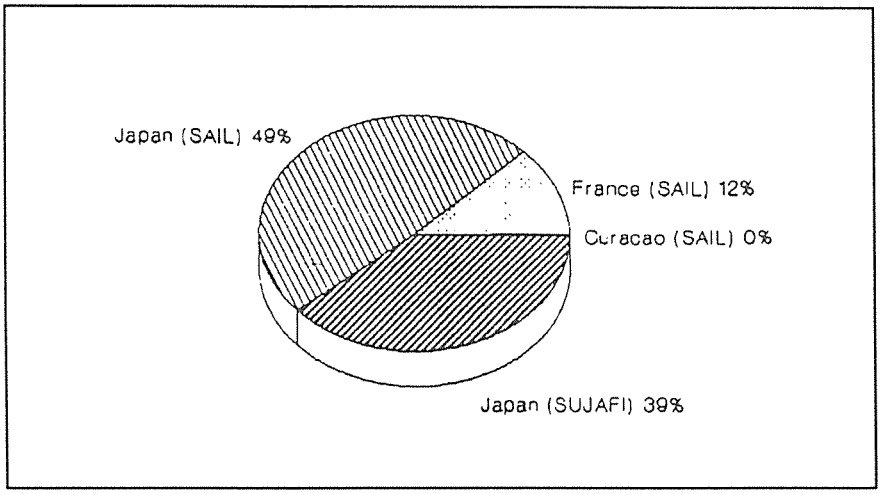



**Figure 2**: Destination of shrimp exports.

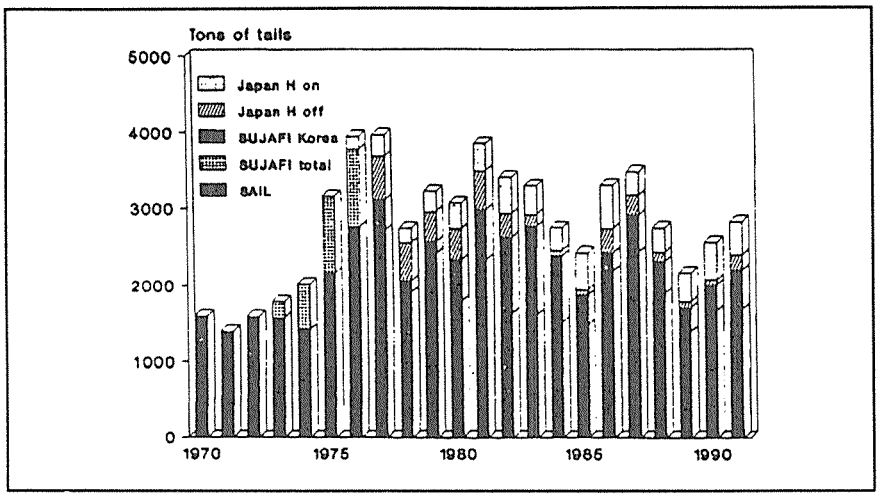



**Figure 3**: Shrimp production by processing plant and fleet.

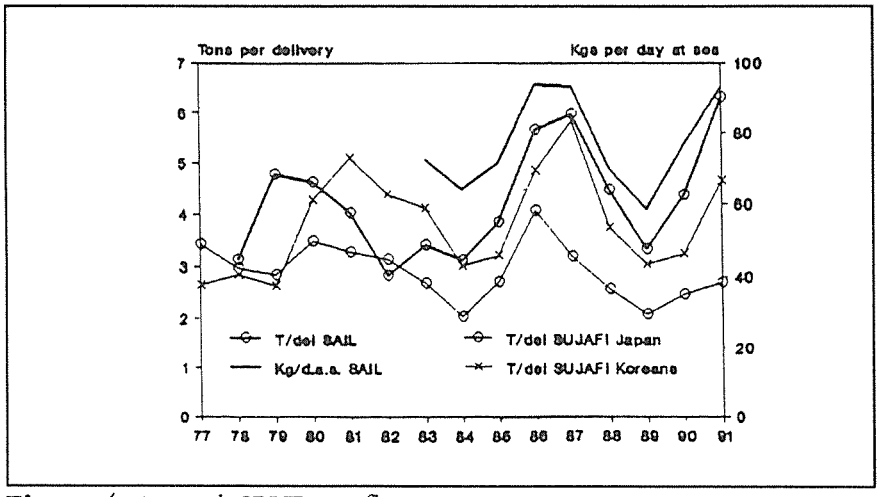



**Figure 4**: Annual CPUE per fleet.

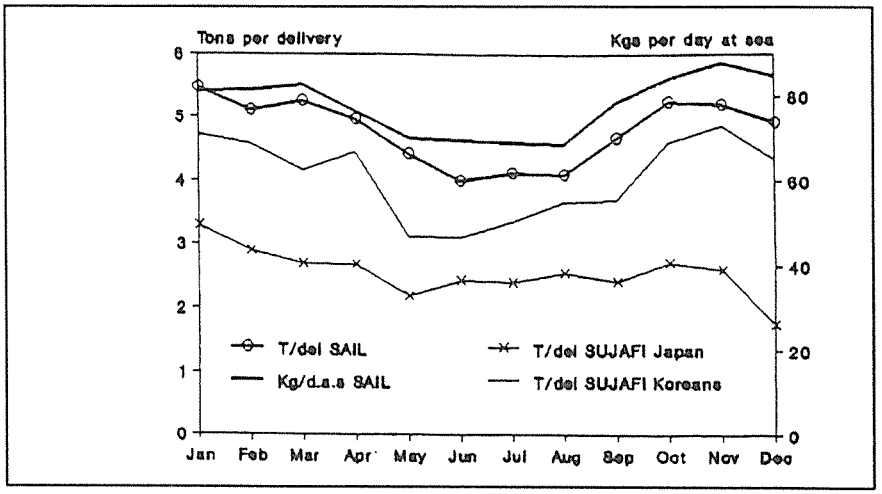
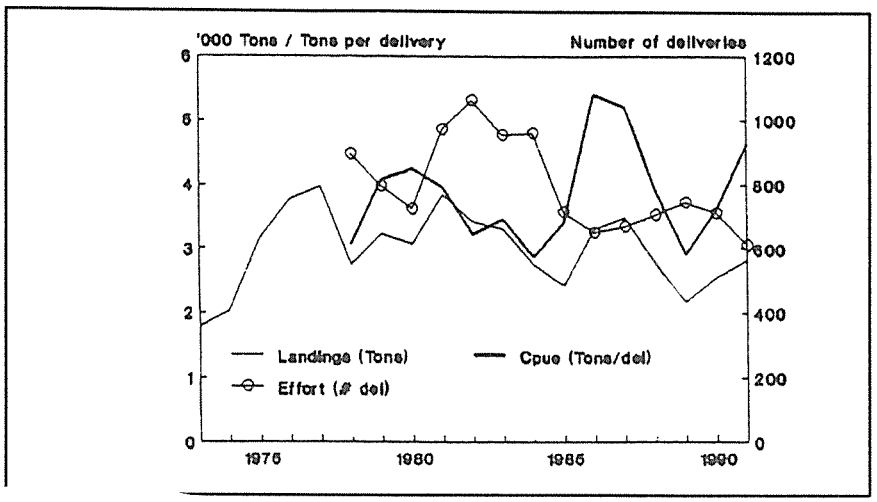



**Figure 5**: Average pattern of monthly CPUE (1987-1991).




l landings, effort, CPUE (all fleets).

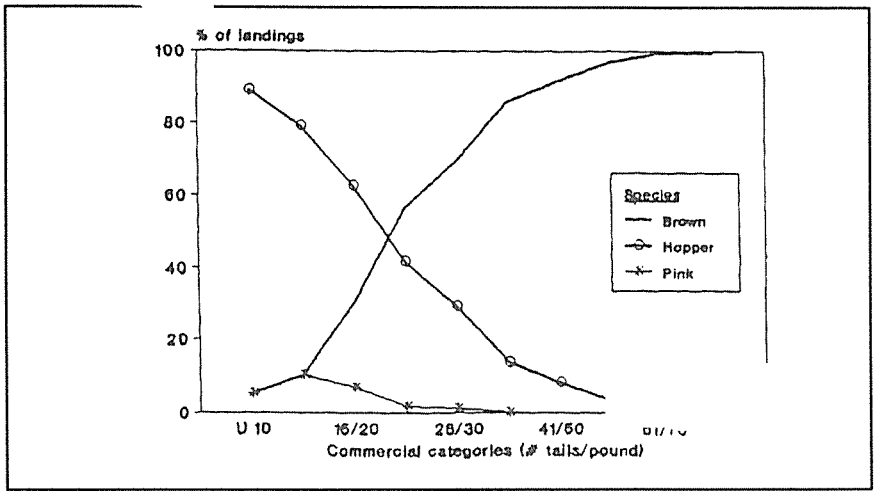



**Figure 7**: Species composition per commercial category (based on samplings at SAIL in 1987).

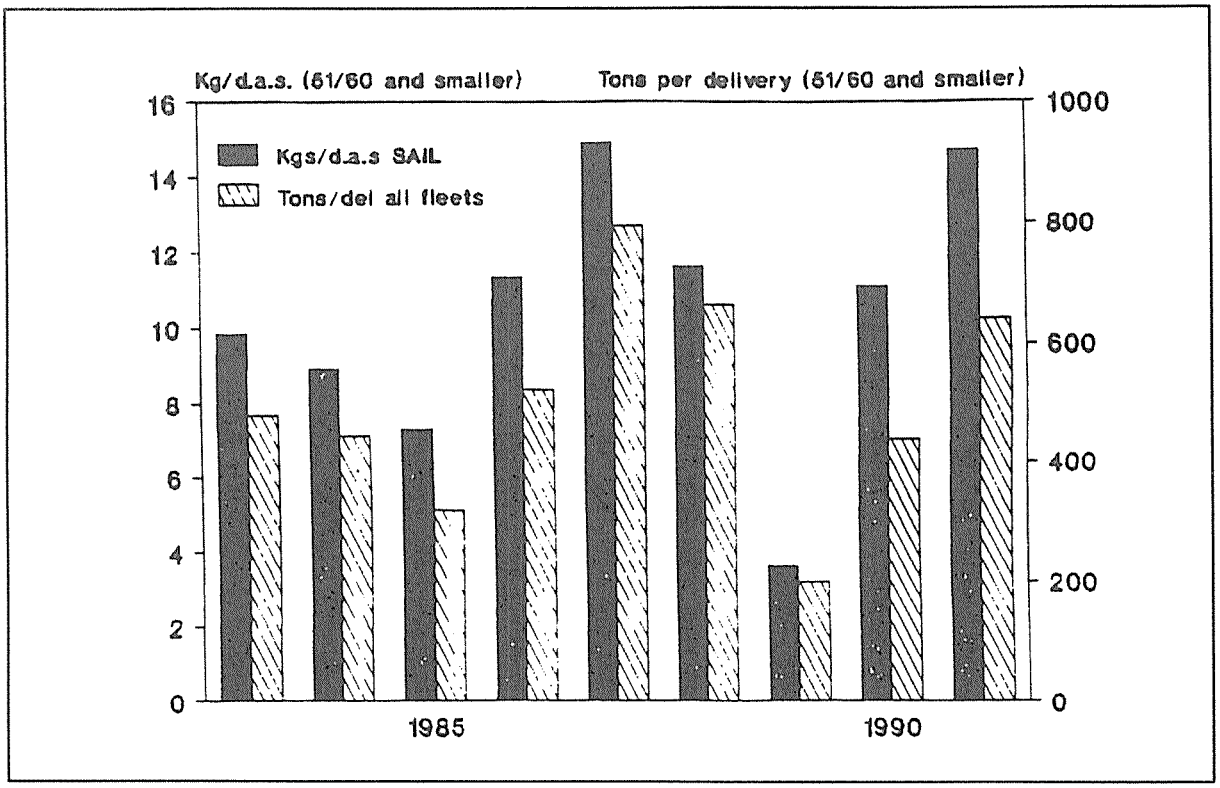



**Figure 8**: Annual recruitment indices.

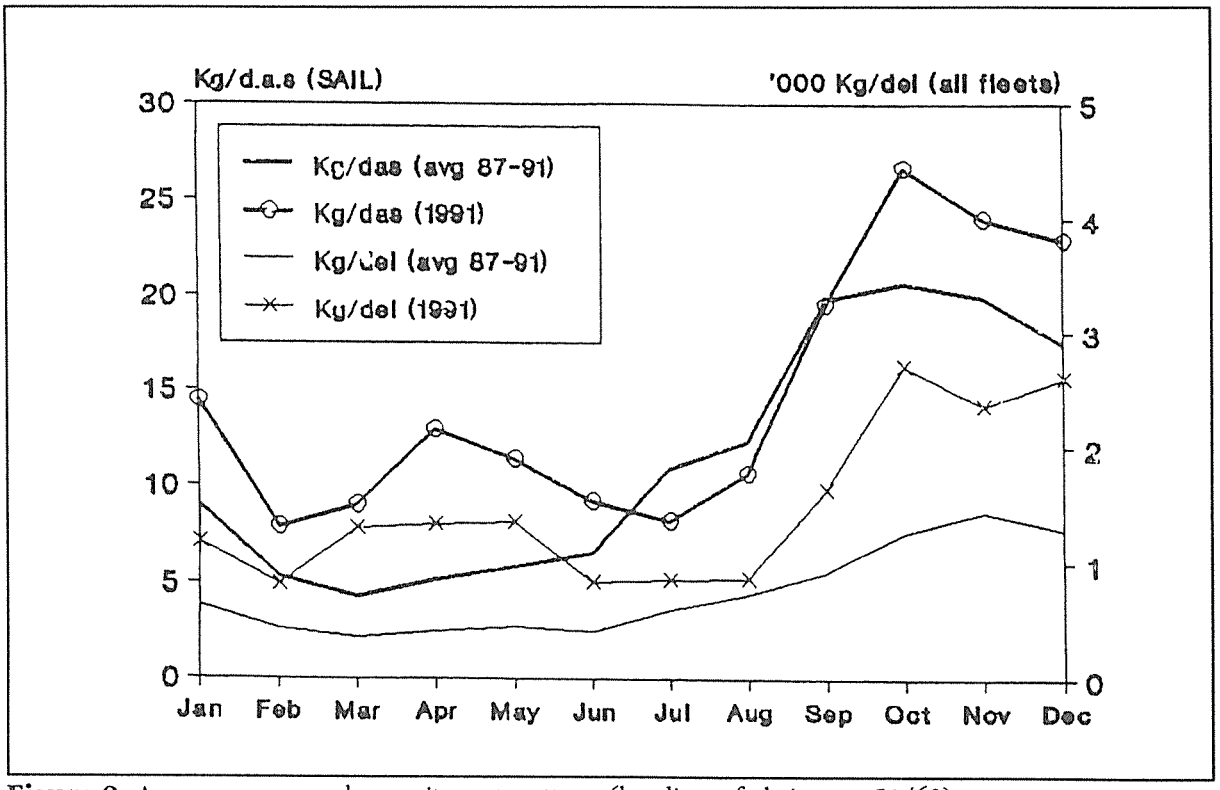



**Figure 9**: Average seasonal recruitment pattern (landing of shrimp ≤ 51/60).

NATIONAL REPORT OF FRENCH GUIANA

# *Evolution de la Pêcherie Crevettière de Guyane Française de 1988 à 1991*

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## I. DESCRIPTION DE LA PÊCHERIE

### A. ACTIVITÉS DE PÊCHE

#### A.1. Les zones de pêche

A.1.1. Délimitation des zones de pêche, limites, profondeurs et caractéristiques du fond

En Guyane française, Cayenne est l'unique port de débarquement de crevettes. La pêcherie traditionnelle repose sur l'exploitation des deux espèces du plateau continental: *Penaeus subtilis* et *Penaeus brasiliensis*.

*P. subtilis* est essentiellement exploitée sur des fonds de 20 à 40 mètres dans deux principaux secteurs:

- à l'ouest entre Sinnamary et Cayenne
- à l'est entre Cayenne et la limite des eaux brésiliennes, à l'embouchure de l'Oyapock.

*P. brasiliensis* est capturée de nuit principalement sur des fonds de 50 à 70 mètres dans la partie ouest du plateau continental entre la limite des eaux surinamiennes à l'embouchure du Maroni, et Sinnamary (Fig. 1).

Les surfaces bathymètriques de 10 à 80 mètres et la distribution saisonnière de l'effort de pêche sur le plateau continental en fonction de la profondeur sont regroupés dans les tableaux 1 et 2.

**Tableau 1**: Surfaces des strates bathymétriques du plateau continental de la Guyane française (en km²).

| CÔTE SONDE | MARONI SINNAMARY | SINNAMARY I. SALUT | I. SALUT CONNETABLE | CONNÉTABLE OYAPOCK | SURFACE TOTALE |
|---|---|---|---|---|---|
| 10-20 m | 1306,83 | 840,11 | 687,89 | 260,44 | 3095,27 |
| 20-30 m | 780,24 | 314,25 | 762,31 | 147,86 | 2004,66 |
| 30-40 m | 1666,17 | 601,72 | 689,95 | 122,28 | 3080,12 |
| 40-50 m | 2624,08 | 1764,33 | 945,67 | 211,36 | 5545,44 |
| 50-60 m | 2670,86 | 2842,23 | 3556,05 | 686,08 | 9755,22 |
| 60-80 m | 670,56 | 1042,26 | 2382,54 | 2725,39 | 6820,75 |
| 10-50 m | 6377,32 | 3520,41 | 3085,82 | 741,94 | 13725,49 |
| 50-80 m | 3341,42 | 3884,49 | 5938,59 | 3411,47 | 16575,97 |
| Total | 9718,74 | 7404,90 | 9024,41 | 4153,41 | 30301,46 |

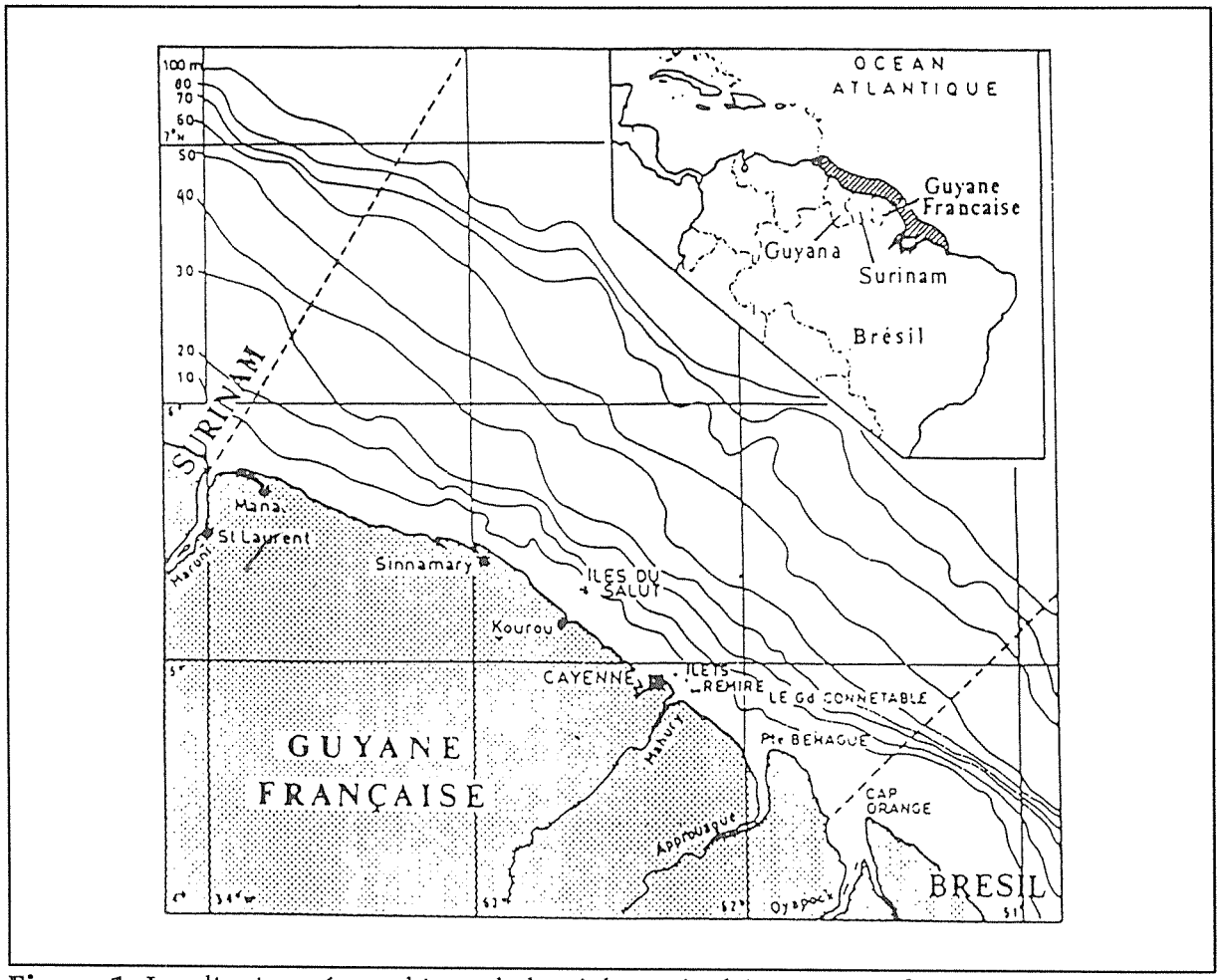


**Figure 1**: Localisation géographique de la pêcherie étudiée : Guyane française dans le plateau guyano-brésilien.

**Tableau 2**: Crevettes du plateau continental : Répartition de l'effort de pêche mensuel en jours de mer (de 1988 à 1991), en fonction de la profondeur. (tableau établi à partir des fiches de pêche).

| AN. | GAMME DE SONDE | MOIS | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | J | F | M | A | M | J | J | A | S | O | N | D |
| 1988 | inf à 30 m | 4 | 13 | 18 | 43 | 19 | 231 | 247 | 264 | 265 | 340 | 220 | 75 |
| | 30 à 50 m | 855 | 1264 | 1100 | 784 | 967 | 913 | 745 | 967 | 1109 | 1187 | 1156 | 870 |
| | 50 à 80 m | 981 | 381 | 748 | 934 | 960 | 645 | 843 | 620 | 302 | 225 | 223 | 836 |
| | Total | 1840 | 1658 | 1866 | 1761 | 1946 | 1789 | 1835 | 1851 | 1676 | 1752 | 1599 | 1781 |
| 1989 | inf à 30 m | 39 | 6 | 5 | | 113 | 26 | 86 | 1077 | 480 | 391 | 76 | 21 |
| | 30 à 50 m | 1048 | 1149 | 1728 | 1500 | 1529 | 1643 | 1669 | 467 | 1109 | 168 | 1305 | 1628 |
| | 50 à 80 m | 791 | 588 | 512 | 419 | 350 | 199 | 204 | 310 | 193 | 330 | 374 | 249 |
| | Total | 1878 | 1743 | 2245 | 1919 | 1992 | 1868 | 1959 | 1854 | 1782 | 889 | 1755 | 1898 |
| 1990 | inf à 30 m | | 41 | 159 | 250 | 346 | 360 | 369 | 612 | 717 | 388 | 217 | 259 |
| | 30 à 50 m | 547 | 1423 | 1476 | 1276 | 1221 | 1036 | 1113 | 807 | 675 | 620 | 714 | 678 |
| | 50 à 80 m | 297 | 161 | 146 | 180 | 277 | 327 | 314 | 259 | 98 | 241 | 258 | 115 |
| | Total | 844 | 1625 | 1781 | 1706 | 1844 | 1723 | 1796 | 1678 | 1490 | 1249 | 1189 | 1052 |
| 1991 | inf à 30 m | Répartition non connue | | | | | | | | | | | |
| | 30 à 50 m | | | | | | | | | | | | |
| | 50 à 80 m | | | | | | | | | | | | |
| | Total | 1275 | 1133 | 1291 | 1266 | 1318 | 1236 | 1315 | 1327 | 1374 | 1410 | 763 | 948 |

Depuis 1988, quelques navires exploitent deux espèces du talus continental : *Solenocera acuminata* (entre 180 et 230 m) et *Plesiopenaeus edwardsianus* (entre 650 et 750 m). La seule zone chalutable se situe entre Sinnamary et la limite des eaux surinamiennes, à l'ouest de la Z.E.E. La répartition saisonnière et bathymètrique de l'effort de pêche sur le talus continental est indiquée dans le tableau 2 bis.

**Tableau 2 bis**: Crevettes du talus continental : Répartition de l'effort de pêche mensuel en jours de mer en fonction de la profondeur (de 1988 à 1991).

| AN. | GAMME DE SONDE | MOIS | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | J | F | M | A | M | J | J | A | S | O | N | D |
| 1988 | 180 à 230 m | | | | | 28 | 55 | 52 | 29 | 50 | | | |
| | 650 à 750 m | | | | | | | | | | 119 | 2 | 30 |
| | Total | | | | | 28 | 55 | 52 | 29 | 50 | 119 | 2 | 30 |
| 1989 | 180 à 230 m | | 2 | | | | 34 | 95 | 78 | 14 | 83 | 19 | |
| | 650 à 750 m | | | | 2 | | 11 | 50 | 42 | 28 | 18 | 49 | 6 |
| | Total | | 2 | | 2 | | 45 | 145 | 120 | 42 | 101 | 68 | 6 |
| 1990 | 180 à 230 m | | | | | | 29 | 35 | 65 | 51 | 51 | 56 | 137 |
| | 650 à 750 m | 14 | | | | 5 | 3 | 20 | 70 | 16 | 57 | 9 | 2 |
| | Total | 14 | | | | 5 | 32 | 55 | 135 | 67 | 108 | 65 | 139 |
| 1991 | 180 à 230 m | 87 | 16 | | | 6 | 47 | 41 | 15 | 12 | | | |
| | 650 à 750 m | 3 | 79 | 54 | 142 | 103 | 113 | 196 | 159 | 132 | 156 | 96 | |
| | Total | 90 | 95 | 54 | 142 | 109 | 160 | 237 | 174 | 144 | 156 | 96 | |

Jusqu'à environ 25 m, les fonds sont constitués de vases fluides dont l'épaisseur peut parfois être très importante (jusqu'à 10 m). Plus profond, jusqu'à environ 50 m, on observe la présence de sables fins à très fins.

Les fonds sont, en général, doux et donc parfaitement chalutables, la pente s'accentuant légèrement d'ouest en est.

A.1.2. Description des modifications saisonnières des stratégies de pêche entre les différentes zones

En ce qui concerne l'espèce *P. subtilis*, le secteur le plus productif, Iracoubo Iles du Salut, est exploité toute l'année ; la partie est du plateau n'est fréquentée qu'au premier semestre.

L'espèce *P. brasiliensis*, quant à elle, est recherchée préférentiellement, vers la fin de l'année.

## A.2. La flotte

A.2.1. Description des différents types de navires, leurs nombres et leurs caractéristiques

En 1991, le nombre de chalutiers en activité en Guyane française s'est élevé à 72. Ceux-ci sont tous de type floridien ; (2 tangons latéraux supportant chacun un train de pêche). Parmi ceux-ci, 6 navires qui exerçent généralement leur activité sur le talus continental, sont équipés en pêche arrière, en plus du système floridien. Les longueurs moyennes hors tout de ces navires sont les suivantes:

- exploitant les crevettes du plateau : 19,80 à 22,85 m
- exploitant les crevettes du talus : 22,85 à 24,35 m

Ces bateaux ont été construits soit aux USA (48 navires), soit en Europe (24 navires). Le matériau de construction est le plastique (11 bateaux) ou l'acier (61 bateaux). La puissance motrice de ces navires varie de 275 à 500 CV avec la répartition suivante (tableau 3):

**Tableau 3**: Répartition des navires selon leur puissance.

| 250-299 CV | 300-349 CV | 350-399 CV | 400-449 CV | 450-500 CV |
|---|---|---|---|---|
| 2 | 15 | 7 | 34 | 14 |

L'année de construction de ces différents navires est indiquée dans le tableau 4.

**Tableau 4**: Répartition des navires selon leur Année de construction.

| 1980 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 2 | 7 | 6 | 5 | 1 | 10 | 20 | 10 | 8 |

A.2.2. Les armements et leur nombre de bateaux

En 1991, les compagnies de pêche exerçant leur activité dans les eaux de la Guyane française sont toutes sous pavillon français. La totalité de la flotte a, en effet, été francisée dans le courant de l'année 1990, avec, parallèlement, le départ des derniers navires américians. Leurs importances relatives, en nombre de bateaux, par mois, sont indiquées dans le tableau 5.

**Tableau 5**: Nombre de crevettiers par mois, par armement.

| AN. | ARMEMENTS | NATION | MOIS | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | J | F | M | A | M | J | J | A | S | O | N | D |
| 1988 | SAHLMAN SEA FOOD | USA | 32 | 32 | 32 | 32 | 32 | 32 | 32 | 32 | 32 | 26 | 26 | 26 |
| | CFP | FRANCE | 10 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 13 | 15 |
| | PIDEG | " | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| | ARMAG | " | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 |
| | GUYAPECHE | " | 3 | 3 | 3 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| | CGP | " | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| | INDEPENDANTS | " | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 |
| | GUYVINA | " | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 |
| | UNIFIPECHE | " | | | | | | | | | | | 2 | 2 |
| 1989 | SAHLMAN SEA FOOD | USA | 26 | 24 | 22 | 22 | 22 | 22 | 22 | 16 | 16 | 16 | 16 | 16 |
| | CFP | FRANCE | 15 | 15 | 15 | 17 | 17 | 17 | 17 | 16 | 16 | 16 | 16 | 16 |
| | PIDEG | " | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| | ARMAG | " | 17 | 17 | 17 | 17 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| | GUYAPECHE | " | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| | CGP | " | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| | INDEPENDANTS | " | 3 | 3 | 3 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 |
| | GUYVINA | " | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 |
| | COPECA | " | | | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| | UNIFIPECHE | " | 3 | 5 | 5 | 7 | 7 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| | SOPEMAG | " | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1990 | SAHLMAN SEA FOOD | USA | 16 | 12 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 0 | 0 | 0 |
| | CFP | FRANCE | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 |
| | PIDEG | " | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| | ARMAG | " | 14 | 15 | 16 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 12 | 12 |
| | GUYAPECHE | " | 5 | 6 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| | CGP | " | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 0 | 0 |
| | INDEPENDANTS | " | 6 | 6 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| | GUYVINA | " | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 5 | 5 | 5 |
| | COPECA | " | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| | UNIFIPECHE | " | 10 | 10 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 11 |
| | SOPEMAG | " | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 1991 | CFP | FRANCE | 16 | 16 | 17 | 17 | 18 | 19 | 19 | 19 | 19 | 19 | 19 | 19 |
| | PIDEG | " | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| | ARMAG | " | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| | GUYAPECHE | " | 7 | 7 | 7 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| | INDEPENDANTS | " | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 10 | 11 | 11 | 11 | 11 |
| | GUYVINA | " | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| | COPECA | " | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| | UNIFIPECHE | " | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 |
| | SOPEMAG | " | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

Nota: "indépendants" = navires appartenant chacun à un propriétaire unique différent, qu'il soit ou non embarqué.

## A.2.3. Les engins de pêche pour chaque type de bateau

Sur le plateau continental, chaque train de pêche, gréé sur chaque tangon, se compose d'une fune (diamètre : 14mm), d'une patte d'oie (longueur : de 45 à 50 m), d'une paire de panneaux plats rectangulaires (8'x36") de 150 kg, et d'un chalut à grande ouverture horizontale de type "Flatnet" ou demi-ballon (figures 2 et 3).

L'un des tangons supporte également un train de pêche d'essai de même conception que les chaluts principaux (ouverture d'environ 4 m, panneaux de 25 kg).

Les chaluts utilisés sur le talus sont de même type; ils sont cependant gréés différemment, jumelés l'un à l'autre et virés par la rampe arrière.

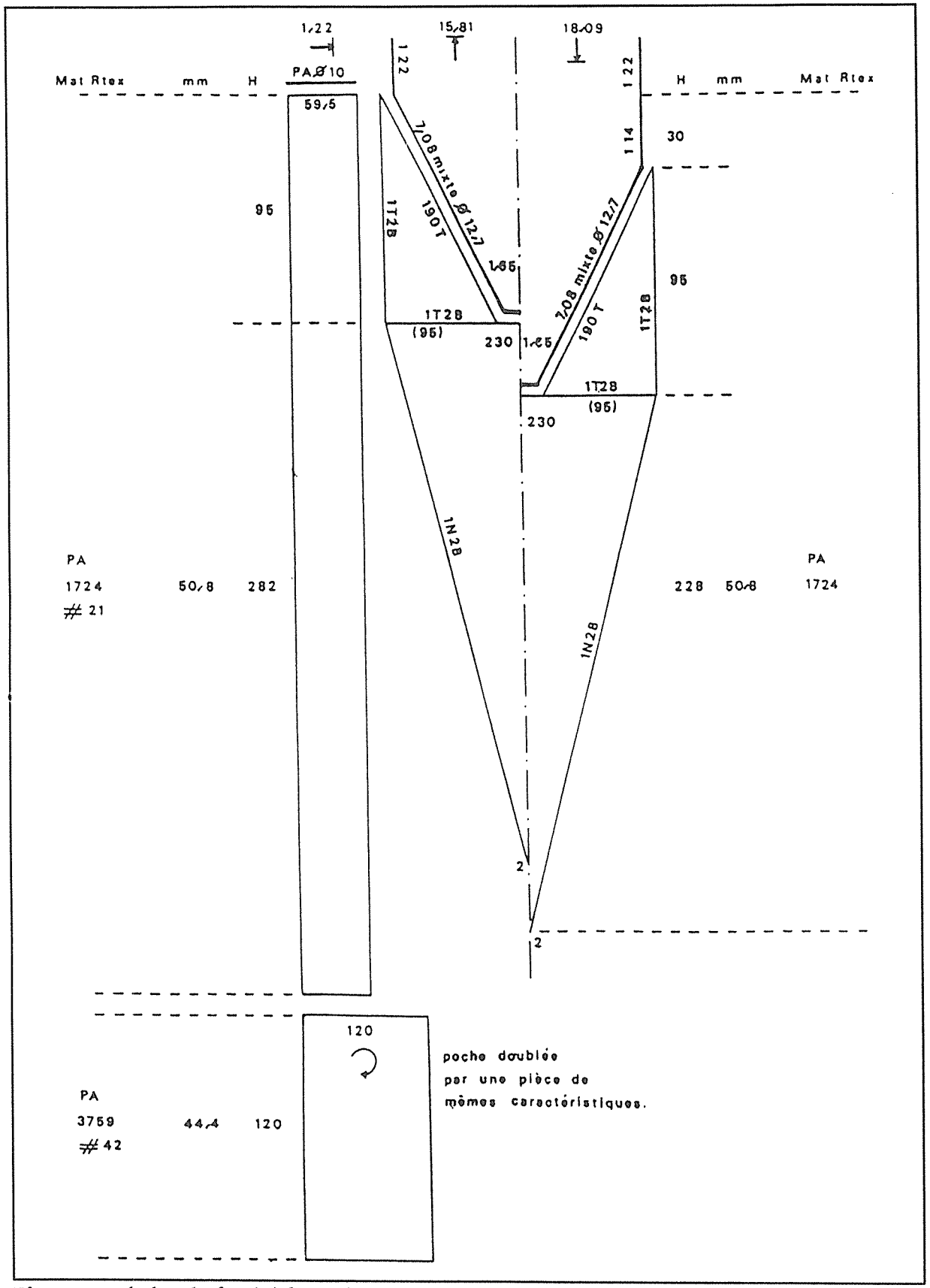


**Figure 2**: Chalut de fond 4 faces / crevettes SHRIMPS / FLATNET. Gréement double floridien. Flottille US de Guyane francaise. IFREMER GUYANE 1984, R. Bellail.
Navire: L ht = 22-23, Jb = 101-129, P = 365

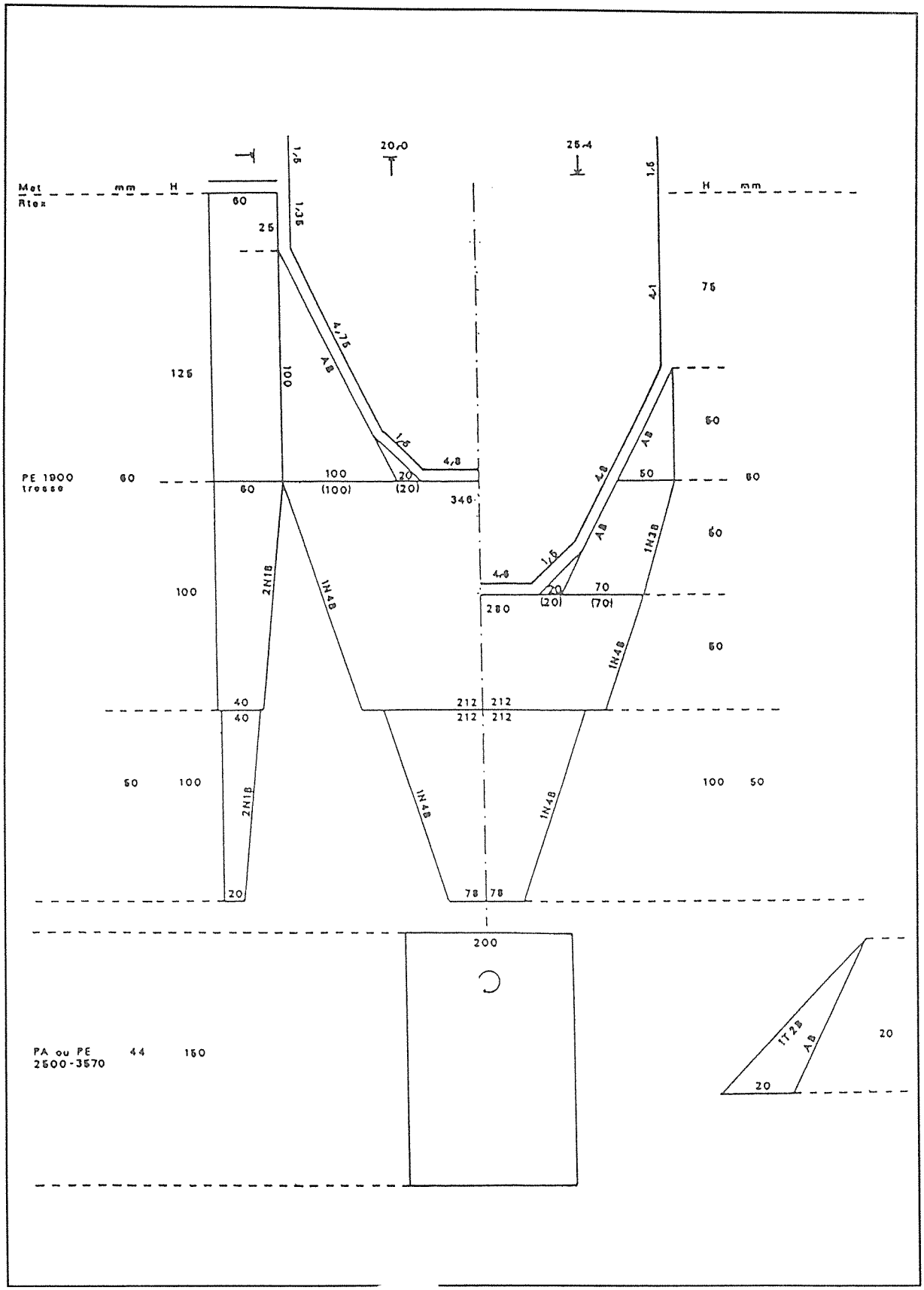


**Figure 3**: Chalut de fond 4 faces / c... RIMPS / SEMI BALLON, LE DREZEN, AP4. Gréement double floridien. Flottille ... e francaise. IFREMER GUYANE 1986, R. Bellail. Navire: L ht = m

A.2.4. Evolution de la flotte

La flottille américaine a définitivement quitté la zone en octobre 1990. De 1990 à 1991, l'évolution de la flottille française a été la suivante:

| | |
|---|---|
| C.F.P. : | + 3 navires |
| GUYAPECHE : | + 1 navire |
| SOPEMAG : | - 1 navire |
| INDEPENDANTS : | + 4 navires |

L'équipage d'un crevettier exerçant son activité en Guyane française se compose de 4 à 6 hommes (y compris le capitaine). La nationalité du personnel embarqué est guyana pour la majorité, brésilienne ou française pour une faible part. Les équipements annexe des navires sont les suivants:

- cales : volume de 45 à 65 m3 (froid statique).
- sondeurs, radars, balise de détresse pour tous les navires (SATNAV pour certains et GPS pour les chalutiers qui travaillent sur le talus).

## A.3. Les stratégies de pêche

Le nombre de jours de mer par campagne semble ne dépendre que des instructions données par l'armateur (ou, bien sûr, des aléas mécaniques, météorologiques ou sociaux). Elle varie, selon les compagnies, de 19 à 30 jours. Le nombre de campagnes, par an, évoluant naturellement dans les mêmes proportions, de 10 à 20.

