NATIONAL REPORT OF TRINIDAD AND TOBAGO

The shrimp and groundfish fisheries of Trinidad and Tobago

by

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1. DESCRIPTION OF THE SHRIMP TRAWL FISHERY

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

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

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

1.1 Fleet Description and Fishing Zones

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

Table 1: Trawler categories

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

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

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All local trawlers use four-seamed, flat nets. Artisanal (Types I and II) and bait trawlers use one stern trawl which is set and retrieved manually. Type III trawlers also have one stern trawl, this is operated with a hydraulic winch while Type IV trawlers use two nets attached to twin outriggers, and which are set and retrieved using a hydraulic (double-drum) winch.

Some of the more important trawl-gear dimensions are given in Table 2. It should be noted that although the information given for Type I trawlers is based on a 1984 survey, the data are considered to be representative of the present fleet.

Table 2: Dimensions of gear for each vessel type

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Vessel Type	Minimum Headrope Length (m)	Maximum Headrope Length (m)	Average Headrope Length (m)	Average Stretched Mesh Size of Cod-end (cm)
I [1]	7	14	10.4	3.8
II [2]	9.2	12.5	10.6	2.45
III [3]	10.1	15.2	11.6	3.5
IV [3]	13.7	13.7	13.7	3.5
Bait Trawlers [2]	6.8	9.75	7.9	2.47

Source: (1) Fisheries Division Trawler Gear Survey, 1984, (2) Fisheries Division Trawler Gear Survey, 1991, (3) Fisheries Division Vessel Census and Trawler Gear Survey, 1991.

Type II and III vessels operate exclusively in the Gulf of Paria (Figure 1) at depths of 1.8 - 18.0 m and 9.0 - 41.4m respectively. Type IV vessels fish all year round in the Gulf of Paria (between 9.0 - 48.6 m) and in the Columbus Channel (between 18.0 - 41.4 m). These vessels also fish on the North Coast during the months of October to January at depths of 37.8 - 57.6 m. 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. The existence of the Fisheries (Control of Demersal [bottom] Trawling Activities) Regulations, provides a regime which governs the area where trawl activity can occur with regard to depths and distance from the coastline as related to vessel type.

Vessels operating from Bonasse, Fullerton and Icacos in the south west are all Type I and trawl in the Gulf of Paria. However, some of these together with other similar vessels from Otaheite and Orange Valley were allowed to trawl in the Orinoco Delta between the months of December to June under a 1985 agreement with Venezuela. This agreement expired in 1995. These vessels normally operate at depths of 1.2 to 3.6m.

The areas of the fishing grounds exploited by local trawlers are given in Table 3. These areas were calculated from interviews and maps drawn by fishermen working on the different trawler types.

Table 3: Areas exploited by the different trawler types

Vessel Type	Region Fished	Depths (m)	Area of Ground (km^2)
I	Orinoco Delta	1.2-3.6	394
II	Gulf of Paria	1.8-18.0	329
III	Gulf of Paria	9.0-41.4	1,793
IV	North Coast	37.8-57.6	235
	Gulf of Paria	9.0-48.6	1,269
	Columbus Channel	18.0-41.4	826

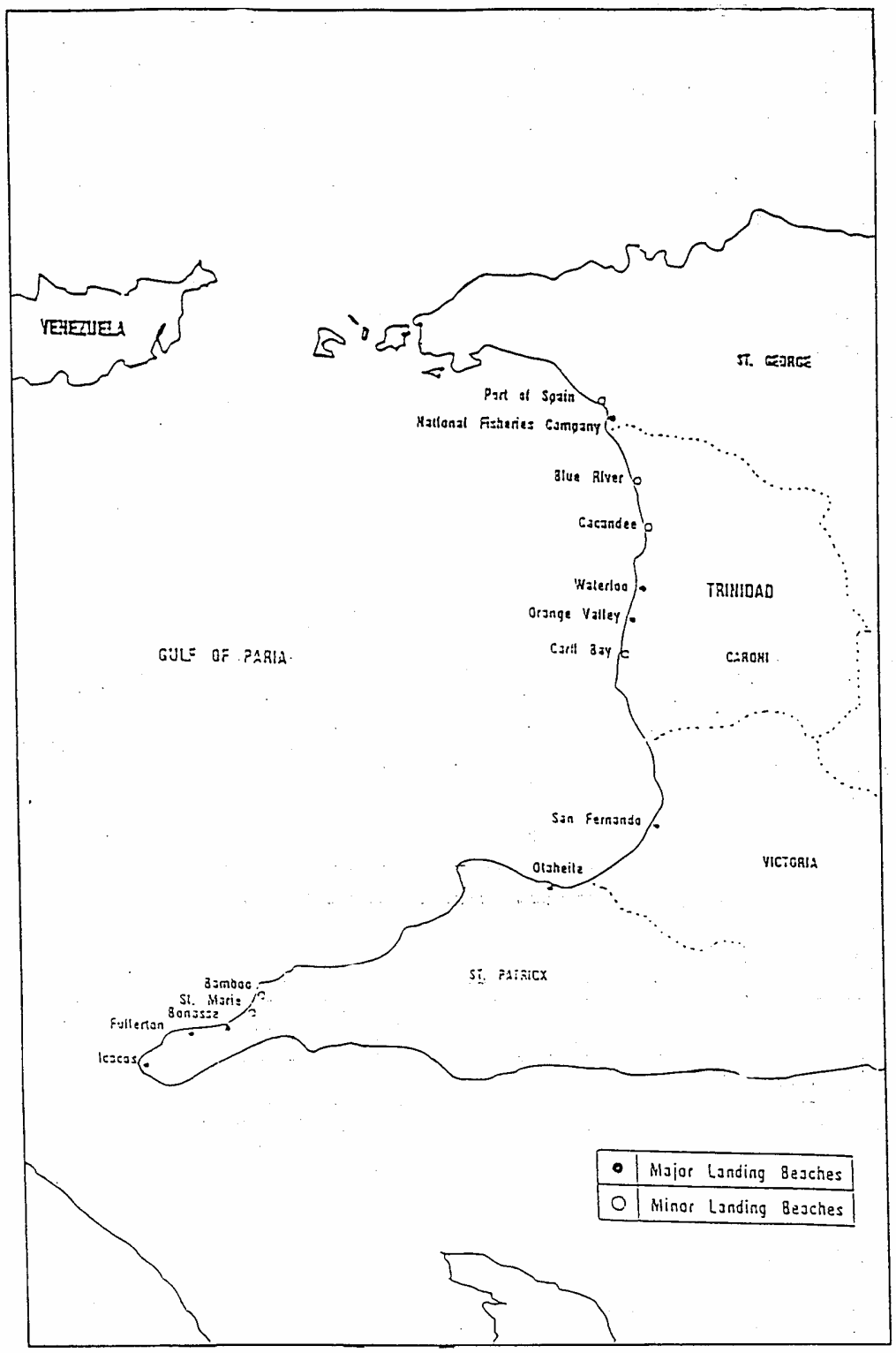

Figure 1: Trawler landing sites in the Gulf of Paria.

Figure 1: Trawler landing sites in the Gulf of Paria

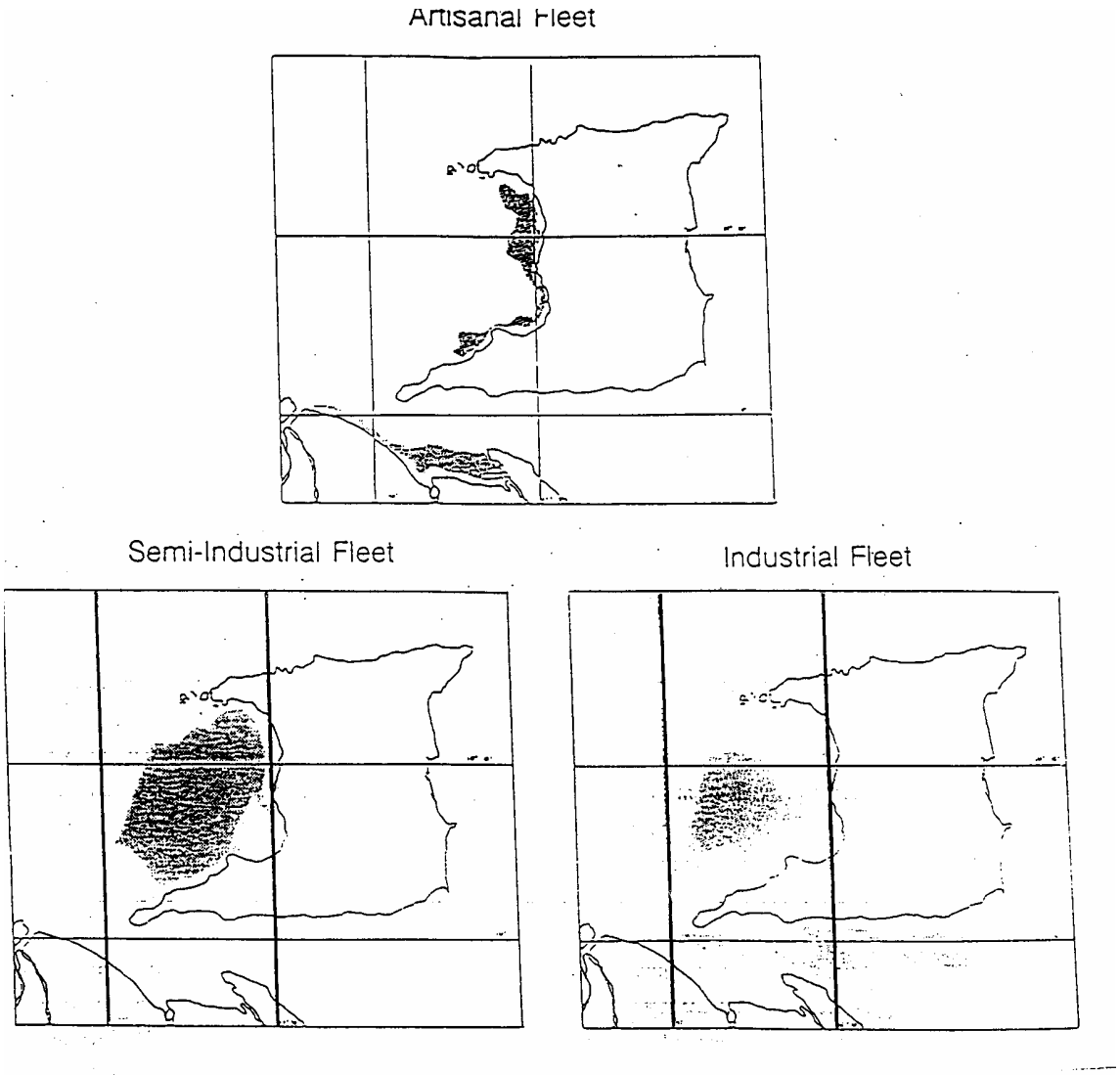

Figure 2: Areas of operation of each trawler type.

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Overall, the total areas fished within each coast are: the North Coast - 235 km^2, The Gulf of Paria - 1,957 km^2, The Columbus Channel - 826 km^2 and the Orinoco Delta - 394 km^2. The total area fished (all trawler types) is 3,412 km^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	Avg duration of trip	Avg # fishing days/month /vessel	Avg # of hauls/day	Avg duration of haul (hours)	Avg Vessel Speed (knots)
I	7-12 hrs	8	6	0.5-1	1
II	5-8 hrs	13	5	1-1.5	1
III	15-18 hrs	16	2 - 4	4	2
IV	7-21 days	17	2 - 4	2-4	3

Source: Interviews with Type I and Type II Fishermen. Extrapolation from Trawler Logbooks

There are some 570 fishermen actively involved in the local trawl fishery of which 231 trawl full-time and 339 trawl part-time (Fisheries Division Vessel Census, 1991). The latter operate in the Orinoco Delta during the months of December to June.

2. SPECIES COMPOSITION

Analysis of shrimp samples collected from commercial landings (March 1991 to present), indicate that Type I vessels operating in the Orinoco Delta (Special Area) land mainly *P. schmitti* (69% total landings) and *P. subtilis* (31% total landings), while Type I vessels trawling inshore in the southern Gulf of Paria land equal amounts of *P. notialis, P. schmitti* and *P. subtilis*, and small amounts of *X. kroyeri*. Type II trawlers operating inshore in the northern Gulf of Paria land approximately 50% *P. notialis*, the other dominant species being *P. schmitti*. *P. subtilis* and *X. kroyeri* are landed in small amounts. In contrast, Type II vessels trawling in the southern Gulf of Paria land mainly *P. schmitti*, other species being present in negligible amounts. Generally, *P. brasiliensis* is rarely found in artisanal trawl landings.

Type III trawlers operating in the nearshore Gulf of Paria land mainly *P. notialis* (63% total landings), and small amounts of *P. schmitti* and *P. subtilis*. No *P. brasiliensis* or *X. kroyeri* are landed.

Type IV trawlers operating offshore in the Gulf of Paria land mainly *P. notialis* (60% total landings) and *P. subtilis* (31% total), with small amounts of *P. brasiliensis*. *P. schmitti* is rare, while *X. kroyeri* is absent from landings. Type IV vessels trawling in the Columbus Channel land mostly *P. subtilis* (51% total landings). *P. brasiliensis* and *P. notialis* are also abundant. No *X. kroyeri* is landed. No information is available on the species composition of shrimp catches from the north coast.

A significant quantity of finfish and crabs are also caught as by-catch, and some authors (Manickchand-Dass and Julien, 1983; Fabres, 1989), state that certain species of finfish may be targeted according to market demand, or during the wet season when shrimp abundance decreases. Information on the species composition of trawl by-catch exists from studies of Type II and III catches (Maharaj, 1989 and Amos, 1990), from commercial landings statistics collected by the Economics, Statistics and Marketing Section of the Fisheries Division (Types I, II and III trawlers) and from landings at the N.F.C. Limited and logbook returns (Type IV trawlers).

The by-catch of Type I trawlers comprise mainly of Serranids and *Cynoscion sp.* However, these vessels generally land little by-catch.