La durée des traits de chaluts par 24 heures est essentiellement fonction des captures accessoires. Le nombre moyen de traits par jour est de l'ordre de 3 à 4, pour les traits de jour, auquel se rajoutent éventuellement 1 ou 2 traits de nuit.

## A.4. Les rejets

A.4.1. Crevettes

Les plus petites crevettes qui apparaissent dans les débarquements ont une longueur céphalotoracique (Lc) de 20 mm ce qui correspond à un poids total de 6 g (soit 167 individus par kilo). Compte-tenu du très faible nombre d'individus capturés, il s'agit de crevettes ayant échappé à un tri rigoureux. Les rejets d'individus de cette taille pourraient être relativement importants. Certains armements, cependant, conservent systématiquement les crevettes à partir d'une taille de 23 mm Lc (8,9 g, soit 115 individus par kilo).

A partir d'une taille de 25 mm Lc, soit 11 g unitaire (91 individus par kilo), la totalité des crevettes est conservée à bord, quelque soit la compagnie. L'espèce *Xiphopenaeus kroyeri* est, elle, systématiquement rejetée.

Si l'on suppose qu'en ce qui concerne les rejets, les navires travaillent tous d'une manière comparable, et compte-tenu de l'importance relative de ces armements par rapport à l'ensemble de la flottille (en nombre de jours de mer), les rejets de crevettes de cette taille (23 à 25 mm Lc) pourraient être estimés à 10,2 t/an. Comparé à l'importance de la production, ces rejets potentiels semblent donc être faibles, en poids ; en nombre, ils ont sans doute une importance non négligeable.

A.4.2. Poissons

Les captures accessoires de poisson représentent environ 10 fois celles de crevettes, en poids.

L'ensemble de ces captures est systématiquement rejeté, mis à part quelques poissons de forte valeur commerciale (Scianidés : *S. similis* et Lutjanidés : *L. synagris*), qui font partie essentiellement de la part de pêche réservée aux marins (godaille).

### A.5. Pêcherie artisanale

Seule l'espèce de crevette côtière, *Xiphopenaeus kroyeri*, fait l'objet d'une exploitation de type artisanale à partir d'installations fixes dites "barrières chinoises", principalement dans la Rivière de Cayenne, où il ne subsiste plus d'ailleurs que quelques installations. La production totale de cette espèce est tout-à-fait marginale et peut-être évaluée à 3 t/mois, soit une production annuelle de 30 à 40 t, uniquement destinée au marché local, en frais.

En Guyane française, il n'existe pas de pêcherie artisanale dirigée vers les crevettes *P. subtilis* et *P. brasiliensis*.

## B. TRAITEMENT DES CAPTURES

### B.1. Traitement industriel des crevettes

B.1.1. Equipements à terre

Trois armements possèdent les capacités de stockage en froid et des équipements à terre pour le traitement des crevettes dont les caractéristiques sont les suivantes:

PIDEG (Pêcheries Internationales de Guyane):

- froid négatif : 2 chambres (1200 m3 et 300 m2)
- tunnel de congélation : 3 chambres (150 m3, 210 m3, 192 m3)
- machine à glace : 2 machines de 7 tonnes jour théorique
- silo à glace : 120 m3
- véhicules frigorifiques : 1 camion frigorifique positif
- calibreuse mécanique

C.F.P. (Compagnie Française de pêche):

- froid positif : 56 m3
- froid négatif : 3 chambres (36 m3 à -10°C, 484 et 523 m3 à -20°C
- tunnel de congélation : 1 chambre de 32 m3
- machine à glace : 1 tonne jour (paillette)
- silo à glace : 27 m3
- calibreuse mécanique
- chaîne de cuisson de crustacés

GUYAPECHE (Société Guyanaise d'Armement et de Pêche) :

- froid négatif : 2 fois 300 m3 avec un sas positif de 100 m3
- véhicule frigorifique : 1 camion frigorifique négatif

B.1.2. Quantités de crevettes traitées annuellement par armement. Nombre de débarquements et relations entre les bateaux et les armements

Les volumes traités par an dans chaque atelier sont regroupés dans le tableau 6. On remarque que la C.F.P. et la PIDEG traitent la production de bateaux extérieurs à l'armement, avec celle de leurs propres navires.

**Tableau 6**: Quantités de crevettes traitées dans les trois ateliers de Guyane française de 1988 à 1991, et nombre de bateaux correspondant.

| | QUANTITES TRAITEES (en tonnes) | NBRE TOTAL DE BATEAUX | NBRE BATEAUX GERES PAR L'ARMEMENT |
|---|---|---|---|
| 1988 | | | |
| GUYAPECHE | 410,67 | 4,4 | 4,4 |
| CFP (1) | 966,29 | 14,54 | 12,2 |
| CFP (2) | 131,11 | 1,0 | 1,1 |
| PIDEG (1) | 1879,04 | 52,3 | 3,0 |
| PIDEG (2) | 24,46 | 0,1 | 0,1 |
| 1989 | | | |
| GUYAPECHE | 295,40 | 5,0 | 5,0 |
| CFP (1) | 1074,47 | 23,0 | 16,1 |
| CFP (2) | 186,81 | 1,8 | 1,8 |
| PIDEG | 2334,13 | 48,9 | 3,0 |
| 1990 | | | |
| GUYAPECHE | 391,53 | 6,8 | 6,8 |
| CFP (1) | 1354,92 | 21,3 | 16,0 |
| CFP (2) | 204,21 | 2,0 | 2,0 |
| PIDEG | 1180,25 | 44,5 | 3,0 |
| 1991 | | | |
| GUYAPECHE | 430,63 | 7,8 | 7,8 |
| CFP (1) | 1281,31 | 28,8 | 18,1 |
| CFP (2) | 341,22 | 5,1 | 5,1 |
| PIDEG | 1602,06 | 27,4 | 3,0 |

(1) crevettes du plateau, (2) crevettes du talus.

On notera l'importance grandissante de l'usine de la CFP, en nombre de bateaux dont la production est traitée, au détriment de celle qui est gérée par le groupe PIDEG. Cette situation est une conséquence de la francisation de la flottille qui a entraîné le départ des navires américains, ceci conditionnant leur production dans cette dernière usine de traitement.

B.1.3. Type de traitement

Le tri des crevettes en catégories commerciales a lieu en mer pour l'ensemble des navires. Chaque armement a sa propre gamme de catégories commerciales. Il existe actuellement 3 gammes de catégories commerciales en Guyane, dont les limites sont présentées sur la figure 4.

Le conditionnement en boîtes cartonnées a lieu en mer pour les armements Guyapêche (boîtes de 2 kg) et Unifipêche (boîtes de 5 kg).

Pour les autres armements, les crevettes triées sont débarquées dans des caissettes en plastique de 8 à 12 kg, puis mises en boîtes cartonnées de 20 kg.

B.1.4. Pourcentage de la production traitée entière ou en queues

Les données de production de crevettes en queues "head off" et entières "head on" sont regroupées dans le tableau 7.

**Tableau 7**: Répartition des débarquements de crevettes en queues et en crevettes entières.

| | QUEUES | | ENTIERES | |
|---|---|---|---|---|
| ANNEES | tonnages | % | tonnages | % |
| 1988 | 2534,6 | 59,41 | 1731,8 | 40,59 |
| 1989 | 1492,7 | 40,30 | 2211,5 | 59,70 |
| 1990 | 860,6 | 21,91 | 3066,5 | 78,09 |
| 1991 | 320,7 | 9,68 | 2993,1 | 90,32 |

L'évolution de ces données montre qu'après avoir été essentiellement destinées au marché américain (crevettes "head-off"), les crevettes de Guyane sont à présent exportées en presque totalité vers l'Europe (crevettes "head-on")

### B.2. Traitement des captures de la pêche artisanale

L'ensemble des captures de la pêche artisanale, constituée uniquement de crevettes "sea-bob" est commercialisé exclusivement en frais sur le marché local.

## C. LE MARCHÉ DE LA CREVETTE

### C.1. Le marché local

Le marché local n'absorbe qu'une toute petite partie de la production de crevettes.

La crevette "sea-bob" est vendue en frais localement entre 25 et 30 francs le kilo.

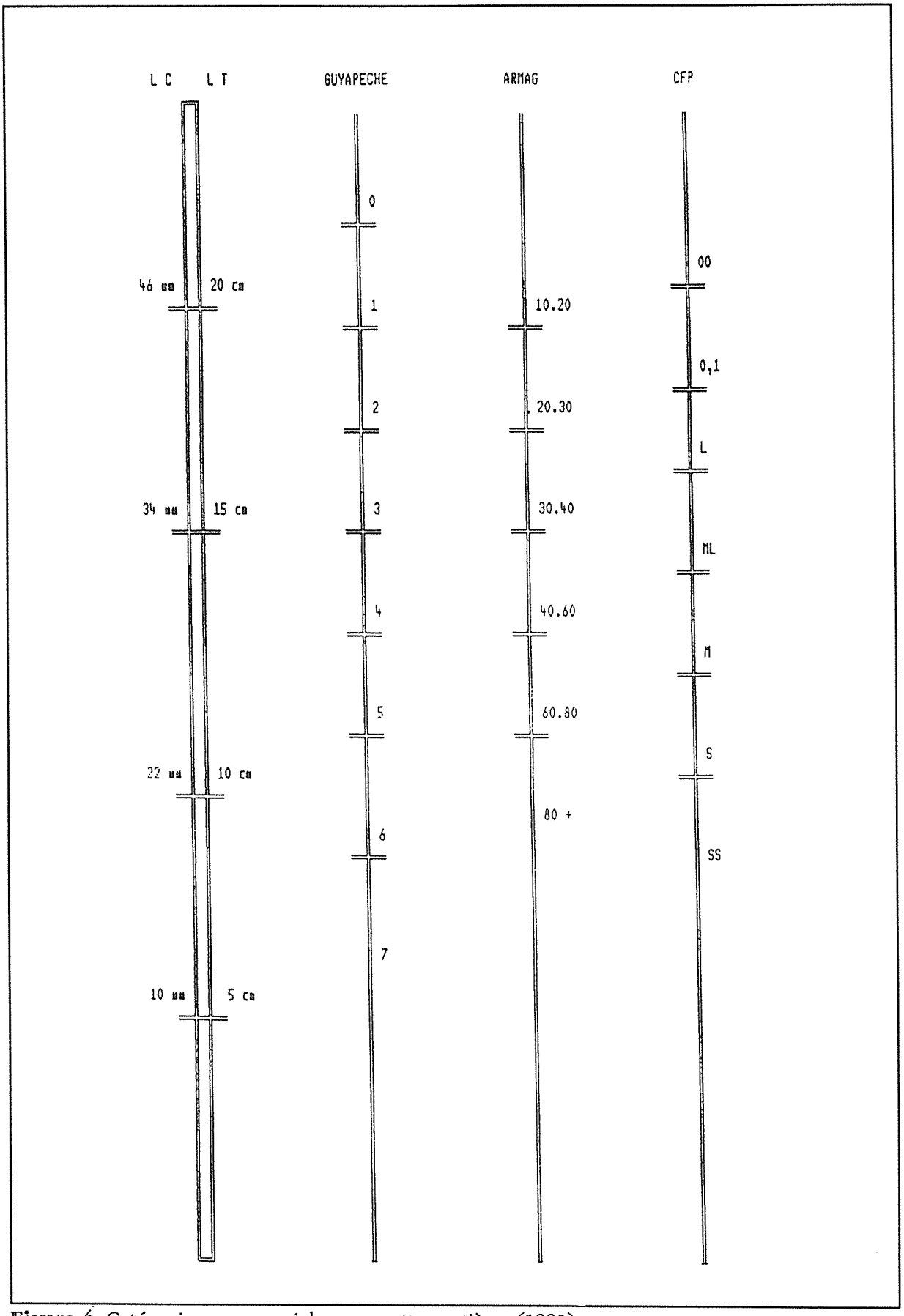


**Figure 4**: Catégories commerciales : crevettes entières (1991).

Le tonnage total de crevettes pénéïdes (*Penaeus subtilis* et *Penaeus brasiliensis*) vendu congelé est de l'ordre de 100 à 120 tonnes par an. Ces crevettes sont commercialisées entières ou en queues, à des prix très variables selon la taille et selon le point de vente. Ces prix s'échelonnent entre 45 F (LC = 25 mm environ ; moins de 90 unités par kilo) et 175 F (LC = 45 mm ; moins de 20 unités par kilo) pour les crevettes entières et entre 40 F et 160 F pour les queues de crevette.

La demande locale porte essentiellement sur des crevettes de taille moyenne, qu'elles soient entières (Lc = 35 MM ; moins de 36 unités par kilo) ou en queues.

### C.2. Le marché à l'exportation

D'après les données des Douanes, pour 1990, les exportations ont porté sur un total de 3395 t à destination de:

- France métropolitaine : 1937 t
- Reste de la C.E.E. : 1061 t
- U.S.A. : 268 t
- Caraïbes : 140 t

Le prix moyen au départ a été de 58 F le kilo.

## II. RÉSULTATS D'EXPLOITATION

## A. EFFORT

Les répartitions des bateaux, par flottille nationale, ainsi qu'entre le plateau continental et le talus, sont indiquées sur le tableau 8.

**Tableau 8**: Répartition annuelle des flottilles par zone de pêche en nombre moyen de bateaux (observations mensuelles).

| NATION | 1988 | | 1989 | | 1990 | | | 1991 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | plat | talus | plat | talus | plat | talus | immob | plat | talus | immob |
| USA | 30,5 | | 20,0 | | 8,2 | | | | | |
| FRANCE | 40,7 | 1,1 | 56,9 | 1,8 | 61,2 | 2,0 | 3,2 | 50,6 | 5,1 | 13,4 |
| | 71,2 | 1,1 | 76,9 | 1,8 | 69,4 | 2,0 | 3,2 | 50,6 | 5,1 | 13,4 |
| TOTAL | 72,3 | | 78,8 | | 74,6 | | | 69,1 | | |

plat = bateaux en activité sur le plateau continental, talus = bateaux en activité, immob = bateaux immobilisés pour une durée égale ou supérieure à 15 jours.

Il apparaît que seule la flottille française a exploité les crevettes profondes avec une intensité accrue de 1988 à 1991, le nombre moyen de bateaux passant de 1,1 à 5,1 en quatre ans.

On remarque par ailleurs que, pour la même période, le nombre de bateaux immobilisés est en augmentation continuelle (13,4 navires en 1991).

L'effort de pêche mensuel en nombre de jours de mer est indiqué sur les tableaux 9 (plateau) et 10 (talus).

**Tableau 9**: Effort de pêche mensuel (en nombres de jours de mer), par nationalité, sur le talus continental, de 1988 à 1991.

| AN. | NATION | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 88 | USA | 885 | 833 | 870 | 776 | 896 | 817 | 843 | 820 | 781 | 844 | 695 | 693 |
| | FRANCE | 955 | 825 | 996 | 987 | 1050 | 973 | 992 | 1031 | 895 | 908 | 904 | 1087 |
| 89 | USA | 726 | 612 | 908 | 513 | 574 | 526 | 591 | 429 | 394 | 448 | 435 | 420 |
| | FRANCE | 1152 | 1133 | 1337 | 1406 | 1418 | 1342 | 1370 | 1426 | 1388 | 1323 | 1320 | 1485 |
| 90 | USA | 439 | 296 | 273 | 264 | 265 | 269 | 268 | 255 | 129 | | | |
| | FRANCE | 1388 | 1326 | 1509 | 1442 | 1577 | 1454 | 1527 | 1423 | 1361 | 1249 | 1189 | 1052 |
| 91 | FRANCE | 1275 | 1133 | 1291 | 1266 | 1318 | 1236 | 1315 | 1327 | 1374 | 1410 | 763 | 948 |

**Tableau 10**: Effort de pêche mensuel (en nombre de jours de mer) sur le talus continental, de 1988 à 1991.

| AN. | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 88 | | | | | 28 | 55 | 52 | 29 | 50 | 119 | 2 | 30 |
| 89 | | 2 | | 2 | | 70 | 128 | 132 | 54 | 63 | 67 | 6 |
| 90 | 21 | | | | 5 | 38 | 70 | 114 | 102 | 101 | 86 | 112 |
| 91 | 96 | 104 | 101 | 100 | 148 | 193 | 182 | 149 | 168 | 147 | 47 | 44 |

Rapportées au nombre de bateaux actifs et au nombre total de bateaux, les données d'effort (en valeurs annuelles) sont présentées dans le tableau 11.

**Tableau 11**: Effort de pêche sur le plateau continental, en nombre de jours de mer par bateau.

| | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|
| (1) | 25 | 24 | 23 | 22 |
| (2) | 24,26 | 22,02 | 21,20 | 17,68 |

(1) = Nombre moyen de jours de mer par bateau en activité par mois., (2) = Nombre moyen de jours de mer par rapport au nombre total de bateaux, par mois.

On constate une diminution constante du nombre de jours de mer par bateau actif. Il passe, en effet, de 25 jours par mois et par bateau à 22 jours par mois et par bateau, de 1988 à 1991.

Les variations mensuelles de l'effort de pêche en nombre de jours de mer, par armement, sont regroupées dans le tableau 12 et sur la figure 5.

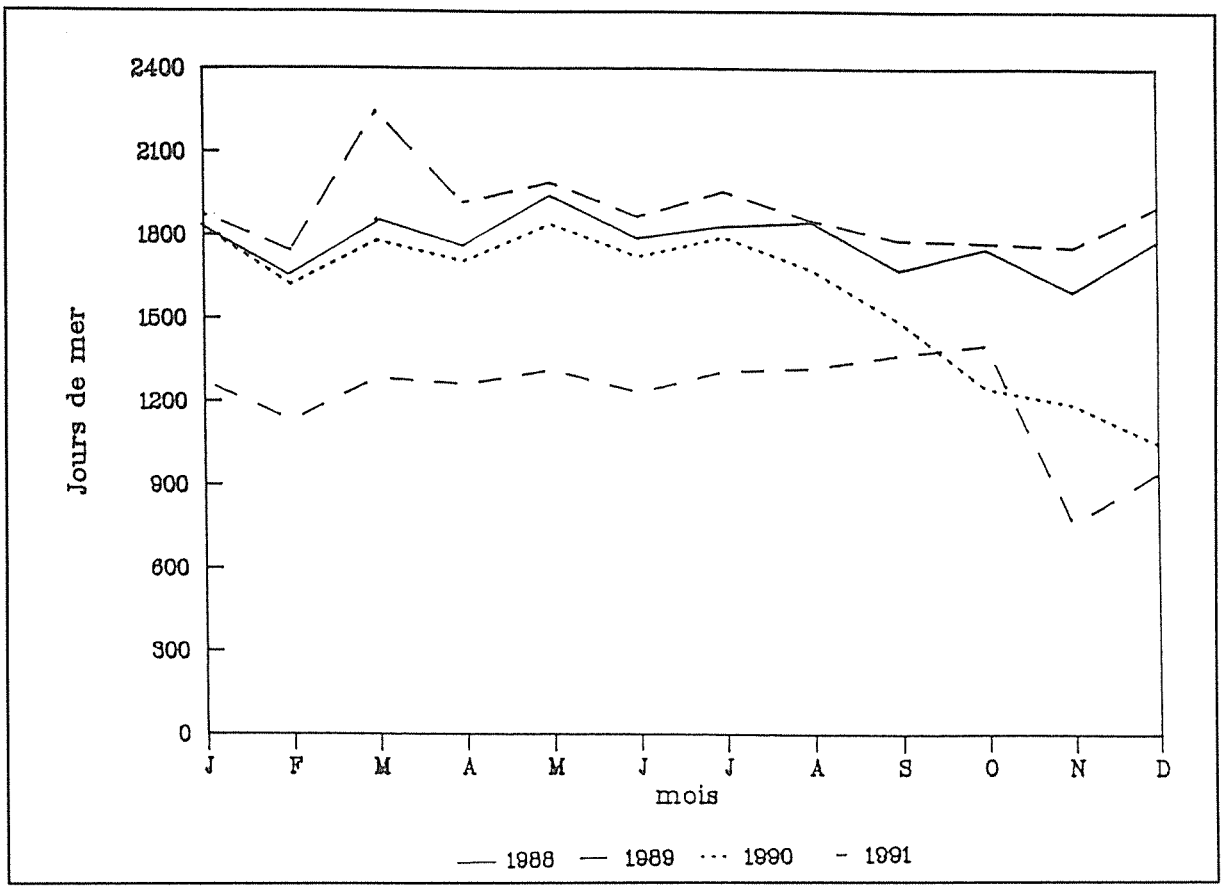


**Figure 5**: Évolution mensuelle de l'effort de pêche sur le plateau continental.

**Tableau 12**: Evolution de l'effort de pêche sur le plateau continental, en jours de mer, par armement et par mois de 1988 à 1991.

| AN. | ARMEMENTS | NATION | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1988 | SAHLMAN SEA FOOD | USA | 885 | 833 | 870 | 776 | 896 | 817 | 843 | 820 | 781 | 844 | 695 | 693 |
| | CFP | FRANCE | 237 | 249 | 301 | 283 | 258 | 251 | 265 | 284 | 221 | 186 | 282 | 309 |
| | PIDEG | " | 66 | 52 | 78 | 76 | 74 | 83 | 65 | 75 | 76 | 85 | 77 | 78 |
| | ARMAG | " | 441 | 350 | 433 | 422 | 466 | 405 | 419 | 447 | 400 | 433 | 274 | 446 |
| | GUYAPECHE | " | 76 | 69 | 73 | 83 | 116 | 124 | 112 | 90 | 81 | 85 | 121 | 126 |
| | CGP | " | 53 | 37 | 39 | 57 | 70 | 45 | 52 | 52 | 54 | 51 | 51 | 55 |
| | INDEPENDANTS | " | 55 | 47 | 46 | 45 | 39 | 39 | 54 | 54 | 38 | 47 | 45 | 28 |
| | GUYVINA | " | 27 | 21 | 26 | 21 | 27 | 26 | 25 | 29 | 25 | 21 | 54 | 45 |
| | TOTAL | | 1840 | 1658 | 1866 | 1763 | 1946 | 1790 | 1835 | 1851 | 1876 | 1752 | 1599 | 1780 |
| 1989 | SAHLMAN SEA FOOD | USA | 726 | 612 | 908 | 513 | 574 | 526 | 591 | 429 | 394 | 448 | 435 | 420 |
| | CFP | FRANCE | 321 | 280 | 338 | 368 | 384 | 288 | 237 | 266 | 263 | 259 | 311 | 373 |
| | PIDEG | " | 82 | 66 | 85 | 80 | 73 | 68 | 85 | 83 | 82 | 73 | 82 | 91 |
| | ARMAG | " | 405 | 409 | 447 | 442 | 401 | 377 | 351 | 380 | 369 | 333 | 342 | 373 |
| | GUYAPECHE | " | 128 | 92 | 125 | 126 | 129 | 118 | 135 | 120 | 118 | 122 | 111 | 124 |
| | CGP | " | 56 | 56 | 57 | 48 | 50 | 55 | 55 | 45 | 57 | 58 | 52 | 39 |
| | INDEPENDANTS | " | 77 | 62 | 89 | 80 | 83 | 114 | 105 | 92 | 81 | 99 | 82 | 105 |
| | GUYVINA | " | 46 | 48 | 42 | 55 | 49 | 48 | 74 | 79 | 83 | 76 | 80 | 73 |
| | COPECA | " | | | 26 | 28 | 38 | 45 | 22 | 57 | 44 | | | 7 |
| | UNIFIPECHE | " | 37 | 120 | 125 | 153 | 183 | 201 | 280 | 279 | 262 | 275 | 236 | 279 |
| | SOPEMAG | " | | | 3 | 26 | 28 | 28 | 26 | 25 | 29 | 28 | 24 | 21 |
| | TOTAL | | 1878 | 1745 | 2245 | 1919 | 1992 | 1868 | 1961 | 1855 | 1782 | 1771 | 1755 | 1905 |

**Tableau 12**: (continué)

| AN. | ARMEMENTS | NATION | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1990 | SAHLMAN SEA FOOD | USA | 439 | 296 | 273 | 264 | 265 | 269 | 268 | 255 | 129 | | | |
| | CFP | FRANCE | 336 | 336 | 350 | 303 | 363 | 281 | 310 | 257 | 327 | 239 | 266 | 238 |
| | PIDEG | " | 72 | 63 | 78 | 67 | 78 | 70 | 88 | 63 | 47 | 57 | 33 | 46 |
| | ARMAG | " | 272 | 316 | 368 | 381 | 418 | 392 | 439 | 412 | 346 | 338 | 243 | 174 |
| | GUYAPECHE | " | 124 | 121 | 166 | 160 | 163 | 147 | 142 | 109 | 116 | 127 | 151 | 135 |
| | CGP | " | 47 | 25 | 51 | 49 | 49 | 51 | 39 | 52 | 49 | | | |
| | INDEPENDANTS | " | 129 | 105 | 112 | 113 | 103 | 118 | 148 | 138 | 93 | 73 | 55 | 34 |
| | GUYVINA | " | 65 | 29 | 56 | 58 | 63 | 78 | 64 | 64 | 61 | 95 | 138 | 114 |
| | COPECA | " | 40 | 35 | 37 | 38 | 47 | 32 | 6 | 48 | 33 | 20 | 25 | 18 |
| | UNIFIPECHE | " | 268 | 245 | 245 | 218 | 235 | 233 | 239 | 229 | 240 | 247 | 230 | 263 |
| | SOPEMAG | " | 35 | 51 | 46 | 55 | 58 | 52 | 52 | 51 | 49 | 53 | 48 | 30 |
| | TOTAL | | 1827 | 1622 | 1782 | 1706 | 1842 | 1723 | 1795 | 1678 | 1490 | 1249 | 1189 | 1052 |
| 1991 | CFP | FRANCE | 277 | 207 | 244 | 228 | 267 | 244 | 229 | 281 | 293 | 291 | 139 | 174 |
| | PIDEG | " | 76 | 56 | 75 | 55 | 52 | 16 | 58 | 57 | 54 | 79 | 28 | 49 |
| | ARMAG | " | 224 | 234 | 254 | 299 | 302 | 298 | 284 | 252 | 284 | 297 | 156 | 165 |
| | GUYAPECHE | " | 131 | 134 | 158 | 167 | 189 | 169 | 186 | 156 | 154 | 141 | 109 | 132 |
| | INDEPENDANTS | " | 103 | 51 | 88 | 85 | 77 | 70 | 118 | 108 | 144 | 153 | 110 | 166 |
| | GUYVINA | " | 122 | 114 | 120 | 124 | 120 | 133 | 136 | 135 | 126 | 119 | 104 | 102 |
| | COPECA | " | 33 | 45 | 42 | 39 | 15 | | | | | | | 5 |
| | UNIFIPECHE | " | 280 | 265 | 296 | 254 | 268 | 280 | 276 | 312 | 292 | 299 | 110 | 144 |
| | SOPEMAG | " | 29 | 27 | 14 | 15 | 28 | 26 | 28 | 26 | 27 | 31 | 7 | 11 |
| | TOTAL | | 1275 | 1133 | 1291 | 1266 | 1312 | 1236 | 1315 | 1327 | 1374 | 1410 | 763 | 948 |

# B. CAPTURES ET DÉBARQUEMENTS

## B.1. Évolution mensuelle des captures

Les débarquements mensuels, par flottille et par an, sont regroupés dans le tableau 13 et sur la figure 6.

**Tableau 13**: Crevettes du plateau continental : Production mensuelle en kilo de crevettes entières de 1988 à 1991.

| AN. | PAVILLON | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 88 | USA | 169116 | 162646 | 329415 | 191179 | 126307 | 105815 | 104280 | 128401 | 144839 | 174302 | 98525 | 129704 |
| | FRANCE | 202063 | 313382 | 287903 | 249456 | 178324 | 172839 | 180220 | 161626 | 177200 | 145162 | 185635 | 138156 |
| | TOTAL | 371179 | 476028 | 617318 | 440635 | 304631 | 278654 | 284500 | 290027 | 322039 | 319464 | 284160 | 267860 |
| 89 | USA | 89812 | 128945 | 85458 | 123546 | 76538 | 85527 | 90730 | 68805 | 47305 | 36846 | 42264 | 52773 |
| | FRANCE | 223478 | 213916 | 251387 | 309828 | 246302 | 262023 | 215017 | 188648 | 213062 | 209625 | 206506 | 235884 |
| | TOTAL | 313290 | 342861 | 336845 | 433374 | 322840 | 347550 | 305747 | 257453 | 260367 | 246471 | 248770 | 288657 |
| 90 | USA | 46133 | 74764 | 62463 | 57527 | 58239 | 44094 | 29299 | 39489 | 37986 | | | |
| | FRANCE | 231967 | 306055 | 440543 | 353985 | 373277 | 288056 | 216460 | 300315 | 284358 | 192798 | 318167 | 170685 |
| | TOTAL | 278100 | 380819 | 503006 | 411512 | 431516 | 332150 | 245759 | 339804 | 322344 | 192798 | 318167 | 170685 |
| 91 | FRANCE | 244615 | 318577 | 339754 | 307361 | 234046 | 186772 | 172515 | 287080 | 382699 | 377910 | 233268 | 229061 |
| | TOTAL | 244615 | 318577 | 339754 | 307361 | 234046 | 186772 | 172515 | 287080 | 382699 | 377910 | 233268 | 229061 |

La production totale est en baisse depuis 1988 ; elle passe de 4266 t à 3319 t. Cette baisse est la conséquence directe d'une diminution de l'effort de pêche et non d'une dégradation des rendements, comme le montre l'analyse des p.u.e.

Les productions, par armement, sont regroupées dans le tableau 14 pour les crevettes du plateau. Elles sont présentées par espèce dans le tableau 15 pour les crevettes du talus.

**Tableau 14**: Crevettes du plateau continental : production par armement et par mois, en kilo de crevettes entières de 1988 à 1991.

| AN. | ARMEMENTS | NATION | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SAHLMAN SEA FOOD | USA | 169116 | 162646 | 329415 | 191179 | 126307 | 105815 | 104280 | 128401 | 144839 | 174302 | 98525 | 129704 |
| | CFP | FRANCE | 47420 | 83761 | 129330 | 67289 | 51782 | 65759 | 50816 | 63639 | 54191 | 52059 | 68348 | 49310 |
| | PIDEG | " | 22007 | 26372 | 26713 | 22074 | 22643 | 15984 | 10132 | 13618 | 18095 | 10432 | 17831 | 15018 |
| | ARMAG | " | 89529 | 141596 | 75671 | 117029 | 55721 | 40843 | 51910 | 36101 | 53815 | 48527 | 34682 | 32283 |
| 1988 | GUYAPECHE | " | 19870 | 30880 | 25544 | 14813 | 21800 | 32634 | 136250 | 26848 | 32019 | 17995 | 30329 | 21683 |
| | CGP | " | 12687 | 18594 | 4912 | 13797 | 12565 | 7875 | 12794 | 9520 | 11464 | 6941 | 15193 | 5715 |
| | INDEPENDANTS | " | 6409 | 9570 | 15286 | 9593 | 9823 | 6017 | 12715 | 7933 | 2292 | 5910 | 8037 | 7759 |
| | GUYVINA | " | 19870 | 2604 | 10444 | 4857 | 3983 | 3722 | 5599 | 3961 | 5319 | 3293 | 11211 | 6383 |
| | UNIFIPECHE | " | | | | | | | | | | | | |
| | SAHLMAN SEA FOOD | USA | 89812 | 128945 | 85458 | 123546 | 76538 | 85527 | 90730 | 68805 | 47305 | 36846 | 42264 | 52773 |
| | CFP | FRANCE | 88510 | 52044 | 94756 | 105710 | 73440 | 80093 | 49417 | 39454 | 48674 | 41815 | 53244 | 89606 |
| | PIDEG | " | 7168 | 20370 | 8852 | 18630 | 16066 | 15711 | 10378 | 10179 | 10843 | 9455 | 9832 | 11723 |
| | ARMAG | " | 71184 | 67021 | 70220 | 84569 | 79106 | 60921 | 54541 | 52868 | 51637 | 58304 | 56603 | 56191 |
| | GUYAPECHE | " | 31294 | 22451 | 26510 | 34653 | 20163 | 28206 | 21755 | 19015 | 23403 | 24880 | 18515 | 24551 |
| 1989 | CGP | " | 7216 | 7494 | 12364 | 9122 | 5689 | 9687 | 8181 | 3743 | 9470 | 11150 | 8579 | 6705 |
| | INDEPENDANTS | " | 12395 | 10838 | 5660 | 6479 | 9673 | 18719 | 14856 | 12117 | 11020 | 9018 | 5778 | 10175 |
| | GUYVINA | " | 3329 | 9149 | 5728 | 12145 | 3897 | 6215 | 10996 | 9039 | 7891 | 10106 | 9742 | 4402 |
| | COPECA | " | | | 2080 | 1499 | 7129 | 7906 | 4013 | 7094 | 5925 | | | 2694 |
| | UNIFIPECHE | " | 2379 | 24544 | 25213 | 32450 | 28334 | 31212 | 37671 | 30317 | 41208 | 41876 | 40433 | 28020 |
| | SOPEMAG | " | | | | 4565 | 2801 | 3346 | 3203 | 4814 | 2985 | 3016 | 3774 | 1810 |
| | SAHLMAN SEA FOOD | USA | 46133 | 74764 | 62463 | 57527 | 58239 | 44094 | 29299 | 39489 | 37986 | | | |
| | CFP | FRANCE | 56150 | 91249 | 160412 | 78303 | 92945 | 71030 | 44768 | 86778 | 59154 | 61535 | 68684 | 60866 |
| | PIDEG | " | 13290 | 13860 | 19401 | 17499 | 15259 | 10503 | 16884 | 3512 | 13438 | 7943 | 6807 | 4182 |
| | ARMAG | " | 34077 | 62473 | 69682 | 92218 | 98624 | 73685 | 45227 | 74746 | 85542 | 28914 | 84294 | 15831 |
| | GUYAPECHE | " | 29290 | 28914 | 37406 | 47081 | 41720 | 41765 | 28698 | 16695 | 44536 | 24332 | 41488 | 9602 |
| 1990 | CGP | " | 11156 | 8995 | 14825 | 9483 | 9322 | 3471 | 5444 | 13422 | 9370 | | | |
| | INDEPENDANTS | " | 16927 | 28201 | 30157 | 18231 | 20562 | 12767 | 21887 | 21145 | 9586 | 777 | 16973 | |
| | GUYVINA | " | 10464 | 8636 | 14990 | 10320 | 18884 | 5039 | 8887 | 15246 | 8368 | 7715 | 25546 | 20531 |
| | COPECA | " | 3475 | 8906 | 5378 | 11886 | 6916 | 8777 | 792 | 5596 | 6235 | 4734 | 2944 | 4468 |
| | UNIFIPECHE | " | 51447 | 49006 | 71121 | 59291 | 56653 | 52339 | 38112 | 52013 | 37546 | 45137 | 58338 | 48914 |
| | SOPEMAG | " | 5691 | 5815 | 17171 | 9673 | 12392 | 8680 | 5761 | 11162 | 10583 | 11711 | 13093 | 6291 |
| | CFP | FRANCE | 42792 | 81025 | 69714 | 49432 | 33110 | 30965 | 18312 | 81716 | 86318 | 105520 | 47978 | 13307 |
| | PIDEG | " | 13979 | 9259 | 7177 | 28764 | 3704 | 876 | 9984 | 15121 | 18444 | 9100 | 19583 | 8878 |
| | ARMAG | " | 53490 | 52286 | 51738 | 68091 | 55170 | 45741 | 37906 | 54751 | 86934 | 52509 | 47803 | 36802 |
| | GUYAPECHE | " | 27104 | 41247 | 49226 | 30015 | 38576 | 23714 | 22383 | 32197 | 48145 | 40836 | 18136 | 59048 |
| 1991 | INDEPENDANTS | " | 11260 | 6916 | 29901 | 12451 | 14116 | 10086 | 7106 | 10487 | 21006 | 36987 | 11976 | 54793 |
| | GUYVINA | " | 17138 | 18878 | 27284 | 34574 | 12365 | 22746 | 22289 | 15239 | 37284 | 21480 | 26362 | 42283 |
| | COPECA | " | 4805 | 12382 | 3668 | 6357 | 2624 | | | | | | | |
| | UNIFIPECHE | " | 69817 | 93249 | 98798 | 73649 | 68558 | 49244 | 49676 | 71853 | 76269 | 11478 | 51379 | 13950 |
| | SOPEMAG | " | 4230 | 3335 | 2248 | 4028 | 5823 | 3400 | 4859 | 5716 | 8299 | | 10051 | |

**Tableau 15**: Crevettes du talus continental : production mensuelle, par espèce, en kilo de crevettes entières, de 1988 à 1991.

| AN. | ESPÈCES | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ORANGE | | | | | 7574 | 26917 | 20817 | 22967 | 19554 | | | |
| | ROSE | | | | | | | | | | | | |
| 88 | SCARLET | | | | | | | | | | 42891 | 859 | 8508 |
| | MEGALOPS | | | | | | | | | | 4135 | | 1341 |
| | TOTAL | | | | | 7574 | 26917 | 20817 | 22967 | 19554 | 47026 | 859 | 9849 |
| | ORANGE | | 265 | | 100 | | 10763 | 51169 | 31039 | 9865 | 33609 | 6128 | |
| | ROSE | | | | | | 7171 | 264 | 805 | 106 | 1230 | 197 | |
| 89 | SCARLET | | | | 496 | | | 11060 | 8100 | 4300 | 3431 | 5507 | 1208 |
| | MEGALOPS | | | | | | | | | | | | |
| | TOTAL | | 265 | | 596 | | 17934 | 62493 | 39944 | 14271 | 38270 | 11832 | 1208 |

**Tableau 15**: (continué)

| AN. | ESPÈCES | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 90 | ORANGE | | | | | | 17844 | 13284 | 29715 | 11828 | 31444 | 25768 | 37085 |
| | ROSE | | | | | | | | 296 | | 125 | 691 | 855 |
| | SCARLET | 2233 | | | | 485 | 987 | 7309 | 9902 | 1335 | 9197 | 2503 | 325 |
| | MEGALOPS | | | | | | | | | | | | |
| | TOTAL | 2233 | | | | 485 | 18831 | 20593 | 39913 | 13163 | 40766 | 28962 | 38265 |
| 91 | ORANGE | 34804 | 4298 | | | 2304 | 14740 | 12115 | 6453 | 5834 | | | |
| | ROSE | 358 | 26 | | | | | | | | | | |
| | SCARLET | 606 | 13346 | 7921 | 21612 | 30108 | 32622 | 40221 | 29886 | 30403 | 32916 | 18844 | |
| | MEGALOPS | | | | | | | | | | | | |
| | TOTAL | 35768 | 17670 | 7921 | 21612 | 32412 | 47362 | 52336 | 36339 | 36237 | 32916 | 18844 | |

ORANGE = *Solenocera acuminata* (200 m), ROSE = *Parapenaeus longirostris* (200 m), SCARLET = *Plesiopenaeus edwardsianus* (700 m), MEGALOPS = *Penaeopsis megalops* (300-500 m).

## B.2. Évolution saisonnière des débarquements

En ce qui concerne les crevettes du plateau, les débarquements sont maximaux pendant les mois de mars-avril, minimaux en juillet puis de nouveau assez élevés en septembre-octobre (Tableau 14 et figure 6).