A study of the Type II trawl fishery conducted between August 1986 and May 1987 identified 70 species of finfish from 40 families in the by-catch, as well as several species of Portunid crabs. Of the fish caught, commercially important species accounted for only 15-33% of the total finfish catch (Maharaj, 1989). It was estimated that approximately 94.13% of the by-catch of Type II trawlers was discarded in 1986.

Commercial landings statistics for the period 1987-1991 indicate that the by-catch landed by Type II vessels comprise mainly of *Sardinella brasiliensis, Anchoa sp., Diapterus sp., Lutjanus sp., Micropogonias sp.* and Portunid crabs. A large quantity of juvenile fin-fish of several different species are also landed as 'Mixfish'.

In a one month study of the Type III trawl fishery, Amos (1990) identified 25 species of fin-fish in the by-catch, from 14 families. The most abundant families were the Carangidae, Gerreidae, Lutjanidae, Sciaenidae, Triglidae and Portunidae. Approximately 59.67% of the fin-fish caught during this study was discarded. The by-catch landed by Type III trawlers during the period 1987-1991 comprise mainly of the following: *Harengula jaguana, Opistonema oglinum, Lutjanus sp., Cynoscion sp., Micropogonias sp.,* Portunid crabs and 'Mixfish'.

Analysis of Type IV logbook returns indicate that 64.8% of the total by-catch is discarded. These vessels land mainly *Decapterus sp., Diapterus rhombeus, Lutjanus sp., Cynoscion sp., Micropogonias sp.,* several types of Sharks and 'Mixfish'. The percentage contribution of each species to the total by-catch landings of each trawler type for the years 1987-1991, is given in Appendices I to IV.

3. POLICY AND REGULATIONS

A formal policy for Fisheries Sectoral Development was formulated by the government in its October 1994 Statement "Policy Directions for Marine Fisheries of Trinidad and Tobago in the 1990's" prepared in co-operation with FAO (Project TCP/TRI2352 A). It noted that fisheries development will evolve in an integrated marine framework, particularly coastal fisheries and that the participation of the fishing industry in management was critical to resource conservation, efficient economic use of fisheries resources and equitable allocation of benefits. The management objectives enunciated in the government's proposal are to:

1. implement efficient and cost-effective fisheries management;
2. ensure through proper conservation and management that the fisheries resources are not endangered by over-fishing;
3. ensure that the exploitation of the fisheries resources and the conduct of related activities, are consistent with ecological sustainability (e.g. for target species, non-target species and the marine environment);
4. maximise economic efficiency of commercial fisheries;
5. ensure accountability to the fishing industry and the community at large for fisheries management;
6. achieve appropriate cost-sharing arrangements between all the beneficiaries of sound fisheries management.

The priority need was recognized in the artisanal fisheries (including the trawl component) for broad based rural development initiatives to relax inshore fishing pressure and to monitor the socio-economic performance of these fisheries and coastal communities. In terms of the off-shore trawl fisheries it was also recognized that fishing capacity and fishing effort needed to be limited and that this requires negotiating with Venezuela in particular, as well as joint research programmes, on a bilateral and subregional basis.

The inter-dependence of the various components of the trawl fishery and interactions with other fisheries was further identified for analysis in terms of sustainable exploitation, economic efficiency and social equity. The need for a possible re-structuring of the multi-fleet trawl fishery was highlighted as a policy direction as well as the development of efforts to reduce the level of finfish by-catch particularly immature and undersized fish to avoid growth and recruitment over-fishing.

In the context of limited entry to these fisheries to avoid the negative consequences of "Open Access", the government has further indicated that licensing systems are to be implemented and analyses to be conducted prior to this regime to ensure technical and social issues are addressed and workable administrative systems implemented.

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 "The Fisheries (Control of Demersal [Bottom] Trawling Activities) Regulations, 1991" were adopted under the Fisheries Act, (Chapter 67:51). The Regulations have been extended biannually and are still in force.

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 or less (ie. Type III trawlers);
    - outside the eight (8) fathom contour for the non-artisanal trawlers of greater than 180 horse power (ie. Type IV trawlers); and
(c) no demersal trawling is permitted off the East Coast of Trinidad, nor within twelve (12) nautical miles off Tobago.

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.

Steps have been taken to initiate more effective management measures, including the limitation of effort on the shrimp trawl fishery to the levels existing in 1988. The imposition of this latter measure, which in the absence of an appropriate legal basis in the Fisheries Act, has had to be adopted on the basis of a 1988 Cabinet Decision, has highlighted the inadequacy of the existing legislation as a basis for modern management of the fisheries.

The recent report of a ministerial committee appointed to examine the trawl regulations recommended further measures to restrict trawling activities in inshore areas and off the north coast. Additional restrictions on fleet size were also recommended.

Resulting from the requirement to export shrimp to the USA, i.e. 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 are required to use TEDS on a permanent basis.

4. ECONOMIC INFORMATION

The fishing industry of Trinidad and Tobago accounts for approximately 13.5% of Agriculture's contribution to the GDP, which is itself only about 2% of the national GDP. The Fisheries Sector, although relatively small, is making a significant contribution to the economy in terms of employment, nutrition, export earnings and the stability it gives to the rural communities (Ferreira and Maharaj, 1993; UNDP/FAO Project INT/91/007, 1994).

In 1994, trawling accounted for approximately 21% by weight and 28% by value (shrimp 24%) of the total annual production from the country's artisanal fleet. Estimates indicate that some 946 tonnes of shrimp and 656 tonnes of by-catch at a value of $TT15 M and 2.4 M respectively, were landed by artisanal and semi-industrial trawlers (data are unavailable for the industrial trawlers).

4.1 Shrimp Processing

Shrimp processing in Trinidad and Tobago is handled by a variety of privately-owned companies which have supplemented the role previously performed by the National Fisheries Company (NFC). This activity cannot be clearly differentiated into industrial shrimp processing and artisanal shrimp processing since catches from all classes of trawlers are used at the processing plants. As shrimp trawling activity is mainly seasonal, processing also follows this trend, thus processing plants are largely temporary establishments. Only about 16 processors/exporters operate full-time.

Apart from these individual processors, some degree of processing occurs at the Orange Valley Fishing Complex where vessel owners and retailers employ personnel on an *ad hoc* basis to peel the shrimp before retailing is done.

Shrimp is graded according to an existing size regime prior to selling and are frequently sold according to species, since some degree of sorting is done on board the vessels. This grading according to size, indirectly leads to some degree of species differentiation (Table 5).

Table 5: Shrimp categories utilised by processors

Category	Small (per lb)	Medium (per lb)	Large (per lb)	Extra large (per lb)
Heads on	66 - 90	41 - 65	16 - 40	0 - 15
Heads off		42 - 67	26 - 41	0 - 25

Products sold locally include fresh chilled shrimp, peeled and breaded shrimp, shrimp patties as well as shrimp fingers. Exports are mainly in the form of fresh-chilled shrimp or frozen shrimp though a small proportion of the exports is in the forms of heads-off and peeled product. Statistics obtained from the Tourism and Industrial Development Company indicate that for the first three-quarters of 1995, exports totalled 422 tonnes with an F.O.B. value of TT$15.1M. These figures were affected by the imposition of an embargo on the export of shrimp to the United States of America from May to August, 1995. Corresponding export figures for the years 1992 to 1994 were 436 tonnes, (TT$7.2M), 405 tonnes (TT$11.4M) and 323 tonnes (TT$16M).

The traditional export markets for shrimp are the United States of America, the United Kingdom and Canada. As a result of the temporary embargo, exporters were forced to secure alternative markets which included islands of the English-speaking Caribbean as well as the French Departments of Guadeloupe and Martinique. The lucrative export market created an upward movement of the retail price on the local market to TT$10.00 per kilo for small-medium shrimp and TT$22.00 for large "cork" shrimp.

Revenue (FOB values) earned from exports of shrimp (heads-off) for the years 1991 to 1994 were obtained from the Export Development Corporation and are given in Table 6.

Table 6: Total shrimp exports (1991-1994)

Year	Quantity (kg)	Value ($TT)
1991	361,317	7,192,242
1992	435,810	7,184,322
1993	404,571	11,395,960
1994	322,892	16,036,660

Local wholesale prices are determined by bidding at the major landing sites, while buyers visit the beaches at out-lying districts where they purchase the catch either for the local retail market or for export.

5. CATCH AND EFFORT

Landing of shrimp and finfish by-catch from trawling takes place exclusively along the Gulf of Paria and the south-western peninsula (Figure 1). There are eight major landing sites: Sea Lots (the compound of the former National Fisheries Company Limited (NFC) bought over by the Taiwanese KWOJENG Co. Ltd. in November 1994) which is the main landing site for the industrial fleet (Type IV); the Orange Valley Wholesale Fish Market where the semi-industrial fleet (Type III) is based as well as some Type II artisanal vessels; the San Fernando and Otaheite Fish Markets, as well as Waterloo which are mainly Type II landing sites; and Bonasse, Fullerton and Icacos in the south-western peninsula which represent the base for the artisanal fleet (mostly Type I and some Type II) which operated for several years in the Orinoco Delta under a TT/Venezuela agreement. In addition, there are four minor landing sites: Carli

Bay, Cacandee Sluice, Blue River and Port of Spain Fish Market. The number of vessels operating at each landing site is given in Table 7.

Table 7: Number of trawlers per landing site

Landing Site	# Type I Trawlers	# Type II Trawlers	# Type III Trawlers	# Type IV Trawlers	Total # of Trawlers
Port of Spain	1		1	2	4
National Fisheries Co. Ltd.				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	21	209

Source: Fisheries Division Vessel Census, 1991

5.1 Beach Landings System

Landings and effort data (data form attached as Appendix 5) are available for up to seven of these sites from the 1970s to the present. These are Port of Spain, Orange Valley, San-Fernando, Otaheite, Bonasse, Fullerton and Icacos. Appendix 6 gives the number of months for which data are available at these sites for 1980 to 1996. Enumerators at each site collect data 10 days/fortnight with the exception of the enumerator at Otaheite who up to only recently was employed for just five (5) days/fortnight.

The data for 1991 to 1996 are computerized in Oracle (Prior to this the data are available only in hard copy.). The programming to facilitate the raising of these data by trawl fleet and fishing area for each beach to account for non-enumerated fishing days is currently in progress. The raising factor here would be the total number of fishing days at the beach divided by the number of enumerated fishing days at the beach. These figures will then need to be raised to account for the vessels not covered by the beach landings system. Raisings must be done for each trawler type operating within a particular fishing area separately in order to obtain estimates for the various fleets and areas. The raising factor here would be the total number of vessels of a particular fleet in the zone according to the census divided by the total number of vessels of the particular fleet at the enumerated beaches in the zone according to the census.

The data are not recorded by species but by genus or family. Appendix 7 gives a listing of the shrimp and fish categories recorded for each beach.

5.2 Logbook Programme

The data collected under the beach landing system covers only the artisanal and semi-industrial fleets. A review of the landings of the industrial fleet for 1989 was conducted using the National Fisheries Company Limited (NFC, main landing site for the fleet) records (Lum Young and Maharaj, 1991). However, these records give the quantity sold to NFC but do not account for the quantity removed by vessel owners from the NFC compound, nor quantity given to crew, nor quantity sold at Port of Spain market prior to or after landing at NFC.

Hence, in November 1991, a logbook programme was implemented to collect catch/effort data from the semi-industrial (8 trawlers) and industrial (20 trawlers) fleets. A logbook form is attached as Appendix 8. The programme was not very successful and collapsed by May 1992. Of the 28 vessels, 6 never submitted returns. For the semi-industrial fleet during the period November 1991 to mid-January 1992, returns were submitted for 14% of the fishing trips. For the industrial fleet over the period November 1991 to January 1992, returns were submitted for 45% of the fishing trips (33% of the fishing days).

The logbook data are computerized in dBase IV. Data for 17 trips (17 days) remain to be entered. Several reports were generated: individual vessel summaries by fishing area and for all areas combined bi-monthly; and fleet summaries by fishing area and for all areas combined bi-monthly.

Very preliminary estimates of trawl landings, fishing effort, catch rates and revenues earned for 1991 to 1993 are given in Table 8.

The figures for the industrial fleet were determined from logbook data and are considered to be very preliminary. Based on estimates provided by the Trinidad and Tobago Trawler Owners' Association (B. Maharaj, pers. comm.), total shrimp catch from this fleet for 1995 was estimated to be 423 tonnes from 268 trips with 66.7% being derived from the south coast, 25% from the north coast and 8.3% from the Gulf.

Table 8: Estimates of trawl landings, fishing effort, catch rates and revenue (1991-1993).

Year	Item	Special fishing area	Other artisanal trawlers	Type III (semi-industrial)	Type IV (industrial)	Total
1991	Shrimp landings (t)	288	362	162	1,000	1,912
	Shrimp revenue ($TTM)	4.5	2.3	2.0	12.0	20.8
	By-catch landings (t)	*	190	174	300	664
	By-catch revenue ($$M)	*	0.5	0.6	1.1	2.2
	Trips	5,478	11,523	3,911	300	21,212
	Shrimp CPUE (kg/trip)	52.57	31.42	41.42	3,333.33	3458.74
	By-catch CPUE (kg/trip)	-	16.49	44.49	1,000	1060.98
1992	Shrimp landings (t)	168	286	145	n/a	599
	Shrimp revenue ($TTM)	2.7	2.4	1.8		6.9
	By-catch landings (t)	*	171	261		432
	By-catch revenue ($$M)	*	0.4	1.0		1.4
	Trips	3,330	11,294	3,986		18,610
	Shrimp CPUE (kg/trip)	50.45	25.32	36.38		75.77
	By-catch CPUE (kg/trip)	-	15.14	65.48		80.62
1993	Shrimp landings (t)	272	282	125	n/a	679
	Shrimp revenue ($TTM)	4.5	2.1	1.9		8.5
	By-catch landings (t)	*	98	248		346
	By-catch revenue ($$M)	*	0.2	1.0		1.2
	Trips	4,793	10,065	3,619		18,477
	Shrimp CPUE (kg/trip)	56.75	28.02	34.54		84.77
	By-catch CPUE (kg/trip)	-	9.74	68.54		78.28

* = negligable values, n/a = data not available

The by-catch landed is only a portion of that captured, the rest is discarded at sea. A survey of the Type II fishery in the Gulf carried out by Maharaj (1989) between August 1986 and May 1987 estimated that in 1986, 94.13 % of the total by-catch by weight (1500 of 1594 tonnes) of Type II vessels was discarded. In a one (1) month study of the commercial Type III trawl fishery, Amos (1990) reported 25 species of finfish by-catch from 14 families with three families (Gerreidae, Carangidae and Sciaenidae) comprising 62% of the by-catch by weight. 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, over 95 % of the individuals sampled were immature. 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. Sciaenids represented approximately 74% by weight of the by-catch. The dominance of Sciaenids in trawl catches was also recorded during a trawl survey in northwestern Trinidad from February to November 1981 using the MV Provider, a 27-m-long vessel equipped with two side trawls (Manickchand-Heileman and Julien-Flüs, 1990; Manickchand-Dass and Julien, 1983).