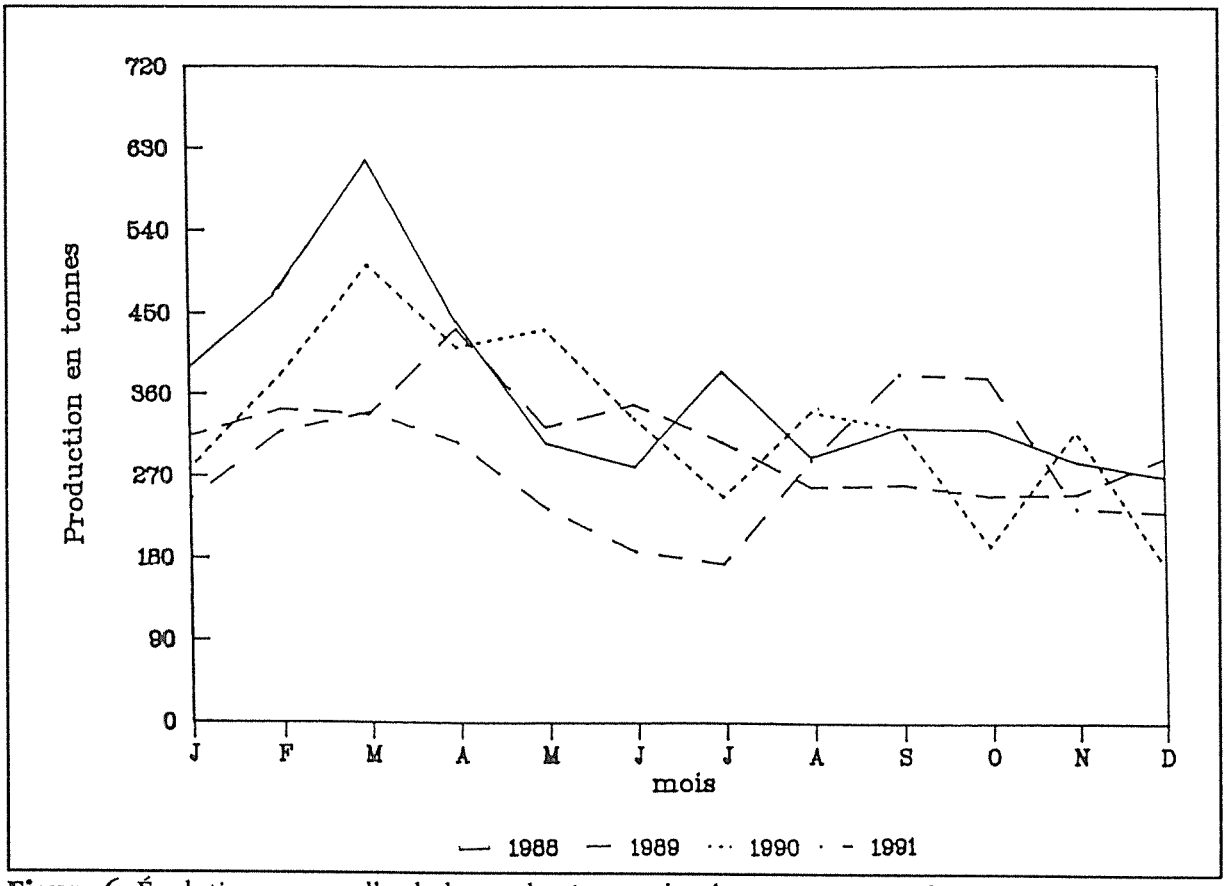


**Figure 6**: Évolution mensuelle de la production sur le plateau continental.

## C. CAPTURES PAR UNITÉ D'EFFORT

Les moyennes mensuelles (en kilo par jour de mer) sont regroupées dans le tableau 16. L'aspect général de la courbe moyenne présente un gros pic de printemps et un pic beaucoup moins marqué d'automne (Figure 7).

- l'année 1988 apparaît comme une année de fort rendement (225,9 kg/jour par rapport à 195 kilo/jour, moyenne de référence établie sur 14 ans de 1978 à 1991). Les mois les plus productifs ont été février, mars et avril.

- l'année 1989, à l'inverse, a été caractérisée par des rendements plus faibles que la moyenne, à peu près tout au long de l'année. Une lente décroissance des rendements peut être constatée de janvier à décembre alors qu'aucun pic de printemps ou d'automne n'est observable.

- En 1990, les rendements ont été presque toujours supérieurs à la moyenne de référence sans pour autant atteindre des valeurs exceptionnelles.

- l'année 1991 est apparue comme une année moyenne pendant le premier semestre. Les rendements au cours du second semestre, particulièrement en septembre, octobre et décembre, se sont, par contre, révélés exceptionnellement élevés (plus fortes valeurs enregistrées depuis 1978).

**Tableau 16**: Evolution des rendements par jour de mer, par armement et par mois (de 1988 à 1991).

| AN. | ARMEMENTS | NATION | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1988 | SAHLMAN SEA FOOD | USA | 173,2 | 230,7 | 335,7 | 251,5 | 158,0 | 127,9 | 120,8 | 143,4 | 173,0 | 170,0 | 200,6 | 147,2 |
| | CFP | FRANCE | 203,5 | 280,9 | 433,9 | 245,5 | 213,0 | 210,7 | 219,0 | 256,6 | 277,9 | 278,3 | 261,8 | 149,8 |
| | PIDEG | " | 338,5 | 355,7 | 342,4 | 339,6 | 193,5 | 270,9 | 155,8 | 206,3 | 210,4 | 130,4 | 287,6 | 132,9 |
| | ARMAG | " | 276,3 | 301,9 | 262,7 | 243,3 | 132,0 | 110,7 | 109,5 | 100,0 | 148,7 | 80,7 | 181,6 | 75,2 |
| | GUYAPECHE | " | 228,3 | 441,1 | 381,2 | 217,8 | 200,0 | 245,3 | 283,2 | 248,5 | 280,8 | 214,2 | 244,5 | 185,3 |
| | CGP | " | 309,4 | 387,9 | 409,3 | 226,1 | 256,4 | 201,9 | 196,8 | 170,0 | 229,2 | 289,2 | 253,2 | 98,5 |
| | INDEPENDANTS | " | 136,3 | 167,9 | 372,8 | 245,9 | 188,9 | 300,8 | 244,5 | 161,9 | 109,1 | :23,1 | 154,5 | 193,9 |
| | GUYVINA | " | 217,7 | 200,3 | 261,1 | 211,1 | 209,6 | 338,3 | 143,5 | 120,0 | 204,5 | 253,3 | 200,2 | 122,7 |
| | UNIFIPECHE | " | | | | | | | | | | | | |
| | TOTAL | | 207,1 | 283,5 | 342,0 | 248,8 | 168,3 | 157,4 | 148,3 | 159,7 | 190,4 | 154,9 | 219,1 | 132,7 |
| 1989 | SAHLMAN SEA FOOD | USA | 143,9 | 170,1 | 160,6 | 202,5 | 165,6 | 133,2 | 152,4 | 126,2 | 123,5 | 104,6 | 91,6 | 98,4 |
| | CFP | FRANCE | 280,0 | 240,9 | 274,6 | 263,6 | 214,7 | 272,4 | 170,9 | 153,5 | 185,7 | 176,4 | 171,7 | 225,1 |
| | PIDEG | " | 115,6 | 214,4 | 142,7 | 270,0 | 214,2 | 198,8 | 117,9 | 156,6 | 115,3 | 106,2 | 138,4 | 160,5 |
| | ARMAG | " | 169,8 | 186,1 | 155,3 | 197,5 | 132,9 | 194,0 | 139,4 | 145,2 | 145,0 | 53,4 | 174,7 | 130,0 |
| | GUYAPECHE | " | 235,2 | 249,4 | 212,0 | 234,1 | 190,2 | 204,3 | 181,2 | 161,1 | 164,8 | 192,8 | 201,2 | 203,0 |
| | CGP | " | 171,8 | 129,2 | 193,1 | 172,1 | 129,2 | 164,2 | 146,1 | 129,0 | 160,5 | 199,1 | 136,1 | 257,9 |
| | INDEPENDANTS | " | 163,0 | 140,7 | 92,7 | 104,5 | 129,2 | 168,6 | 125,9 | 121,1 | 121,1 | 103,6 | 105,0 | 95,9 |
| | GUYVINA | " | 123,3 | 172,6 | 272,7 | 202,4 | 92,8 | 151,6 | 137,4 | 120,5 | 111,1 | 104,1 | 123,3 | 74,6 |
| | COPECA | " | | | 173,3 | 57,6 | 475,3 | 143,7 | 160,5 | 107,4 | 116,1 | | | 107,7 |
| | UNIFIPECHE | " | 118,9 | 208,7 | 193,9 | 231,7 | 174,9 | 195,0 | 127,6 | 146,4 | 143,5 | 140,0 | 135,6 | 138,0 |
| | SOPEMAG | " | | | | 157,4 | 215,4 | 159,3 | 118,6 | 192,5 | 142,1 | 104,0 | 139,8 | 86,2 |
| | TOTAL | | 182,3 | 188,8 | 186,7 | 213,9 | 168,8 | 181,6 | 146,7 | 139,1 | 143,3 | 140,4 | 139,8 | 144,8 |

**Tableau 16**: (continué)

| AN. | ARMEMENTS | NATION | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SAHLMAN SEA FOOD | USA | 155,3 | 155,8 | 246,9 | 232,0 | 172,8 | 153,1 | 144,3 | 135,7 | 145,0 | | | |
| | CFP | FRANCE | 202,7 | 266,8 | 415,6 | 255,9 | 266,3 | 245,8 | 189,7 | 281,7 | 241,4 | 236,7 | 253,4 | 261,2 |
| | PIDEG | " | 139,9 | 184,8 | 366,1 | 208,3 | 211,9 | 156,8 | 157,8 | 117,1 | 158,1 | 172,7 | 154,7 | 190,1 |
| | ARMAG | " | 156,3 | 198,3 | 219,1 | 212,0 | 248,4 | 209,3 | 118,7 | 164,3 | 198,0 | 194,1 | 205,6 | 186,2 |
| | GUYAPECHE | " | 194,0 | 249,3 | 322,5 | 243,9 | 252,8 | 248,6 | 197,9 | 292,9 | 285,5 | 191,6 | 242,6 | 171,5 |
| | CGP | " | 359,9 | 166,6 | 290,7 | 379,3 | 127,7 | 128,6 | 126,6 | 159,8 | 173,5 | | | |
| 1990 | INDEPENDANTS | " | 166,0 | 152,4 | 292,8 | 162,8 | 178,8 | 190,6 | 142,1 | 133,8 | 112,8 | 23,5 | 160,1 | |
| | GUYVINA | " | 115,0 | 345,4 | 374,8 | 202,4 | 222,2 | 112,0 | 123,4 | 234,6 | 121,3 | 116,9 | 179,9 | 164,2 |
| | COPECA | " | 112,1 | 164,9 | 316,4 | 224,3 | 164,7 | 179,1 | 132,0 | 116,6 | 239,8 | 157,8 | 210,3 | 154,1 |
| | UNIFIPECHE | " | 197,1 | 203,3 | 298,8 | 257,8 | 227,5 | 231,6 | 174,0 | 170,0 | 196,6 | 180,5 | 249,3 | 267,3 |
| | SOPEMAG | " | 172,5 | 161,5 | 296,1 | 201,5 | 177,0 | 166,9 | 110,8 | 242,7 | 196,0 | 300,3 | 211,2 | 209,7 |
| | TOTAL | | 175,4 | 198,0 | 308,0 | 230,5 | 220,8 | 203,8 | 151,9 | 183,9 | 156,1 | 192,8 | 218,8 | 223,7 |
| | CFP | FRANCE | 187,7 | 319,0 | 277,7 | 235,4 | 157,7 | 114,3 | 136,7 | 234,1 | 302,9 | 352,9 | 225,2 | 316,8 |
| | PIDEG | " | 153,6 | 197,0 | 205,1 | 279,3 | 56,1 | 175,2 | 149,0 | 252,0 | 307,4 | 325,0 | 244,8 | 341,5 |
| | ARMAG | " | 267,5 | 236,6 | 215,6 | 241,5 | 184,5 | 127,4 | 136,8 | 229,1 | 265,0 | 229,3 | 190,5 | 368,0 |
| | GUYAPECHE | " | 172,6 | 271,4 | 307,7 | 227,4 | 177,8 | 134,7 | 119,7 | 194,0 | 321,0 | 281,6 | 221,2 | 461,3 |
| | INDEPENDANTS | " | 118,5 | 256,1 | 267,0 | 234,9 | 196,1 | 121,5 | 91,1 | 136,2 | 149,0 | 226,9 | 176,1 | 260,9 |
| 1991 | GUYVINA | " | 131,8 | 200,8 | 255,0 | 245,2 | 117,8 | 156,9 | 161,5 | 138,5 | 220,6 | 221,4 | 181,8 | 522,0 |
| | COPECA | " | 150,2 | 217,2 | 244,5 | 147,8 | 114,1 | | | | | | | |
| | UNIFIPECHE | " | 230,4 | 350,6 | 340,7 | 301,8 | 221,2 | 177,8 | 173,1 | 233,3 | 288,9 | 337,8 | 213,2 | 324,4 |
| | SOPEMAG | " | 176,3 | 185,3 | 124,9 | 183,1 | 215,7 | 136,0 | 167,6 | 197,1 | 286,2 | | 264,5 | |
| | TOTAL | | 194,1 | 280,4 | 276,7 | 249,9 | 176,1 | 139,3 | 144,1 | 214,6 | 268,4 | 292,7 | 208,6 | 363,6 |

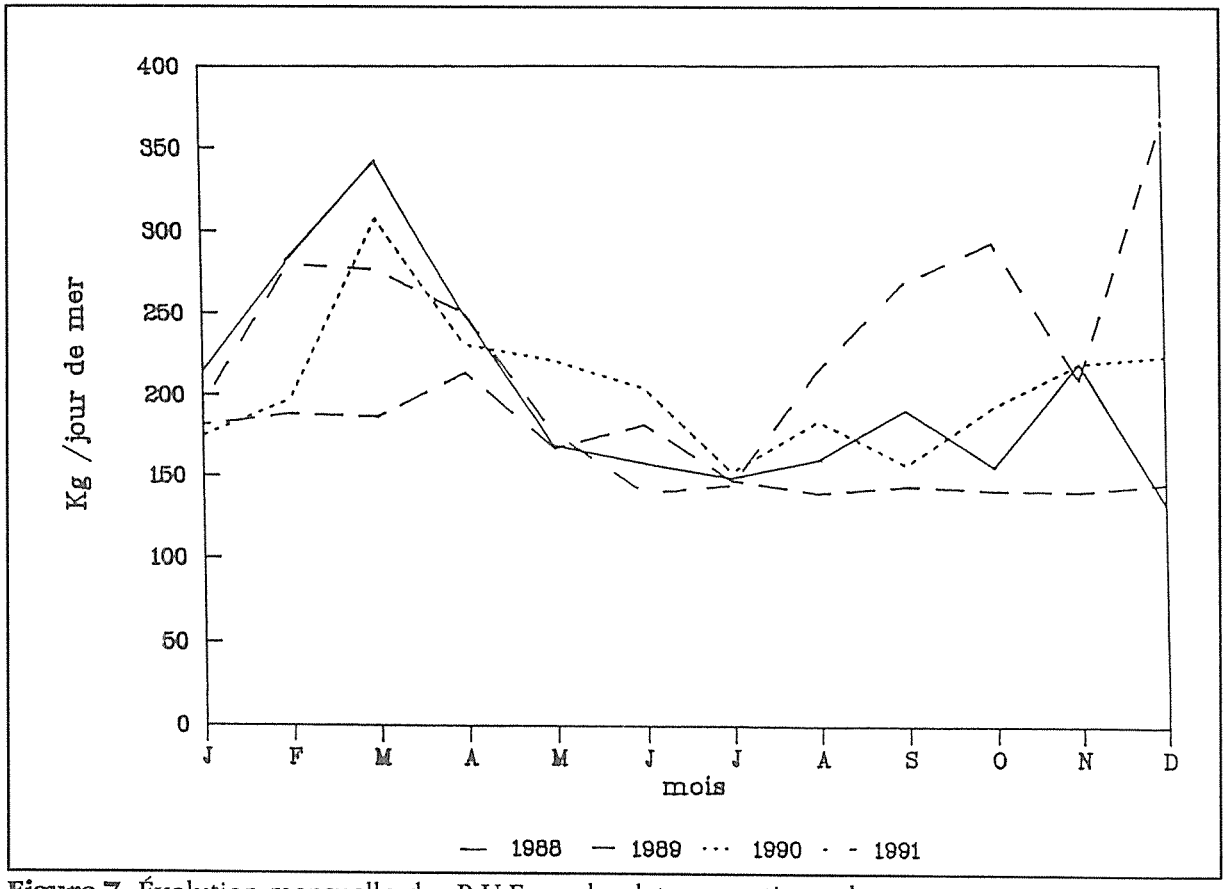


**Figure 7**: Évolution mensuelle des P.U.E. sur le plateau continental.

## D. PÊCHERIES ARTISANALES

Aucune donnée n'est disponible pour ce type de pêcherie.

# III. LA RESSOURCE EXPLOITÉE

## A. DISTRIBUTION EN CATÉGORIES COMMERCIALES

La distribution des captures au sein des différentes catégories commerciales montre une évolution nette depuis 1988. Cette année là s'est, en effet, caractérisée par le début de l'exploitation des fonds de moins de 30 mètres.

Entre 1989 et 1991, on constate une tendance à l'augmentation de l'importance relative des crevettes de petites tailles au détriment des grosses ; la classe 80+ passant de 5,3% à 7,1% (en nombre d'individus débarqués), alors que la classe U10 passe de 1,4% à 0,6% dans le même temps.

En 1991, les petites catégories commerciales (plus de 40 crevettes/kg) représentent 77,5% du nombre total de crevettes pêchées. Cette valeur, très élevée, est révélatrice de l'intensité de l'effort de pêche dirigé sur les petites crevettes.

## B. COMPOSITIONS PAR ESPÈCE ET PAR SEXE

La composition par espèce et par sexe des captures de crevettes pour les années 1988 à 1991, est indiquée dans les tableaux 17 à 20.

On remarquera que *P. brasiliensis*, qui entrait pour plus de 5% dans les captures, en nombre d'individus, en 1988, ne représente plus que 1 à 2% à partir de 1990. Cette espèce peut donc être considérée comme secondaire dans la pêcherie de crevette pénéïde de Guyane française. L'effort de pêche dirigé sur cette dernière espèce est généralement plus important au second semestre qu'au premier.

En ce qui concerne le sexe ratio des captures, on notera la prédominance des femelles, tant pour *P.subtilis* que pour *P. brasiliensis*.

**Tableau 17**: Composition des captures mensuelles par espèce et par sexe, pour 1988.

| | J | F | M | A | M | J | J | A | S | O | N | D | MOYEN. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SUBTILIS | | | | | | | | | | | | | 94,92 |
| mâle | 28,35 | 42,44 | 48,88 | 20,29 | 38,47 | 30,47 | 29,09 | 22,09 | 32,69 | 35,15 | 40,47 | 26,95 | |
| femelle | 61,97 | 53,65 | 50,48 | 72,89 | 42,61 | 53,94 | 57,93 | 66,77 | 51,79 | 57,78 | 51,20 | 61,68 | |
| BRASIL. | | | | | | | | | | | | | 5,08 |
| mâle | 2,33 | 0,39 | 0,15 | 1,16 | 5,22 | 5,87 | 6,20 | 4,64 | 7,95 | 0,44 | 0,02 | 2,31 | |
| femelle | 7,35 | 3,52 | 0,49 | 5,66 | 13,70 | 9,72 | 6,78 | 6,50 | 7,57 | 6,63 | 8,31 | 9,06 | |

**Tableau 18**: Composition des captures mensuelles par espèce et par sexe, pour 1989.

| | J | F | M | A | M | J | J | A | S | O | N | D | MOYEN. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SUBTILIS | | | | | | | | | | | | | 95,44 |
| mâle | 38,63 | 37,25 | 41,43 | 30,77 | 34,70 | 28,96 | 34,27 | 25,98 | 26,73 | 27,77 | 38,47 | 37,10 | |
| femelle | 49,58 | 49,91 | 52,17 | 62,32 | 55,44 | 63,53 | 58,48 | 57,51 | 65,96 | 65,00 | 48,37 | 57,29 | |
| BRASIL. | | | | | | | | | | | | | 4,56 |
| mâle | 4,25 | 7,31 | 2,79 | 1,23 | 2,17 | 3,27 | 3,14 | 9,93 | 3,17 | 1,95 | 8,25 | 0,82 | |
| femelle | 7,54 | 5,53 | 3,61 | 5,68 | 7,69 | 4,24 | 4,11 | 6,58 | 7,14 | 5,28 | 4,21 | 4,75 | |

**Tableau 19**: Composition des captures mensuelles par espèce et par sexe, pour 1990.

| | J | F | M | A | M | J | J | A | S | O | N | D | MOYEN. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SUBTILIS | | | | | | | | | | | | | 96,60 |
| mâle | | 43,17 | 46,74 | 42,16 | 49,22 | 42,80 | 42,44 | 33,94 | 48,26 | 47,30 | 49,72 | 45,83 | |
| femelle | | 55,33 | 51,64 | 55,61 | 47,55 | 49,24 | 48,65 | 65,01 | 50,31 | 50,86 | 49,46 | 53,95 | |
| BRASIL. | | | | | | | | | | | | | 1,40 |
| mâle | | 0,31 | 1,12 | 1,56 | 1,83 | 4,45 | 3,80 | 0,48 | 1,09 | 1,33 | 0,59 | 0,12 | |
| femelle | | 1,19 | 0,50 | 0,67 | 1,40 | 3,51 | 5,11 | 0,57 | 0,34 | 0,51 | 0,23 | 0,10 | |

**Tableau 20**: Composition des captures mensuelles par espèce et par sexe, pour 1991.

| | J | F | M | A | M | J | J | A | S | O | N | D | MOYEN. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SUBTILIS | | | | | | | | | | | | | 97,95 |
| mâle | 38,60 | 48,51 | 43,11 | 33,71 | 44,44 | 36,22 | 37,28 | 41,58 | 43,0 | 42,53 | 48,94 | 39,74 | |
| femelle | 57,55 | 46,23 | 53,46 | 64,46 | 52,18 | 58,89 | 56,85 | 55,18 | 55,58 | 54,15 | 43,43 | 54,34 | |
| BRASIL. | | | | | | | | | | | | | 2,05 |
| mâle | 1,88 | 4,50 | 1,06 | 0,97 | 1,26 | 1,65 | 2,84 | 1,41 | 0,75 | 2,23 | 4,58 | 4,08 | |
| femelle | 1,17 | 0,76 | 2,37 | 0,86 | 2,12 | 3,24 | 3,03 | 1,83 | 0,57 | 1,09 | 3,05 | 1,84 | |

## C. DISTRIBUTION DES CAPTURES EN FRÉQUENCE DE TAILLE

La composition en classes de taille (Lc) des captures de *P. subtilis* et *P. brasiliensis* est indiquée dans les tableaux 21 et 22 pour les années 1990 et 1991.

On remarquera la grande stabilité interannuelle des positions des modes pour chacune des espèces, et pour chaque sexe.

*P. subtilis* mâles : 27 à 28 mm.
*P. subtilis* femelles : 31 mm.
*P. brasiliensis* mâles : 38mm.
*P. brasiliensis* femelles : 48 à 49 mm.

Les compositions des captures pour 1988 et 1989 sont comparables.

**Tableaux 21 et 22**: Composition en classe de taille des captures par sexe de *P. subtilis* et *P. brasiliensis* pour 1990 et 1991.

| *1990* | *P. Subtilis* | | *P. Brasiliensis* | |
|---|---|---|---|---|
| Lepl | MALTOT | FEMTOT | MALTOT | FEMTOT |
| 15 | 2109 | 0 | 0 | 0 |
| 16 | 0 | 1305 | 0 | 0 |
| 17 | 2609 | 5508 | 0 | 0 |
| 18 | 4560 | 9567 | 0 | 0 |
| 19 | 47652 | 57943 | 0 | 0 |
| 20 | 76637 | 116691 | 0 | 0 |
| 21 | 300882 | 344724 | 0 | 0 |
| 22 | 650932 | 334523 | 0 | 0 |
| 23 | 2258292 | 928767 | 0 | 0 |
| 24 | 3892604 | 1638059 | 0 | 0 |
| 25 | 8320541 | 2632948 | 0 | 0 |
| 26 | 12182144 | 3623352 | 0 | 0 |
| 27 | 14219287 | 5068916 | 0 | 0 |
| 28 | 13229159 | 7362346 | 0 | 0 |
| 29 | 7361838 | 6378911 | 0 | 0 |
| 30 | 4335534 | 7997426 | 8574 | 0 |
| 31 | 2661230 | 8070441 | 8574 | 0 |
| 32 | 1432858 | 6887378 | 0 | 0 |
| 33 | 652606 | 7122966 | 1784 | 0 |
| 34 | 606027 | 6243823 | 72031 | 0 |
| 35 | 452675 | 5278945 | 284082 | 0 |
| 36 | 210713 | 3981694 | 363913 | 4612 |
| 37 | 82353 | 3023280 | 372377 | 0 |
| 38 | 69518 | 2848382 | 388414 | 1181 |
| 39 | 16665 | 1305216 | 328642 | 2591 |
| 40 | 16124 | 1027124 | 279194 | 15937 |
| 41 | 1501 | 870617 | 146390 | 18908 |
| 42 | 3254 | 767680 | 63255 | 52769 |
| 43 | 0 | 548792 | 29273 | 70318 |
| 44 | 0 | 362964 | 16740 | 138984 |
| 45 | 0 | 242598 | 454 | 171561 |
| 46 | 0 | 208796 | 0 | 194860 |
| 47 | 0 | 144312 | 582 | 169230 |
| 48 | 0 | 110220 | 1164 | 159281 |
| 49 | 0 | 63280 | 0 | 199863 |
| 50 | 0 | 22457 | 582 | 137194 |
| 51 | 0 | 43459 | 1164 | 148352 |
| 52 | 0 | 28041 | 582 | 204266 |
| 53 | 0 | 11614 | 0 | 117758 |
| 54 | 0 | 16882 | 582 | 62159 |
| 55 | 0 | 20324 | 0 | 26833 |
| 56 | 0 | 7466 | 0 | 12578 |
| 57 | 0 | 1652 | 0 | 800 |
| 58 | 0 | 1290 | 0 | 402 |
| 59 | 0 | 2320 | 0 | 987 |
| 60 | 0 | 978 | 0 | 0 |
| 61 | 0 | 0 | 0 | 0 |
| 62 | 0 | 0 | 0 | 0 |
| 63 | 0 | 0 | 0 | 0 |
| 64 | 0 | 0 | 0 | 0 |
| 65 | 0 | 0 | 0 | 0 |
| Total | 73090304 | 85765977 | 2368353 | 1911424 |

| *1991* | *P. Subtilis* | | *P. Brasiliensis* | |
|---|---|---|---|---|
| Lepl | MALTOT | FEMTOT | MALTOT | FEMTOT |
| 15 | 4520 | 2966 | 0 | 0 |
| 16 | 0 | 2416 | 0 | 0 |
| 17 | 0 | 1625 | 0 | 0 |
| 18 | 3176 | 37277 | 0 | 0 |
| 19 | 44051 | 48411 | 0 | 0 |
| 20 | 103957 | 137767 | 0 | 0 |
| 21 | 214927 | 202287 | 0 | 0 |
| 22 | 683119 | 545065 | 0 | 0 |
| 23 | 1879780 | 1208809 | 0 | 1125 |
| 24 | 4119157 | 1966998 | 0 | 0 |
| 25 | 6650065 | 2986854 | 0 | 0 |
| 26 | 8428006 | 3812589 | 0 | 0 |
| 27 | 10678891 | 4819242 | 0 | 0 |
| 28 | 11260193 | 6316875 | 0 | 0 |
| 29 | 8572951 | 6469864 | 0 | 0 |
| 30 | 5017482 | 7037104 | 103 | 16886 |
| 31 | 3101305 | 7285981 | 2874 | 0 |
| 32 | 2552436 | 6793726 | 45991 | 134 |
| 33 | 1650069 | 6957576 | 296746 | 0 |
| 34 | 811086 | 6073948 | 306785 | 192 |
| 35 | 303941 | 5432763 | 399450 | 8142 |
| 36 | 129122 | 3987306 | 418795 | 19248 |
| 37 | 126875 | 3611829 | 265226 | 14546 |
| 38 | 93513 | 3073718 | 368827 | 31230 |
| 39 | 40751 | 1759782 | 359912 | 31177 |
| 40 | 34670 | 1448848 | 343490 | 58759 |
| 41 | 6408 | 869666 | 300146 | 59579 |
| 42 | 1676 | 731903 | 183040 | 87623 |
| 43 | 1438 | 650891 | 103954 | 164793 |
| 44 | 1253 | 430979 | 36502 | 188511 |
| 45 | 344 | 396425 | 1063 | 254349 |
| 46 | 634 | 287642 | 0 | 150525 |
| 47 | 0 | 201898 | 3875 | 191786 |
| 48 | 0 | 178014 | 331 | 289787 |
| 49 | 0 | 114792 | 331 | 213702 |
| 50 | 0 | 103343 | 0 | 176942 |
| 51 | 0 | 71644 | 0 | 127098 |
| 52 | 0 | 59683 | 0 | 118775 |
| 53 | 0 | 38143 | 0 | 77115 |
| 54 | 0 | 32406 | 0 | 55397 |
| 55 | 0 | 9022 | 0 | 27711 |
| 56 | 0 | 5305 | 0 | 13988 |
| 57 | 0 | 5103 | 0 | 1885 |
| 58 | 0 | 968 | 0 | 4956 |
| 59 | 0 | 30 | 0 | 1417 |
| 60 | 0 | 0 | 0 | 0 |
| 61 | 0 | 0 | 0 | 0 |
| 62 | 0 | 0 | 0 | 0 |
| 63 | 0 | 0 | 0 | 0 |
| 64 | 0 | 0 | 0 | 0 |
| 65 | 0 | 0 | 0 | 0 |
| Total | 66515796 | 86209483 | 3437441 | 2387378 |

## D. CYCLE ANNUEL DE RECRUTEMENT, INDICES ANNUELS ET VARIABILITÉ

Pour l'espèce *P. subtilis*, on a retenu comme indice de recrutement les proportions dans les captures d'individus de taille (Lc) inférieure à 23 mm pour les mâles et inférieures à 26 mm pour les femelles. L'évolution saisonnière de cet indice, par sexe, est présentée dans le tableau 23 pour les années 1989 à 1991.

**Tableau 23**: Indice de recrutement mensuel (1990 et 1991) et bimestriel (1989) en pourcentage pour l'espèce *P. subtilis*.

| | JANV/FÉV | | MARS/AVR | | MAI/JUIN | | JUIL/AOÛT | | SEPT/OCT | | NOV/DÉC | | ANÉE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1989 | | | | | | | | | | | | | |
| mâle | 1,98 | | 2,34 | | 4,07 | | 10,87 | | 4,50 | | 5,14 | | 4,71 |
| femelle | 3,23 | | 6,58 | | 8,89 | | 8,75 | | 7,18 | | 10,99 | | 7,79 |
| 1990 | | | | | | | | | | | | | |
| mâle | | 2,58 | 1,08 | 5,78 | 1,19 | 7,41 | 16,96 | 13,81 | 3,18 | 1,77 | 2,02 | 1,90 | 4,15 |
| femelle | | 4,08 | 2,04 | 7,22 | 1,49 | 15,29 | 20,12 | 7,79 | 6,20 | 13,13 | 5,37 | 2,97 | 6,91 |
| 1991 | | | | | | | | | | | | | |
| mâle | 0,89 | 1,59 | 0,17 | 1,05 | 5,27 | 3,20 | 5,97 | 7,39 | 8,97 | 6,23 | 4,24 | 1.38 | 4,41 |
| femelle | 3,06 | 2,21 | 2,43 | 2,13 | 9,55 | 9,82 | 9,45 | 9,05 | 16,80 | 13,08 | 10,34 | 3,53 | 8,28 |

L'examen de ce tableau montre la relative stabilité des indices de recrutement annuel.

A contrario, cette valeur subit de fortes variations intra-annuelles. Ainsi, en 1989 et en 1990, le pic de recrutement a eu lieu en juillet-août alors qu'en 1991, le maximun est survenu en septembre-octobre.

## E. RÉSUMÉ DE L'ÉTAT DES CONNAISSANCES SUR LES NOURICERIES

L'ORSTOM (Institut Français pour le Développement en Coopération) poursuit l'inventaire des nouriceries de *P. subtilis*. Il étudie, en outre la phase prérecrutée de cette espèce dans les deux estuaires des rivières de Sinnamary et de Cayenne. On observe un pic principal d'abondance des post-larves en mai et des pics secondaires en juin-juillet, septembre et décembre.

Une bonne corélation existe entre les maxima d'abondance de post larves, le cycle de maturité des femelles et les pics de recrutement dans la pêcherie des jeunes crevettes (cohortes).

## F. PROGRÉS DANS LA CONNAISSANCE DE LA RESSOURCE

L'analyse fine des structures en taille des captures, par navire et par marée, avant agrégation des données, a permis d'observer l'apparition de quatre cohortes annuelles dans la pêcherie et de suivre leurs évolutions. Il a donc été possible de suivre mensuellement la croissance de ces cohortes en déterminant la position statistique de leur taille modale et en suivant son déplacement.

Les vecteurs de prise mensuels, par cohorte ont été établis en nombre d'individus capturés. Ils sont regroupés dans le tableau 24.

**Tableau 24**: Captures en nombre en milliers d'individus capturés par cohorte et par mois. (Le numéro des cohortes est contruit de la manière suivante : les 2 premiers chiffres indiquent le millésime de l'année, les 2 derniers le mois d'apparition des femelles dans les captures).

| MOIS | | 9110 | 9107 | 9105 | 9101 | 9010 | 9007 | 9005 | 9001 | 8910 |
|---|---|---|---|---|---|---|---|---|---|---|
| JAN | M | | | | | 57,2 | 3557,3 | 622,1 | 29,0 | |
| | F | | | | 26,1 | 1271,5 | 4189,3 | 788,8 | 76,7 | 8,3 |
| FEV | M | | | | 424,7 | 5480,8 | 1152,9 | | | |
| | F | | | | 19,5 | 4743,3 | 1751,5 | 184,6 | 27,2 | |
| MAR | M | | | 2,7 | | 1833,9 | 3846,3 | | 14,9 | |
| | F | | | | 1198,0 | 4967,3 | 607,2 | 287,6 | 6,2 | 0,3 |
| AVR | M | | | | 4281,2 | 2211,8 | 16,6 | | | |
| | F | | | | 3286,9 | 4102,3 | 1122,2 | 125,6 | 4,1 | |
| MAI | M | | | | 558,7 | 2982,3 | 1161,9 | | | |
| | F | | | 26,3 | 3061,4 | 1998,7 | 425,9 | 4,1 | 5,0 | |
| JUI | M | | | 21,4 | 1884,1 | 972,5 | 3,4 | | | |
| | F | | | 373,6 | 2767,5 | 1045,4 | 401,6 | 150,7 | 25,4 | |
| JUI | M | | 260,7 | 2553,0 | 85,2 | 18,4 | 9,1 | | | |
| | F | | 416,3 | 953,1 | 1644,2 | 1150,3 | 151,3 | 139,2 | 7,6 | |
| AOU | M | | | 2126,0 | 3549,6 | 226,2 | 158,9 | 4,2 | 0,6 | |
| | F | | 801,7 | 4015,7 | 2153,1 | 839,5 | 166,6 | 62,0 | 10,6 | |
| SEP | M | | | 7201,0 | 2339,6 | 12,5 | 316,3 | | | |
| | F | | 3663,6 | 7065,8 | 1522,7 | 49,6 | 42,1 | 45,8 | | |
| OCT | M | 108,8 | 8238,6 | 315,1 | 37,4 | 4,4 | | | | |
| | F | 171,8 | 3165,7 | 6660,6 | 988,7 | 37,5 | 59,9 | | 2,2 | |
| NOV | M | 222,0 | 5106,7 | 111,6 | 126,1 | 11,2 | | 0,6 | | |
| | F | 424,2 | 2540,1 | 1565,0 | 274,2 | 49,5 | 7,9 | | | |
| DEC | M | 6,8 | 4279,1 | 233,3 | 86,6 | 2,3 | | | | |
| | F | 907,0 | 2618,0 | 2567,2 | 83,6 | 10,5 | 5,6 | 0.6 | | |

Quatre cohortes annuelles apparaissent dans les captures en janvier, mai, juillet et octobre.

On remarque également:

- que ces cohortes ont une importance relative variable (la cohorte 9105 étant de très loin prépondérante tant pour les mâles que pour les femelles).

- que la pêcherie ne repose en fait que sur l'exploitation d'une ou deux cohortes, ce qui rend les p.u.e. extrèmement sensibles aux variations d'importance de celles-ci.

- que les cohortes ont une productivité maximale 3 mois après leur entrée dans la pêcherie, pour les femelles, et 4 mois après pour les mâles. Le rendement de ces classes d'âge diminuent alors très rapidement par la suite.

## G. DYNAMIQUE DES POPULATIONS, PARAMÈTRES DÉTERMINÉS LOCALEMENT

Une première analyse des composantes biologiques de la pêcherie a été réalisée en 1988 (LE GALL et DINTHER) ; elle a donné les résultats suivants regroupés dans le tableau 25.

**Tableau 25**: Paramètres biologiques de la pêcherie de crevettes *P. subtilis* et *P. brasiliensis* de la Guyane française estimés sur une base mensuelle en 1988.

| ESPECE | SEXE | K | Linf. | M | F | Y/Rmax |
|---|---|---|---|---|---|---|
| *P. Subtilis* | male | 0,155 | 45 | 0,2 | 0,125 à 0,193 | 3,0 |
| | femelle | 0,19 | 55 | 0,2 | 0,131 à 0,189 | 4,6 |
| *P. Brasiliensis* | male | 0,266 | 53 | 0,2 | 0,121 à 0,150 | 8,6 |
| | femelle | 0,300 | 70 | 0,2 | 0,121 à 0,139 | 13,6 |
| Linf. = Longueur infinie du céphalothorax (Lc). Y/Rmax = En g. | | | | | | |

L'étude de croissance actuellement en cours, par la méthode précédemment indiquée, permet d'ores et déjà d'affiner ces valeurs, à l'origine probablement sous-estimées en ce qui concerne les paramètres biologiques de croissance. Les paramètres calculés à ce jour sont probablement, à l'inverse, légèrement surestimés, les cohortes n'ayant pu encore être suivies sur la totalité de leur cycle vital. Ils sont regroupés dans le tableau 26.

**Tableau 26**: Paramètres de croissance en cours d'actualisation (calculés par la méthode de Ford-Walford).

| ESPECE | SEXE | K | Linf. |
|---|---|---|---|
| *P. Subtilis* | male | 0,52 | 48,6 |
| | femelle | 0,51 | 63,6 |
| *P. Brasiliensis* | male | 0,72 | 52,9 |
| | femelle | 1,09 | 56,3 |

Une analyse de cohorte (programme anaco) est actuellement en cours.

## H. RÉSUMÉ DES MESURES DE GESTION APPLIQUÉES

La dernière modélisation bio-économique de la pêcherie crevettière, qui date de 1988, (GILLY et COCHET) prenait en compte les trois composantes de la pêcherie, présentes à l'époque, (française, japonaise et américaine).

L'utilisation d'un modèle pluri-spécifique pluri-métiers (2 espèces, 2 sexes, 3 flottilles) a permis d'estimer l'incidence des différentes stratégies d'aménagement de la pêcherie : retrait de la flottille américaine, intégration par francisation de la flottille japonaise, développement de la composante française.

C'est ce qui est, en fait, advenu, la francisation de la pêcherie ayant été accomplie en 1990.

La conclusion de cette modélisation a été que la ressource peut soutenir une production globale de 3800 T/an pour une flottille de 80 navires de type "français" avec, pour corollaire, une diminution de résultats de chaque unité, le maintien de la production, en valeur, pouvant être obtenu par une flottille de 75 à 85 navires.

Il convient maintenant de réactualiser ce diagnostique compte-tenu des nouveaux paramètres de croissance récemment calculés, d'un nombre de navires actifs plus faible que prévu et de l'effort de pêche accru sur les cohortes en cours de recrutement.

# IV. ASPECTS ÉCONOMIQUES

La totalité de la filière crevette a fait l'objet d'une expertise, en 1991, à la suite des difficultés de commercialisation apparues récemment et attestées par les prix moyens de vente de ces trois dernières années:

1988 - 61,90 F 1989 - 62,80 F 1990 - 60,00 F

La chute de ces prix est probablement due à la montée en puissance de la production aquacole mondiale.

L'étude bio-économique qui a été conduite a mis en évidence l'existence de prix de revient élevés, de l'ordre de 46 à 52 F/kilo, provoqués essentiellement par trois facteurs:

- des investissements coûteux, à terre particulièrement,
- une politique salariale mal contrôlée,
- une mauvaise valorisation des produits.

Malgré cela, la filière devrait rester rentable, en dehors des frais financiers, la rentabilité financière pouvant être évaluée à environ 18%.

Les recommandations de cet audit portent particulièrement sur la commercialisation des produits.

En effet, compte-tenu de la bonne qualité des crevettes de Guyane française, le marché le plus porteur est celui de la crevette entière crue, congelée de taille moyenne à forte destinée au marché de détail.

Les petites crevettes, qui entrent directement en concurrence avec les produits aquacoles moins chers doivent quitter la Guyane à des prix de gros généralement bas à destination des marchés européens. Le prix de ce type de produits est actuellement orienté à la baisse.

Il semble donc que le maintien de la rentabilité économique de cette activité de pêche en Guyane française passe par une réorientation de l'effort de pêche vers des crevettes de plus grande taille et par une commercialisation sur des marchés, certes plus restreints mais également plus rémunérateurs.

# V. CAMPAGNES DE RECHERCHE RÉALISÉES, EN COURS OU PRÉVUES

## A. CAMPAGNES RÉALISÉES DANS LE PASSÉ

Dix campagnes de prospection d'une semaine ont été réalisées entre novembre 1986 et juillet 1988.

Pour *P. subtilis*, elles ont permis de préciser, entre 15 et 40 m, les répartitions bathymétriques des juvéniles (longueur inférieure à 100 mm) et des femelles matures, entre les mois d'avril et de novembre.