Major landing sites for groundfish from methods other than trawling are Erin and Moruga on the south coast and Icacos on the south-west peninsula. Of the total estimated landings of groundfish from mono- and multifilament gillnetting and banking in 1994, croaker (*Micropogonias furnieri*) was most important, accounting for 65% by weight (627 tonnes) and 63% by value ($TT2.6M). Blinch (*Diapterus spp.*) represented 11% by weight and value (105 tonnes, $TT0.5M) and salmon (*Cynoscion spp.*) 9% by weight (87 tonnes) and 15% by value ($TT0.6M).

6. BIOLOGICAL DATA COLLECTION

The shrimp biological 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).

The programme implemented comprised weekly sampling at each of the 8 major trawl landing sites along the Gulf of Paria namely, Sea Lots, Waterloo, Orange Valley, San Fernando, Otaheite, Bonasse, Fullerton and Icacos . The sample target is two (2) vessels per beach per week if the catch is sorted and four (4) vessels per beach per week if the catch is unsorted. For sorted catches the sample size is 10 lbs per size category except for small categories in which case 2-3 lbs are sampled. For unsorted samples the target size is 10 lbs. With regard to the industrial fleet the catches are always sorted into such categories as medium, large, and extra large (all whole shrimp although at one time these categories were landed headless) as well as small (hoppers) and small (mixed). The artisanal and semi-industrial fleets on the other hand may leave the catches unsorted or sort them into such categories as small, small/medium, medium, medium/large and large.

Each sample taken from the shrimp landings of a vessel is sorted by species and sex, and carapace lengths recorded (tail lengths with telson for headless shrimp at Sea Lots). Lengths were measured to the nearest mm up to around May, 1995 after which lengths were measured to the nearest mm below. The change to the latter method of measuring came about due to the implementation of the CFRAMP Large Pelagics, Reef and Slope Fishes Assessment Subproject's biological data collection programme which applied this method. The length frequencies are recorded on voice-activated tape recorders and later transcribed onto forms and computerized. The total weight of shrimp sampled per vessel is recorded as well as the total weight of shrimp landed by the vessel sampled. If the catch sampled is sorted then these weights are recorded by size category.

Length frequency data for each species and sex combination separately are summarized monthly by trawler type and fishing area. Table 9 lists the various trawler fleets and areas of operation for which length frequency data have been or are being collected.

During the initial years of the programme (1991 and 1992), the number of valid samples was low due to the fact that several samples had to be discarded either because all the relevant weights were not collected or because all the categories of a sorted catch were not sampled. Subsequent to 1992 although these problems were ironed out, there were still some problems maintaining the programme due to lack of resources. With respect to the Type IV vessels, samples were obtained at the National Fisheries Company (NFC) in Sea Lots up to 1992 only, since sampling terminated when the company closed down in 1993. It is important to note that even if the target is met in terms of number of samples obtained it is hardly ever met in terms of weight (except for samples at NFC where the time factor was not a serious problem as it is at the other sites). In general, for the artisanal and semi-industrial fleets the sample weights obtained per vessel whether unsorted or per size category range from about 0.75 lbs to 4 lbs and average about 2 lbs. Appendix 9 gives the number of shrimp length frequency samples

Table 9: Areas of operation of the various trawl fleets.

Trawler Type	Fishing Area
I	South Gulf of Paria (Area 10)
I	North Gulf of Paria (Area 11)
I	Venezuela
II	Venezuela
II	South Gulf of Paria (Area 10)
II	North Gulf of Paria (Area 11)
III	Gulf of Paria
IV	Gulf of Paria
IV	Columbus Channel
IV	North Coast of Trinidad

available for analysis from the artisanal (Type II) and semi-industrial (Type III) fleets which operated in the Gulf of Paria over the period 1992 to 1996.

6.1 Treatment of Length Frequency Data

Shrimp length frequency data are summarized monthly for each species and sex combination separately by trawler type and fishing area. Since the programme was implemented in 1991 the data have been processed as follows. Length frequencies for a particular species and sex, fleet and area were added across samples for the month. This was done for unsorted samples separately and for each size category of sorted samples separately. Only for the sorted samples were the pooled length distributions for the month then raised to the total landings of the vessels sampled by size category separately. The raising factor used for the small category for e.g., a particular fleet, area, month, species and sex was the total landing (comprising all shrimp species) in the small category of the vessels sampled divided by the total sample weights (comprising all shrimp species) in the small category. The pooled, unraised, length frequency distribution from unsorted samples was then added to the pooled and raised length frequency distributions for each size category from the sorted samples to give the monthly length frequency distribution for a particular species, sex, month, area and fleet. This was then entered in FiSAT. Based on a review of these data by Ehrhardt (1997) this approach would produce biased results since the length frequency distributions are not homogenous among samples and the sample sizes are not proportional to landings.

Based on the review by Ehrhardt (1997) the following procedure is now being applied to estimate the catch in numbers and catch in weight, both by size class, for a particular shrimp species and sex for a particular month, fleet, area. The length frequency distributions for a particular species and sex for each unsorted sample and for each size category of a sorted sample are converted to weights by length class using the length weight relationships derived by Lum Young et al. (1992). These weights are summed over all length classes for a particular species and sex in an unsorted sample or in each size category of a sorted sample. These sums are added across all species and sexes to estimate the weight of each unsorted sample or size category of a sorted sample separately. For each unsorted sample or size category of a sorted sample the weight distribution for a particular species and sex, fleet and area is then raised to the landed weight from the boat sampled. The raising factor here would be the weight of all shrimp landed by the boat divided by the estimated weight of all shrimp sampled.

For sorted samples the raising factor would comprise the weights for a particular size category. These raised weight distributions for a particular species, sex, fleet and area are then added across for the month. This pooled weight distribution is then raised to the total landed weight for the fleet, area, month. The raising factor here would be the total weight of all shrimp landed by the fleet, area, month divided by the total weight of all shrimp landed by the boats sampled for the month. The resulting raised weight distribution for a particular species and sex is used to derive the catch in numbers by size class by

dividing the weights in each size class by the mean weight of a size class. The length frequency data are being entered in Access and the raising procedure is being done in Excel.

7. KNOWLEDGE OF THE RESOURCE (RECRUITMENT, NURSERIES, POPULATION DYNAMICS, ETC.)

The nature of the shrimp trawl fishery in Trinidad and Tobago dictates that activities in the inshore waters by the artisanal vessels impinge upon the catches of the semi-industrial and industrial vessels which trawl in the offshore waters. Juveniles hatched in the brackish-water mangrove swamp nurseries migrate from the coastal waters and are harvested sequentially and spatially, first by the artisanal vessels and then by the Type III and Type IV crafts. Since the resources of the Guiana-Brazil Shelf shrimp fishery have been identified as belonging to one stock (which is carried by currents northward along the north-east coast of South America) then recruitment and population dynamics of the local shrimp trawl fishery are also affected by the activities within neighbouring trawl fisheries.

Prior to 1992, not much work was done locally with regard to the recruitment, nurseries and population dynamics of the penaeid shrimp species. Table 10 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, *et. al.* 1992).

Table 10: Information obtained about the shrimp resources from surveys carried out locally

Study area	Time period	Heading	Information obtained	Reference
Inshore waters of the Gulf of Paria, Trinidad	Oct 1984 - May 1986	Spawning	*X. kroyeri* breeds all year round. 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) Smallest mature male was 6.3 cm.	
		Impact of Environmental Factors	*X. kroyeri* is highest in the catch when salinities are about 32%. 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. 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. A second spawning was not evident from the data set.	Fabres, B. (1988)
Oropouche Bank adjacent to the mangroves of the South Oropouche Swamp	1983 - 1984	Species Composition	*X. kroyeri* dominates between September and April. *P. schmitti* is the most common species during the period of peak rainfall and river discharge, i.e., June and July. *P. notialis* and *P. subtilis* are present in lesser quantities.	Ramcharan, E.K. (1989)
		Impact of Environmental Factors	The dependence of *X. kroyeri* on both mangrove and phytoplankton carbon is apparent. *P. schmitti* is dependent upon the freshwater pulse, low salinity regime and mangrove carbon which is generated at the onset of the rainy season.	

Table 10: Information obtained about the shrimp resources from surveys carried out locally (continued)

Study area	Time period	Heading	Information obtained	Reference
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. *P. schmitti* was most abundant from September to October and very low from November to May. *P. notialis* was highest in the catch from January to May and lowest from October to January. The quantity of *P. subtilis* in the catch fluctuated with highest levels occurring from November to May. *. 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. The maximum length in the northern Gulf of Paria was 41 mm and 59 mm in the south. 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. (kg/hr) (kg/hr) Northern Gulf of Paria: Day 2.29 Night 2.47 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. *P. brasiliensis* is caught in minimal quantities in the Gulf of Paria. *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. <u>Relative Contribution by Weight of Penaeid Shrimp Species</u> Species / Mean % (wt) / N Gulf of Paria / S Gulf of Paria / Total *P. brasiliensis* 3.64 5.01 4.46 *P. notialis* 30.19 39.35 35.69 *P. schmitti* 36.37 10.80 21.03 *P. subtilis* 29.99 44.85 38.92	Amos, M. (1990)

Table 10: Information obtained about the shrimp resources from surveys carried out locally (continued)

Nearshore Gulf of Paria, Trinidad	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. *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. 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. The dominance of *P. subtilis* and *P. notialis* in the Gulf of Paria reflects their euryhaline preferences.	Amos, M. (1990)

Subsequently, preliminary work was conducted to obtain information on the resources upon which the shrimp trawl fishery is based. Two studies were conducted, one based upon the five major species occuring in the Trinidad and Tobago trawl fishery, and the other upon the Orinoco Delta shrimp fishery which is exploited by Type I shrimp trawl vessels.

In 1992, morphometric relationships between weight at length and between weight and length types were determined for the five commercially important shrimp species (Lum Young et al, 1992). Shrimp samples were obtained, over a five month period from January to June 1992, from the commercial landings of vessels operating in the Gulf of Paria and Columbus Channel. The target was 10 individuals from each of the carapace length groups 0-10mm, 10-20mm, 20-30mm, 30-40mm and 40-50mm for each species and sex. However, the length ranges obtained were those available in the commercial catch during the time period and hence the results may be regarded as preliminary. Both predictive (ordinary least squares) and functional (geometric mean) regressions were performed on the data collected using Lotus 1-2-3 (Lotus Development Corporation, 1990) to establish the morphometric relationships by sex (separately and combined) for the following:

1. Total weight (Wtot/g) on total length (Ltot/mm).
2. Total weight (Wtot/g) on carapace length (Lcar/mm).
3. Tail weight (Wtail/g) on tail length with telson (Tltel/mm).
4. Tail weight (Wtail/g) on tail length without telson (TL/mm).
5. Tail weight (Wtail/g) on carapace length (Lcar/mm).
6. Tail weight (Wtail/g) on total weight (Wtot/g).
7. Total length (Ltot/mm) on carapace length (Lcar/mm).
8. Rostral length (Lros/mm) on carapace length (Lcar/mm).
9. Tail length with telson (Tltel/mm) on carapace length (Lcar/mm).

10. Tail length without telson (TL/mm) on carapace length (Lcar/mm).
11. Tail length with telson (Tltel/mm) on total length (Ltot/mm).
12. Tail length without telson (TL/mm) on total length (Ltot/mm)

A preliminary stock assessment of the two (2) dominant species *P. subtilis* and *P. schmitti* exploited by the shallow water shrimp trawl fishery in the "Special Fishing Area" adjacent to the mouth of the Orinoco River, (Venezuela) was also conducted in 1992 within the FAO/ UNDP TRI/91/001/TR9 project (Lum Young *et. al.*, 1992b). The analysis was based on length frequencies collected in the 1990/91 fishing season (i.e., December 1990 to June 1991).

Table 11: Estimates of the constants (functional regression) for total weight on carapace length ($W_{tot} = u(L_{car})^v$).

Species	Male			Female		
	u ($x10^{-4}$)	v	r	u ($x10^{-4}$)	v	r
P. schmitti	7.0357	3.1283	0.9901	9.2198	3.0287	0.9840
P. notialis	16.7569	2.8589	0.9864	18.1956	2.8839	0.9983
P. subtilis	7.2001	3.0634	0.9714	21.5008	2.7096	0.9770
P. brasiliensis	11.5260	2.8814	0.9862	7.9631	2.9997	0.9802
X. kroyeri	31.3561	2.5010	0.9970	45.6641	2.3887	0.9949

The length frequency data for the landings from this "Special Fishing Area" suggest that *P. schmitti* remains in the fishery till the end of life, while *P. subtilis* migrates offshore at intermediate sizes. It is believed that this fishery is based principally on the progeny from spawning in the previous autumn. Estimates for the von Bertalanffy length at age constants were determined as follows. Pairs of values of $L\infty$ and K from the literature were used in the equation from Munro and Pauly (1983) $\phi = \ln K + 2 \ln L\infty$ (where ϕ, Munro's phi prime, is a measure of overall growth performance) to determine an overall mean value for ϕ for all the locally occurring species. The maximum observed lengths for each of the relevant species by sex from all the length frequency data obtained from the Trinidad trawl fishery were assumed to approximate the $L\infty$'s and hence used in the above equation with the estimate of ϕ to obtain estimates for K. These growth constants were then used in the Pauly equation to estimate natural mortalities. These results are given in Table 12. The growth and mortality parameters upon which the assessment is based are hence provisional and need to be refined. The results of the assessment must therefore be considered to be very preliminary. The two species were found to have similar growth and natural mortality rates. Total mortalities for each combination of species and sex were obtained from catch curve analysis of the pooled monthly length frequency distributions for the study period which also used the growth constants as input. The same inputs were utilised in determining the recruitment/selection ogives. The output values chosen were those from the smoothed logistic transformation. Both analyses were assisted by use of the COMPLEAT ELEFAN suite of programs (Gayanilo *et al*, 1989). The estimated lengths at 25 percent, 50 percent and 75 percent retention are shown in Table 13.