Les plus forts rendements sont enregistrés:

- sur les fonds supérieurs à 25 mètres en avril, en octobre et en novembre.
- sur ceux de 25 à 39 mètres en juin,
- sur les fonds inférieurs à 30 mètres en juillet et août (époque de plus forte abondance sur l'ensemble des campagnes).

Au sein de ces rendements, les juvéniles sont peu représentés en avril et en juillet (5 à 15%), mais plus fréquents en juin et en octobre (15 à 40%). Quant aux femelles matures elles sont pratiquement absentes des captures en avril et octobre (moins de 5%), mais fréquentes en juillet et en août (5 à 25%).

## B. CAMPAGNES À LA MER EN COURS OU PRÉVUES

Un programme d'étude du recrutement de *P.subtilis* demarre en 1992. Deux campagnes annuelles, au printemps et à l'automne sont prévues. Ces périodes correspondent, en effet, aux pics de recrutement les plus importants de l'année. La première de ces campagnes aura lieu au mois d'octobre 1992.

Le découpagne géographique en quatre zones est conforme à celui qui a été réalisé lors des campagnes de 1986 à 1988 concernant la bathymétrie, quatre intervalles ont été définis sur la bande 10-50 mètres. On obtient 16 strates au total.

Une centaine de traits de chalut d'une demi-heure sont prévus lors de chaque campagne (avec un minimum de 2 traits par strate). En tenant compte des données acquises lors des précédentes campagnes de recherche, il a été prévu de réaliser un nombre de traits deux fois plus important dans la sonde 20-30 m, par rapport à une allocation proportionnelle à la surface de chacune des strates dans les autres bandes bathymétriques. Parallèlement, l'effort d'échantillonnage a été divisé par deux sur la sonde 40-50 m, là où les jeunes *P. subtilis* sont théoriquement moins abondants.

# VI. AMÉNAGEMENTS

La pêcherie est gérée par la Communauté Economique Européenne aprés avis des instances nationales sur la base d'un TAC annuel. Celui-çi est défini pour 1992 par le règlement 3892/91 du Conseil des Communautés Européennes.

L'évolution de ce TAC est indiquée dans le tableau suivant (Tableau 27).

**Tableau 27**: TAC, apports réels et écarts au TAC de 1988 à 1991.

| ANNEE | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|
| TAC | 4680 | 4810 | 4100 | 4100 |
| apports réels | 4256 | 3704 | 3927 | 3314 |
| Escart au TAC | -412 | -1106 | -173 | -768 |

On remarque que ce TAC n'a jamais été atteint depuis 1988.

Ce TAC est réparti entre la Communauté Economique européenne et certains pays ACP voisins auxquels sont accordés les droits individuels suivants pour 1992 (tableau 28) :

**Tableau 28**: Répartition du TAC et de l'effort de pêche maximal autorisé entre les pays ACP voisins.

| PAYS | CAPTURE AUTORISÉE (en t) | NOMBRE MAX. DE NAVIRES LICENCIÉS | NOMBRE MAX. DE JOURS DE MER |
|---|---|---|---|
| Barbade | 24 | 5 | 200 |
| Guyana | 24 | 5 | 200 |
| Trinidad and Tobago | 60 | 8 | 350 |

Il est à remarquer que ces droits, reconduits depuis plusieurs années, n'ont jamais été utilisés.

L'ensemble des navires autorisés à pêcher dans la ZEE ont, pour contrainte principale, outre le respect du TAC, de ne pas chaluter dans des eaux d'une profondeur de moins de 30 m. Pour compléter cette réglementation CEE, le Préfet de la Région Guyane, dans un arrêté du 15 janvier 1992, a limité à 72 le nombre de navires français autorisés à pêcher dans les eaux de la Guyane française pour 1992.

Le respect de cette réglementation générale est considéré comme satisfaisant, à l'exception de l'interdiction de l'exploitation de la bande côtière des 30 m. Un assouplissement de cette mesure est souhaitée par certains armements qui privilègient, avec l'obtention de rendements élevés, la capture de crevettes de petite taille.

## VII. RESSOURCES SECONDAIRES

Les ressources secondaires sont essentiellement constituées par les crevettes de talus continental. En effet, depuis 1989, les ressources en crevettes du talus continental de la Guyane française sont exploitées en routine par un des armements guyanais (la C.F.P.).

A la fin 1991, 6 crevettiers spécialement conçus et équipés pour ce type de pêche ont débarqué environ 340 tonnes de crevettes profondes.

## A. COMPOSITION DES CAPTURES PAR ESPÈCE

Deux espèces font l'objet d'une exploitation régulière:

- *Solenocera acuminata*: crevette "orange", pêchée vers 200 mètres, uniquement de nuit.

- *Plesiopenaeus edwardsianus* : crevette "scarlet", pêchée vers 700 mètres, de jour et de nuit.

## B. EFFORTS, APPORTS ET RENDEMENTS

Les tableaux 29 à 31 fournissent depuis 1988 l'effort de pêche mensuel (en jours de mer), les captures mensuelles (en kg) et les p.u.e. (En kg par jour de mer) pour les 2 espèces majeures (*S. Acuminata* et *P. Edwardsianus*).

**Tableau 29**: Production annuelle (tonnes).

| ANNEES | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|
| "Orange" | 97,8 | 142,9 | 167,0 | 80,5 |
| "Scarlet" | 52,3 | 34,1 | 34,3 | 258,5 |
| TOTAL | 150,1 | 177,0 | 201,2 | 339,0 |

**Tableau 30**: Effort de pêche annuel (jours de mer).

| ANNEES | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|
| "orange" | 214 | 325 | 424 | 224 |
| "scarlet" | 151 | 206 | 196 | 1233 |
| TOTAL | 365 | 531 | 620 | 1457 |

**Tableau 31**: Prise par unité d'effort en kg par jour de mer.

| ANNEES | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|
| "orange" | 457 | 440 | 394 | 360 |
| "scarlet" | 346 | 166 | 175 | 210 |

Pour la crevette "orange", *S. acuminata*, les p.u.e. n'ont cessé de chuter depuis 1988, signe d'un affaiblissement progressif du stock.

Pour la crevette "scarlet", *P. edwardsianus*, la chute est brutale dès la première année, puis les p.u.e. augmentent un peu en 1990.

## C. TRAITEMENT DE CES PRODUITS ET MARCHÉ

- *S. acuminata* est conservée en queues (noircissement des têtes) et calibrée en 2 catégories commerciales (S : "small" et M : "mixed") dans des cagettes de 8 à 10 kg.

- *P. edwardsianus* est conservée entière et calibrée en 7 catégories commerciales dans des barquettes de 3 kg environ (tableau 32).

La production est exportée en totalité vers l'Europe (Italie notamment).

**Tableau 32**: Catégories commerciales utilisées pour la crevette "scarlet".

| Cat. Com. | 4 | 3 | 2 | 1 | 0 | 00 | 000 |
|---|---|---|---|---|---|---|---|
| L tot. (en mm) | <160 | 160-180 | 180-205 | 205-230 | 230-255 | >255 | |
| Poids (g) | <25 | 25-33 | 33-50 | 50-67 | 67-83 | 83-125 | >125 |

## D. RÉSUMÉ DES RÉSULTATS OBTENUS LORS DES CAMPAGNES DE RECHERCHE

Quatre campagnes de prospection de la zone chalutable du talus continental guyanais, réalisées en 1990 et 1991, ont permis de mettre en évidence:

- une zone chalutable réduite en Guyane située à la limite des eaux surinamiennes (3400 km2)
- une forte biodiversité de crevettes profondes (25 espèces) mais des rendements très faibles, sauf pour les deux espèces majeures actuellement exploitées.

## E. POTENTIEL EXPLOITABLE

Le potentiel exploitable de crevettes profonde est indiqué dans le tableau 33.

**Tableau 33**: Potentiel exploitable de crevettes profondes.

| ESPECES | *S. Acuminata* | *P. Edwardsianus* |
|---|---|---|
| Distribution | 185-235 mètres (de nuit) | 447-855 mètres (de jour et de nuit) |
| Biomass apparentes | 75 tonnes | 92 tonnes |
| Sondes de milleurs rendements | 200 mètres | 700 mètres |

Au vu de ce tableau on constate que les possibilités de diversification de la pêcherie crevettière traditionnelle du plateau continental guyanais vers l'exploitation des crevettes profondes apparaissent limitées.

# NATIONAL REPORT OF BRAZIL

by
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## I. INTRODUCTION

This paper presents a summary of current knowledge of the biology and fishery of the pink shrimp, *Penaeus subtilis*, captured on the northern coast of Brazil. The literature on the subject was reviewed and during the presentation of the results, citations will be made.

## II. SHRIMP INDUSTRY DESCRIPTION

The shrimp is exploited in northern Brazil by both an artisanal or small scale fishery, and an industrial fishery. Both systems are very important socially and economically for the region and for the nation.

### II.A. SMALL SCALE FISHERY (ARTISANAL)

According to Isaac, Dias Neto and Damasceno (1992), the artisanal sub-sector of shrimp fishery of Pará and Maranhão states, involves approximately 124,000 of the 198,850 artisanal fishermen of their coastal areas, where the artisanal shrimp fishery is relatively important.

The most important species present in the catch in the Pará estuary, are *Penaeus subtilis* (pink shrimp), *Penaeus schmitti* (white shrimp), and *Xiphopenaeus kroyeri* (sea-bob), with the predominance of one specie over the others depending on the area, the season and environmental conditions, especially the salinity. In the Maranhão estuary there is evidence of the predominance, of the sea-bob.

With respect to techniques and fishing gears the most important are the "trawl", the "cast-net" and the "matapí". They are described by Isaac, Dias Neto and Damasceno, op cit.

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1 DIRPED, IBAMA, Brasilia

2 IBAMA, Belém

3 CEPENE, Tamandaré (Pernambuco)

The use of boats in artisanal fishery (small scale), differs between Maranhão and Pará states, and information is not available for Amapá state. On the Maranhão coast small trawls are commonly used to catch *X. kroyeri.* This is not the case on the Pará coast.

Frequently, boats are used only to transport the fisherman and his catch to the coast. The most common types of boats are the "dugout" (small canoe made out of a tree trunk), used most frequently in the "tarrafas" and" puçás" fisheries, and "geleiras" (a vessel of 10-15 meters length, generally), used for the transportation of people (5-6 people) and fishing nets in the "zangaria" fishery. There is no monitoring of the catch which could provide a realistic estimate of the production of juveniles of marine species captured by the artisanal fishery along the northern coast of Brazil. However, we do know that the dominant species are the pink shrimp (*P. subtilis*) and the sea-bob (*X. kroyeri*).

Beginning in 1977 the systematic collection of samples of *P. subtilis* from the artisanal catch, in order to obtain biological data, has made it possible to observe that, although extremely unstable, the catch is of great importance for many communities located along the coast.

The shrimp produced by this fishery, in addition to being sold fresh and frozen, is cooked in saltwater and marketed in the country as dried and salted shrimp.

## II.B. INDUSTRIAL FISHERY

### 1. Fishing grounds

The industrial shrimp of northern Brazil fishery takes place between the border with French Guiana and the border between Ceará and Piauí. According to Studart-Gomes (1988), three sub-areas of fishery may be identified (Fig 1), whose main characteristics are:

I - Maranhão coast : From the mouth of the Parnaiba river to cape Gurupi. The fishing grounds are not very deep (20- 40m), and consist of hard sediments and clear waters.

II - Amazonas : From the mouth of the Pará river to southern Amapá. This area is under the influence of the Amazon river. The fishing grounds are located at a depth between 40 and 60m in muddy waters and with a substratum which varies between mud, sand and rocks.

III - Amapá coast : The fishing grounds are deeper (between 60 and 100m), and the sea bottom is rocky and irregular (presence of "canyons"). There are strong currents which require great skill from the captains.

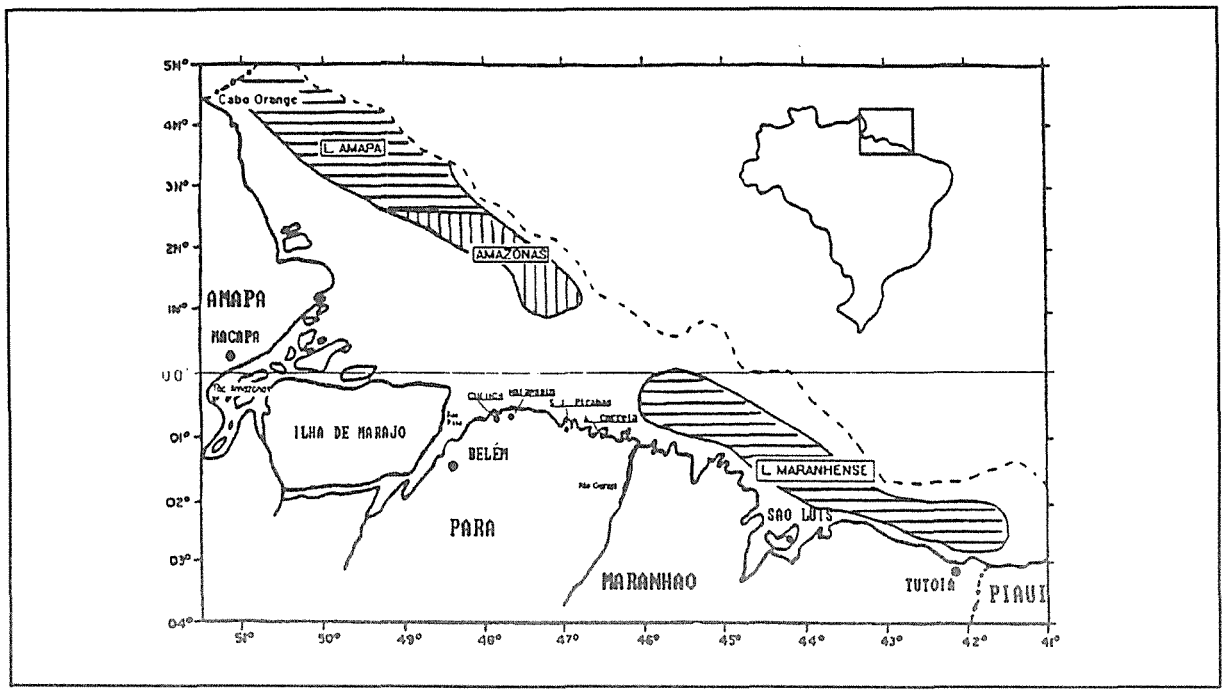


**Figure 1**: Shrimp fishing areas of Northern Brazil.

In the area between the mouth of the Pará river and Tutóia, there are many places where fishing is impossible, due to strong tidal currents, irregular depth thick layers of mud, rocks, trunks of trees, etc. This zone may function as a natural barrier between stocks. On the other hand, surveys undertaken with research vessels indicate that rocky areas and those with hard sediments have very low concentrations of shrimp. However there are innumerable areas where is possible to fish one or more of the types of artisanal gear and techniques mentioned earlier.

## 2. Fleet

The number of vessels in operation in each state is shown in table 1. The fleet, with the exception of some boats in Piauí, consists of vessels with a total length between 19 and 25m, and a displacement of between 50 and 182 tons. They are powered by main engines of 235 to 710 HP. Freezing systems and instruments for communication, navigation and eco-sounding are used.

The Brazilian government decided not to permit companies to charter new foreign boats since the fleet was already at the maximum of 250 vessels. Only 3 of the boats in operation in 1991 were chartered (Korean flag), the rest being Brazilian.

The vessels undertake on average six trips a year, with an average duration of 33 days. There are normally 5/6 men on board.

With the exception of a few single trawls used in the Tutóia area, the rest of the boats operate with the double-rig system. Each operation takes normally about 4 to 6 hours.

During the off season which extends from july to november, fleet operations are reduced and the nighttime is the most productive period.

### 3. Processing activity

The number of companies per state and the type of activity are shown in Table 2: fishing and marketing, fishing, processing and marketing, processing and marketing.

The national catch is processed into frozen tails, with most beheading taking place on board shortly after removal from the net. Tails are then immersed in a solution of sodium meta-bisulphite, placed in nylon bags and frozen. After landing the product is thawed, classified by size (number of tails/pound), according to international standards, packaged in 5 pound cases and frozen again, and then ready for the market.

### 4. Commercialization

More than 90% of northern Brazilian pink shrimp production is exported, with the main buyers being in the United States of America and in Japan.

The average price of a kilo of frozen shrimp tails exported from Belém in the period 1978/91 varied between US$6,91/kilogram and US$9.67/kilogram (FOB), and generated an income in 1991 around US$39.783.510,00 (table 3).

The market price of the product varies among companies depending on the final market. The price obtained depends on product quality, especially average size, which is related to the area where the fleet is operating. The price offered by Japanese market has been historically higher than the one offered by USA market. Therefore Japanese is more exigent than USA.

## III. RESULTS OF EXPLOITATION

After reaching its lowest yields in 1986 (99 kg of tails per day at sea), the shrimp fishery recovered in the two following years, stabilizing between 1989 and 1991 at around 110/kg of tails per day at sea (Table 4).

In the period from 1986 to 1991 small fluctuations were observed in fishing effort, measured in number of trips and of days at sea.

Compared with the historical series of registered landings, the years 1987 and 1988 were atypical, with record landings reaching 10,039,266 kgs and 9,916,330 kgs respectively. This was followed by the stabilization in landing volumes in subsequent years, at around 6,500,000 kgs a year, live weight.

Tables 5, 6, and 7 show the performance of the fleet by place of origin and allow us to observe changes in catch, fishing effort and CPUE, for each state.

# IV. EVALUATION OF THE RESOURCE

An evaluation of the resource was undertaken in a paper written by Isaac, Dias Neto and Damasceno (1992), who in addition to presenting the results obtained, reviewed and/or compared them with those available on the species in the area or on the family Penaeidae elsewhere in the world.

The main results are briefly presented below.

1. Reproduction

The data suggest the existence of two intensive spawning periods, the first from march to july, and the second from september to october.

The average length at which 50% of the females begin to mature for the first time is 110mm. However spawning usually occurs at a length $L_{50}$ of 140mm.

2. Recruitment

In spite of the fact that the entrance of postlarvae into the rivers occurs all year long, the conclusion obtained from the data of 1986 is that there are two peaks of greater intensity between February and April, and between July and September. However we consider necessary to confirm these results with analysis of other years data.

With respect to the migration of juveniles towards the open sea (and recruitment to the industrial fishery), two peaks were also observed, the first between December and May and the other between July and August. The first one is more significant and corresponds to a peak in production, as because is during those months that better catch rates are obtained.

The modes of the two recruitment peaks are separated by a period of less than half an year. The course of the time between arrival and leave of the shrimp on the nursery is around two or three months.

3. Biometrical relationships

The above mentioned study presents a total weight ($W_t$) / total length ($L_t$) relation, and a total length ($L_t$) / tail length ($T_t$) relation. A review of the biometrical relations found in the literature on the species found on the Brazil-Guyana coast was also carried out, for comparison with results obtained in Brazil.

4. Growth

The authors have used three different methods to estimate the von Bertalanffy growth curve. This was done for males and females separately, and also for both sexes grouped. The last one was done with the expectation of using average parameters for application in models of stocks assessment.

The calculations were based on the results of samplings carried out on the landings of the industrial fishery. Due to problems with data from nursery samples they were not considered in the analyses (Table 8).

5. Death Rate

The death rates were calculated by several methods and the results are as follows:

a) Total death rate (Z)

The values were calculated through different methods and the average obtained was 3.35.

b) Natural death rate (M)

Estimations obtained indicated an average of 1.84.

c) Death rate caused by fishery (F)

Based on values of Z and M, the value of F was approximately 1.6. Through cohort analysis this rate varied between zero and 3.5 with an average of 1.5 by year.

6. Stock Assessment

In 1986, the meeting of the Permanent Group of Studies-GPE (SUDEPE/PDP, typed) estimated the Maximum Sustainable Yield (MSY) and the corresponding fishing effort, using the Schaefer model, for the area including Northern Brazil and French Guyana. A MSY of 11,337 tons per year (whole weight), and an effort of 64,346 days at sea were calculated.

The group also estimated that the MSY for the Brazilian area was around 7,900 tons a year (whole weight) or 5,004 tons a year (tail weight), for a fishing effort of 44,889 days at sea.

Isaac, Dias Neto & Damasceno (op.cit) used the Schaefer and Fox models to produce the results found in Table 9.

These authors have also done assessments using cohort analysis based on length frequency distributions, whose main conclusions are:

a) Recruitment

This analysis concluded that the fishery for *P. subtilis* was at the point of maximum sustainable yield (MSY). An increase in yield, according to the model is practically impossible, especially if we think of the economic consequences.

It was also shown that a modification in the mesh-size of the nets in order to permit an increase or decrease in the size of shrimp captured would not improve the yield of the fishery.

b) Cohort analysis

As a conclusion, the cohort analysis has demonstrated clearly that a reduction in the fishing effort may be an intelligent and economically viable policy. However, this kind of measure may cause great social and economic problems. Therefore, it seems clear that current level of effort should not be changed significantly, because in this case besides the already known biological consequences of increasing fishing effort on the juveniles stocks, it would reduce profits with shrimp fishery and this, of course, would also cause socio-economic problems.

Because of the lack of detailed information on the economic parameters of the shrimp fishery in Northern Brazil it was not possible to use the Jones predictive model (1982) with data on catch value and cost. For the same reason, it was impossible to use that model with data of catches. However, the data available were used to estimate these values and although of a preliminary nature, we think they are adequate for a first analysis.

## V. ECONOMIC ASPECTS

Besides the information already presented, taken from Isaac, Dias Neto and Damasceno (op. cit), an economic analysis could not be conducted due to the lack of reliable data on catch cost. It was possible, however, to calculate the total income curve, adjusting data to Schaefer's model (1954) and to Fox's model (1970).

The results show that the maximum income varied between 46 and 50 millions of dollars, obtained with an effort of between 56 and 79 thousands days at sea (Table 9).

The comparison of these results with the estimated income for the northern Brazilian coastal fishery, in the last few years (Table 3), also shows that we are operating at the limits for maximum economic efficiency.

## VI. SECONDARY RESOURCES

Between december 1987 and may 1989, a research project, called "Multidisciplinary study for by-catch utilization of the industrial shrimp fishery in the northern Brazil coast", was conducted.

The project studied three aspects of the fishery : biological, socio-economic and technological. The biological analysis, undertaken by IBAMA/Pa aimed at determining the composition, structure and yield of the by-catch. The socio-economic analysis was undertaken by the IDESP (Economical Development Institute of Pará State), and studied the economic viability of using the by-catch by using a special vessel to collect the by-catch at sea or by using boats from the fleet to bring in the by-catch. The technological analysis was conducted by the Federal University and aimed at characterizing the shrimp fleet, assessing the storage capacity, determining freezing curves for shrimp and fish, characterizing the proportional fauna technologically (composition of the by-catch), carry out studies on the quality and shelf life of fish conserved in ice and develop products for the more common species in the by-catch.

All these results are detailed in the Third Meeting Report of the Permanent Group on Shrimp Studies (GPE) held in Pernambuco (Brazil) in march 1992, and are available to this workshop.

## VII. MANAGEMENT

The number of vessels in operation in the fishery is limited to 250. All have special licenses renewable on an annual basis with the payment of a tax, and are obliged to present a map containing information on the boats catch.

Since 1986 a closed season has been established from december to february.

A costal zone of 10 miles is protected from all forms of trawling in Pará and Amapá state, and 3 miles in Maranhão and Piauí state.

There are no specific regulations for nursery grounds except the prohibition of any type of motorized trawl in these areas.

## VIII. CONCLUSIONS

The shrimp fishery in the northern Brazil coast,since 1984, has been operating at levels with permit the maximum possible sustained yield, leading to the conclusion that fishery management must maintain fishing effort at the levels utilized in the last few years.

From the point of view of the resource use, management of the fishery has shown good results. However, there are some problems : large quantities of by-catch are discarded, licences are concentrated in the hands of a small number of firms (deficiency of the licensing system used), and conflicts arise between the artisanal and industrial fisheries (industrial boats trawling near the coast).

The introduction of a closed season resulted immediately in a considerable recuperation in the productivity of the fisheries and a considerable reduction in the proportion of small shrimp landed, which certainly increased the global income from this activity (IBAMA, GPE/1992).

## IX. REFERENCES

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**Table 1**: Number of licensed vessels in the shrimp fishery of Northern Brazil, based in Pará, Amapá, Piauí and Ceará states.

| YEARS | PARA/AMAPA | PIAUI (1) | CEARA | TOTAL |
|---|---|---|---|---|
| 1970 | 6 | - | - | 6 |
| 1971 | 27 | - | - | 27 |
| 1972 | 16 | - | - | 16 |
| 1973 | 28 | - | - | 28 |
| 1974 | 34 | - | - | 34 |
| 1975 | 26 | - | - | 26 |
| 1976 | 39 | - | - | 39 |
| 1977 | 48 | - | - | 48 |
| 1978 | 50 | - | - | 50 |
| 1979 | 73 | 11 | 2 | 86 |
| 1980 | 131 | 19 | 8 | 158 |
| 1981 | 121 | 23 | 6 | 150 |
| 1982 | 127 | 18 | 10 | 155 |
| 1983 | 137 | 18 | 24 | 179 |
| 1984 | 208 | 19 | 27 | 254.(2) |
| 1985 | 224 | 22 | 41 | 287.(2) |
| 1986 | 196 | 20 | 40 | 256.(2) |
| 1987 | 198 | 12 | 36 | 246 |
| 1988 | 177 | 15 | 36 | 228 |
| 1989 | 183 | 17 | 42 | 242 |
| 1990 | 189 | 19 | 48 | 256.(2) |
| 1991 | 180 | 16 | 47 | 242 |

Source: IBAMA

(1) 10 vessels are below 18m in Piauí's fleet. (2) The number 250 was exceeded due to the entry and departure of leased vessels (licenses used for more than one vessel during the year).

**Table 2**: Information on the industrial sector operating in the shrimp fishery of Northern Brazil.

| STATE | NUMBER OF COMPANIES BY ACTIVITY | | | | TOTAL |
|---|---|---|---|---|---|
| | Fishing & Marketing | Fishing, Processing & Marketing | Only Processing | Processing Marketing | |
| AMPA | - | 01 | - | 0 | 01 |
| PARA | 06 | 05 | - | 01 | 12 |
| PIAUI | - | 01 | - | - | 01 |
| CEARA | 08 | 05 | 02 | - | 15 |
| TOTAL | 14 | 12 | | 01 | 29 |

Source: IBAMA

**Table 3**: Data on catch (t of tails), price per kg of tails and total income of the shrimp fishery of Northern Brazil.

| YEARS | LANDING (t of tails) | PRICE/KG US$ | INCOME US$*10^6 |
|---|---|---|---|
| 1978 | 1.718 | 6,91 | 11.871 |
| 1979 | 2.064 | 9,03 | 18.638 |
| 1980 | 3.571 | 6,97 | 24.890 |
| 1981 | 4.477 | 6,99 | 31.297 |
| 1982 | 3.770 | 9,67 | 36.456 |
| 1983 | 3.900 | 9,45 | 36.855 |
| 1984 | 5.494 | 8,21 | 45.106 |
| 1985 | 5.132 | 7,34 | 37.676 |
| 1986 | 4.575 | 8,85 | 40.489 |
| 1987 | 6.435 | 8,62 | 55.470 |
| 1988 | 6.357 | 8,57 | 54.479 |
| 1989 | 4.490 | 8,64 | 38.794 |
| 1990 | 3.919 | 8,61 | 33.742 |
| 1991 | 4.329 | 9,19 | 39.783 |

Source : IBAMA/CACEX

**Table 4**: Catch landed, fishing effort and landing per unit effort for the Brazilian fleet operating in the pink shrimp fishery of Northern Brazil.

| YEARS | CATCH | | FISHING EFFORT | | CPUE | |
|---|---|---|---|---|---|---|
| | Tail | Whole | Trip Number | Sea Days | Trip Number | Sea Days |
| 1970 | 169789 | 264871 | 42 | 987 | 4043 | 172 |
| 1971 | 646485 | 1008571 | 169 | 3518 | 3825 | 184 |
| 1972 | 264864 | 413188 | 88 | 1896 | 3010 | 140 |
| 1973 | 1084594 | 1691967 | 182 | 4550 | 5859 | 238 |
| 1974 | 716625 | 1117935 | 221 | 5967 | 3243 | 120 |
| 1975 | 495918 | 773632 | 153 | 4394 | 3139 | 113 |
| 1976 | 871955 | 1360250 | 248 | 7018 | 3516 | 124 |
| 1977 | 1162124 | 1812913 | 330 | 9133 | 3522 | 127 |
| 1978 | 1718407 | 2680715 | 299 | 8502 | 5747 | 202 |
| 1979 | 2063529 | 3219105 | 468 | 10976 | 4421 | 188 |
| 1980 | 3571095 | 5570908 | 793 | 23039 | 4504 | 155 |
| 1981 | 4476648 | 6983571 | 739 | 26027 | 6055 | 172 |
| 1982 | 3770477 | 5881944 | 712 | 24170 | 5362 | 156 |
| 1983 | 3899217 | 6082779 | 833 | 26343 | 4679 | 148 |
| 1984 | 5493466 | 8569807 | 1272 | 39239 | 3419 | 140 |
| 1985 | 5131830 | 8005655 | 1368 | 48875 | 3752 | 105 |
| 1986 | 4574966 | 7136947 | 1231 | 46212 | 3212 | 99 |
| 1987 | 6435427 | 10039266 | 1294 | 45641 | 4679 | 141 |
| 1988 | 6356622 | 9916330 | 1214 | 38760 | 5234 | 164 |
| 1989 | 4489849 | 7004164 | 1241 | 40449 | 3627 | 111 |
| 1990 | 3918749 | 6113248 | 1122 | 35952 | 3490 | 109 |
| 1991 | 4328753 | 6752855 | 1090 | 36376 | 3970 | 119 |

Source: IBAMA

**Table 5**: Catch landed, fishing effort and landing per unit of effort, for the Brazilian fleet operating in the pink shrimp fishery of the State of Pará.

| YEARS | LANDING (Kg) | | FISHING EFFORT | | CPUE | |
|---|---|---|---|---|---|---|
| | Tail | Whole | Trip Number | Sea Days | Trip Number | Sea Days |
| 1970 | 169789 | 264871 | 42 | 987 | 4043 | 172 |
| 1971 | 646485 | 1008517 | 169 | 3518 | 3825 | 184 |
| 1972 | 264864 | 413188 | 88 | 1896 | 3010 | 140 |
| 1973 | 1084594 | 1691970 | 182 | 4550 | 5959 | 238 |
| 1974 | 716625 | 1117935 | 221 | 5967 | 3243 | 120 |
| 1975 | 495418 | 773632 | 153 | 4394 | 3139 | 113 |
| 1976 | 871955 | 1360250 | 248 | 7018 | 3516 | 124 |
| 1977 | 1162124 | 1812913 | 330 | 9133 | 3522 | 127 |
| 1978 | 1718407 | 2680715 | 299 | 8502 | 5754 | 202 |
| 1979 | 1971890 | 3076148 | 446 | 10478 | 4421 | 188 |
| 1980 | 3301682 | 5150624 | 733 | 21271 | 4504 | 155 |
| 1981 | 4111060 | 6413254 | 679 | 21261 | 6055 | 172 |
| 1982 | 3426179 | 5344839 | 639 | 22942 | 5362 | 156 |
| 1983 | 3663696 | 5715366 | 783 | 24780 | 4679 | 148 |
| 1984 | 5126993 | 7998109 | 1187 | 36695 | 4319 | 140 |
| 1985 | 4483562 | 6994357 | 1195 | 42729 | 3752 | 105 |
| 1986 | 4045966 | 6311707 | 1120 | 40747 | 3612 | 99 |
| 1987 | 5772427 | 9004986 | 1161 | 40941 | 4972 | 141 |
| 1988 | 5647296 | 8809782 | 1079 | 34461 | 5234 | 164 |
| 1989 | 4051157 | 6319805 | 1120 | 36433 | 3617 | 111 |
| 1990 | 3510918 | 5477032 | 1006 | 32279 | 3490 | 109 |
| 1991 | 3886249 | 6062548 | 979 | 32632 | 3970 | 119 |

Source: IBAMA/SUPES/Pa

**Table 6**: Catch landed, fishing effort and landing per unit of effort for the Brazilian fleet operating in the pink shrimp fishery of the State of Ceará.

| YEARS | LANDING (kg) | | FISHING EFFORT | | CPUE (kg tail) | |
|---|---|---|---|---|---|---|
| | Tail | Whole | Trip Number | Sea Days | Trip Number | Sea Days |
| 1979 | 21845 | 34078 | 3 | 107 | 7282 | 204 |
| 1980 | 76188 | 118744 | 11 | 368 | 6926 | 107 |
| 1981 | 54838 | 85547 | 12 | 376 | 4404 | 146 |
| 1982 | 80831 | 126096 | 19 | 657 | 4309 | 123 |
| 1983 | 134603 | 209981 | 34 | 1368 | 3130 | 98 |
| 1984 | 259622 | 405010 | 64 | 2118 | 4121 | 123 |
| 1985 | 447536 | 698159 | 126 | 4300 | 3552 | 104 |
| 1986 | 401000 | 625550 | 136 | 4406 | 2948 | 91 |
| 1987 | 522000 | 814320 | 147 | 4770 | 3551 | 109 |
| 1988 | 553173 | 862950 | 109 | 3878 | 5075 | 143 |
| 1989 | 230904 | 360211 | 51 | 2019 | 4528 | 114 |
| 1990 | 291151 | 452476 | 69 | 2795 | 4220 | 104 |
| 1991 | 286992 | 447230 | 57 | 2532 | 5035 | 113 |

Source: IBAMA/SUPES/Ce

**Table 7**: Catch landed, fishing effort and landing per unit of effort, for the Brazilian fleet operating in the pink shrimp fishery of the State of Piauí.

| YEARS | LANDING (kg) | | FISHING EFFORT | | CPUE (kg tail) | |
|---|---|---|---|---|---|---|
| | Tail | Whole | Trip Number | Sea Days | Trip Number | Sea Days |
| 1979 | 69794 | 108879 | 44 | 671 | 1586 | 104 |
| 1980 | 193295 | 301540 | 168 | 2274 | 1148 | 85 |
| 1981 | 310750 | 484770 | 222 | 3047 | 1402 | 102 |
| 1982 | 263467 | 411009 | 149 | 2103 | 1773 | 125 |
| 1983 | 100918 | 157432 | 75 | 1125 | 1345 | 89 |
| 1984 | 106851 | 166688 | 88 | 1542 | 1241 | 69 |
| 1985 | 200730 | 313139 | 129 | 2648 | 1556 | 76 |
| 1986 | 128000 | 199000 | 85 | 1357 | 1506 | 94 |
| 1987 | 141000 | 219960 | 54 | 1141 | 2611 | 123 |
| 1988 | 156153 | 243600 | 59 | 1254 | 2646 | 124 |
| 1989 | 207788 | 324150 | 56 | 1198 | 3710 | 173 |
| 1990 | 116680 | 182021 | 61 | 1152 | 1913 | 101 |
| 1991 | 155512 | 242600 | 81 | 1215 | 1919 | 128 |

Source: IBAMA/SUPES/Pi

**Table 8**: Estimates of the growth parameters $L_\infty$, K and $t_0$, corresponding to the march cohort, obtained in this study with data from the industrial fishery.

| DATA | SEXES | METHODS | $L_\infty$ (MM) | K (1/year) | $t_0$ (years) |
|---|---|---|---|---|---|
| Frequency distribution | grouped | ELEFAN I | 220 | 1,08 | - |
| | males | ELEFAN I | 187 | 1,08 | - |
| | females | ELEFAN I | 225 | 1,00 | - |
| | grouped | Wetherall | 213 | | - |
| | males | Wetherall | 178 | | - |
| | females | Wetherall | 208 | | - |
| Modal length | males | Bhattacharya/Allen | 171 | 1,23 | -0.528 |
| | males | Bhattacharya/EIAL | 172 | 1,20 | -0.537 |
| | females | Bhattacharya/Allen | 218 | 1,07 | -0.441 |
| | females | Bhattacharya/EIAL | 216 | 1,12 | -0.441 |
| Average (general) | | | 201 | 1.11 | |
| Average (males) | | | 177 | 1.17 | |
| Average (females) | | | 217 | 1.06 | |

**Table 9**: Results of the application of the Schaefer and Fox production models (biological and economic) to the data on the shrimp catch of the Northern Brazilian coast.

| DATA | METHODS | MSY(t) or MEY(1000 US$) | $F_{may}$ (days at sea) | R |
|---|---|---|---|---|
| Production 1978-88 | Schaefer | 8490 | 52336 | 0,88 |
| Production 1978-88 | Fox | 9090 | 72087 | 0,87 |
| Income 1978-88 | Schaefer | 46602 | 56421 | 0,75 |
| Income 1978-88 | Fox | 50138 | 78819 | 0,75 |

# *Review of the Shrimp Fisheries and Resources on the Guyana-Brazil Shelf*

by
Pierre Charlier[1]

## I. STRUCTURE OF THE SHRIMP FISHING INDUSTRY IN THE REGION

### I.A. THE AREA AND ITS BOUNDARIES

The Guyana-Brazil continental shelf hosts one of the major penaeid shrimp fisheries in the world. The fishing grounds stretch grossly between the Amazon and the Orinoco rivers. These rivers do not function as absolute barriers, however, and transfers of biomass occur across them. In Brazil for example juveniles of brown shrimp appear to migrate from the coast of the State Pará (East of the Amazon) towards fishing grounds situated in front and to the West of the estuary. Fishing activities of the fleet based at Belém also shift seasonally, exploiting grounds situated East of the estuary during part of the year.

At the other end of the area there is no clear-cut discontinuity at the level of the Orinoco river. Topography suggests that the shrimp populations in the Gulf of Paria may not mix to a great extent with those located Southeast of Trinidad. It is impossible, however, to separate in the landings statistics of Venezuela the part caught respectively in the Gulf of Paria and in the area between Trinidad and Guyana, as the same vessels operate in the entire area, considered a single zone.

Until eventual sub-stocks within the region have been individualized, and the movements of the fleets are better documented, it seems practical to include in a review of this fishery all the fishing grounds situated between the Paria Peninsula (Venezuela) and the border between the Brazilian States of Maranhão and Piauí.

#### Artisanal / industrial fishing

The definitions of industrial and artisanal fishery differ from country to country. Trawlers with an engine of more than 250 HP are considered of the industrial type. Trawlers with an engine of 100-250 HP are generally called "semi-industrial" or "coastal". Both types are treated together in this

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[1] Fisheries Department, Paramaribo, Suriname.

discussion. Artisanal fishermen either have no boat, a non-motorized boat, or a boat with an engine power of less than 150 HP, without a mechanical gear retrieve equipment.

In terms of production, the industrial segment dominates the artisanal one, with some 80% of the landings (table I.1).

**Table I.1**: Production of the artisanal / industrial shrimp fisheries.

| COUNTRIES | APPROXIMATE *Penaeus spp* SHRIMP LANDINGS (tons per year, live weight) | | | | |
|---|---|---|---|---|---|
| | Industrial | | Artisanal | | Total |
| Brazil | 6-9,000 | 75% | 2-3,000 | 25% | 8-12,000 |
| French Guyana | 4,000 | 100% | - | - | 4,000 |
| Suriname | 5,000 | 100% | 0-50 | - | 5,000 |
| Guyana | 3,200 | 100% | 0-50 | - | 3,200 |
| Venezuela | 1,000 | 70% | 400 | 30% | 1,400 |
| Trinidad & Tobago | 500-800 | 50% | 300-500 | 50% | 800-1,300 |
| Total | 19-23,000 | ±80% | 2,7-4,000 | ±20% | 22-27,000 |

With respect to the relative importance of the artisanal shrimp fishery, the countries can be divided in three categories:

- countries without, or with a negligible artisanal shrimp fishery : French Guyana, Suriname, Guyana;
- countries with an important artisanal shrimp fishery, dominated (in yields) by the industrial fleet : Brazil and Venezuela;
- in Trinidad and Tobago both types of fishing have a comparable contribution.

## Definition of fishing zones

Although the area is trawlable for the most part, and little natural obstacles can be found, shrimp is not distributed homogeneously. Shrimp populations differ from Northwest to Southeast, and these differences were exploited, before the declaration of Exclusive Economic Zones (EEZ's) by the countries of the region, by a multinational fleet that used to concentrate on the most productive grounds, shifting from Brazil in the beginning of the year towards the North. Fishing vessels are no longer allowed to operate in several EEZ's, and it is convenient to distinguish fishing zones limited by national boundaries.

On the other hand, the depth is a major factor in the distribution of shrimp species and sizes. The fishing grounds can therefore also be divided into deeper grounds, fished mainly by night, and shallower grounds, exploited by day. In Brazil, a third area called "Tutóia" (eastern part of the State Maranhão) is identified. Table I.2 proposes a division of the area into zones, with some of the characteristics of each zone.

While fleets that can be stamped as industrial operate in the entire area almost without discontinuity, penaeid shrimp are exploited by artisanal fishermen only in a few well delimited areas, also mentioned in table I.2. These areas are always situated in shallow, brackish water, and do not overlap with those of the industrial fleet.

**Table I.2**: Shrimp fishing zones within the region.

| COUNTRY | IND/ART | ZONE DEFINITION | DEPTH RANGE (m) | OTHER CHARACTERISTICS | AREA (km²) |
|---|---|---|---|---|---|
| Brazil | I1 | Tutóia : coastal area, State Maranhão | 20-40 | Day fishing | |
| | I2 | Foz da Amazonas : off Amazon estuary | 40-60 | Day fishing | |
| | I3 | Amapá | 60-100 | Night fishing | |
| | A1 | lagoons, coast of State Pará | 0-1 | Brackish water | |
| French Guyana | I4 | shallower zone | 20-40 | Day fishing | |
| | I5 | deeper zone | 40-80 | Night fishing | |
| Suriname | I6 | shallower zone | 20-40 | Day fishing | 20,000 |
| | I7 | deeper zone | 40-80 | Night fishing | 19,000 |
| | A2 | Coastal lagoons (2 areas) | 0-1 | Brackish water | |
| Guyana | I8 | shallower zone | 20-40 | Day fishing | |
| | I9 | deeper zone | 40-80 | Night fishing | |
| Venezuela | I10 | Orinoco - Guyana | 20-80 | | 60,000 |
| | A3 | Orinoco estuary (special fishing zone) | 0-5 | Fishing agreement | 394 |
| | A4 | North of the Gulf of Paria | 0-5 | | |
| Venezuela/Trinidad & Tobago | I11 | Columbus Channel | 10-60 | Fishing agreement | 826 |
| | I12 | Gulf of Paria | 10-40 | | 1,957 |
| Trinidad & Tobago | I13 | North coast | 37-58 | | 235 |
| | A5 | West coast, shallow area | 2-8 | | |

## I.B. THE INDUSTRIAL SECTOR

### 1. The fleets

Types of vessels, equipment

The types of boats and equipment found in the industrial fishery show little variation : the classical double rigged trawler is used, with engines ranging from 250 to 500 HP, and freezing equipment. Part of the vessels use 4 nets and others use 2 nets. How this affects the fishing power has not been investigated in the region. There are two notable exceptions : the semi-industrial vessels of Trinidad and Tobago are smaller, with a lower engine power, they use a single net, and carry out one day trips ; in French Guyana a few trawlers, which exploit deep-sea shrimp during part of the year, are larger, have engines of 600 HP, and equipment for deep-sea fishing (stern-trawl). They use the usual double rigged gear when operating on the shelf.

As the movements of the boats through the area are now restricted by the national EEZ's, they could be classified into fleets in accordance with the country of registration and the landing place, the zones exploited and the strategy. Table I.3 proposes such a classification, and shows some characteristics of the individualized fleets.

**Table I.3**: Main characteristics of the different fleets (industrial) in 1991.

| COUNTRY / FLEET | | BOAT AND GEAR | | | # TRIPS PER BOAT | | ZONES EXPLOITED | |
|---|---|---|---|---|---|---|---|---|
| | | # boats | # nets | HP | per year | length(days) | | |
| Brazil | | | | | | | | |
| B1 | Ceará | 34 | 2 | ? | ? | ? | } coastal | I1 |
| B2 | Piauí | 7 | ? | ? | ? | ? | } fishing (also | I1 |
| B3 | Piauí | 15 | ? | < 250 | ? | ? | } sea-bob) | I1 |
| B4 | Pará/Amapá | 97 | 2 | 250-400 | 7 | 30-45 | exploits also finfish | I2 (I3, I1) |
| B5 | Pará/Amapá | 65 | 2 | 250-400 | 7 | 30-45 | little fin-fish | I3 (I2, I1) |
| French Guyana | | | | | | | | |
| F1 | main | 66 | 2 | 275-450 | 12 | 15-25 | | I4 (I5) |
| F2 | deep-sea | 6 | 1-2 | 500 | 10 | 25 | deep sea shrimp seasonally | I5 (I4) |
| Suriname | | | | | | | | |
| S1 | Korean | 93 | 4 | 365-425 | 5 | 50-70 | shallow/interested in by-catch | I6 |
| S2 | Japanese | 34 | 4 | 365-565 | 5 | 50-90 | deeper/not interested in by-catch | I7 (I6) |
| Guyana | | | | | | | | |
| G1 | U.S. | 61 | 4 | | 6-8 | 35-45 | less interested in by-catch | I8 (I9) |
| G2 | Guyanese | 51 | 2 | | 6-7 | 30-35 | seasonally exploits sea bob, fin-fish | I8 |
| G3 | Japanese | 6 | 2 | | 5-6 | 45-60 | deeper grounds, more night fishing | I9 (I8) |
| Venezuela ('89) | | | | | | | | |
| V1 | Güiria | 53 | 2 | av 490 | 3-5 | 10-15 | } Gulf of Paria | I10, I11, I12 |
| V2 | Cumaná | | 2 | | | 13-16 | } & Guayana | |
| Trinidad & Tobago | | | | | | | | |
| T1 | NFC | 20 | 2 | av 356 | 15 | 7-21 | | I11, I12, I13 |
| T2 | Semi-ind. | 9 | 1 | av 176 | 120 | 1 | shallower areas | I12 |

Shallower and deeper fishing grounds

In each country part of the vessels exploit preferentially the deeper grounds, mainly at night, and another part operate in the depth range 20-40 meters, during the daytime. There is a lot of overlapping, of course, and where the two types of fishing grounds are not too distant, boats may shift between them and fish, during some seasons, day and night.

In the countries with a multinational fleet, the strategies usually coincide with different nationalities. This is most clear in Suriname, where a Japanese fleet targets the larger shrimp, especially the "Hopper" *Penaeus brasiliensis* (highly demanded in Japan) on the deeper fishing grounds. The Korean fleet operates in shallower waters, where the yields are often better, all sizes and species together. The strategy of the national fleet is similar to the Korean one (many captains are Korean).

In Guyana the situation is similar, though the Japanese fleet is much smaller. A further distinction can be made between the national fleet, that is also interested in catching finfish and sea bob, and the US fleet, where finfish remains a by-catch *sensu stricto*. Differences can be noted in the average length of trip (longer for the Japanese, shorter for the nationals), and in the equipment (4 nets for the US and 2 nets for the rest).

In Brazil, where the fleet is now entirely national after a period of some ten years during which foreign vessels could be hired by local companies, it seems that the companies have inherited, and still maintain the habits and strategies of the fishermen they have been working with. The companies which hired Japanese boats still tend to exploit preferentially the deeper (and more difficult) Amapá fishing grounds (larger shrimp size). Those who worked with Koreans exploit the zone I2 (Foz da Amazonas). On this base it is possible to distinguish two fleets. As in Suriname and

in Guyana, there is a lot of overlapping. In addition, both fleets also visit, in the second half of the year, the Tutóia area, otherwise exploited by the fleets based in Ceará/Piauí.

In French Guyana the deeper fishing grounds used to be exploited mainly by the foreign (Japanese and US) vessels. Since these fleets either have left or have been absorbed in the process of gallicisation, and no part of the present fleet seems to have taken over this strategy, the deeper grounds now appear less exploited. This is reflected by the decrease in the landings of *P. brasiliensis*, from ± 20% of the total in 1985 to ± 5% in 1991. There is no significant difference in strategy/grounds exploited within the present fleet, except for the small fleet exploiting alternatively the deep-sea shrimp and the shrimp of the continental shelf.

In Venezuela, where there has never been an foreign fleet, a distinction can be made between the fleets based in Cumaná and Güiria, although how far their strategies differ is not known.

In Trinidad and Tobago there are two types of non-artisanal vessels. The first is the usual double rigged type, and the second is the so called "semi industrial" vessel, which exploits different (shallower) fishing grounds.

## 2. Landing places and handling

As important for the design of a proper data collection system is the way the product is delivered, handled and processed.

Number of landing places

The industrial landings used to be concentrated in a small number of facilities, which received large amounts of shrimp. It is still the case in Brazil, Guyana, Suriname and Trinidad and Tobago (for the industrial fleet ; the landings of the semi industrial fleet are scattered). New facilities have been built recently in other countries, notably French Guyana, after many years of monopoly by one single processing company. Two recent plants are also operating in Guyana. In Venezuela the landings are parcelled between numerous small scale facilities.

Grading head-off shrimp

As long as the production was mainly exported to the United States of America, the shrimp was basically headed and kept on ice or (from the end of the '60's) frozen individually (in bags) on board. On shore, they were sorted mechanically by size after thawing, and graded in some 10 size categories. These categories were standard, defined by the number of pieces per pound (under 10, 10-15, etc). The damaged shrimp was classified into a smaller number of secondary categories (P/O = picked out, large, medium, small). This system still prevails in Brazil, Suriname, Guyana. All shrimp was processed this way in French Guyana too, until the company Pideg lost his monopoly. Less and less shrimp was processed head-off there after 1986, coinciding with a shift towards European export markets.

Smaller facilities, as well as some facilities created recently do not have mechanical grading equipment. The tails are sorted by hand into a smaller number of categories, particular to each plant. This is the case in Guyana (2 facilities) and in part of the plants in Venezuela, where the relative importance of head-on and head-off landings is not known. In Trinidad and Tobago the shrimp is sorted on board into 4 categories, landed head-on and headed in the processing facility.

Grading head-on shrimp

Head-on shrimp production is important in French Guyana, where the bulk of the production is marketed head-on since 1987, and in Suriname, where it forms the major part of the production by the Japanese companies. Small amounts of shrimp are also processed head-on in Guyana, Brazil, and Venezuela. Grading is now on board (in French Guyana, grading was on shore in the beginning). Unlike the head-off grading, each company maintains its own categories of head-on shrimp, in accordance with the requirements of a particular export market.

Freezing and packing

All shrimp is frozen on board. The shrimp headed on board is then thawed at landing, before grading, and frozen again, definitively, after grading, with (in a block of ice), in boxes of two kilograms in most cases. The "picked-out" shrimp generally receive a different treatment (packed in 1 kg bags for example), and so do the other secondary categories (peeled shrimp).

The head-on shrimp, after it is graded on board, can be either disposed in its final package of 2 kilograms, frozen in a block of ice, ready for export (Japanese fleet, Suriname), or in plastic trays *without ice* (French Guyana). In the first case, the packages need only, at landing, to be transferred to the cold storage of the plant, awaiting shipment. In the second case, the content of a number of trays is transferred (the shrimp remaining frozen) in the final cartridge, by amounts of 2 to 10 kilograms.

Quality categories

The companies generally commercialize shrimp under several brand names, which correspond to requirements of specific buyers. These requirements are based on the quality of the product, but may also coincide with other peculiarities like moulted individuals (soft shell), differences in species composition, etc.

**Table I.4**: Types of products / processing (industry) in 1991.

| COUNTRY / FLEET | CHARACTERISTICS OF THE PROCESSING | | | | | | | PRODUCTION PER YEAR (tons, live weight) | |
|---|---|---|---|---|---|---|---|---|---|
| | # plants | Head ON/OFF | Commercial categories B/S[1] | grades[2] | species[3] | Packing & freezing B/S [1] | unit | Total | Average/plant |
| Brazil | | | | | | | | | |
| B1 | 2 | OFF ? | S ? | ? | - | S ? | 2 ? | 700 | 350 |
| B2 | 1 | OFF ? | S ? | ? | - | S ? | 2 ? | 250 | 250 |
| B3 | ? | ? | ? | ? | - | ? | ? | ? | |
| B4 | 4 | OFF | S | A | - | S | 2 kg | 4,700 | ±1,200 |
| B5 | 2 | OFF | S | A | - | S | 2 | 1,900 | ±1,200 |
| | | ON | B | C | - | B | 2 | 400 | |
| French Guyana | | | | | | | | | |
| F1 | 5 | ON | B | D | - | B | 10 | 1,700 | } |
| | | ON | B | C | - | B | 10 | 1,100 | } ±600 |
| | | ON | B | C | - | B | 5 | 300 | } |
| F2 | 1 | ON | B | C | - | B | 2 | 700 | } ±900 |
| | | OFF | S | B | - | S | 2 | 200 | } |
| Suriname | | | | | | | | | |
| S 1 | 2 | OFF | S | A | W/BNS | S | 2 | 2,500 | } |
| | | | | | | | | | } ±2,000 |
| S 2 | 1 | OFF | S | A | W/BNS | S | 2 | 1,100 | } |
| | | ON | B | C | B/WNS | B | 2 | 400 | |
| Guyana | | | | | | | | | |
| G1 | 1 | OFF | S | A | W/BNS | S | 2 | 2,400 | ±2,400 |
| G2 | 3 | OFF | S | B | - | S | 2 | 200 | |
| | | | | A | W/BNS | S | 2 | } | |
| | | | | | | | | } 500 | } ±200 |
| G3 | 1 | OFF | S | A | W/BNS | S | 2 | } | |
| | | ON | B | C | B/WNS? | B | | 100 | |
| Venezuela | | | | | | | | | |
| V1 | | | | | | | | 500 | |
| & | } 14 | OFF | S | A/B | W/BNS | S | ? | | <100 |
| V2 | | ON | ? | ? | W/BNS | S | ? | 500 | |
| Trinidad & Tobago | | | | | | | | | |
| T1 | 1 | ON | B | C | B/WNS | S | ? | 400 | ±400 |
| | retail | ON | - | - | - | - | - | 200 | |
| T2 | retail | ON | - | - | - | - | - | 200 | |

[1] Sorted on board (B) or on shore (S)

[2] A = counts per lb : machine grading of tails into 10-14 # per pound categories
B = visual grading of tails into 3-6 size categories (super small, small, medium, large, etc)
C = visual grading of whole shrimp into 5-8 # per pound categories
D = visual grading of whole shrimp into 7-8 size categories (small, medium, large, etc)

[3] W = *Penaeus schmitti*, B = *P. brasiliensis*, N = *P. notialis*, S = *P. subtilis*

## Sorting by species

Certain species may be packed and marketed separately. It is the case in Suriname and Guyana for the white shrimp (*Penaeus schmitti*) (when it forms a significant part of the landing), less appreciated on the export market. On the other hand, the same species is packed separately in Venezuela for the opposite reason, because its larger average size makes it more valuable.

Head-on *P. brasiliensis* is packed separately by the Japanese, because of the preference of the Japanese market for this species. On the contrary, this species consists of small individuals in Trinidad and Tobago and forms the least valued category.

**Table I.5**: Structure of the industrial / semi-industrial shrimp fishery.

| COUNTRIES | # SHRIMP COMPANIES | | BOATS | | # FLEETS / STRATEGIES | # FISHING ZONES |
|---|---|---|---|---|---|---|
| | fishing | proc'ng | # boats | % national | | |
| Brazil Ceará | ? | 2 | 34 | 100 | 2 | } |
| Piauí | ? | 1 | 22 | 100 | 1 | } 3 |
| Pará/Amapá | 24 | 6 | 162 | 100 | 2 | } |
| French Guyana | 16 | 5 | 72 | 100 | 2 | 2 |
| Suriname | 19 | 2 | 127 | 12 | 2 | 2 |
| Guyana | ± 20 | 4 | 118 | 43 | 3 | 2 |
| Venezuela | ? | 14 ? | ±70 | 100 | 2 | 3 |
| Trinidad & Tobago | ? | 1 ? | 29 | 100 | 2 | 3 |

## I.C. THE ARTISANAL SECTOR

Fishermen using a manually retrieved fishing gear are considered artisanal fishermen. Table I.5 summarizes the limited information available on this type of shrimp fishery. The main (known) zones are the brackish-water lagoons along the coast of the State of Pará (Brazil), part of the estuary of the Orinoco river, and shallow areas situated in the northern and eastern parts of the Gulf of Paria. A variety of gear is used, from hand-seine in Brazil to small trawls in Trinidad and Tobago. The number of units is known in Trinidad and Tobago and in Venezuela (approximately).

Artisanal catches are much lower in Guyana, Suriname and French Guyana, and consist mostly of incidental catch of other fisheries, particularly the chinese seine, targeting smaller shrimp species, sea-bob (*Xyphopenaeus kroyeri*) and white-bellied shrimp (*Nematopalaemon schmitti*).

Shrimp of the genus Penaeus caught by artisanal fishermen are generally in the early stages their biological cycle : for example juvenile *P. subtilis* in Brazil and in Suriname. This is not always the case, however. The non-motorized artisanal shrimp fishery along the Venezuelan shore North of the Gulf of Paria exploits mainly adult *P. schmitti*.

**Table I.6**: Characteristics of the artisanal shrimp fisheries.

| COUNTRY | ZONE | # UNITS | TYPE OF GEAR | # LANDING PLACES | PRODUCTION |
|---|---|---|---|---|---|
| Brazil | Estuarine area, coast of Pará | ? | hand seine | 6 ? | 2-3,000 tons |
| | Amapá coast | ? | | ? | ? |
| French Guyana | probably incidental catch in chinese seines | | | | ? |
| Suriname | 2 lagoon zones : East of Corentijne river and East of Commewijne river | occasional fishermen | hand seine | 3 | 0 - 50 tons |
| | incidental catch in chinese seines | | | | < 10 tons |
| Guyana | incidental catch in chinese seines | | | | ? |
| Venezuela | shallow waters along North coast of the Gulf of Paria | ± 400 | beach seine | ? | ± 400 tons |
| Trinidad & Tobago | Orinoco, special fishing zone } West coast (1-3 fms) } | 56 motor'd boats | manual trawl | } 13 } | } 100-200 tons } |
| | West coast (1-5 fms) | 129 idem | idem | 5 | 100-200 tons |

# II. AVAILABLE INFORMATION AND DATA COLLECTION SYSTEMS

## II.A. SOURCES OF INFORMATION

In the region the industrial fleets take the largest part of the catch for their account. As the industry generally records for its own use detailed information on the landings and on the corresponding efforts, it is practical to start with this source of data. This requires a certain level of cooperation from the part of the industry, which can be encouraged by providing some feedback in the form, for example, of a statistical bulletin. The submission of information to the Government is generally included in the agreements closed by the industry, through the licensing system.

An important issue is to select and standardize the data to be provided by the industry, to obtain them on a regular basis, and to verify them. The difficulty of the task will depend on the number of processing and fishing companies, their size (small companies often have a less comprehensive administration), their geographical dispersion.

All countries have more or less similar dispositions. Information is submitted to governments in three main formats:

- the requests for fishing licence and/or registration;
- the logbooks;
- the landing reports.

Table II.1 provides a summary of the types of reports submitted by the industry in each country, and of their reliability.

The information which can not be submitted by the industry has to be obtained by direct observation. The collaboration of the industry will also be necessary.

**Table II.1**: Sources of data on the shrimp industry.

| COUNTRY | FLEET | LANDING REPORTS | | | | LOGBOOKS | | FLEET REGISTRATION | |
|---|---|---|---|---|---|---|---|---|---|
| | | source* | freq'cy | coverage | rel'ty | coverage | rel'ty | coverage | rel'ty |
| Brazil | B1&2&3<br>B4&5 | P,A | trip | 100 % | + | 60-70 % | - | 100 % | + |
| French Guyana | all | A | trip | 100 % | + | 80% | ? | 100 % | + |
| Suriname | all<br>S2 | P<br>F | month<br>trip | 100 %<br>80 % | +<br>? | ? %<br>? % | -<br>- | 100% | + |
| Guyana | all<br>G2 | P<br>F,A | trip<br>month | 80 %<br>?? % | +<br>- | 80 % | - | 100 % ? | + |
| Venezuela | all | P,A | trip | 100 % | + | 80 % | - | ? | ? |
| Trinidad & Tobago | T1<br>T2 | A<br>data collect | trip<br>trip | 100 %<br>? | +<br>+ | 75 %<br>50 % | -<br>- | 100 %<br>90 % | +<br>+ |

* Reporting forms are filled out by the fisheries administration (A), by the processing industry (P), or by the fishing companies (F)

## 1. Registration of the vessels

All countries have a fleet registration system, through which permanent information on the vessel (type, year of construction, dimensions, capacities, engines), the type of fishing (target species, gear, fishing grounds) and the crew is recorded. This information is updated every year, and is considered reliable and complete in most cases. Its usefulness will depend on the following aspects:

- whether certain details useful for the assessment of the fishing power are included, especially on fishing gear and fish finding equipment;
- whether it is updated throughout the year (vessels leaving the fishery, changes in equipment);
- whether it is computerized and data can be readily extracted.

## 2. Logbooks

Logbooks are also compulsory, and record a similar type of information, in all countries of the region. Data on catch is entered by haul and should represent the real catch, before any part is discarded, specified by species. Logbooks also provide for the recording of the most precise information on effort (time effectively spent fishing), as well as on the geographical distribution of catch, effort, cpue.

This very detailed material is generally not processed, however, for two main reasons:

- the reliability of the information provided is considered poor, particularly as there is no control on the way the logbooks are filled in. In some cases they are known to be filled in ashore, after completion of the trip, by someone who was not on the boat.
- the mass of information produced is such that it cannot be processed manually, and the countries are not yet equipped with the adequate software to analyze them.

In the best cases a sample is processed manually, in order to extract information on:

- the geographic distribution of effort, catch, cpue (Venezuela);
- average indicators on the effort such as the average time per day spent fishing, the number of hauls, night/day fishing, etc.

Reliability of the logbooks could be improved if used in combination with an observer program, as it is currently done in Venezuela.

## 3. Landing reports

Landing reports are the major format by which the industry supplies information. They are submitted after each trip or by month. Data are entered on a trip by trip basis, except in the case of Suriname where the data supplied are already aggregated by fishing company and month (all trips of the same company in the month together).

These reports present data on landings, and not on real catches. The difference lies in:

- discards
- transhipments
- sales outside the plant (legal or illegal)
- part of the catch kept by the crew
- auto-consumption

A coverage of almost 100% is achieved in most countries. The reliability is usually very good, but depends also on the way the data are collected. The information is most reliable in the case where a fisheries administrator regularly visits the industry and collects himself (copies) information as it is recorded in the industry's own books. This is time consuming, however, and most of the time the companies have agreed to fill in forms designed by the governments and to submit them monthly. Government employees then visit only recalcitrant companies. On the other hand, it is considered safer to receive the information on landings from the processing companies, which keep detailed records for themselves, than from the fishing companies, often smaller scale, with a less reliable administration. Data on effort, however, should be preferably obtained from the fishing companies.

## 4. Direct observation

The purpose of direct observations can be:

- to obtain information which is not supplied by the industry;
- to complement and specify information supplied by the industry;
- to verify information supplied by the industry.

Observations can be carried out by enumerators at landing places, by observers on board fishing vessels, by samplers at different locations between landing and marketing of the product.

Data on the artisanal fishery will typically need to be obtained by enumerators. The only case in the region where catch and effort data on what is considered here as "non-artisanal" fishing are also currently recorded by enumerators is the semi-industrial fishery (T2) in Trinidad and Tobago, because deliveries are scattered at a number of places which are also used by artisanal units.

Venezuela is the only country with a regular program of observers on board. The purpose is to record detailed information on the geographic distribution (catch, cpue, species and sizes), and

accessorily to check the validity of the logbooks. Observers are sometimes used in Brazil, in connection with particular investigation schemes.

## II.B. DATA PROVIDED BY THE INDUSTRY

### 1. Data on landings

A summary of information available on landings is given in table II.2.

**Table II.2**: Available data on catch/landing.

| C'NTRY | FLEET | PERIOD | SOURCE | PERIOD 'TY | SPECIFICATIONS [1] | PROCESSING OF THE DATA BY MONTH |
|---|---|---|---|---|---|---|
| Brazil | B1&2&3<br>B4&5 | 1978- | landing reports | trip | H/OFF : main size categories, total P/O, total losses<br>H/ON : total (no categories) | -H/OFF : main size categories, P/O, losses, by plant<br>-H/ON : total by plant<br>-H/OFF+H/ON : total all plants in eq H/OFF, no categories |
| | B4&5 | | logbooks | haul | total | not processed |
| French Guyana | all | 1963-86 | landing reports | trip | H/OFF size categories, P/O categories | - by category by plant (only one plant ?)<br>- total by category all plants |
| | all | 1986- | idem | trip | size categories (H/ON and H/OFF) (several grading systems) | - by categories & plants<br>- total landings all plants (no categories) |
| | all | | logs | haul | total | not processed |
| Suriname | all | 1978- | landing reports | month | H/OFF : - by plant : size categories, P/O categories, culls<br>- by fishing company : total<br>H/ON : total by fishing c'y (no cat's) | - H/OFF : - by category and plant<br>- by category total all plants<br>- H/ON : total all fishing cies (no cat.)<br>- H/OFF+H/ON : total all plants (eq H/OFF) |
| | S2 | 1982- | idem | trip | size categories (H/OFF & H/ON), broken | not processed |
| | all | 1981- | logbooks | haul | total | not processed |
| Guyana | all | 1986- | landing reports | trip | H/OFF : size categories, pieces, sour shrimp<br>H/ON : total (no categories) | - total for all plants reported (± 80 %) : by H/OFF size categories, sour, tot H/ON |
| | G2 | 1991- | idem | month | total (no categories) | - total not graded<br>- total all plants all categories in equiv. H/OFF |
| | all | | logbooks | haul | total | not processed |
| Venezuela | all | 1973- | land. rep. | trip | total by species categories | total by species categories, all plants |
| | all | | logbooks | haul | total by species categories | sample processed for geograph. distribution |
| Trinidad & Tobago | T1 | 1991- | land. rep. | trip | by size and species categories | by size and species categories |
| | T2 | 1991- | collectors | trip | total | total |
| | all | | logbooks | haul | total | not processed |

[1] Species refer to the species categories given in table I.5

Total landings

As the data compiled are always based on the landing reports, they do not represent the total catch but the quantities landed at the plants. The impact of practices like transhipment, unofficial sales and discards may well vary from country to country, but is difficult to assess. The data are considered reliable as far as the total landings are concerned. In Guyana however smaller plants are not delivering landing reports and the information on corresponding landings has to be extracted from a monthly report prepared by the fishing companies.

Landings head-off

The landing reports are prepared after grading of the shrimp in the plant. The data can therefore be specified by commercial size category. This information is readily obtained from the plants which are large enough to have a mechanical grading line (counts/lb categories). It is not obtained, in Venezuela and Guyana, from the smaller companies that use a visual grading into fewer categories (see table I.4).

Besides the main categories expressed in number of tails per pound, there are a number of secondary categories for shrimp of inferior quality. Such categories are called "picked out" (P/O large, medium, small), "broken", "losses", "pieces", "culls", etc. Part of the shrimp landed may also undergo a separate treatment (peeling, sour shrimp, cooking). These categories, less important in weight landed, are often reported globally, without specification by categories (see table II.2).

The different quality categories within each size category are not reported.

Landings head-on

In French Guyana, where most of the landing is processed head-on, the companies report carefully by size categories (each has its own).

In Suriname, the landing reports from the processing companies do not mention the categories for the head-on landings. These are obtained through another landing report, filled-in by the fishing companies. The reliability of the data on head-on landings can be questioned, as no control is possible, neither on the total amounts nor on the distribution by size categories of the head-on landings.

In Trinidad and Tobago the shrimp is graded head-on on board, the landings by size categories are available. The landings of the semi-industrial fleet are marketed head-on.

In the countries where only a small part of the shrimp is landed head-on (Brazil, Guyana), head-on production is reported globally.

Species

The landings are reported by species categories (white/others) in Venezuela. In Suriname and Guyana, where the shrimp is to a certain extent sorted by species (*P. schmitti* is packed separately when in significant proportions), this is not specified in the landing reports. In Trinidad and Tobago the hopper (*P. brasiliensis*) constitutes a separate category, which is reported as such.

Processing of the data

Calculating the total landings (by month, year), by fishing company, processing plant, and total is straightforward in most cases, and somewhat more laborious in Guyana, where reporting by the processing companies do not cover 100 % of the landings and has to be complemented with the monthly reports from the fishing companies.

The data by size category are easily compiled in monthly totals by category by fishing and/or processing company. Where compatible count/lb categories are used, the landings of several plants can be summed by category. This is done by month and year in Suriname and Guyana, not in Brazil.

On the landings classified in the secondary categories, some information may be lost in the aggregation by month : in Guyana for example they are grouped in a monthly figure of "total not graded". The same is true for the head-on landings where these are in the minority. In Suriname the data on head-on landings by size categories have not been processed into totals by category by month.

Unlike the head-off landings, the head-on landings of different plants cannot be summed by categories, as the grading systems always differ.

## 2. Data on effort

Table II.3 summarizes the data on effort collected by each country.

**Table II.3**: Available data on effort.

| COUNTRY | FLEET | PERIOD | SOURCE | PERIOD'TY | TYPE OF EFFORT DATA |
|---|---|---|---|---|---|
| Brazil | B1&2&3 | | | | |
| | B4&5 | 1978- | Licensing syst | year | # licensed boats (with characteristics) |
| | | | Landing reports | month | # active boats (having landed) |
| | | | | month | # landings per vessel |
| | | | | trip | # days at sea |
| | | | | trip | # days fishing |
| | | | Logbooks | day | # hauls & hours fishing (not processed) |
| French Guyana | all | | Registration | year | # authorized boats (+ characteristics) |
| | | | Landing reports | month | # landings per vessel |
| | | | | trip | # days at sea |
| | all | | Logbooks | day | # hauls, hours fishing (not processed) |
| Suriname | all | 1980- | Licensing syst | year | # licensed boats (with characteristics) |
| | | | Landing reports | month | # landings per fishing cy |
| | S1 | 1982- | | month | # days at sea, per fishing cy |
| | all | | Logbooks | day | # hauls, hours trawling (not processed) |
| Guyana | all | | Licensing syst | year | # licensed boats (with characteristics) |
| | | | Landing reports | month | # landings per vessel |
| | | | | | # active boats |
| | all | | Logbooks | day | # hauls & hours trawling (not processed) |
| Venezuela | all | | Licensing syst | year | # licensed boats (with characteristics) |
| | all | | Landing reports | month | # landings per vessel |
| | | | | trip | # days at sea |
| | all | | Logbooks | day | # hauls & hours trawling (sample processed into # days per depth and zone of "" nm2) |
| Trinidad & | all | | Licensing syst | year | # licensed boats (with characteristics) |
| Tobago | T1 | | Landing reports | month | # landings per vessel |
| | T1 | | Logbooks | trip | # days at sea |
| | | | | trip | # hauls & hours trawling |
| | T2 | | Data collectors | trip | # days at sea |
| | | | | trip | # hours fishing |

Number of boats

The number of boats is recorded in all countries through a registration and licensing system. The list of the boats is updated every year. It can be considered that the totality of the fleet is registered. A problem can occur where trawlers of the same type (also) exploit other resources like fin-fish, sea-bob, deep-sea shrimp. It is the case in several countries:

- in French Guyana 6 trawlers exploit deep-sea shrimp during part of the year;
- in Suriname several trawlers are targeting fin-fish, and a few were fitted out to carry out experimental fishing (for snapper, etc). This is not mentioned on the registration forms;
- in Guyana there are sea-bob, finfish and prawn fishing licences, but a number of vessels switch during the year from prawn trawling to sea-bob and/or fin-fish trawling.

Characteristics of the fleet

Detailed characteristics of each vessel are recorded through the licensing/ registration system. Useful information for the appreciation of the fishing power is included (engine power, overall length, year of construction). The data on the fishing gear, indispensable for the classification of the vessels (particularly where they may exploit different resources) are often too succinct : the number and type of nets and/or their dimensions is not mentioned, data on mesh size unreliable, etc.

Number of active boats

The number of active boats, indicating the number of boats having landed during a given period, is recorded in Brazil and Guyana. In French Guyana a meticulous account is regularly held, through personal contacts, of the condition of each boat (reparations, periods at dock, accidents, wreckages).

Number of trips

The number of trips is easily calculated when data are entered by landing. In Suriname as the information obtained from the processing industry is already aggregated by fishing company and month, the number of trips of each vessel is not known, except for the Japanese fleet (reported by the fishing companies).

Number of days at sea

This figure is recorded for every trip except in Suriname (aggregated by fishing company and month) and Guyana (dates of the trips not given in the landing reports).

Number of fishing days

This information, recorded only in Brazil, also on a trip by trip basis, is relevant in case of distant fishing grounds.

Number of hauls and of fishing hours

This information is recorded in the logbooks, and may be one of the more reliable aspects of the information obtained through that format, as it coincides with the entries in the captain's own logbook and is not considered confidential. Number of fishing hours is recorded by the enumerators for the semi-industrial fleet in Trinidad and Tobago.

Processing of the data

The number of vessels is computed on a year basis, the number of active boats on a month basis, the number of days at sea and of fishing days is computed by fishing company, month, year. The data from the logbooks are not processed, except for a sample used in Venezuela to estimate the geographic distribution of effort (in days at sea).

The most precise effort data available (processed) at fleet level is the number of fishing hours (fleet T2), of fishing days (fleets B3 and B4), of days at sea (French Guyana, Venezuela, fleets T1 and S1), and of trips (Guyana, fleet S2).

The effort data (number of boats, number of days at sea) have been standardized in Brazil and French Guyana.

## 3. Sources of error, suggestions for improvement

1. The following limitations result in biases in the evaluation of catches, fishing effort, composition of the catch.

   - Poaching: the majority of the countries claim that some illegal fishing occurs, due to a lack of means to control the EEZ.

   - Transshipment: is considered a serious problem in some countries, particularly Guyana (up to 25% of the production may have been sold at sea in certain years) and Suriname. It can be pointed out that the quality of the data is also affected in the country where the "transshipped" shrimp ends up.

   - Discards: the extent to which smaller sizes are discarded probably varies from country to country, depending on the presence of a market for small shrimp. Even within a country the amounts discarded may differ between companies, depending on each one's marketing policy (French Guyana). In Suriname the landing of small shrimp is discouraged by one of the processing plants, and this may have caused a higher degree of discards during certain seasons, by certain vessels.

Contrary to poaching and transshipment, discards should be relatively easy to assess by means of an observers programme.

- Auto-consumption and unofficial sales could be roughly estimated through interviews.

- Landing places not covered by the system : especially in countries with numerous small-scale shrimp factories, the processing and marketing pattern may be changeable. This could be accounted for by a periodic survey.

2. The registration/licensing systems should provide for a clear classification of the trawlers according to the resource exploited (penaeid shrimp, fin-fish, sea-bob, deep-sea shrimp). Vessels fishing seasonally two or more resources should be registered as such. The corresponding data on the gear used in each season should be registered.

3. The time unit for catch and effort data collection should be the trip, with identification of the vessel, dates and amounts landed by commercial categories. In the case of vessels with several seasonal activities, each trip should be classified according to the target resource and the gear used. A coverage of 100% of the landings should be achieved.

4. As much as possible, the information on landings should be obtained from the processing companies. Maximum use should be made of their own classification : all size categories, quality categories, species categories, secondary categories, quality categories, by-products, should be recorded. As far as possible, the companies should be requested to submit extracts from their own records (photocopies, print-outs) instead of filling out special forms.

5. The number of days at sea should be used as the standard unit of effort. This information should be obtained from the fishing companies through a simple list of boats landing (classified by target/gear) with the landing date and the number of days at sea.

6. Effort, expressed in number of boats and number of days at sea, should be standardized.

7. The licensing/registration system, and the landing/effort data, should each be computerized as a data base system. This would facilitate the input of more detailed data (all categories mentioned in point 4 here above), and accelerate the processing and the extraction of information. A common basic structure could be designed, for each of the two data bases, for the whole region.

8. The logbooks collected over the years by each country contain a mass of unexploited information. They should receive a preliminary analysis (on a sample basis) in order to determine which part of the data recorded may be usable in the present stage, which part may become reliable through adequate control (for example by comparing with the captain's own logbook, or in combination with an observers programme). A simplified version should be designed (for the region), recording only data considered reliable/verifiable. A computerized data base should be designed to process the selected information. A common structure can be worked out for the region.

9. A bulletin presenting relevant statistical information should be produced periodically and offered to the companies as a feedback/counterpart for their cooperation. This bulletin could be a part of the data base system mentioned above.

## II.C. SAMPLINGS AT THE PROCESSING PLANTS

### 1. Purposes of the samplings

The type of information recorded by the industry itself is global and does not allow for detailed analysis of a multispecies fishery. In Brazil, where a single species (*Penaeus subtilis*) makes up more than 90% of the landings, and in French Guyana, where the second species (*P. brasiliensis*) is present only in the largest size categories, analyses (biological cycle, recruitment pattern, cohort analysis) have been attempted using information on the landings by size categories. In the other countries different species are present in all size categories.

The purpose of sampling at the processing plants is to differentiate the landings by species, sex, and size, and accessorily to collect other biological information like maturity stages, length-weight relations, etc.

### 2. Current sampling programmes

Sampling programmes have been under way in Brazil since 1975, in Suriname since 1984, in French Guyana since 1986 and in Trinidad and Tobago since 1991 (see table II.4). The sampling strategy has been adapted several times in French Guyana and Brazil (see details in table II.5). In French Guyana and Trinidad and Tobago all (industrial) fleets are covered by the sampling scheme, in Brazil only the fleets based in Pará and Amapá, and in Suriname only the head-off landings are sampled.

Strategies

Each country has selected a particular strategy in accordance with its resources and the structure of the industry.

In French Guyana, Suriname and Trinidad and Tobago sampling is stratified by commercial categories. In Brazil the stratification by size categories has been removed in 1986, in order to reduce to amount of manpower required.

French Guyana maintains an elaborate stratification by fleet. There is a stratification by processing plant in Suriname, no stratification by fleet or processing plant in Brazil. In Trinidad and Tobago the industrial and semi-industrial fleets are treated separately.

The number of samples taken per stratum varies between countries from 1 to 10. The sample size remains in the range of 100-300 pieces.

**Table II.4**: Summary of current samplings at processing facilities

| COUNTRY | FLEET | PERIOD | COVERAGE | PURPOSE |
|---|---|---|---|---|
| Brazil | B4&5 | 1975-85 | Head-off landings | Length frequency distributions of the total *P. subtilis* (♂,♀) landings, calculated from weight frequency distributions |
| | B4&5 | 1986-87 | idem | idem |
| | B4&5 | 1988- | idem | idem |
| French Guyana | all | 1986-90 | all landings | Species/sex composition and length frequency distributions for the total landings |
| | all | 1991-92 | idem | idem |
| Suriname | S1 | 1985- | Head-off landings | Species/sex composition by size category } Length freq'cy distributions |
| | S1 | 1985- | idem | Category/length conversion tables by species/sex } for the total H/OFF landings, } by species/sex |
| Trinidad & Tobago | T1 | 1991- | Landings at NFC | Species/sex composition and length frequency distributions for the total landings |
| | T2 | 1991- | Landings at Orange Valley | idem |
| | Artisanal | 1991- | Landings at 5 sites (out of 19) | idem |

Data collected (see Table II.5)

The main size parameter is the carapace length in French Guyana and Trinidad and Tobago, the tail length in Suriname and the tail weight in Brazil. All these countries have data to work out their own biometric relations for the main species.

While French Guyana and Trinidad and Tobago record all data from the entire sample, Brazil and Suriname introduced a sampling in two steps. In Brazil the length and the maturity stages are taken for a sub-sample only. In Suriname only the species and sex (in number per kg) composition of the samples are recorded. The length frequency distribution of each species/sex are calculated with a set of conversion tables size category/length, which are revised one to two times a year.

Maturity stages by size are taken in Brazil (on a sub-sample), in French Guyana (all samples) and in Suriname (sporadic).

Manpower requirements

A rough estimate is given in Table II.5. It can be seen that stratified sampling carry heavy labour charges. The amount of manpower needed is roughly proportional to the number of pieces sampled. However, as the length of the manipulation depends on the data recorded, the process is much quicker when shrimp is just counted by species/sex (and not measured), as it is currently done in Suriname.