Table 12: Estimated von Bertalanffy growth constants and natural mortality coefficients
CL= carapace length

Species	Sex	$L_{max} = L_\infty$ (mm)	K ($month^{-1}$)	Estimates of M (yr^{-1})
P. schmitti	Male	43 CL (207 TL)	0.1716	3.120
	Female	49 CL (218 TL)	0.1322	2.593
P. subtilis	Male	41 CL (185 TL)	0.1888	3.428
	Female	48 CL (205 TL)	0.1377	2.709

Modifications of the Thompson and Bell model (1934) were used to estimate likely yields, catch rates, mean individual weights and exploited biomass from a range of annual fishing efforts. In the case of *P. subtilis*, the numbers of shrimp migrating off the fishing ground were also estimated. The variation in annual recruitment during recent years was determined by simulation. This involved estimating the recruitment necessary in each year to achieve the observed yields from the observed efforts. Table 14 gives the estimated numbers of zero-age recruits.

Table 13: Estimated lengths at 25%, 50% and 75% retention

Percent Retention	Carapace Length (mm)			
	P. schmitti		*P. subtilis*	
	Male	Female	Male	Female
L25	25.392	26.848	20.581	23.037
L50	27.323	30.135	21.941	24.555
L75	29.254	33.422	23.302	26.074

The principal finding from this preliminary assessment was that the potential effort of 70 vessels (estimated at 7,000 trips for a season) would be adequate to fully utilize the resource (i.e. to achieve MSY). Furthermore, additional fishing effort might result in increased yield from this fishery but can result in less migration of shrimp to the fishing grounds in the Columbus Channel, and hence to a reduction of yield to the industrial trawlers.

Table 14: Estimated number of zero-age recruits

Year	Number of recruits (millions)		
	P. schmitti	*P. subtilis*	Total
1990/91	31.69	95.43	127.12
1989/90	40.95	105.88	146.83
1988/89	18.78	59.02	77.80
1987/88	51.02	105.76	156.78
1986/87	38.80	102.36	141.16

8. DESCRIPTION OF THE GROUNDFISH FISHERY

8.1 Fleet Description and Fishing Zones

The vessels targetting groundfish are pirogues between 6-10 meters long. They are constructed of wood, fibreglass or fibreglass coated wood. These vessels may use one or two outboard engines with average horsepower of 45-75 HP (Henry and Martin, 1992). There is no mechanisation of operations, however, most vessels carry ice chests for storage of catch. Vessels are owned by private individuals with some persons owning more than one vessel.

Table 15 shows the numbers of fishing vessels which operate gears to capture groundfish.

Table 15: Number of vessels with primary fishing method

	Mono (P)	Mono (D)	Multi (P)	Multi (D)	Banking	Longline (D)	Beach Seine
Trinidad	38	124	198	18	198	58	23
Tobago	46	6	1	2	35	1	34

Mono = monofilament gillnet, Multi = multifilament gillnet, P = pelagic, D = demersal
Source: Fisheries Division Census, 1991

While trawling accounts for major landings of groundfish, the main fishing gear used to target groundfish is the monofilament demersal set gillnet, known locally as; "transpearing", "monoflemming", or "white net". Other gears which also capture groundfish include demersal longlines or "palangue", banking, beach seine, fishpots, and multifilament gillnets or "fillet", which though set on the surface may also catch groundfish due to deployment at shallow depths. This is an inshore fishery and most fishing is done in depths between 9-14 meters.

The monofilament gillnet lands a greater percentage and variety of species as bycatch than the multifilament gillnet. This is due to both its demersal deployment and the fact that the monofilament net has a higher hanging ratio, and therefore entanglement ability, than the multifilament net (Hodgkinson-Clarke, 1990).

Monofilament nets may be fished both day and night, and are set demersally with either both ends anchored or one end anchored and the other attached to the boat by the cork or float line. Multifilament nets are fished at night, except during bright moonlight, at the surface of the water. They may be free drifting or attached to the boat at one end. Gear characteristics for monofilament and multifilament gillnets are shown in the following table (Table 16):

Table 16: Gear description for gillnets

Net type	Mesh size	Twine guage	Weight	Mesh depth	Length
Nylon Mono-filament	114mm/4.5" 102mm/4.25" 95mm/3.75"	9, 10, 12, 15, 18 (10 most used)	5-8 bales per net (50 or 25 lb bales)	100 mesh/50lb 50 mesh/25lb	450-1098m
Nylon Multi-filament	114mm/4.5" 102mm/4.25" 95mm/3.75"	12, 15	3-6 bales per net (50 or 25 lb bales)	100 mesh/50lb	732-1190m

Source: Henry, C. and L. Martin, 1992

The sites of major groundfish fishing activity are the west (Gulf of Paria) and south (Columbus Channel) coasts of Trinidad, with minor activity occurring on the east and north coasts.

The general topography of the Gulf of Paria is fine mud with areas of shell debris and sand while the Columbus Channel is featureless with a fine mud substratum (Hodgkinson-Clarke, 1990). The west and south coast are shallow with maximum depths of 40 and 54 meters respectively (British Admiralty Chart no. 493).

8.2 Target Species

The main target species for the gillnet fishery is carite (*Scomberomorus brasiliensis*), but the following species are caught in association with the carite, especially in the relatively shallow coastal waters. Kingfish (*Scomberomorus cavalla*), salmon (*Cynoscion spp.*, *Macrodon spp.*), croaker (*Micropogonias furnieri*), blinch (*Diapterus spp.*), grunt (*Haemulon spp.*, *Genyatremus luteus*, *Orthopristis spp.*), redfish/snapper (*Lutjanus spp.*, *Rhomboplites aurorubens*) and catfish (*Arius spp.*).
Nominal statistics from enumerated beaches indicate that for both multi- and monofilament gillnets, croaker is the most important species landed by weight and value, followed by catfish, blinch, salmon, redfish, and grunt, in that order. In banking, redfish is most important, followed by croaker, grouper, salmon, and catfish, respectively.

The following Table (Table 17) shows the percentage contribution of individual groundfish species to the total catch weight, by gear, of all groundfish for 1994, it also shows the contribution made by groundfish species to the total catch by gear of all species:

8.3 Policy and Regulations

The principal legislation having relevance to domestic fishing is the Fisheries Act of 1916 which has been amended twice (1966 and 1975), but remains very limited in scope This Act still constitutes the basic fisheries law in so far as domestic fisheries are concerned. The Act applies to all rivers and tidal waters in Trinidad and Tobago and to the 12 mile territorial sea, but does not apply to the EEZ.

Table 17: Percentage contribution of groundfish species to total groundfish catch weight, by gear.