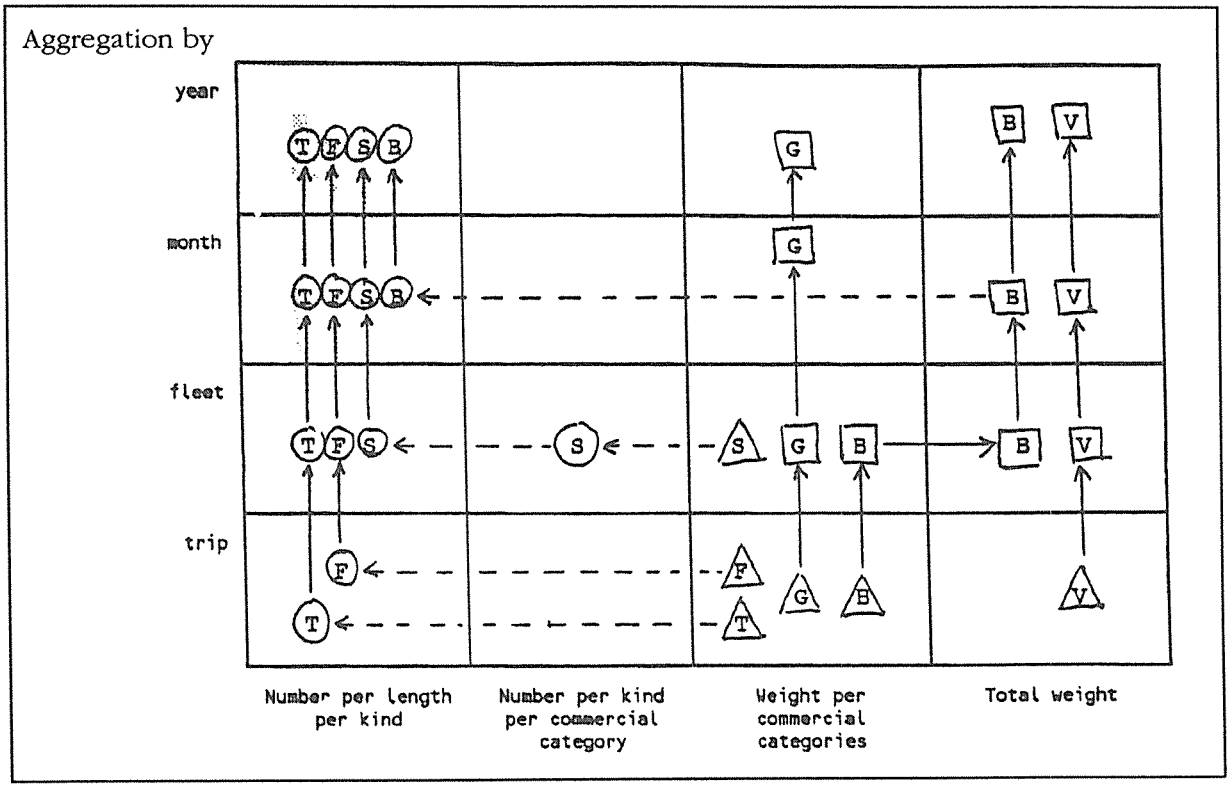
Extrapolation to the total landings

The schema hereunder tries to show graphically the steps by which the landing data are processed in each country (B=Brazil, G=Guyana, etc), and which information is obtained. Triangles represent the input of data from the industry, squares represent figures calculated by summing of these inputs. Circled is the information extrapolated from the samplings. Dotted lines indicate calculations based on results of samplings, solid lines indicate simple summing operations.

**Table II.5**: Details on the samplings at the processing facilities.

| COUNTRY | FLEET | PERIOD | STRATIFICATION | | | NUMBERS SAMPLED | | | DATA RECORDED[1] | | | | | | | | | LABOUR[3] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | time | fleet | size cat | sample size[2] | #samples / stratum | #samples / month | S | X | M | AL | CL | AW | TW | W | SS | (men*days/ month) | # shrimps/ man*day |
| Brazil | B4&5 | 1978-85 | month | 1 | 10 | 100-200 | 2 | 2-4,000 | + | + | 5 | | | + | | | + | 6 | 600 |
| | B4&5 | 1986-87 | month | 1 | no | 1,000 | 2 | 2,000 | + | + | 5 | | | + | | | + | 3 | 600 |
| | B4&5 | 1988- | month | 1 | no | { 400 | 2 | 800 | + | + | | | | + | | | + | } 3 | 200 |
| | | | | | | { 200 | 2 | 400 | + | + | 5 | + | | + | | | + | } | |
| French Guyana | all | 1986-90 | month | 5 | 7-10 | 100-150 | 1 | ±4,000 | + | + | 3 | | mm | | + | + | + | 5 | 800 |
| | all | 1991-92 | month | 9 | 7 | 100-150 | 1-3 | ±12,000 | + | + | 3 | | mm | | + | + | + | 15 | 800 |
| | all | 1992- | month | 5 | 7 | 100-150 | 2 | ±8,000 | + | + | 3 | | mm | | + | + | + | 10 | 800 |
| Suriname | S1 | 1985- | month | 2 | 13 | 150-250 | 5-10 | 20-25,000 | + | + | | | | | | | | 10 | 2,500 |
| | S1 | 1985- | 6 months | 1 | 13 | 100/kind | 1 | 1-2,000 | + | + | 3 | mm | + | | | | | 4.5 | 400 |
| Trinidad & Tobago | T1 | 1991- | month | 1 | 5 | 150-400 | ±8 | 8-9,000 | + | + | | | mm | | | | | 15 | 600 |
| | T2 | 1991- | month | 1 | 1-3 | 150-300 | ±5 | 2-3,000 | + | + | | | mm | | | | | } 20 | 400 |
| | Artisanal | 1991- | month | 2 | 1-3 | 150-300 | 5-10 | 2-5,000 | + | + | | | mm | | | | | } | |

[1] S=species, X=sex, M=maturity stages, AL=abdominal length, AW=abdominal weight, CL=carapace length, W=weight by species/sex, SS=soft shell
[2] varies according to the size category
[3] driver not included




## 3. Comments

Many of the factors which are important for the definition of a sampling programme differ from country to country. Among these factors the following can be cited : the number of processing plants and of commercial categories, the number of major species in the landings, whether the shrimp is landed already packed for export (the samples represent a loss for the industry in this case). The total number of samples that can be taken also depends on the availability of manpower.

It is advisable to start with determining what the samplings are wanted for, which variables will be estimated, and which level of variance is acceptable. Catch curve analysis for example would not require more than reasonable annual length frequency distributions. A simple, unstratified sampling scheme (like the current one in Brazil) may be sufficient to calculate annual mortalities. Cohort analysis based on annual size frequencies may require a lower variance. A much tighter sampling scheme will be required as soon as monthly size frequency distributions are needed, for example:

- Recruitment and migration patterns based on identification of modes;
- Quantification of annual recruitment;
- Calculation of growth parameters (Battacharya, Modal Progression Analysis).

For the time being, as growth parameters have not been properly calculated in the region, and quantification of recruitment should become one of the corner-stones for management, it seems appropriate to maintain sampling schemes that aim at the maximum level of precision that can be achieved with a manpower of 10-15 men*days/month (current level in Trinidad and Tobago, French Guyana, Suriname). For each country (where this manpower is available) a sampling scheme should be worked out, holding the following into account:

- Use should be made of the grading into size categories by the industry. A stratification by categories will substantially reduce the variance of the estimates of monthly numbers (per kind and length) landed, as the species composition, the sex ratio and obviously the distribution by sizes vary with the commercial size category.

- If it can be established that the grading mechanism is not changing over time, the length frequency distributions by kind of shrimp (species and sex) in each category remain valid and it is not necessary to take length data more than once in while for a check. This should be true at least when grading is mechanic. In Suriname for example the mechanisms of the grading line at SAIL are adjusted every day, and no seasonal variation in the size distributions was observed. This is not necessarily true for other grading procedures, however, particularly when it is visual, and when commercial categories are broader.

  Up to 80% of the time spent on each sample can be spared if only the number of pieces by kind and the total weight are recorded, instead of each individual length or weight. This time could be spent on the secondary categories, which are often overlooked at present, and on other aspects of the sampling strategy (deeper stratification, more samples per stratum).

- As the composition of the catch varies between fishing grounds, and several fishing grounds are exploited during a trip, the composition is not homogeneous in the fish hold of a landing vessel. The sample should be taken in several times if it is to be representative of the total landing of the vessel. This may be difficult when shrimp is landed packed / frozen (Japanese landings in Suriname) or by large units (8-10 kgs for a particular company in French Guyana).

In short, the following sources of variance should be investigated prior to optimization:

- variations of species/sex composition of each commercial category:
  - within the boat (different parts of the hold)
  - between boats of the same fleet
  - between fleets

- size composition by species/sex:
  - in each commercial category over time
  - in each commercial category between the processing plants

### 4. Conclusions

Sampling of industrial landings is an indispensable to obtain the data necessary for stock assessment, particularly when the fishery is multispecies.

There is a need to review the current sampling schemes and to optimize them, holding the structure of the industry, the manpower available, and the data requirements of the analytical methods the results are to be used for into account. A number of analyses of variance are required prior to optimization.

The model that will emerge from such studies will be useful to design several types of sampling schemes, adapted to different situations, including situation of countries where sampling programmes still have to be initiated.

Regional cooperation would be therefore an appropriate approach for the design and/or optimization of sampling schemes, as well as for the training of personnel, at the level of the data collector/sampler and of the data analyst.

## II.D. SAMPLING OF JUVENILES

### 1. Purpose of the samplings

Samplings of the early stages of the biological cycle have been initiated in Brazil (juveniles, almost uninterrupted since 1976), Suriname (juveniles, since 1984) and French Guyana (post-larvae, since 1989). The purpose is to obtain information on the early life of the shrimp, before recruitment in the trawl fishery. Specifically these samplings were designed to:

- investigate the presence of different species at nursery level;
- identify portions of the coast that play the role of nursery for penaeid species and recognize areas with special importance for the recruitment and conservation of the resource;
- understand the recruitment mechanisms, particularly seasonality, dependence on external (environmental) factors, relationship with stock fluctuations;

collect length frequency distribution data that could be used to investigate aspects of the biological cycle like growth and natural mortality parameters.

**Table II.6**: Summary of the samplings of juveniles and post-larvae.

| COUNTRY | PERIOD | PLACES | METHOD OF COLLECTION | PURPOSE |
|---|---|---|---|---|
| Brazil | 1976-88<br>1988- | Pará coast (East of Amazon)<br>idem | by fishermen (hand seine)<br>idem | Species composition, biometric studies, monthly length frequency distributions for artisanal landings of *P.subtilis* (♂,♀)<br>Monthly length frequency distributions idem |
| French Guyana | 1986-87<br>1989- | Brackish water lagoons (Mana)<br>Cayenne river estuary | plankton net<br>plankton net | Identification of nurseries, species & length composition (juveniles)<br>idem (post-larvae) |
| Suriname | 1984-87<br>1984- | Brackish water lagoons (3 areas)<br>Estuarine areas | by fisheries staff (hand seine)<br>Sampling of fishermen catch (chinese seine) | Identification of nurseries, species composition, length freq distrib. for juvenile *P. subtilis* (♂,♀)<br>Species composition and length freq. distributions for all species |

## 2. Results, problems encountered

Table II.7 gives the characteristics of the samplings of juveniles carried out in Brazil and Suriname and compares the type of data collected.

The first goal has been achieved. It has been shown that *P. subtilis* is the only Penaeus species to be present in the coastal areas prospected, which are the State of Pará in Brazil, French Guyana and Suriname.

Coastal surveys have resulted in the identification of important nursery areas, in brackish lagoons. Their contribution to the shrimp fishery has not been quantified, however, and the fishing grounds that depend on each of them for shrimp recruitment have not been delimited either. Large portions of the coast have remained unexplored, even in the countries mentioned above.

**Table II.7**: Details on the samplings of juveniles.

| COUNTRY | PERIOD | # SAMPLINGS PER MONTH | # SHRIMP SAMPLED | | DATA COLLECTED [2] | | | | | | | LABOUR (men*day/month) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Sample size | # sampled per month | S | X | AW | TW | CL | TL | W | Collect. [1] | Process. |
| Brazil | 1976-88 | 6 places<br>1 sampling/month | 100-400<br>(all species)<br>100 | 1,000-3,000<br><br>600 | +<br><br>+ | +<br><br>+ | <br><br>+ | <br><br>+ | <br><br>+ | +<br><br>+ | +<br><br>+ | }<br>} 4<br>} | 4 |
| | 1988- | idem | 300<br>(*P. subtilis*)<br>100 | 1,500<br><br>600 | +<br><br>+ | <br><br>+ | <br><br>+ | <br><br>+ | <br><br> | +<br><br>+ | <br><br> | }<br>} 4<br>} | 4 |
| Suriname | 1984-87 | 3 places<br>1 sampling/month | 0-300<br>(all species) | 0-900 | + | + | | | | + | + | 12 | 4 |
| | 1984-87 | 5-10 places<br>1 sampling/month | 100-500<br>(all species) | 500-5000 | + | + | | | | + | + | 5 | 10 |
| | 1991- | 1 place<br>1 sampling/month | 1,000-2,000<br>(all species) | 1,000-2,000 | + | + | | | | + | + | 1½ | 10 |

[1] including driver/boatman
[2] S = species, X = sex, AW = abdominal weight, TW = total weight, CL = carapace length, TL = total length, W = total weight by species/sex

Recruitment was found to take place year round. Periods of more intensive recruitment have been identified by means of these samplings, particularly in French Guyana, and coincide with the seasonality deduced from data of the industry.

Particularly in the case of juveniles, it was found to be very difficult to standardize the sampling method in order to obtain quantitatively significant information. There are currently no data on catch and effort (by artisanal fishermen), or other indicators of biomass the data obtained from samplings could be associated with.

Length frequency data are difficult to analyze, because samples are taken at places where migratory phenomena take place. Moreover, due to the imperfections of the sampling devices, the samplings may not represent correctly the population sampled (Isaac, Dias Neto and Damasceno., 1991).

### 3. Comments

The lack of quantitative data has prevented the realisation of a comprehensive analysis of the results from the juveniles samplings. Even so there is a wealth of information in those data collected over many years. They should be exploited to extract information on species composition (Penaeus and non-Penaeus species), and seasonality (even based on qualitative data). The calculation of annual recruitment indices and an assessment of the importance of the areas identified as nurseries for the fishery should be attempted, even based on statistically imperfect data.

Based on the conclusions of such an analysis, it would probably be possible to design more rigorous sampling schemes. The results would become more useful if associated with artisanal catch and effort data.

Surveys of yet unexplored coastal areas should be carried out and the samplings (juveniles and post-larvae) should be extended to other zones identified as nursery grounds.

Information on the migration of juveniles from the nurseries to the fishing grounds would be of great relevance to assess the role of different coastal areas as shrimp nurseries and their importance for the fishery.

## II.E. ECONOMIC DATA

In the whole region, almost no data on the economic aspects of the shrimp fishery are collected in a sustained (routinely) way. According to the scientific staff met in several countries, however, this does not mean that the information is inaccessible.

## 1. Current situation

Economic data can be divided into data on costs and data on prices.

Data on costs

No information is currently routinely collected, for several reasons:

- They are not easily accessed : these data cannot be collected by observation nor from another source than the industry itself, which is not too inclined to provide information often considered confidential.
- This type of data does not lend itself to tabulation or to statistical treatment.

However, when needed for a particular study, cost data can be extracted from the annual (accountant's) reports the companies are required to supply to the Governments. Moreover, companies are often prepared to supply, on request, information for enquiry/study purposes.

Data on prices

Data on shrimp prices are regularly collected in Trinidad and Tobago (off-the-boat prices by commercial categories) and in Suriname (export prices by commercial categories for each shipment). In Guyana and Venezuela, an annual average value per kg is applied (all categories together) for general statistical purposes, and also to calculate export taxes.

There are several reasons why detailed data on the real prices obtained on the export markets are generally not collected. Export prices should in fact be collected in the importing country : they are difficult to verify from the exporting country. Data on price at landing are often irrelevant, when the owner of the fishing company is exporting himself (there is no off-the-boat sale). Price data are of little use without data on costs. For models like Thomson & Bell, yearly averages by size can be calculated afterwards, based on published international market prices ("green sheets", etc.).

## 2. Possible improvements

In spite of all the difficulties mentioned here this type of data is essential for bio-economic analysis, and some system should be devised to collect them on a regular, instead of an *ad hoc*, sporadic basis.

As to the exact type of data to collect, the data requirements of the programme BEAM IV could be used as guidelines (taken from Per Sparre and Niels Vestergaard, in SWIOP, 1990). The analysis makes a distinction between the harvesting sector and the processing, storage and marketing sector.

For the harvesting component, the costs are classified into:

- the costs which are proportional to fishing effort : these can be expressed in costs per day at sea, and include fuel and lubricants, food, ice and water, repairs and maintenance, crew wages, etc.;
- the fixed costs: these are calculated per vessel per year and include the depreciation of boat, gear and equipment, interest on capital, insurance, licence fees, shore staff salaries, etc.;
- the costs which are proportional to the catch : these are calculated as percentage of the catch value (crew shares).

In the processing/storage/marketing component all costs as well as the investment can be expressed as a proportion of the weight processed, and include transport, insurance, packaging material, power and water, repairs and maintenance, wages, depreciation, interest on capital, export tax, etc.

For the prices, average export prices per commercial size are essential and should be calculated from price data concerning several shipments through the year. If these cannot be obtained, standard world market prices could be used. Ex-vessel prices should be collected wherever they are applicable. In some cases they can be calculated as a fraction of the export price.

## II.F. DATA ON THE ARTISANAL FISHERY

Information on the artisanal fisheries is always more difficult to obtain because the small scale fishermen are not recording detailed data for themselves. Data have to be recorded by data collectors at scattered, often remote landing places. The countries where shrimp exploitation by small-scale fishermen are significant enough to justify such an effort are Brazil, Venezuela and Trinidad and Tobago.

Only in Trinidad and Tobago has a system been implemented (since 1991) to record artisanal catch and effort data. Data on species and size composition are collected, on a sampling basis, in Trinidad and Tobago, Brazil and Suriname (artisanal fisheries where penaeid shrimps are caught incidentally).

Given the present state of knowledge and the manpower available, it is impossible to recommend a comprehensive data collection system for artisanal shrimp catch in Brazil or Venezuela.

A first step should rather be to conduct surveys of the artisanal communities exploiting shrimp, including the communities already identified as well as unexplored areas where such communities could be present (particularly in Amapá, and in parts of the coast of Venezuela and Guyana, between the Orinoco and the Essequibo rivers).

The surveys should have the following purposes:

- to identify all artisanal fishing communities exploiting penaeid shrimp in the region;

- to collect preliminary information on number of fishermen, effort and catch per year, value, species and size composition, seasonality;
- to provide a preliminary assessment of the impact of small-scale fisheries on the resource.

Based on the results of the surveys, and depending on the availability of manpower, data collection systems could be worked out for part or the totality of the artisanal communities.

**Table II.8**: Available data on *Penaeus spp.* exploitation by artisanal fisheries.

| COUNTRY | LANDINGS/EFFORT | SPECIES/SIZE COMPOSITION |
|---|---|---|
| Brazil | no data except a rough estimate of yearly landings (2-3,000 tons) | based on samplings of juveniles |
| Suriname | included in the figures on landings by chinese seine,.. | based on samplings of juveniles |
| Guyana | idem | no |
| Venezuela | incomplete data collected on landings, rough estimate of yearly landings at 400 tons | samplings carried out in 1989-1992 |
| Trinidad & Tobago | since 1991, data collectors at the 7 main landing beaches record landing by trip, # landings, # fishing hours | sampling of the landings (same 7 beaches ?) |

# III. STOCK ASSESSMENT

## III.A. CURRENT STATE OF KNOWLEDGE ON BIOLOGICAL ISSUES

### 1. Biometric parameters

Several countries in the region have collected biometric data and calculated various types of relations. The results are summarized in table III.1.

While relations are available for *P. subtilis*, much less work has been done for *P. brasiliensis*, and almost no biometric studies have been carried out (in the region) on the other species.

Those relations can be used in countries where such relations have not yet been calculated. Attention must be paid to the way measurements were carried out, however. Length can be measured in various ways, and the results will differ. It is therefore preferable that investigators use relations they have established themselves.

In order to compare data from the different countries, all data should be transformed into a standard length, that could be total length, tail length, or carapace length.

Paula Lum Young et al. (1992) provide a list of biometric parameters for the species of the region, both obtained locally and outside this region.

**Table III.1**: Biological information / biometric relations.

| *Penaeus subtilis* ♀ a | ♀ b | *Penaeus subtilis* ♂ a | ♂ b | *Penaeus brasiliensis* ♀ a | ♀ b | *Penaeus brasiliensis* ♂ a | ♂ b | *Penaeus schmitti* ♀ a | ♀ b | *Penaeus schmitti* ♂ a | ♂ b | *Penaeus notialis* ♀ a | ♀ b | *Penaeus notialis* ♂ a | ♂ b | COUNTRY & REFERENCE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Weight (g) / length (mm) relationships : $W = a * L^b$** | | | | | | | | | | | | | | | | |
| **1. Total weight / total length** | | | | | | | | | | | | | | | | |
| $3.890*10^{-6}$ | 3.14 | $8.318*10^{-6}$ | 2.98 | $5.623*10^{-6}$ | 3.08 | $9.120*10^{-6}$ | 2.98 | | | | | | | | | French Guyana, Venaille |
| $4.357*10^{-6}$ | 3.126 | $6.658*10^{-6}$ | 3.024 | | | | | | | | | | | | | Brazil Barbosa & da Rocha |
| $3.997*10^{-6}$ | 3.146 | $4.738*10^{-6}$ | 3.105 | $4.785*10^{-6}$ | 3.121 | $1.467*10^{-6}$ | 2.892 | | | | | | | | | Region, Dragovich & al |
| | | | | | | | | $2.012*10^{-6}$ | 3.27 | $3.45*10^{-6}$ | 3.16 | | | | | Venezuela, Altuve & al |
| $3.00*10^{-4}$ | 3.211 | $0.73*10^{-6}$ | 3.480 | $2.500*10^{-6}$ | 3.258 | $1.500*10^{-6}$ | 2.854 | $3.90*10^{-6}$ | 3.203 | $5.30*10^{-6}$ | 3.112 | $10.00*10^{-6}$ | 3.058 | $4.000*10^{-6}$ | 3.172 | Trinidad & Tobago, Fabres |
| | | | | | | | | | | | | | | | | Brazil, Isaac & al |
| ♀,♂ comb.: | a=$5.103*10^{-6}$ ; b=3.09 | | | | | | | | | | | | | | | Trinidad & Tobago, Fabres |
| | a=$2.49*10^{-6}$ ; b=3.252 | | | a=$5.10*10^{-6}$ ; b=3.099 | | | | a=$4.80*10^{-6}$ ; b=3.150 | | | | a=$1.96*10^{-6}$ ; b=3.067 | | | | |
| **2. Tail weight / tail length** | | | | | | | | | | | | | | | | |
| $1.504*10^{-5}$ | 2.990 | $4.127*10^{-5}$ | 2.757 | $2.401*10^{-5}$ | 2.902 | $1.154*10^{-5}$ | 2.557 | | | | | | | | | Fr. Guyana, Dintheer & al |
| $1.600*10^{-5}$ | 3.093 | $3.200*10^{-5}$ | 2.875 | $1.600*10^{-5}$ | 3.071 | $0.570*10^{-5}$ | 3.271 | $1.600*10^{-5}$ | 3.102 | $2.30*10^{-5}$ | 2.993 | $2.20*10^{-5}$ | 3.079 | $1.200*10^{-5}$ | 3.131 | Trinidad & Tobago, Fabres |
| ♀,♂ comb.: | a=$5.15*10^{-2}$ ; b=3.63 | | | | | | | a=$5.15*10^{-2}$ ; b=3.63 | | | | | | | | Guyana, Gimenez & al |
| | a=$1.700*10^{-5}$ ; b=3.057 | | | a=$1.200*10^{-5}$ ; b=3.116 | | | | a=$1.800*10^{-5}$ ; b=3.066 | | | | a=0.0211 ; b=3.083 | | | | Trinidad & Tobago, Fabres |
| **3. Tail weight / carapace length** | | | | | | | | | | | | | | | | |
| $1.151*10^{-3}$ | 2.690 | $0.871*10^{-3}$ | 2.803 | | | | | | | | | | | | | Brazil Barbosa & da Rocha |
| $1.789*10^{-3}$ | 2,638 | $1.089*10^{-3}$ | 2.800 | $0.565*10^{-3}$ | 2.987 | $0.958*10^{-3}$ | 2.774 | $0.435*10^{-3}$ | 3.121 | $0.52*10^{-3}$ | 3.103 | $1.335*10^{-3}$ | 2.846 | $1.241*10^{-3}$ | 2.826 | Trinidad & Tobago, Fabres |
| ♀,♂ comb.: | a=$1.744*10^{-3}$ ; b=2.649 | | | a=$0.644*10^{-3}$ ; b=2.926 | | | | a=$0.491*10^{-3}$ ; b=3.099 | | | | a=? ; b=2.851 | | | | Trinidad & Tobago, Fabres |
| **4. Tail weight / total length** | | | | | | | | | | | | | | | | |
| $3.610*10^{-6}$ | 3.068 | $4.387*10^{-6}$ | 3.022 | | | | | | | | | | | | | Brazil Barbosa & da Rocha |
| **5. Total weight / carapace length** | | | | | | | | | | | | | | | | |
| $1.582*10^{-3}$ | 2.734 | $1.377*10^{-3}$ | 2.792 | | | | | | | | | | | | | Brazil Barbosa & da Rocha |
| $2.150*10^{-3}$ | 2.710 | $1.155*10^{-3}$ | 2.908 | $7.960*10^{-4}$ | 3.000 | $1.153*10^{-3}$ | 2.881 | $7.010*10^{-4}$ | 3.116 | $7.11*10^{-4}$ | 3.132 | $1.820*10^{-3}$ | 2.884 | $1.840*10^{-3}$ | 2.822 | Trinidad & Tobago, Fabres |
| ♀,♂ comb.: | a=$2.056*10^{-3}$ ; b=2.726 | | | a=$9.080*10^{-4}$ ; b=2.958 | | | | a=$7.480*10^{-4}$ ; b=3.106 | | | | a=$0.839*10^{-3}$ ; b=2.879 | | | | Trinidad & Tobago, Fabres |
| **Weight / weight relationships : $W_1 = a + b * W_2$** | | | | | | | | | | | | | | | | |
| **1. Total weight / tail weight** | | | | | | | | | | | | | | | | |
| -1.31 | 1.75 | -0.14 | 1.64 | -5.43 | 1.77 | -1.21 | 1.60 | | | | | | | | | French Guyana, Venaille |
| -0.133 | 1.606 | $4.4*10^{-2}$ | 1.515 | | | | | | | | | | | | | Brazil Barbosa & da Rocha |
| **2. Tail weight / total weight** | | | | | | | | | | | | | | | | |
| 0.5408 | 0.592 | 0.2671 | 0.612 | 2.986 | 0.561 | 0.674 | 0.638 | | | | | | | | | Region, Dragovich & al |
| 0.6820 | 0.614 | 0.3741 | 0.639 | 0.0701 | 0.673 | 0.0381 | 0.685 | 0.5355 | 0.610 | 0.4933 | 0.638 | 0.3591 | 0.632 | 0.1268 | 0.676 | Trinidad & Tobago, Fabres |
| ♀,♂ comb.: | a=0.6344 ; b=0.6175 | | | a=0.0838 ; b=0.6741 | | | | a=0.6745 ; b=0.6130 | | | | a=0.4702 ; b=0.636 | | | | Trinidad & Tobago, Fabres |
| **Length / length relationships : $L_1 = a + b * L_2$** | | | | | | | | | | | | | | | | |
| **1. Total length / tail length** | | | | | | | | | | | | | | | | |
| -0.09 | 1.60 | 5.67 | 1.49 | -10.34 | 1.64 | 0.59 | 1.52 | | | | | | | | | French Guyana, Venaille |
| | | | | | | | | | | | | | | | | Guyana, Gimenez & al |
| ♀,♂ comb.: | a=$1.02*10^{-2}$ ; b=1.59 | | | | | | | | | | | | | | | |
| **2. Total length / carapace length** | | | | | | | | | | | | | | | | |
| 24.33 | 3.49 | 7.93 | 4.23 | 41.38 | 3.18 | 4.99 | 4.19 | | | | | | | | | French Guyana, Venaille |
| 12.432 | 3.850 | 6.843 | 4.265 | | | | | | | | | | | | | Brazil Barbosa & da Rocha |
| | | | | | | | | 42.215 | 3.304 | 31.719 | 3.721 | | | | | Venezuela, Altuve & al |
| 21.6903 | 3.813 | 24.239 | 3.924 | 9.5814 | 4.177 | 0.8521 | 4.627 | 11.8829 | 4.209 | 8.6707 | 4.611 | 10.7214 | 4.115 | 15.119 | 4.234 | Trinidad & Tobago, Fabres |
| ♀,♂ comb.: | a=24.0120 ; b=3.7875 | | | a=6.0072 ; b=4.3636 | | | | a=13.2168 ; b=4.2694 | | | | a=12.9146 ; b=4.137 | | | | Trinidad & Tobago, Fabres |
| **3. Carapace length / total length** | | | | | | | | | | | | | | | | |
| -5.862 | 0.277 | -3.020 | 0.249 | -9.235 | 0.297 | -1.192 | 0.239 | -8.64 | 0.29 | -9.261 | 0.28 | -6.063 | 0.277 | -0.158 | 0.227 | Region, Dragovich & al |
| **4. Tail length / carapace length** | | | | | | | | | | | | | | | | |
| 14.2449 | 2.330 | 4.8184 | 2.938 | 3.0029 | 2.804 | 6.8501 | 2.691 | 6.2040 | 2.746 | 3.6772 | 3.059 | 8.8194 | 2.639 | 8.5997 | 2.832 | Trinidad & Tobago, Fabres |
| ♀,♂ comb.: | a=14.6078 ; b=2.381 | | | a=4.6537 ; b=2.760 | | | | a=7.1304 ; b=2.796 | | | | a=9.6142 ; b=2.766 | | | | Trinidad & Tobago, Fabres |

## 2. Growth

Until 1991, no specific growth study on any of the species had been carried out in the region. When required as input for assessment studies, growth parameters were taken from studies on either the same species or similar species in other regions.

In recent years several attempts have been made to extract growth parameters from size frequency distributions obtained on the industrial landings (see table III.2). The method of Powell was used to select pairs of $L_\infty$ and K values, to be tested on cohort analysis. This was done on *P. subtilis* in French Guyana and Brazil, as well as during the previous workshop (data from Brazil, French Guyana, Suriname), and on *P. brasiliensis* in French Guyana (Dintheer & Le Gall, 1988).

In Brazil several analytical methods have been recently used by Isaac, Dias Neto and Damasceno, including modal progression analysis. Values are also being calculated in Trinidad and Tobago in 1992.

The values obtained for K varied very widely, from 1-1.2, average found in Brazil by Isaac, Dias Neto and Damasceno, to 2.2-2.4, selected by Dintheer and Le Gall (who tested values from 1.5 to 3.6) in French Guyana.

**Table III.2**: Biological information on growth.

| $L_\infty$ (mm, total length) | | K (year$^{-1}$) | | $t_o$ | | METHOD | COUNTRY AND REFERENCES |
|---|---|---|---|---|---|---|---|
| ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | | |
| ***Penaeus subtilis*** | | | | | | | |
| 210 | 161 | 2.04 | 3.12 | | | taken from *P. notialis*, Ivory Coast | French Guyana, Garcia et al, 1984 |
| 120-135 (tail length) | 105-115 (tail) | 1.5-3.6 | 1.8-4.2 | | | Powell & test on cohort analysis | French Guyana, Dintheer & Le Gall, 1988 |
| 195, 205, 125, 128, 130 (tail) | | 2.28-2.40 | | | | taken from Dintheer & Le Gall and tested on cohort analyze | Region, WECAFC 1988 |
| 225 | 187 | 1.00 | 1.08 | | | ELEFAN I | Brazil, Isaac, Dias Neto & Damasceno, 1992 |
| 208 | 178 | | | | | Powell | |
| 216 | 172 | 1.12 | 1.20 | -0.441 | -0.537 | Modal progression analysis, ETAL | |
| 218 | 171 | 1.07 | 1.23 | -0.441 | -0.528 | Modal progression analysis, Allen | |
| 205 | 185 | 1.65 | 2.27 | | | Munro & Pauly equation (1983) | Trinidad & Tobago, Fabres, unpublished data |
| ***Penaeus brasiliensis*** | | | | | | | |
| 145-153 (tail length) | 130-137 (tail) | 1.8-4.2 | 1.8-4.2 | | | Powell & test on cohort analysis | French Guyana, Dintheer & Le Gall, 1988 |
| ***Penaeus schmitti*** | | | | | | | |
| 218 | 207 | 1.59 | 2.06 | | | Munro & Pauly equation (1983) | Trinidad & Tobago, Fabres, unpublished data |
| 225 | 205 | 1.55 | 1.19 | | | ELEFAN | Venezuela, Altuve, Alió and Marcano, 1992 |

During the workshop at Cayenne, the most "reasonable" values for female *P. subtilis* seemed to be:

| | |
|---|---|
| K | 2.28 |
| $L_\infty$ (head off) | 128 mm |

Growth parameters for *P. schmitti* have been calculated recently in Venezuela using data from the artisanal fishery (Altuve et al., in press) and in Trinidad and Tobago (Fabres, pers. comm.). Parameters have not been calculated for *P. notialis* in the region. Paula Lum Young et al. reviewed bibliographic values for growth parameters on the four species.

## 3. Mortalities

Natural mortality has not been investigated in the region, and values taken from compilations, principally the compilation by Garcia and Le Reste (1981) were used in the assessments. The value most commonly used is 0.2 per month, for all species (see table III.3).

**Table III.3**: Biological information on natural mortality.

| ♀ | ♂ | METHOD | COUNTRY AND REFERENCES |
|---|---|---|---|
| | | ***Penaeus subtilis*** | |
| 2.40 | 2.40 | taken from compilation, Garcia 1984 | French Guyana, Dintheer & Le Gall, Region, WECAFC, 1988 |
| 1.37<br>1.86<br>1.90<br>1.81-2.50 | 1.33<br>1.86<br>2.11 | Paloheimo / Beverton Holt<br>Paloheimo / S.L.<br>Pauly equation<br>Rikhter & Efanov equation | Brazil, Isaac, Dias Neto & Damasceno, 1992 |
| | | ***Penaeus brasiliensis*** | |
| 2.40 | 2.40 | taken from compilation, Garcia 1984 | Region, WECAFC, 1988 |

Isaac, Dias Neto and Damasceno, using the various methods available to obtain a first approximation of the natural mortality ( by regression of total mortality on effort and by empirical formula's) find much lower values, mostly between 1.3 and 2.0.

## 4. Reproduction/maturation

The size at first maturation of *P. subtilis* female has been investigated in Brazil, making use of the samplings at the industry. Values (total length) of 110 mm for $L_{50}$ and 195 mm for $L_{100}$ were found.

During the workshop in Cayenne (1988), values of respectively 140 mm and 85 mm (tail length) were used (to calculate fecundity per recruit).

Periods of maximum reproductive activity (gonadal maturity of females) were identified in Brazil from March to July (main season) and from September to October (secondary).

## 5. Recruitment

Although small shrimp is caught by the industrial fishery year round, peaks in the landings have been clearly identified in Suriname, French Guyana and Brazil. These peaks correspond to the recruitment of *P. subtilis*. Two peaks of different intensities are observed in Brazil and French Guyana, only one in Suriname. The main recruitment season appears to be from December to May

in Brazil, from March to June in French Guyana, from July to September in Suriname. Secondary recruitment seasons are July-August in Brazil, and September-October in French Guyana.

### 6. Species distribution, location of nurseries, migrations

The relative distribution of the two mains species show the predominance of *P. subtilis* in the southern range (Brazil, French Guyana), whereas *P. brasiliensis* is more important off Suriname and Guyana (the main component in Guyana ?). Although *P. brasiliensis* is almost absent in Brazil, *P. subtilis* is present in the entire area.

The presence of predominantly large *P. brasiliensis* in French Guyana and eastern Suriname, and of small individuals of the same species in the catches made off Guyana, suggests a migration of the adults of this species from Northwest to Southeast (see for example Kawahara, 1985, WECAFC, 1989). The *P. subtilis* seems to migrate from shallow waters towards the depth, but movement parallel to the shore certainly take place as well.

Nurseries have been located for *P. subtilis*, in Brazil (coast of Pará) and in Suriname (2 lagoons zones). The nursery at Mana (French Guyana) described by Rossignol in 1972 seems to have discontinued this function even before the area was transformed into rice culture. Even for the *P. subtilis*, the identified nurseries do not seem to explain the recruitment necessary to supply the fishery. Shallow areas, mud flats in the coastal zone probably play a substantial role in the production of juvenile shrimp.

*P. schmitti* is confined to shallow waters, and there are probably several separated stocks.

## IV. MANAGEMENT

### IV.A. OBJECTIVES

Given the very diverse political and economic contexts, the management objectives of the shrimp fisheries can be expected to vary among the countries. In general they have not been formally identified, but it is possible to list, from various sources, a number of preoccupations existing in each country. This has been done in table IV.1.

These preoccupations can be grouped into broad objectives as follows:

I. Long term conservation of the resource

II. Economic optimisation (Maximum Economic Yield) of the industry

III. Maximise rent for the country

IV. Maximise employment

V. Food security: maximum production/utilization of:
   A. shrimp
   B. other (by-catch, sea bob, etc.)

**Table IV.1**: Management of the industrial shrimp fishery: objectives.

| COUNTRY | PRIORITY 1 | PRIORITY 2 | APPARENT PRIORITY ORDER |
|---|---|---|---|
| Brazil | - prevent overfishing<br>- increase production and benefits<br>- and contribution to employment<br>- without endangering long term conservation of resource<br>- transfer of technology from foreign companies<br>- better utilization of by-catch | | I,II<br>IV,V<br>III |
| French Guyana | - long term conservation of resource<br>- optimize the yield per recruit | - short term economic considerations | I,II |
| Suriname | - long term conservation of resource<br>- maximise foreign currency returns for the country | - employment<br>- production of food/proteins (by-catch) | I<br>III<br>IV,V |
| Guyana | - long term conservation of resource<br>- increase benefits for the country<br>- optimize profitability of this industry<br>- contribution to national food security<br>- employment | - optimize utilisation existing facilities<br>- increase foreign exchange earnings | I,II<br>IV,V<br>III |
| Venezuela | - long term conservation of resource<br>- local economic development (Guayana area)<br>- improve profitability of the industry | - increase utilization (valorisation ?) of underexploited resource<br>- employment (not a problem in the region itself) | I,II<br>V<br>IV |
| Trinidad & Tobago | objectives and priorities to be determined in 1992 | | |

Because the information available does not allow for comparisons between the results of alternative policies, an order of priority has not been established by the countries either. It is not possible, for example, to set a priority order between employment and economic optimization if the respective social and economic costs and advantages of various options cannot be weighed against each other. This is, of course, the object of (bio-economic) modelling. If a discussion is to be held on management before results of such modelling are available, it is necessary to start with an "apparent order of priority", as suggested in table IV.1.

All countries cite as primordial the long term conservation of the resource, meaning preserving the capacity of the resource to provide its maximum sustainable yield, whether this yield is currently actually taken or not.

There is also a broad consensus to consider optimization as a means to maximize the net economic benefits of the industry (though not at all cost). As most of the shrimp is destined for export, net foreign currency earnings is often a major index of these benefits.

Countries where an international fleet is operating generally put emphasis on maximizing the rent to the country. For countries where the fleet is national, the prosperity of the shrimp industry itself may be the objective. Maximizing the benefits of the industry contributes to the fulfilment of the objective in both cases, as all the State can extract from the activity is a fraction of these benefits.

These two objectives (I and II-III) can therefore be considered as common to the entire region. With respect to the two additional objectives (IV, V) that are mentioned in most countries, the picture is much more disparate. The importance of the employment objective, and the practical implications of this objective depend on the presence of a national fleet, of a processing industry on shore, of an artisanal fishery, as well as on the general socio-economic context.

While maximizing the production of shrimp does not seem to receive much priority, most countries are concerned about the utilization of by-catch and other secondary resources. The goals pursued can be either to maximise the amounts of by-catch landed, or to utilize better the amounts of by-catch currently landed.

## IV.B. REVIEW OF CURRENT DISPOSITIONS

The fishery has remained practically unregulated until the proclamation by the countries of the region of their 200 miles Exclusive Economic Zones, which took place in the course of the years 70's.

### Limiting entry

The first measure that naturally followed the extension of the national jurisdiction to the fishing grounds was an attempt to control the fleets through registration. Not until several years later were restrictive measures taken. Brazil restricted access to national vessels (with a possibility of joint venture / hiring of foreign boats in a transitional phase) in 1978.

Brazil was also the first country to set a maximum number of trawlers (250 in 1980). In other countries the fishery remained basically open access, even though attempts were made in French Guyana to control indirectly the size of the fleet, through TAC ("Total Allowable Catch") and financial measures (subsidies granted or not granted for the construction of vessels).

In the course of the 80's, after the shrimp industry was given an "overcapitalisation" diagnostic, a few countries took measures to effectively curb the level of investment and effort : the number of boats was frozen in Venezuela, Trinidad and Tobago, and Guyana. A reduction of the fleet was recommended, though not enforced, in Guyana and Suriname. The gradual replacement of the international fleet by a national one was strongly encouraged in French Guyana and Brazil, and was achieved by the end of the 80's.

Today only French Guyana has officially an open access policy, in conformity with general EEC rules. The system there is based on the annual calculation of TAC, thus controlling indirectly the effort. In Eastern Venezuela, Guyana and Suriname, however, the situation practically amounts to an open access one. Maximum number of boats have been set or recommended, but requests for licences are not turned down. In Venezuela the registration of trawlers (coming from other provinces) in the oriental harbours (Güiria) is even encouraged, in order to unchoke other fishing grounds. Only Brazil and Trinidad and Tobago are really limiting the number of boats.

**Table IV.2**: Management : summary of the current dispositions.

| COUNTRY | LIMITATION OF EFFORT | GEAR | TAC | CLOSURES | | LICENCE FEE | OTHER |
|---|---|---|---|---|---|---|---|
| | | | | areas | seasons | | |
| Brazil | 250 vessels (1980)<br>"coastal vessels" (<250 HP, <18 meters length, and <80 TRB) not included | no | no | no shrimp trawling :<br>- all depths, States Amapá,Pará,Maranhão<br>- idem, State Piauí<br>- 10 nm from shore, States Amapá,Pará<br>- 3 nm from shore, State Maranhão<br>- Amazon estuary : 46.50-48.00W 00.00-01.30N | dec-jan ('86) (dates variable)<br>dec-feb ('90)<br>} year<br>} year<br>} Oct-Nov ('90) | in jan '92 : equivalent to 350-500 US$, depending on overall length | fuel subsidies (earlier) |
| French Guyana | - EEC boats : open access<br>- non EEC : number vessels & d.a.s. calculated yearly (from TAC) | 45 mm cod end | yes | no trawling :<br>- 3 nm from shore<br>no shrimp trawling :<br>- < 30 m depth | year<br>year | no | ≥ 30%shrimp in catch<br>< 50% protected species |
| Suriname | no limitation (recommended 120 in 1986, 100 in 1989) | 45 mm cod end | no | no shrimp trawling :<br>- <12 fathoms<br>- <15 fathoms | jan-jun (1980)<br>jul-dec | 7,500 US$ (foreign flag)<br>7,500 Sf (national) | no catfish in by-catch<br>2% export tax |
| Guyana | - maximum 100 boats (1986) (+ 33 sea bob licences)<br>- present number frozen: no newcomer except replacement | | no | (proposed: no shrimp trawling,all depths) | (proposed : nov-jan) | from January 1992: 100 US$ (foreign flag)<br>20 US$ (nationals) | 10% export tax<br>fuel subsidies (till June 90)<br>by-catch 15 MT/year/boat minimum |
| Venezuela | - vessels must be based at Güiria (1992)<br>- no trawler construction nationwide since july '89 | 32 mm cod end | no | no trawling :<br>- 3 nm from shore, in the Gulf of Paria | year | | |
| Venezuela (s.f.z.*) | - 60 T&T artisanal trawlers | 35 mm cod end | no | - whole area | jul-nov | no | 50 % landings in Venezuela |
| Trinidad & Tobago | - no new trawler (1988) | 35 mm cod end | no | no trawling, year round:<br>- all depths, East coast<br>- 2 nm from shore, N. and S. coasts<br>- 12 nm from shore, Tobago<br>- <1 fm (Gulf of Paria)<br>- <4 fm (Gulf of Paria, artisanal)<br>- <8 fm (Gulf of Paria, >180 HP) | | no | waiver on Value Added Tax on equipment ;<br>fuel subsidised |
| (*) special fishing zone under a Venezuela - Trinidad & Tobago fishing agreement (Orinoco estuary). | | | | | | | |

With respect to foreign fleets, they have access to the EEZ of Suriname and Guyana (limited national fleet), and of French Guyana, on a temporary basis, to collect the surplus of the TAC (theoretically) not extracted by the EEC fleet. The resource is reserved to nationals in Venezuela, Trinidad and Tobago, Brazil.

## Financial regulations

Fishing licence fees and taxes are levied, particularly in countries with international fleets. The purpose is to extract a part of the benefits for the public treasury, not to regulate the amount of effort. This goal is pursued mainly through the licence fees in Suriname, which explains that no limitation of the number of boats is enforced, and through the export taxes in Guyana. Licence fees levied in Guyana and Brazil have no significance with regard to the national economies.

Financial incentives like subsidized fuel have been suppressed everywhere (except Venezuela and Trinidad and Tobago).

### Closures

Closure, either of areas and/or of seasons, is the other type of regulations largely in use in the region. See table IV.2 for details. A EEZ-wide closed season for the industrial shrimp fishery is implemented in Brazil only, and aims at protecting recruitment during the (major) peak period. The purposes of closing particular areas, either permanently or seasonally, can be multiple. Closed areas are intended to protect recruitment, either year round (French Guyana, under 30 meters depth ; Brazil, 10 nm from shore) or during the peak season (Brazil : Amazon estuary, Piauí). The purpose of the closed zone (8 miles from shore) in Venezuela is the protection of small-scale fishermen. The two goals are combined in the regulations taken in Suriname and Trinidad and Tobago.

The most elaborate closure regulation at this time is found in Brazil, where the dates of the closed season are determined every year.

### Other regulations

A set of regulations are applied throughout the region, and are not included in table IV.2:

- each fishing vessel has to be registered in the country where it operates.
- the catch must be landed in the country of registration of the boat (50% for the Trinidadian artisanal fishery in the special fishing zone under the agreement with Venezuela).
- there are various reporting obligations (logbooks, landings reports, etc).

All countries except Brazil and Guyana have implemented a minimum cod-end mesh size.

Regarding the by-catch, the measures adopted by a few countries either aim at limiting the damage to (juveniles of) commercial fin-fish species (French Guyana, Suriname), or at limiting the waste (Guyana).

### International agreements

There are two international agreements concerning the shrimp fishery in the region. A zone between Venezuela and Trinidad and Tobago is open to vessels of both sides, each remaining subject to its national regulations. The same treaty provides for an artisanal zone ("special fishing zone") open for trinidadian fishermen, in the estuary of the Orinoco. In French Guyana a quota is reserved for ACP countries of the region (generally not utilized).

### Artisanal fishery

Regulations concerning the artisanal shrimp fishery are almost non existent. In general these fishermen benefit from the prohibition of industrial trawling in shallow/coastal waters. Only in the

"special fishing zone" regulated by the Trinidad and Tobago - Venezuela fishing agreement are a maximum number of units, a closed season and gear limitations established.

## IV.C. EFFICIENCY OF CURRENT MANAGEMENT STRATEGIES

Unfortunately no study has been done on the impact of the current regulations. The current management problems mentioned by fisheries officers in each country give indications as to which extent the objectives are being met. A few of these problems are listed in table IV.3, and can be sorted up in relation with the objectives.

**Table IV.3**: Management : problems (as presently identified in each country).

| COUNTRY | CONSERVATION | EFFORT CONTROL | ECONOMIC VIABILITY | CONFLICTS WITH | UNDER-EXPLOITATION/ INADEQUATE USE OF |
|---|---|---|---|---|---|
| Brazil | - Impact of artisanal fishing<br>- Protection of nursery areas | - reevaluate optimal level of effort<br>- control of illegal fishing<br>- impact of trawlers smaller than 18 meters length<br>- quasi monopoly licences | - Efficiency national fleet (poor transfer of technology from rented boats)<br>- Impact of artisanal fishing | - Artisanal (fin-fish) fishermen : gear destruction<br>- Aquaculture : use of coastal areas<br>- Artisanal (shrimp) fishermen : sequential fishing | - by-catch |
| French Guyana | - Overfishing small sizes | | - Year to year yield fluctuations | | - by-catch<br>- large sizes<br>- *P. brasiliensis* |
| Suriname | - Overfishing small sizes<br>- Protection of nursery areas | - definition optimal level of effort<br>- control of illegal fishing and transshipment | - Heavy operating costs, in foreign currency<br>- Year to year yield fluctuations | Artisanal fishermen : (gillnetters) : loss of gear | |
| Guyana | | - definition optimal level of effort<br>- control of illegal fishing and transshipment<br>- interferences with finfish and sea-bob trawling | Idem | Idem | |
| Venezuela | | - optimal level of effort unknown<br>- control of illegal fishing and transshipment<br>- overlapping fin-fish and shrimp trawling activities<br>- pressure of fleets from other (overexploited) areas | | | - by-catch<br>- parts of area (Orinoco estuary & South coast) |
| Trinidad & Tobago | | - optimal level of effort unknown<br>- illegal fishing<br>- need to reduce effort | - economic overexploitation | | |

### 1. Problems related to the conservation of the resource

The dangers identified concern the most vulnerable segments of the biological cycle, in the early stages of development.

Very little is done indeed for their preservation. The nurseries, where they have been identified, do not enjoy any protection. As for the juveniles and the small sizes before recruitment, it is felt, in French Guyana and Suriname at least, that they remain too vulnerable to trawling, either because

legislation on closed zones is not enforced (Suriname) or because it may be inadequate (derogations are given to the 30 meters regulation, French Guyana).

## 2. Problems related to the economic optimization

Level of effort

By mentioning the (re-)definition of the optimal level of effort as one of the management problems, the countries express their lack of confidence in the estimates provided until now. Two main explanations can be given:

- As soon as Maximum Economic Yield supersedes Maximum Sustainable Yield as the major objective for management, an economic analysis is indispensable. Economic information is very scarce and has been hardly analyzed until now.
- The stocks, because of their dependency on the highly variable recruitment, fluctuate widely from year to year, and so may the optimal level of effort. A value calculated from a few years' data is not necessarily applicable to another year.

Control of the EEZ

It is worthless setting constraints on the registered fleet if illegal practices cannot be repressed. Several countries lack the means to effectively enforce regulations.

Country-specific problems

Country-specific issues should be dealt with at national level, but are mentioned briefly here. Some recently introduced types of (smaller) boats do not fall under the current legislation, in Brazil for example, and they can raise the total effort above the desired level. They need to be included, after standardisation, in the computation of the total effort. The effort of fleets targeting shrimp accessorily, or during part of the year, should also be held into account. Another factor affecting economic viability is, in the case of international fleets, the high cost of expatriate manpower, whereby a large part of the benefits are exported. A solution would be the replacement of foreign fleets, or at least of their crews, by local ones.

## 3. Conflicts between different groups of interest

There are potential conflicts between categories of shrimp fishermen, users of the same resource in different areas / stages of development (sequential fisheries) in Brazil, where artisanal fishing communities are important. Conflicts also arise between fishermen exploiting different resources on the same fishing grounds. Gear damage to the gillnet fisheries is cited in Brazil and Suriname. The trawlers are also extracting (particularly juveniles of large fin-fish species) from the resources exploited by small-scale fishermen.

Another potential problem in this region is the competition between fishermen and other users of areas which are vital for the shrimp fishery, notably the nursery areas. Situated in the coastal zone they can be found suitable for a number of purposes ranging from recreational to aquaculture and agriculture.

As soon as a limited entry management system is introduced, rivalries among potential (concurrent) users of the shrimp resource itself will also have to be solved. This is currently the case in Brazil, where there are more than 250 candidates for the 250 shrimp fishing licences.

### 4. Problems of underexploitation / underutilisation

The by-catch is considered a problem by most of the countries, both because of the underutilisation of a readily available resource, and because of the destructive aspects. The regulations introduced by a few countries have failed to produce convincing results.

## IV.D. SUGGESTIONS FOR A COMMON APPROACH OF MANAGEMENT

From all the above discussion it appears that the major impediment to the management of the shrimp fishery is the lack of information. It is therefore of prime importance to improve the knowledge on the resource and its exploitation. This will be further discussed in the next chapter.

Although no recommendations on management were made after the earlier session of this Workshop (Cayenne, 1988), it is believed that concrete recommendations could be selected after discussion of detailed data, at the opportunity of regional workshops. At this time, however, only general lines for management can be set.

1. A common, regional management approach should be based on common objectives, and these could be, as discussed above:
   - the long-term conservation of the resource : to maintain the potential of the resource at its present level
   - optimization of the economic yield, in a broad sense

   Other objectives have a less universal, more national character, and could be considered in a later phase.

2. The types of measures suitable to achieve these objectives then need to be reviewed. The utility of different types of regulations has been discussed in a number of published papers. It is important to hold the local enforcement capabilities into account.

   The long term conservation of the resources means protecting the most vulnerable phases, i.e. in the present stage of knowledge the nurseries and the juveniles before recruitment to the fishery. The total harvest of shrimp should also not exceed a maximum level (which is normally not easily reached in the case of a shrimp fishery).

Possible strategies for optimization are given in table IV.4, ranked from simplest (requiring less info) to more sophisticated (more info). The simplest measures involve the determination of an optimum level of effort. This level can be estimated by making use of models of increasing complexity, from production models to predictive cohort analysis. The data requirements of each approach are also given in the table. Among the other measures available the most useful, given the enforcement capabilities, are the closures, primarily to contribute to the protection of vulnerable stages, but also to fine tune the fishing mortalities per age, in order to maximize the production value.

**Table IV.4**: Type of regulations and information required for various management objectives.

| OBJECTIVES | ACTION | TYPE OF REGULATIONS | INFORMATION NEEDED | DATA AND SOURCES |
|---|---|---|---|---|
| Long term conservation | Control extraction during critical phases :<br>- recruitment | closed seasons/areas | Main recruitment<br>- areas<br>- seasons | { - Catch by area/size (logbooks)<br>{ - field<br>- catch by month/size (landing rep) |
| | | protection nurseries | location nurseries<br>(recr-stock relation)<br>juvenile migrations | - field (survey)<br><br>- field (tagging) |
| | - mature females | closed areas/seasons | space-time distribution<br>adult migrations<br>(spawning stock/recruitment) ? | - field (surveys)<br>- field (surveys, tagging) |
| | - total population | control global effort | stock-recruitment relation | - recruitment : size composition |
| Economic optimization | - Set optimum effort | - set effort at f(MEY)<br>(# boats, # days at sea) | - simple yield/effort relation<br>(surplus production model)<br>- costs/effort relation | - total catch and effort per year<br>- average price per size<br>- economic (cost) data from industry |
| | - Set optimum effort<br>- Set optimal size at first capture | - set effort at f(MEY)<br>- closed areas/seasons | - yield/effort relation :<br>yield per recruit model<br><br>- costs/effort relation | - growth parameters<br>- average mortality parameters<br>- annual size composition<br>- average prices, costs data |
| | - Set optimum effort<br>- Set fishing mortalities by size | - set effort at f(MEY)<br>- measures to vary fishing mortality by size | - yield/effort relation :<br>predictive cohort analysis<br>- costs/effort relation | - idem + fishing mortality and price per size, & estimate of recruitment<br>- average prices, costs data |
| | - as above, adapted each year<br><br>(- decrease production costs) ? | - as above, adapted each year | - as above + :<br>- early estimate recruitment<br><br><br><br>- prediction on prices & costs | - as above + :<br>- recruitment/environment studies &/or<br>- monthly size composition of landings<br>- surveys in recruitment areas<br>- economic investigations |
| Maximizing country rent | - as above + :<br>- maximise local business & labour in the industry<br>- maximise levies | - licence fees, taxes, etc | - as above | - as above |
| Employment | - maximise fleet size<br>- scale down boat size<br>- priorize artisanal fishery | - set # of vessels ?<br>- gear restriction | - performance of different types of vessels, including semi-industrial and artisanal<br>- artisanal prod, eff, etc | - catch & effort, species & size composition of different types boats<br>- economic data : prices, costs for different types of boats |
| Maximise production | | - set effort at F(MSY)<br>- closed areas/seasons | - as economic optimization | - as economic optimisation |

The type of regulations to concentrate on at this stage are therefore:

- protection of nurseries;
- closed areas/seasons;
- regulation of effort (number of boats, standardized);

3. Once research has produced more detailed information, refined regulations could be introduced:

   - variable closed seasons, based on monitoring of the nurseries;
   - annual quotas based on early assessment of recruitment and forecasting of cohort biomass;
   - regulations on mesh size and minimal landing size could become effective if combined with adequate closure periods/areas.

4. The elaboration of effective solutions/regulations for country-specific issues, even if these cannot easily be discussed at international level, will benefit from the models worked out at regional level.

   - financial measures : means to recuperate and redistribute part of the rent of the fishery;
   - decrease of the production costs;
   - choices between different types of exploitation : industrial, semi-industrial, artisanal, depending on the collection of social and economic data on the different types of fishing modes.

5. Besides the execution of investigation programmes and the pooling of data, regional cooperation would be of particular relevance for the following aspects of shrimp fisheries management:

   - Discussion of possible regulations and assessment of their impact : exchange of national experience on the effects of specific regulations ; study of the eventual impact in neighbouring countries of regulations taken by one country ; assessment at regional level of impact of regulations taken by several countries ; simultaneous tests of different options (for example closed seasons of different lengths) in different countries;
   - Adoption of similar or coordinated measures, for example in the protection of areas;
   - Early detection of recruitment maxima, based on regional data : if interrelation can be established between recruitment patterns in several countries and with environmental parameters, the start of the recruitment peak period could be forecasted longer in advance, based on other country's observations and, for example, closure dates determined accordingly;
   - At the same conditions as above, forecasts of abundance (thus fine-tuning of regulations, quotas) could be achieved based on regional (recruitment, environment) data;
   - Some cooperation could be possible in the enforcement of coordinated measures, like simultaneous closures.

# V. INVESTIGATIONS

The ultimate goal of investigations is to supply the information needed for management of the fishery resource. The priorities are therefore set in accordance with the management objectives. A regional approach in the conception and execution of investigation programmes would be adequate for the following reasons:

- The main shrimp stocks are shared, and no investigation restricted by national boundaries would cover properly one of them.
- The management problems and the goals of investigation are similar in the different countries. Progress achieved in part of the region can be useful for the rest of the region.
- Expertise lacking in a country can be present in another country of the region.
- Regional projects would have better prospects to be funded.

## V.A. CURRENT NATIONAL PROGRAMMES, PRIORITIES

The countries of the region have the following research programmes concerning the shrimp resources.

### 1. Brazil

IBAMA has identified a number of fishery resources of national importance, which are receiving priority. A "GPE" (Permanent Research Committee) is created for each of these resources and is in charge of the investigation programmes. Penaeid shrimp ("Camarão rosa do Norte") is one of the two main resources identified for the North region. Programmes completed recently include:

- A by-catch survey has been completed in 1989-90. The results are ready for publication.
- An investigation on the incidental turtle catches was started in october 1991. It is based on observations on board commercial trawlers.

The data collection and the sampling programmes are carried on. Other investigations are not planned for the near future. Among research ideas mentioned by staff members of IBAMA, that cannot be carried out by lack of funding : survey of nurseries in Amapá, shrimp tagging experiments, exploitation of the trawlers logbooks, processing technology for the fish by-catch.

## 2. French Guyana

Two institutes, the "Institut Français de Recherche pour l'Exploitation de la Mer (IFREMER) and the "Institut Français de Recherche pour le Développement en Coopération" (ORSTOM) are involved in investigations on shrimp resources. The current priorities are:

- The continuation, by IFREMER, of the sampling programme at the industry and the fine-tuning of decomposition of landings into cohorts.
- The study of recruitment of *P. subtilis*, based on:
  - nursery and post-larvae surveys (conducted by ORSTOM);
  - trawl surveys of the recruitment of juveniles (in cooperation with Suriname).

## 3. Suriname

The main on-going activity is the sampling of the industry landings. The priorities for the near future are:

- the optimization of the sampling procedure and data collection system;
- the study of *P. subtilis* recruitment mechanisms (trawl surveys during recruitment peak seasons), in cooperation with French Guyana;
- the analysis of the results of juveniles samplings. Depending on the results, a new sampling programme may be designed.

## 4. Guyana

Top priority is the improvement of the data collection system, in the framework of a cooperation programme with Canada, and the preparation of a management plan.

A sampling programme at the industry should also be started, when staffing and funding problems are solved.

## 5. Venezuela

Investigations are mainly carried out by observers on board. Besides the general observers programme, the main on-going activity is the study of incidental turtle catch. Coupled to this programme is the collection of data on fish by-catch.

### 6. Trinidad and Tobago

In Trinidad and Tobago the main objective, since 1991, is the setting up of a comprehensive fisheries information system, that is also covering the shrimp fisheries, both industrial and artisanal.

Another priority investigation field is the study of the impact of human activities in the Gulf of Paria.

## V.B. PROPOSED ACTIVITIES AT REGIONAL LEVEL

Table IV.4 reviews the information needed in accordance with management objectives. Part of this information can be obtained through data collection systems, and another part requires field investigations. For the reasons mentioned at the beginning of this chapter, a regional approach should be adopted wherever possible, for example by including the following aspects in regional proposals:

- instead of starting in all countries at the same time, which would be unpractical due to the limited staff available, there are activities which could start with a pilot phase in one/part of the countries, and be extended afterwards to the rest of the countries. This approach would also enhance the harmonization of methods used throughout the region.
- multinational training activities could be foreseen in the proposals.
- regional seminars should be an important element in the scheduling of the activities and give the participating countries ample opportunity to exchange views, data, experience.
- dissemination of results both during execution and after completion of each activity should be done at regional level.

The following activities could become part of a regional programme.

### 1. Optimisation of the data obtained from the shrimp industry

The systems currently in use to collect data from the shrimp industry need to be reviewed in several countries, in order to improve efficiency and reliability. It would be useful, at the same time, to harmonize them to some extent, in such a way that:

- the information produced is similar and can be compiled at regional level;
- the information is in an adequate format for computerisation ;

## 2. Sampling of the industrial landings

The sampling schemes currently in use need to be optimised. Statistical analyses have to be carried out (see suggestions in part II), and require technical assistance.

Sampling schemes could be designed for the countries that have not started such a programme yet. Training could be provided at different levels : determination of sampling procedures, processing of the sample, processing of the results, data analyze, optimization.

Methods and results should be discussed regionally.

## 3. Computerization

The data processing remains a long, tedious, sometimes unreliable process in most countries of the region. It could be computerized through the creation of three data bases:

- one for the registration/licensing of the vessels;
- one for the data supplied by the industry;
- one for results of samplings of the industrial landings.

A general structure could be designed for each data base, in accordance with common requirements. Each data base could then be fine-tuned and run in a particular country, as a pilot phase. After revision and improvement, they could be gradually adapted and implemented in other countries.

## 4. Survey of the artisanal fisheries

The importance and evolution of artisanal fisheries exploiting penaeid shrimp is very poorly documented. A survey of the communities could be carried out in the region, covering both known communities and regions where the presence of communities is possible. This survey would produce such basic information as number of fishermen involved, the approximate production, main species, etc.

Based on this information a data collection system could be designed, either for the whole region or for a particular part of the region where artisanal fishery is of particular importance.

## 5. Development of a methodology for the collection of economic data

None of the countries of the region has thus far developed a satisfactory way to collect and deal with economic data on the shrimp fisheries. A methodology could be worked out for the collection, processing and analyze of this type of data, and implemented in a country as a pilot application.

The results could be analyzed during a workshop, and the methodology could be adapted for use in other countries.

## 6. Development of a methodology for the exploitation of logbooks

Logbooks are requested from shrimp fishing vessels in all countries. The utility of this form of reporting by the industry is very low, because the logbooks are in the practice not exploited. The information available in the logbooks should be inventoried and receive a preliminary analysis in order to:

- determine which part of the data is worth analyzing;
- extract information from this part and perform preliminary analyses;
- determine which part could become useful if control is implemented;
- design the right control system;
- finally, a new version of logbook should be designed.
- implementation could start with a pilot phase in one of the countries.

## 7. Analyze of unexploited data/sampling results

In several countries various types of data have been collected, mainly through samplings, and have not been properly analyzed. Assistance could be provided in the exploitation of this information (assessment of the utility of the data, design of a methodology, eventually support for publication).

## 8. Studies on the impact of management regulations

Every regulations set should be accompanied by a survey and/or the recording of specific data designed to assess its effects and its efficiency. Possible phasing of this activity would be:

- Design of a methodology adapted to a given type of regulations;
- Implementation, for example in a case study (one country, several countries, possibly several variants of the regulations).
- Review of:
  - the methodologies used to assess the effects;
  - the effects of various types of regulations;
  - the applicability in other countries.
- Coordination in the study of trans-border effects.

## 9. Bio-economic analyses

Bio-economic analyses are basically carried out at national level. A regional approach could include:

- the elaboration of guidelines;
- the assessment of the data collected at national level;
- comparisons between countries (for some economic parameters difficult to obtain);
- discussion of results after a common study period on several fleets.
- Modelling: the existence of several countries with different economic contexts (and different economic constraints for the shrimp industry) would make it possible to test several hypotheses at the same time.

## 10. Observers programmes

Observers programmes (on board shrimp trawlers) could benefit from a regional cooperation in the following ways:

- determination of the information that can be obtain through this type of programme (from experience of particular countries);
- design of programmes, organisational aspects;
- design of a methodology for the processing of information collected through observers programme;
- discussion of results.

The following proposals have a major "field survey" component and will require more extensive funding.

## 11. Assessment of the nurseries

Although a number of biotopes have been identified as playing an important role as nursery for penaeid species, this role has not been quantified. A comprehensive assessment of the nursery grounds should be carried out, with the following components:

- surveys of the less known parts of the coast : Amapá, Eastern part of the Orinoco delta;
- development of a methodology for sampling post-larvae and juveniles at the nurseries;
- evaluation of the production of the identified nurseries, description of the seasonality and of the contribution to the recruitment;
- design of a monitoring system in order to collect quantitative data ; test on a pilot area;
- study of different types of measures to protect key nursery areas;
- assessment of nurseries in the broader framework of coastal management: identification of alternative use of coastal areas, classification of most important parts of the coast.

A workshop should conclude studies carried out in several areas of the region.

### 12. Study of the recruitment mechanisms

Recruitment, particularly its year to year variations, is one of the most important factors for the management of the fishery. A main recruitment season (corresponding to one species, *P. subtilis*) has been identified in several countries. Surveys at sea carried out during the right season will help understand the recruitment mechanisms. The recruitment of the second species, *P. brasiliensis* could be investigated in a later phase.

In addition, the role of shallow waters in the recruitment should be investigated through surveys of these waters. Different types of environmental parameters should be recorded and analyzed in order to identify relationships with recruitment. Other relationships to be investigated are recruitment-stock et environment-stock.

### 13. Survey of spawning areas and periods

Surveys at sea could be carried out in order to identify zones and periods of maximum abundance of spawning adults.

### 14. Determination of growth and mortality parameters

Besides various analytical methods based on data recorded at landing, more accurate estimates of these parameters could be obtained through a tagging programme. The same programme will generate information on the migrations. Such a programme was already recommended by the earlier session of workshop in Cayenne. Annex 9 of that workshop's report reads :"The assumption that important migrations exist between Guyana and Brazil, leading to the need for coordinated management, is critical for the rationalisation of the fisheries of the region and should absolutely be verified."

## V.C. POSSIBLE FINANCING SOURCES

The proposed activities should be carried out essentially by the national fisheries/research institutions of the region. Given the number of countries, and even though simultaneous execution of all proposals in all countries is out of the question, coordination will be of crucial importance for the success of any of them. A regional project could be set up to carry out the following tasks:

- selection of project ideas and interested countries, in concurrence with the different governments;
- elaboration of specific project proposals;
- preparation of a global regional programme based on the approved project proposals;
- coordination of activities undertaken by several countries;

- identification, recruitment, financing of required technical assistance (intra and extra regional);
- dissemination of results of regional activities;
- direct support (financing) of intra-regional travel, workshops, etc;
- identification of funding possibilities for the main (more costly) programmes, coordination of the preparation and submission of project documents/proposals in the right format.

A U.N. agency could be approached to finance the project and to carry the costs for the execution of several of the proposed activities (consisting of short-term consultancies, intra-regional travel etc.). For the activities requiring more extended funding, particularly those focused on field operations (surveys), specific funding will be needed. Possible sources include FAO, ICA, EEC, bilateral development agencies.

The EEC offers several schemes under which funding can be provided. An interesting, generally underexploited possibility is provided by the STD Programme (Science and Technology for Development). This programme encourages cooperative investigation proposals involving institutions of both ACP and of EEC countries. The selection of proposals is done by periods of five years. The deadline for the lustrum 1990-1994 is December 1992.

A cooperative research programme involving Suriname and French Guyana is currently in preparation. The main objective is the study of brown shrimp recruitment. An agreement should be signed between the two countries in the next months. This programme will be financed by the EEC (through the European Regional Development Fund, IFREMER and the French and Suriname Governments.

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# *Preliminary Results on the Artisanal Fishery of Penaeid Shrimps on the Northwestern Coast of the Gulf of Paria, Venezuela*

by
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## INTRODUCTION

Starting in the sixties there exists a shrimp fishery through the northeastern shelf of South America, from Venezuela to Brazil, which has progressively intensified (Fabres, 1988). Shrimp fishing activities in Venezuela are performed near the shore, in waters shallower than 40 fm, using three types of gear: industrial trawl, artisanal trawl and beach seining.

The industrial trawling was made by 136 steel vessels in 1991, with a total catch of 1,500 t shrimp and 7,000 t fish, representing the most important fishery in the area. The details of this fishery are reported in Marcano *et al* (1992). The operation of the fleet is allowed in areas beyond 3 nm from shore in the Gulf of Paria, thus reducing the interaction problems with the artisanal fleet. There are no restrictions to its operation in the area of the Orinoco river delta.

Ewald & Cadima (1971) reported that the most important shrimp species for the trawling fishery in the Gulf of Paria were the white shrimp, *Penaeus schmitti*, the brown shrimp, *P. subtilis*, and to a lesser degree the sea-bob, *Xyphopenaeus kroyeri*. These authors also indicated that mean total length for the white shrimp was between 11 and 16 cm.

In the artisanal trawling fishery only trinidadian fishermen are participating, under an agreement between the governments of Venezuela and of Trinidad & Tobago. Fishing is practised by a nominal group of 60 vessels 10 m in length, using outboard engines and a single trawl. Operations take place in front of the Orinoco river delta, in depth less than 5 fm. Although the agreement mandates that al least 50% of the catch should be landed in Venezuela, all landings have taken place in Trinidad, near the Icacos Peninsula. Details of this fishery are offered by Fabres (1992).

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During 1992 several permits for operation of this type of artisanal trawling in the southern Gulf of Paria have been granted to fishermen from Güiria by the venezuelan fisheries office.

The artisanal fishery using beach seines is practised by a group of fishermen from several localities in the northwestern Gulf of Paria. This fishery has a recent origin (about 1985) and affects a small area of the distribution of the shrimp resources in the Gulf of Paria. The purpose of this report is to provide details about the exploited shrimp resources by the artisanal fishermen operating with beach seines between Irapa and Güiria.

## I. MATERIALS AND METHODS

The study was performed in fishing localities in the north-western part of the Gulf of Paria, between Irapa and Güiria, from September 1989 to May 1992. Samples were taken from the catch of the artisanal fishermen at Irapa, Soro and Punta de Piedras, covering both extremes of the area where the fishery is practised. Whenever possible, weekly samples were taken, using FONAIAP staff or samplers from the study localities. All shrimps were identified to species, sexed (when possible), and the total length measured to the closest mm, using a ruler. Estimates of the effort and total catch by locality were obtained from the reports at the Regional Fisheries Office in Güiria.

## II. BIOLOGICAL DATA ON THE SHRIMP RESOURCES

### II.A. ENVIRONMENT

The Gulf of Paria is a large estuary of 9,700 km2, located in the eastern region of Venezuela, between this country and Trinidad & Tobago (Fig. 1). Several rivers (Orinoco, San Juan, Ajíes) discharge in it, which induces a permanent brackish and turbid water condition, with a mean temperature between 27°C and 32 °C (Alió *et al.*, 1990). The shores are covered by mangroves, interrupted by numerous channels which allow the drainage of the sea water penetrating inland with the tidal flow. A semi-diurnal tidal regime is present in the area, with up to 1.5 meter oscillations between high and low waters during spring tides.

This coastal environment serves as a refuge for a great deal of larvae and juvenile shrimp and fish resources, besides of providing nourishment for a fast growth.

### II.B. LIFE CYCLE

Ewald & Cadima (op cit.) reported that the white shrimp spawns in the southern area of the Gulf of Paria, in front of Punta Campana. From this area, larvae would move up with the dominant current which presents an anticyclonic motion, recruiting to the mangrove covered shore of the western and northern Gulf of Paria. In Irapa and surroundings, the animals reach about 5 cm TL,

where there is an incorporation to artisanal fisheries. The range of sizes varies from 6 to 16 cm TL, with a mean of 10.5 cm. In the eastern side of the fishing area (Punta de Piedras), the range of sizes is 10 to 20 cm TL, with a mean of 15 cm. Intermediate zones show ranges from 9 to 18 cm TL. Frequency polygons are shown in order to describe the migratory movement of the population (Fig. 2).

From Punta de Piedras towards Trinidad, the white shrimp is not found near shore, what seems to evidence a migratory movement of the population towards deeper, more saline waters away from shore.

### Sex ratio and morphometric characteristics

The artisanal fishery of the zone exploits juvenile to adult shrimps in the range 6 - 16 cm TL. Primary sexual characters (thelicum or petasma) can be easily recognized starting at 7 cm TL. The observed sex ratio was 1:1 males to females (N > 17,000). Females reach larger sizes than males, but this size difference becomes evident at sizes larger than 14 cm (Figs. 3 and 4). The slope of the weight - length relationship for females was significantly larger than for males (Student t-test, $P < 0.01$). The differences between sexes in the relation between carapace length and total length were negligible (see Fig. 5a and 5b).

### Reproductive aspects

No mature or impregnated females were observed in the study area. A reduced number of mature males (N=20) were found, in the size range 13 - 15 cm TL. These males had terminal ampullae developed, white to yellow in colour, and spermatophores in good stage ; most males were immature, with round and small, translucent, ampullae. This evidence indicates that reproduction is not taking place among the animals captured in the zone.

## II.C. FISHERY ASPECTS

### The fishermen communities

Fishing activities take place in the communities next to shore, being the most important : Irapa and beaches in the vicinity, Güinima, El Curí, Las Piedras, Soro, El Champán and Punta de Piedras. Other inland communities have also shrimp fishermen who are transported to the fishing grounds in trucks by the buyers. These latter communities are Campo Claro, Alto Mara and Juan Pedro. It has been estimated that approximately 1,600 fishermen participate in the activity, with a total of 400 beach seines. It must be mentioned that among the fishermen are included a large amount of women and children, being this one of the few fisheries in the country that incorporates other than men to the activity.

## Fishing methods

The fishing is most commonly performed by groups of 3 persons (a fishing unit). Only beach seines are utilized as gear, made with polyamide (nylon) and varying in length according to the zone, from 15 to 70 m, with mesh size 19 to 25 mm, stretched. The gear is longer towards the western part of the area, since the substrate condition (lower silt-clay proportion in the sediments) allows the operation of larger seines.

Fishing almost always takes place at night, in contrast with other artisanal shrimp fisheries in the country (Araya Peninsula, Coro's Golfete, Maracaibo Lake and the southern coast of the Gulf of Venezuela) which are made during the day. Fishing time is about 3 - 5 hours, using the seines for short periods while walking on the beach at depth not deeper than 1,5 m (with the water level at breast height). The semi-diurnal tidal regime, and the large amplitude of tides, allow the use of middle to full and full to middle tides for the fishing activity. Fishing at low tide is not practised because of the large amount of mud in the sediment below the middle tide level.

## Composition of the catch

The brown shrimp predominates in the shrimp community among the animals smaller than 4 cm TL, with a proportion close to 100%. The proportion of the white shrimp increases progressively after the 4 cm TL, reaching about 100% for animals larger than 7 cm TL. Recruitment of the white shrimp to the artisanal fishery occurs at 5,5 cm TL. The commercial catch is mainly integrated by the white shrimp (98%), with the brown shrimp, the sea-bob and the prawns, Macrobrachium spp., representing the other 2%.

Alió *et al.* (1990) discussed that the penaeid shrimp postlarval community is integrated by the grooved shrimp, the white shrimp, and the sea-bob. The brown shrimp represented more than 85% of the postlarvae found in the general area of the northern Gulf of Paria, with small variations at different times of the year. The disappearance from the shore of individuals larger than 4 cm TL of this latter species, suggests the presence of a migratory movement towards deeper water at this earlier stage. In the other hand, the white shrimp would remain for a longer period near shore. This agrees with the fact that the composition of the industrial catch, performed at the deepest water of the area (18 to 40 m), is mainly integrated by brown shrimp. The white shrimp is the main species integrating the catch of the artisanal fishery near shore, and is only captured by the industrial trawlers during operations in zones shallower than 18 m (Marcano et al., 1992).

## Catch

Total catch for the area during 1990 and 91 were 43,8 and 79,1 t (whole shrimp), respectively. The large difference between these years is probably due not only to actual variation in the catch but also to improvements in the recollection of data during 1991. Captures were reduced during the first 9 months of 1990, increasing during the last quarter of that year and the whole 1991 (Fig. 7). There were several periods of greater abundance at 2 - 3 month intervals, affecting the different

fishing areas synchronously, implying that the same phenomenon causing the variation affects the general area. The landings at Las Piedras - Soro represented 62% of the shrimp catch, followed by the landings at El Curí - Irapa (34%) and Punta de Piedras (5%; Fig. 8).

Because of the many factors influencing the fishing activity of the artisanal community, it is difficult to estimate and to standardize the level of effort in this fishery. Among the factors affecting the effort can be mentioned : landing places, seasonal variation in the number of fishermen, tidal rhythms, lunar cycles ; all of which influence the number of fishermen that can be operating on a beach at a certain time of the year.

The monthly c.p.u.e. during 1991 shows two periods of greater abundance of shrimp, Jan.-Mar., and Aug.-Nov., when landings were above 200 Kg/day (Fig. 9). The analysis of probability of capture vs. total length indicated that estimates of 25, 50 and 75 percentiles between males and females do not show appreciable differences (Fig. 10 and 11, and Table 1).

**Growth**

The monthly data from Irapa and Punta de Piedras were jointly analyzed and separated by sex. Calculations were made using the ELEFAN Program, version 1.1 (Gayanilo et al., 1989).

Estimated $L\infty$ values for males and females were close to the actual maximum sizes observed in the field for the white shrimp, being females larger than males after 14 cm TL (Table 2). The values for Effective Growth ($\phi$) were very close for both sexes, thus an intermediate estimate for both sexes (2.79) could be used in this case. The estimated fishing mortality is reduced in comparison with the estimated natural mortality, suggesting a low level of exploitation of the shrimp resources in the area. The level of effort could be increased in a controlled way, with the introduction of more efficient gear.

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**Table 1**: Probability of capture for *Penaeus schmitti*, with the beach seines used in artisanal fisheries in the northern Gulf of Paria.

| PERCENTILE | TOTAL LENGTH (cm) | |
|---|---|---|
| | males | females |
| 25 | 8.4 | 8.3 |
| 50 | 9.2 | 9.4 |
| 75 | 10.1 | 10.4 |

**Table 2**: Estimated growth parameters, and fishing and natural mortalities in the *Penaeus schmitti* population from the northern Gulf of Paria.

| SEX | von Bertalanffy eq. | | EFFECT. GROWTH $\phi$ | TOTAL MORTAL. Z | NATURAL MORTAL. M* | FISHING MORTAL. F | F/Z |
|---|---|---|---|---|---|---|---|
| | $L_\infty$ (cm) | K ($year^{-1}$) | | | | | |
| males | 20.5 | 1.18 | 2.69 | 2.59 | 2.21 | 0.38 | 0.15 |
| females | 22.5 | 1.55 | 2.89 | 4.94 | 2.58 | 1.82 | 0.41 |
| M* Pauly's empirical equation (Gayanilo *et al.*, 1989) | | | | | | | |

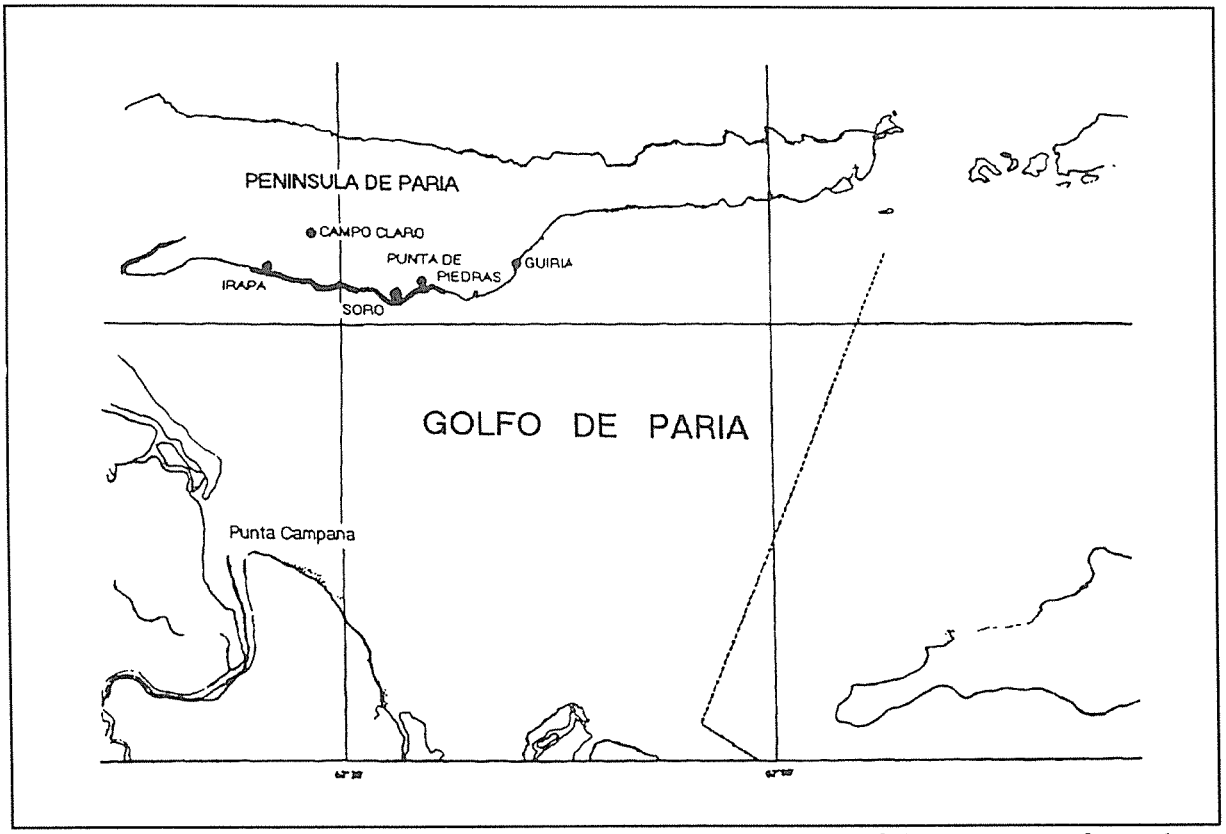


**Figure 1**: Map of the Gulf of Paria. The area where the artisanal fisheries are performed are indicated with a thick line.

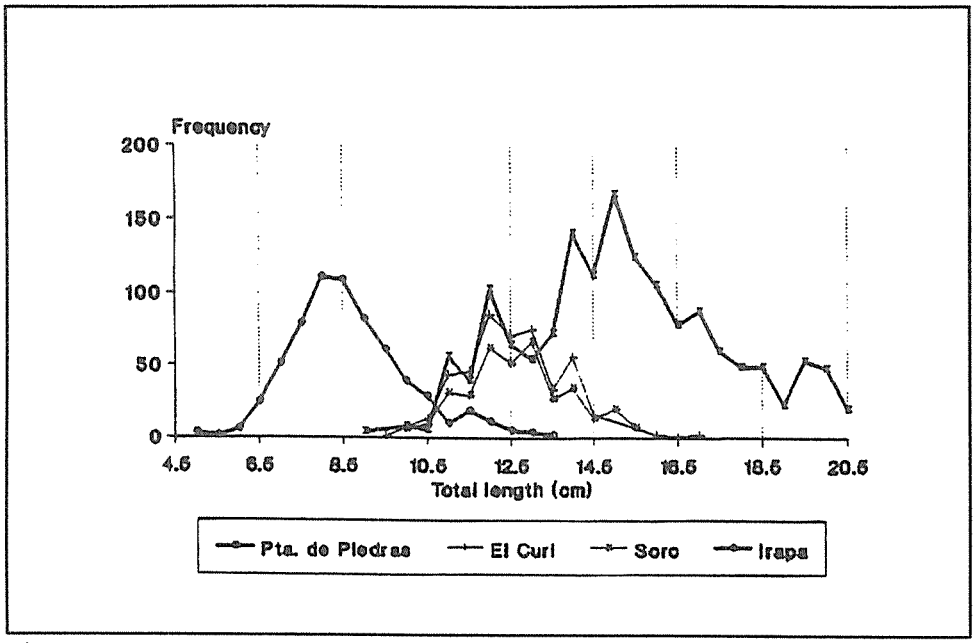


**Figure 2**: Frequency polygons for the 1990 catch of white shrimp at different localities in the northern Gulf of Paria.

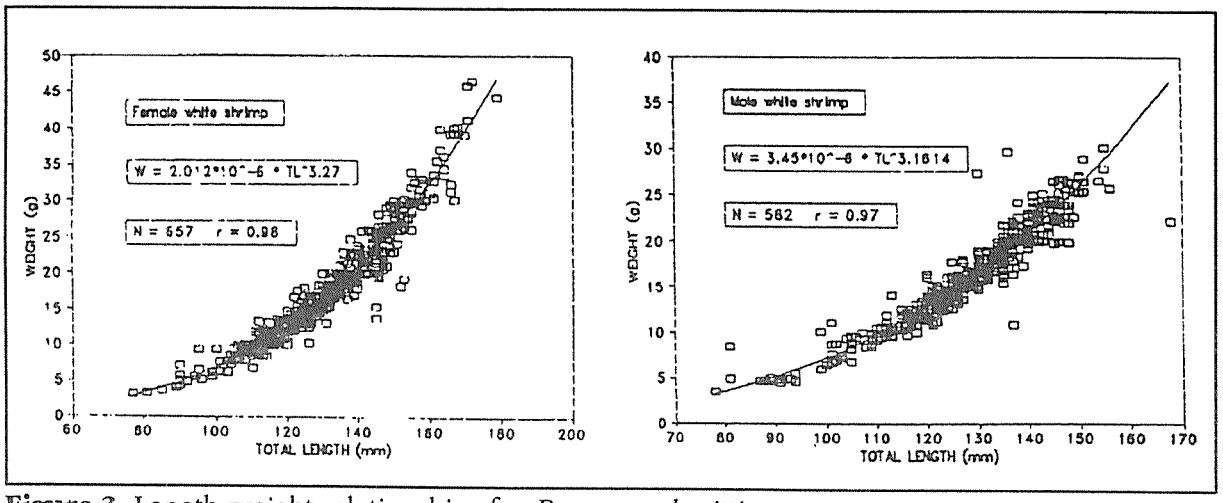


**Figure 3**: Length-weight relationships for *Penaeus schmitti.*

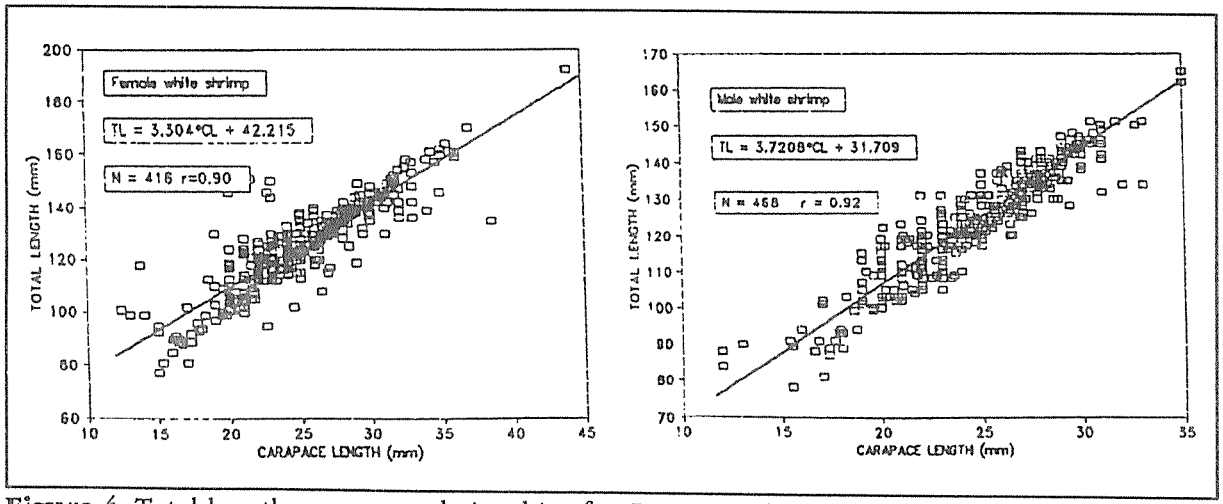


**Figure 4**: Total length-carapace relationships for *Penaeus schmitti.*

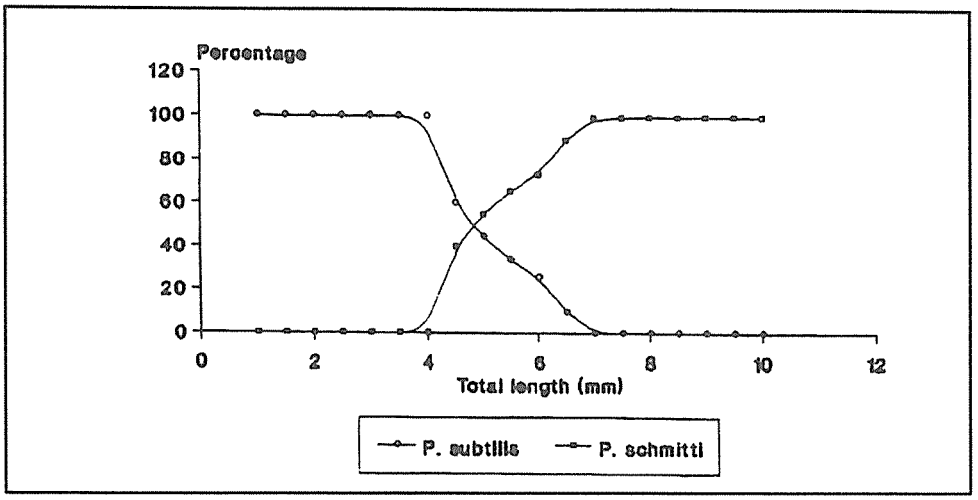


**Figure 5**: Percentage of juvenile shrimp in the artisanal fisheries of the northern Gulf of Paria.

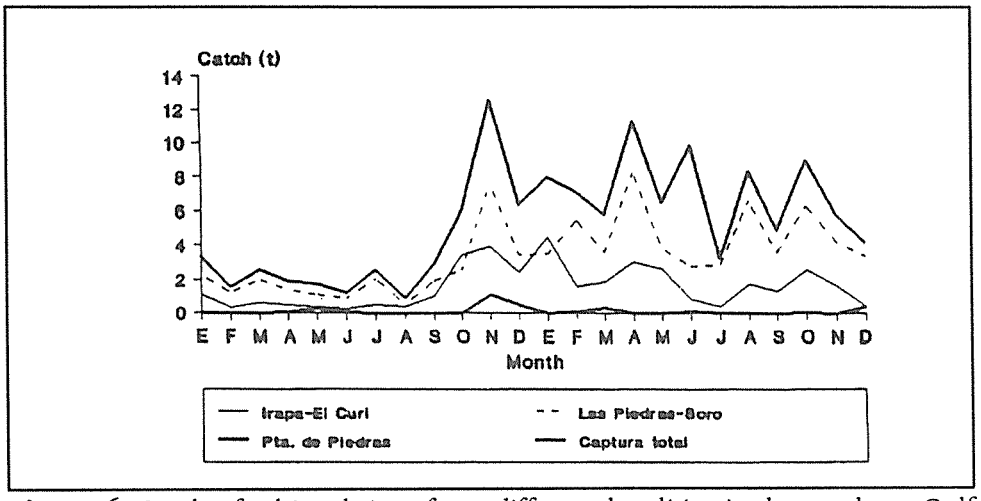


**Figure 6**: Catch of white shrimp from different localities in the northern Gulf of Paria, from January 1990 to December 1991.

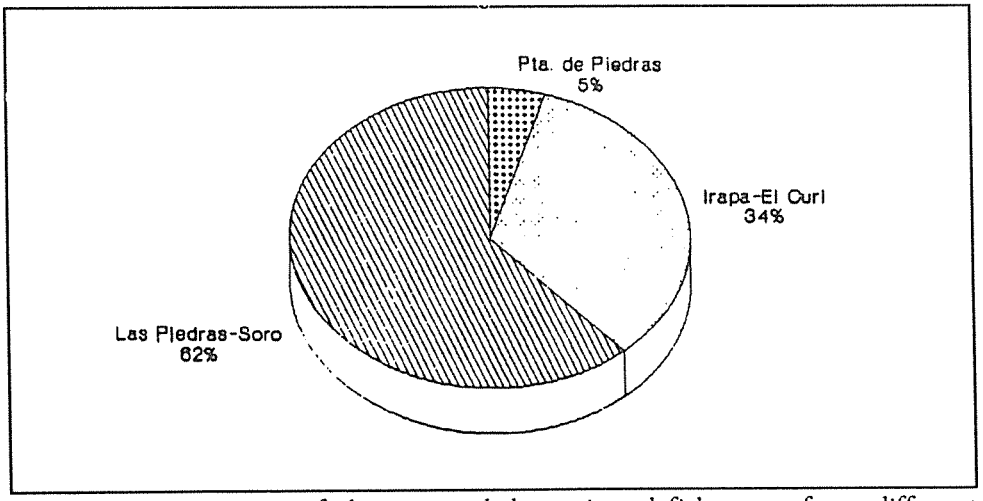


**Figure 7**: Percentage of shrimp catch by artisanal fishermen from different localities in the northern Gulf of Paria.

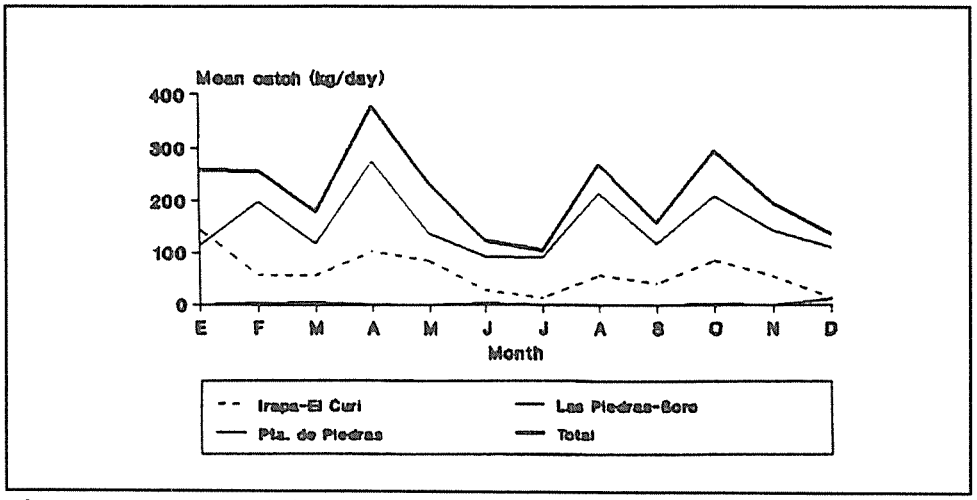


**Figure 8**: Mean catch by zone in the artisanal fishery of white shrimp in the northern Gulf of Paria, during 1991.

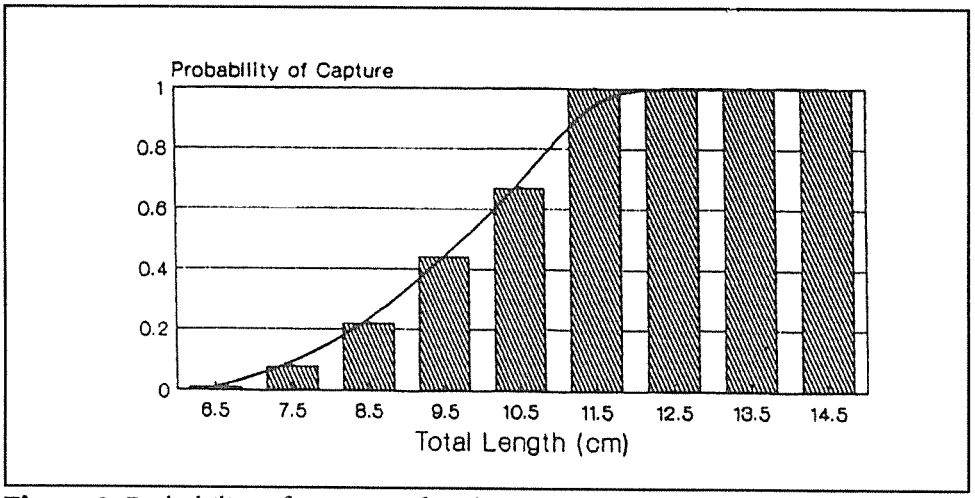


**Figure 9**: Probability of capture of male *Penaeus schmitti* in the Gulf of Paria.

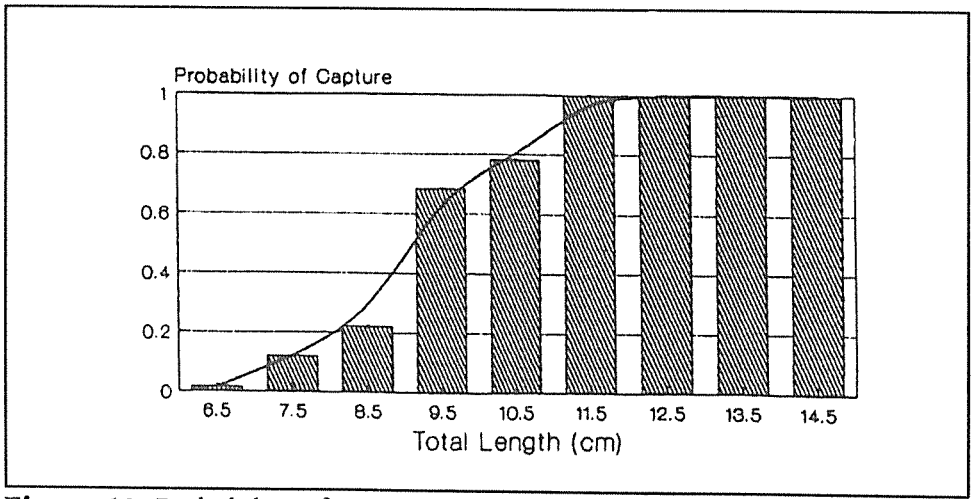


**Figure 10**: Probability of capture of female *Penaeus schmitti* in the Gulf of Paria.

# *Use of Escape Panels for Fish in Shrimp Trawl Nets*

by
J.J. Alió[1], L.A. Marcano[1] and E. Trujillo[2]

## INTRODUCTION

In Venezuela, trawling fisheries represent the second most important fishing activity, after tuna. The trawling activity involves some 450 Florida type vessels, which commercially operate around five coastal regions.

The shrimp trawling gear used on these vessels has a 50 mm mesh (stretched) in the body and 35 mm mesh in the tip or purse, which makes them poorly selective regarding the shrimp accompanying fauna. Such nets are used 24 hours a day, capturing shrimps, fishes and molluscs during the night, and mostly fishes and molluscs by the day (Marcano et al., 1985).

Captures of 1991 were estimated in 7,000 tons of shrimps with an associated by-catch of 11,7000 t, of which 30,000 t had commercial interest (fish, molluscs, crabs) ; the rest (no commercial by-catch) was dumped in the sea (Marcano et al.,1992). Most of this discard is composed of fish juveniles (Salaya et al., 1980; Penchaszadeh et al, 1983; Valdés, 1983; Alió, 1985; Marcano et al., 1985). The percentage of discarded fauna has progressively lowered in the last years, since smaller fish, as well as more fish species, are being commercialized.

Some alternatives for a better use of this non-commercial accompanying fauna have been proposed, such as the manufacturing of new dietary products, or its use for animal feed, but another possibility is to avoid its capture altogether. In this sense, Conolly (1986) recommends that any system to be used in commercial fishing vessels must be a simple and low-costing one, so it can be widely accepted and used by fishermen. In the past years, several different systems designed to make trawling nets more selective have been suggested, among them some that scare the fishes away (West et al, 1984), or systems dividing the net vertically, leaving its upper part (with a wider mesh) for the bigger fishes and the lower one for crustacea and flat fishes (anonymous, 1988).

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Several trials have proved, that among the different sections of a trawling net, it is in the sac and tunnel through where most of the fish escape away (Treshev, 1964; Vandeville, 1986). So, those would be the ideal places to install escape hatches to let the non-commercial fauna out without damaging them. However, Main & Sangster (1983, quoted by Conolly, 1986) argue that once the fish enter a trawling net and reach its end, they are either too stressed or too tired and then its escape response is seriously impaired.

Conolly (op. cit.) made several attempts by cutting escape panels in the tunnel of a trawling net. Even though the results showed a 40% decrease in the capture of non-commercial species, the capture of shrimp also decreased in 25%, making the modified net inefficient in terms of profitability. In further trials, installing exclusion devices for fish, the mouth of the net was totally blocked, which allowed the adult fishes to easily escape, but juveniles could not find its way out of the net, so this modified net was also discarded.

The present essay tests the use of escape panels set along the tunnel of the trawling net, and corrects the problems inducing losses in the shrimp catch previously observed by Conolly in his trials.

## I. MATERIALS AND METHODS

The trawling shrimp nets used in this essay are similar to those used by the Venezuelan fleet in its Florida-type vessels. Those nets are semi-flat, with the following dimensions: float rope: 20 mst; foot rope: 21 mst; four sides; vertical opening 1 - 2 mst; 51 mm mesh size, stretched, of diamond shape in the wings and tunnel, made up with polyamide (PA) 210/28 twisted thread; 32 mm mesh size in the sac, made up of PA 210/132 twisted thread (see Fig. 1).

Three different types of panels were tested; all of them were installed in the upper part of the net tunnel (see Fig. 1).

a) The initial type of escape panel was made by substituting a section of the net roof (92 x 62 mesh), with a section of netting with 42 x 31 square mesh, made up of PA 210/28 twisted thread. Both were dyed with tar. One cut was made across the piece of net to be substituted, as close to the sac as possible. The rest of the net was left untouched and was pushed down to make it reach the mid-section of the net tunnel. There, it was strongly tied with a piece of rope to both sides of the tunnel, giving it the shape of an inclined plane, and forming a slope which forced the catch to move down the lower side of the net tunnel before reaching the sac. A triangular cut on both sides of this "slope", of 17 x 62 mesh, corrected the excess of net and improved the tension while the net was operational.

b) A second type of escape panel was made covering the upper side of the modified tunnel with a square polyethylene netting, coloured green (59 mm by side) of 28 x 35 mesh.

c) The third type of escape panel was made eliminating the square netting altogether and substituting it with 10 white, polyamide strings of 6 mm ϕ, which kept the operational structure of the gear and would let out any fish reaching this panel. This type of panel allows the monitoring of the maximum escape flow that can be obtained during the operations with these modified nets.

All the trials were made on board of commercial trawling vessels, south of Trinidad Island (inside the common fishing boundary), north of Margarita Island and Sucre State and in the Unare-Píritu shelf, between December 1987 and September 1990. Eight cruises were made using panel "a" and one with each of the other two panels. The operational depth varied between 18 and 58 m, though normally ships operated between 20 and 45 m depth.

During the cruises, a modified net was used on one side of the ship (usually starboard) and a normal net on the other, acting as a first control. During part of the cruise, a second control was set making the ship operate with two normal nets, to verify any possible bias between captures of fish and shrimp between both sides. Differences among captures with the normal nets and the modified ones were later standardized by this bias, according to a correction factor applied to the starboard catch for each item (x):

$$\text{Actual capture.}_x = \text{Capture.}_x + C._x * \text{Capture.}_x$$

where $\text{Capture.}_x$ is the measured catch and $C._x$ is the correction factor.

In two opportunities, several difficulties prevented the ship from operating with two normal nets, so the results for those dates could not be standardized (April 89 and Sept. 90). It was assumed that there was no bias in those two cases.

Each trawl had a duration of 3 hrs. At the end of every trawl, the volume of commercial (shrimp, fish, molluscs and crabs) and non-commercial by-catch (NCBC) was evaluated in each net. The composition of the non-commercial by-catch was evaluated one of every four trawls. In this last evaluation, around 20 kg of the brute capture were taken from each net, separating the material in commercial and non-commercial, for each species; the total weight and number for each group were estimated. Furthermore, during the cruise, from 100 to 200 specimen of the most important species caught with each of the nets were measured, to draw the selection curves.

## II. RESULTS AND DISCUSSION

Captures made in both sides of a Florida-type vessel could notably differ (Table 1). This difference could affect some of the entries, and not others. Due to its variability, it is difficult to give any conclusions regarding their causes, but they may be related to differences in the assembly of the nets, heeling of the ship, etc.

The use of the escape panel for fishes was effective in reducing the capture of NCBC in each one of the cruises made (Table 2). Variability in the number of hauls made in the different cruises was due to difficulties in the use of fishing tools, because even though two modified nets were carried on board, both could be damaged in the same cruise. The percentage of decrease in the capture of NCBC was highly variable. This could be related to the type of community captured (proportion of fishes in the capture), even though its importance could be reduced, if it is observed that in communities with a high or low number of fish (eg.: Oct. 88 and July 89), the decrease in the capture of NCBC was quite similar. By this, it is concluded that differences in the operation of the nets would have a major effect in the variability of the catch.

The escape panel was progressively improved, since the results of the initial cruises showed slightly lower percentages in the reduction of NCBC (12 to 29%). Some more tension was put on the "slope", making triangular cuts on both sides. Lately, the panel was moved forward 2 m, from the mouth of the sac to the beginning of the tunnel, allowing this way the escape of less tired fishes. Besides, the tar-dyed polyamide netting was substituted with a light green, polyethylene netting, with higher floatability and a better contrast for a clear way out in a dark net, turning this way into panel "B".

Even though few cruises were made since these modifications were set (Feb. 90), the reduction figures for the catch of NCBC remained above 30%. In the last cruise, it was measured what would be "the maximum escape opening", substituting the square netting (which allows for the retention of the commercial fish catch) by pieces of string with just the necessary opening to allow the escape of any fish reaching the panel. In spite of this, a 49% of NCBC was registered, compared to the normal nets.

This by-catch is mostly composed of juvenile fish and crustacea. In certain occasions, jellyfish were abundant, decreasing the effectiveness of the escape panels to reduce NCBC (Dec. 87). The proportion of fish among the NCBC captured with the modified nets reduced.

In reference to the size of fish species retained by modified and regular nets, it was observed that while some species showed significantly larger mean size in the modified gear (*Pristopomoides aquilonaris*, *Prionotus carolinus*; in Sep. 90; Student t-test, $P < 0.01$), other species showed no difference in mean size (*Upeneus parvus*, *Diplectrum formosum*; in Sep., 90; *Larimus breviceps*, in Feb. 90). This result is probably related to the fact that the type of panel tested is selective and allows only the escape of certain species.

The catch of shrimps showed variation in the modified in comparison with the regular nets. In certain occasions shrimp capture was larger in the modified nets (an increase of 70% in Sep, 90), while sometimes the opposite result was observed (a decrease of 50% in Jan, 89), compensating each other in average (mean 0 +/- 33%). Fish captures also varied with both types of net, but were consistently larger with the modified ones, increasing in average by 30 +/- 21%. It could have happened that the use of different size vessels during the trials added unwished variation to the results, being it necessary for future trials to restrict the type of vessels used for the experiments.

Conolly (1986) also reported increased catch of fish using nets modified with escape panels. This author estimated that the difference in fish capture was due to the higher speed of the boat during

the experimental trawls, in comparison with the speed during normal commercial operations. In the present study, the speed of the vessel was maintained at 3 knots, similar to the one used by the fleet during commercial operations. However, it is suspected that water flow inside the modified net increases, because of the large opening performed in the roof of the tunnel when the panel was installed. This larger flow would help in the retention of a greater amount of fish.

The fundamental difference between the modifications employed by Conolly (op. cit.) in his trials and the present study, is the utilization of an internal "slope", below the escape panel. This latter structure proved useful in preventing the direct access of the catch to the escape opening, thus reducing the loss of commercially valuable shrimp, while allowing the escape of small fish. Its simplicity and low cost would make it viable to be readily employed by the trawling fleet.

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**Table 1**: Comparison of the catch made with regular nets, on both sides of the vessel (B, Board; S, starboard). Cs, Cf, Cb are correction factors for standardization of the catch of shrimp, fish and by-catch, respectively, by the Starboard net.

| | | CATCH ( x 10 kg) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | shrimp | | | fish | | | by-catch | | |
| DATE | No. HAULS | B | S | Cs | B | S | Cs | B | S | Cs |
| Dec-87 | 52 | 141.0 | 126.0 | 10.6 | 225.0 | 194.0 | 13.8 | 856.0 | 900.0 | -5.1 |
| Aug-88 | 23 | 6.3 | 6.0 | 4.8 | 28.0 | 25.0 | 10.8 | 307.0 | 336.0 | -9.4 |
| Oct-88 | 2 | 3.3 | 4.8 | 46.2 | 4.5 | 4.0 | 12.5 | 31.0 | 32.0 | -3.2 |
| Apr-89 | * | | | | | | | | | |
| Jun-89 | 31 | 19.5 | 19.5 | 0.0 | 16.0 | 16.0 | 0.0 | 677.0 | 668.0 | 1.3 |
| Jul-89 | 19 | 8.0 | 9.3 | -15.6 | 25.8 | 24.3 | 5.8 | 228.0 | 217.0 | 4.8 |
| Aug-89 | 5 | 43.3 | 40.8 | 5.8 | 165.0 | 156.8 | 5.3 | 438.0 | 460.0 | -5.0 |
| Sep-89 | 18 | 10.5 | 10.3 | 2.4 | 26.8 | 29.5 | -10.3 | 191.0 | 190.0 | 0.0 |
| Feb-90 | 11 | 5.0 | 5.0 | 0.0 | 29.0 | 29.0 | 0.0 | 72.0 | 74.0 | -2.8 |
| Sep-90 | * | | | | | | | | | |

* No standardization hauls were made.

**Table 2**: Catch during operations with modified (M) and regular (R) trawling nets, and difference between them (D). The fishing areas (FA) were: T, Southern Trinidad; M, Northern Margarita Island - Sucre State; U, Unare-Piritu shelf.

| | | | | CATCH ( x 10 kg) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | shrimp | | | fish | | | squid | | | octopus | | | crabs | | |
| PANEL TYPE | FA | DATE | No. HAULS | R | M | d | R | M | d | R | M | d | R | M | d | R | M | d |
| a | T | Dec-87 | 27 | 48 | 50 | 4% | 102 | 106 | 4% | | | | | | | | | |
| a | M | Aug-88 | 46 | 12 | 13 | 7% | 57 | 65 | 14% | 4 | 6 | 38% | 54 | 78 | 45% | 60 | 68 | 13% |
| a | M | Oct-88 | 9 | 4 | 2 | -50% | 236 | 340 | 44% | | | | 0.3 | 0.8 | 0% | | | |
| a | M | Apr-89 | 41 | 15 | 14 | -8% | 400 | 432 | 8% | 8 | 8 | 0% | 1.3 | 1.3 | 0% | 3 | 3 | 0% |
| a | M | Jun-89 | 26 | 17 | 14 | -17% | 104 | 132 | 26% | 11 | 12 | 9% | 1.3 | 1.3 | 0% | | | |
| a | M | Aug-89 | 8 | 18 | 19 | 1% | 60 | 87 | 45% | | | | 0.5 | 0.5 | 0% | | | |
| a | U | Jul-89* | 53 | 24 | 40 | 70% | 98 | 131 | 33% | 3 | 3 | 0% | 1.5 | 2.5 | 67% | | | |
| a | U | Sep-89 | 44 | 23 | 20 | -11% | 74 | 123 | 66% | | | | | | | | | |
| Average | | | | | | 0% | (SD=33) | | 30% | (SD=21) | | | | | | | | |
| b | U | Feb-90 | 48 | 33 | 31 | -5% | 111 | 109 | -2% | 15 | 18 | 20% | | | | | | |
| c | U | Sep-90 | 11 | 1 | 1 | 0% | 17 | 9 | -47% | 18 | 1 | 0% | 40 | 40 | 0% | | | |

* If the catch of *Xyphopenaeus kroyeri* is considered, then the difference in the capture of shrimp would be: R=60; M=130; d=117%.

**Table 3**: Catch and composition of by-catch from trawling operations with regular (R) and modified (M) nets. Fishing areas (FA) are: T, Trinidad; M, Northern Margarita Island and Sucre State; U, Unare-Piritu shelf.

| | | | | | | | AMOUNT | | COMPOSITION % | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | CATCH (x 10 kg) | | | EVALUATED (kg) | | fish | | | crustaceans | | other |
| PANEL TYPE | FA | DATE | No. HAULS | R | M | (%) | R | M | R | M | d | R | M | d |
| a | T | Dic-87 | 27 | 555 | 431 | -22 | 76 | 79 | 68 | 62 | 5 | 7 | 27 | 31 |
| a | M | Ago-88 | 46 | 555 | 355 | -36 | 74 | 73 | 50 | 44 | 6 | 14 | 44 | 42 |
| a | M | Oct-88 | 9 | 142 | 115 | -19 | 66 | 77 | 94 | 87 | 2 | 4 | 4 | 9 |
| a | M | Abr-89 | 41 | 1016 | 817 | -20 | 142 | 143 | 90 | 90 | | | 10 | 10 |
| a | M | Jun-89 | 26 | 359 | 316 | -12 | 128 | 30 | 87 | 63 | | | 13 | 37 |
| a | M | Ago-89 | 8 | 145 | 103 | -29 | 21 | 16 | 87 | 89 | 13 | 11 | | |
| a | U | Jul-89 | 53 | 760 | 613 | -19 | 62 | 58 | 49 | 39 | 26 | 45 | 20 | 16 |
| a | U | Sep-89 | 44 | 647 | 404 | -38 | 84 | 72 | 47 | 43 | 24 | 27 | 29 | 29 |
| Average | | | | | | -24% | (SD=9) | | 67 | 61 | 14 | 19 | 24 | 27 |
| b | U | Feb-90 | 48 | 678 | 442 | -35 | 57 | 51 | 34 | 36 | 21 | 23 | 24 | 27 |
| c | U | Sep-90 | 11 | 235 | 116 | -51 | 78 | 85 | 78 | 66 | 3 | 1 | 19 | 33 |

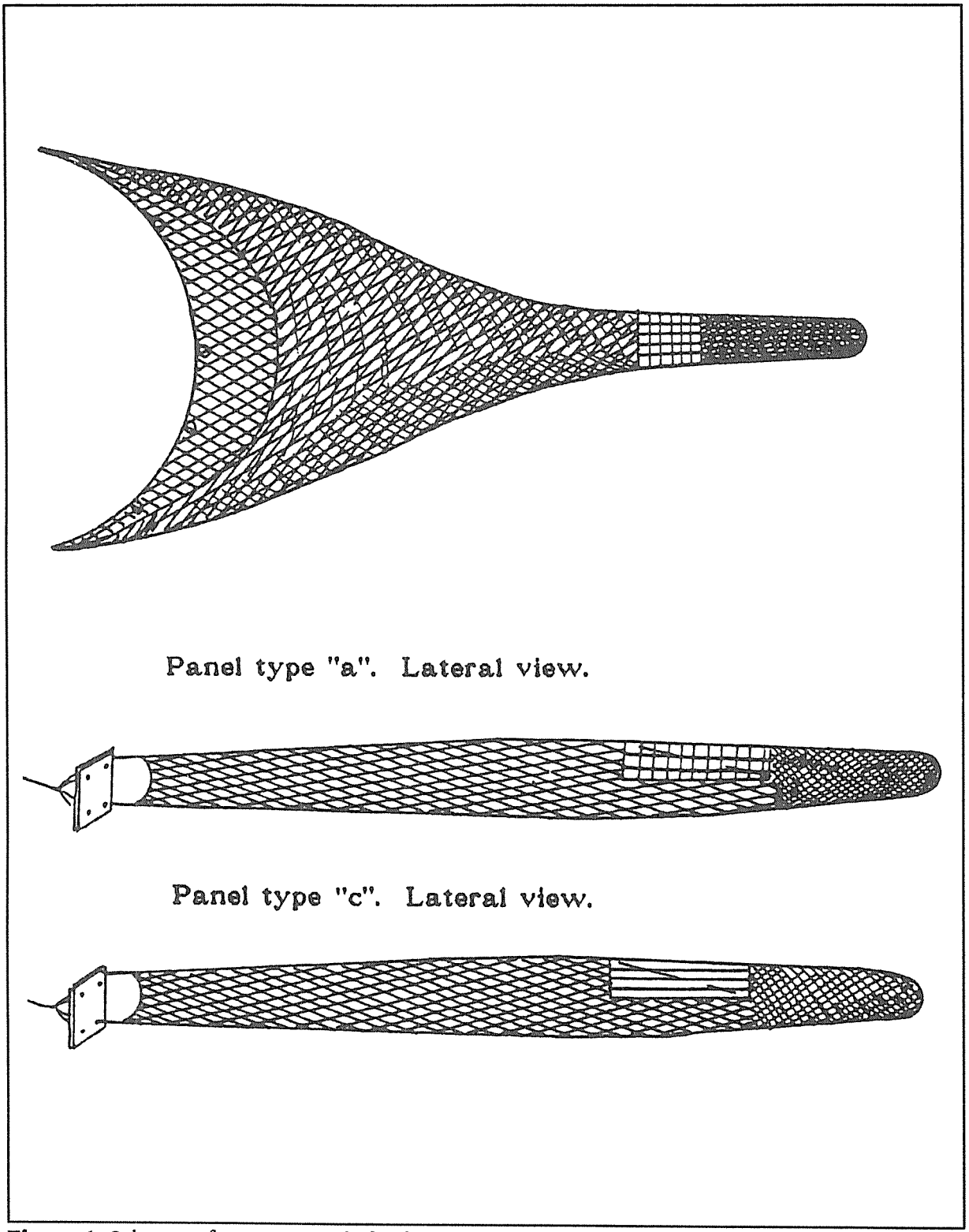


**Figure 1**: Scheme of escape panels for fish, installed in the shrimp trawling nets. Above view.

ANNEX I
PROJECT OUTLINE - DRAFT

# *Guyana-Brazil Shrimp Fisheries Investigation Programme*

. . . . . .

## 1. BACKGROUND AND JUSTIFICATION

- Description and development status of shrimp fishery (industrial and artisanal) catches, effort, etc.

- Economic and social importance; comparison to other fisheries

- Levels of development/research/management/data collection systems

- Environmental concerns (TEDs, by-catch, etc.); impact on marketing and trade

- Issues/problems to be addressed:

    - data and information to support management
    - levels of by-catch
    - level of exploitation, fleet size,effort
    - homogeneity of stocks ?
    - conflicts - industrial/artisanal
    - monitoring/control/enforcement

- Countries (Brazil, French Guiana, Suriname, Guyana, Venezuela, Trinidad and Tobago) agreed to establish a Scientific and Advisory Committee for the Management of the shrimp fisheries in the Guiana-Brazil Management Area (SAC)

## 2. DEVELOPMENT OBJECTIVES

- Improve management for sustained maximum benefits.

- Conservation of shrimp resources and associated fauna for maximum economic and social benefits.

## 3. IMMEDIATE OBJECTIVES

- Institutional strengthening of the SAC
- Generate data and information for sound management of the shrimp fisheries
- Provide scientific and management advice to national Fisheries Administrations through the SAC
- Support in policy making, planning, management, technology and research.
- Improvement of data base and information systems
- Technical assistance in research/development.
- Identification of additional resources (eg industry) for specific activities.
- Establishment of mechanisms for industry participation and support in research, training and development of the shrimp fishery sector
- Increase utilisation of by-catch and other associated fauna

## 4. EXPECTED RESULTS

- Improved knowledge of the resource for management purposes
- Trained personnel in each participating country
- Policies for management
- Technology transferred and adapted to local conditions
- Improved information and data collection systems
- Regional cooperation (TCDC & ECDC), exchange and sharing of data and information
- Common approaches to conservation issues ( TEDs, By-catch, etc.)
- Compatibility in data collection and processing processes
- Appropriate legislation

Beneficiaries

- Industry, country, fishermen.

## 5. ACTIVITIES

- Training courses and Workshops
- Research projects
- Publications and Information Systems
- Technical assistance

All above activities will be focused on:

- Policy formulation
- Planning and management
- Project identification and evaluation
- Technology- escape devices, etc
- Data collection
- Computerisation
- Survey of artisanal fisheries
- Methodologies for collection of economic and other data
- Implementation of log book system
- Impact of management regulations
- Bio-economic analyses
- Observer programmes

- Specific programmes to address specific issues.

## 6. RESOURCES

- Facilities, staff and on-going activities of national and regional institutions.
- Financial and technical resources from external sources including industrial sector
- Personnel

Adviser to SAC
Support staff

Members of SAC
Consultants

- Duty travel
- Upgrading of national facilities and capabilities
- Equipment and supplies
- Sub-contracts
- Training
- Workshops
- SAC Meetings

## 7. MODALITIES OF EXECUTION

- FAO will recruit the core project personnel and organise start of operations. At end of third month a detailed calendar work programme will be submitted to the SAC for approval.

- Management and execution of activities will be carried out by national and regional institutions in collaboration with existing and programmes and projects, under the monitoring and coordination of SAC. Intra and inter-regional cooperation and exchange of information will be promoted. FAO to provide technical advice

- At the end of the first year and each successive year, SAC will meet to evaluate the activities executed and approve the programme for the following year.

## 8. INSTITUTIONAL SETUP

- SAC (participating countries) will decide on the programmes and evaluate the executed activities. FAO will provide technical advice.

- FAO

  i. will be responsible for the international project staff and provide technical back-stopping;
  ii. WECAFC will assist in coordination and liaise with other projects and activities in the region;
  iii. WECAFC will facilitate execution of activities and forum for exchange of information;

- NATIONAL and REGIONAL INSTITUTIONS, in collaboration with FAO and National Fisheries Administrations, will manage and execute all project activities.

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