Species	Banking	Fillet	Monofilament
REDFISH (*Lutjanus spp.*)	63	1	3
SALMON (*Cynoscion spp.*)	2	2	5
CROAKER (*M. furnieri*)	17	85	61
GROUPER (Serranidae)	15	0	0
BROCHET (*Centropomus spp.*)	1	1	4
BLINCH (*Diapterus spp.*)	0	3	13
GRUNT (*Haemulon spp.*)	0	0	3
CATFISH (Ariidae)	2	8	10
% Contribution of groundfish landings to total catch of all species by gear	65	23	50

(Fisheries Division Nominal Statistics, 1994)

With respect to fishing activity targeting the groundfish resources, the recommendations of greatest relevance would be those arising from the assessment of the gillnet fishery in 1992 in which it is proposed that access to the inshore fishery be controlled and that gillnet mesh sizes be increased on a phased basis to a target 4 3/4 inch stretched mesh.

Recent recommendations of a ministerial committee included the immediate implementation of mesh size increases to a minimum of 4" stretched mesh and phasing out of monofilament gillnets over a three (3) year period.

8.4 Economic Information

Processing and Marketing of Fish

Catches from the artisanal vessels are either sold by auction at the major landing sites to exporters and hoteliers or to retailers who supply the domestic market. These are sold as fresh on ice, gutted, dressed or sliced fish.

The following families are of greater economic importance: Carangidae, Sciaenidae, Lutjanidae and Gerreidae. The major export markets for these fish are similar to those for shrimp exports. Prices on both the domestic and foreign markets are not fixed, but are determined by the prevailing market forces. The average price range determined from exporter licence application forms is TT$8.00 per kilogram.

Catch Weight and Value

In 1994, groundfish landings comprising six groups of species, from three gears combined (Monofilament, Multifilament and Banking), contributed a total of 957 tonnes to the total catch estimates of all gears and species, at an estimated value of TT$ 4.2M. This represents an overall contribution of 12.57% (by weight) and 6.62% (by value) to the total annual production from the artisanal fishery for 1994.

Of the total estimated catch and value of groundfish for 1994, croaker was most important, contributing 65% (weight) and 63% (value), and salmon contributed 9% (weight) and 15% (value) to the total.

8.5 Status of the Groundfish Resources

Demersal resources were investigated with a demersal trawl survey programme conducted by R/V Dr. Fridtjof Nansen in 1988 (Institute of Marine Research, Bergen, 1989). The dominant family was Sciaenidae, followed by Lutjanidae. Table 18 summarizes the biomass estimates, by coast, for the main groundfish families.

Table 18: Overview of biomass estimates of groundfish by coast (tonnes)

Family Name	North Coast[1]	East Coast[2]		South Coast ("Joint Area")[3]	Total[4]
		0-50m (t/nm^2)	Beyond 50m (t/nm^2)		
Sciaenidae	3,550	6.4	0.6	5,500	9,050
Lutjanidae	400	1.4	0.6	450	850
Serranidae				200	200
Haemulidae		0.3	0.1	100	100
Other groundfish	750	1.8	1.8	2,000	2,750
Total	4,700	9.9	3.1	8,250	12,950

1 - Two of the catches beyond 50m were exceptionally large, and hence the biomass estimates may be overestimated if these high catches are not representative. The estimates might also reflect a seasonal situation as most of the sampling was done in November.

The dominant species in the 0-50m bottom depth zone were *Micropogonias furnieri* (whitemouth croaker), *Cynoscion jamaicensis* (Jamaica weakfish), *Peprilus paru* (American harvestfish), and *Lutjanus purpureus* (southern red snapper). The main species in the 50-100m bottom depth range were *Cynoscion jamaicensis*, *Ctenosciaena gracilcirrhus* (barbel drum), *Priacanthus arenatus* (Atlantic bigeye), and *Pristipomoides macrophthalmus* (cardinal snapper).

2 - Estimates on mean densities (tonnes/nm^2) are given by depth range. Absolute biomass figures for the whole shelf were not made since major parts of the east coast shelf are not suitable for trawling, and the estimated densities from the trawlable areas are not representative for the whole shelf.

In the 0-50m bottom depth zone the main species were *Stellifer microps* (smalleye stardrum), *airdiella crysura* (white corvina), *Micropogonias furnieri*, *Stellifer griseus* (grey stardrum), *Lutjanus synagris* (lane snapper), *Arius* spp. (catfish), *Cynoscion jamaicensis*, and *Lutjanus analis* (mutton snapper). The 50-100m depth range was dominated by *Cynoscion jamaicensis*, with some *Lutjanus analis* and *Ctenosciaena gracilcirrhus*.

3 - The dominant species were *Cynoscion jamaicensis*, *Micropogonias furnieri*, *Ctenosciaena gracilcirrhus*, *Macrodon ancylodon* (king weakfish), and *Lutjanus synagris*.

4 - Derived from north and south coast estimates.

A yield-per-recruit (Y/R) analysis was conducted for the whitemouth croaker, *Micropogonias furnieri* in Trinidad waters based on samples obtained by trawling between October 1977 and September 1982 (Manickchand-Heileman and Kenny, 1990). This analysis indicated that the maximum sustainable Y/R (175g) is already being obtained, and any increase in fishing mortality would result in overexploitation.

8.6 Landings and Effort

Major landing sites for groundfish from methods other than trawling are Erin and Moruga on the south coast and Icacos on the south-west peninsula(Fisheries Division Census 1991).

Landings and effort data are collected by enumerators based at the major landing sites indicated. The system does not provide however for species specific data collection in all cases, and data for salmon are a combination of the landings of *Cynoscion sp.* and *Macrodon sp*. Data recorded over the period 1991 - 1996 have been computerized in Oracle and can be raised to the entire fleet and to account for non-enumerated fishing days.

8.7 Biological Data

There is currently no ongoing system of biological data collection specific to groundfish species under the research programme of the Fisheries Division and existing data have been derived from several discrete surveys carried out over the past twenty years.

Length frequency data for the Whitemouth Croaker, *Micropogonias furnieri,* one of the more important of the groundfish species, were compiled from past trawl surveys. These surveys include:

- Manickchand-Dass (1980): Monthly catches were collected from industrial (Type IV) trawlers operating in the Northern Gulf of Paria (Area 11) and along the North Coast of Trinidad between September 1977-September 1978, and from hook and line samples for the month of October, 1978.

- Explorer III Survey: Weekly catches were obtained from an artisanal type (Type I) trawler owned by the Fisheries Division and operating in the Northern Gulf of Paria (Area 11) between November, 1984 to April, 1986.

- Sea Prince Survey: The catch of an artisanal (Type II) trawler operating in the Northern Gulf of Paria (Area 11) was sampled weekly between August 1986 to January 1987 and bi-monthly between February 1987 to September 1987. For August, 1986, one entire haul was considered to be representative of the entire catch. Subsequently, each haul was sub-divided into bins, and one bin sampled as a representative of that haul.

- Fridtjof Nansen Hydroacoustic and Trawl Survey: Catches were collected from the North, East and South Coasts of Trinidad during the months of May, August and November, 1988.

All lengths are given in mm and have been entered into Microsoft Excel. The lengths of those fish collected from the Explorer III and Sea Prince surveys are available as standard lengths, while those collected from the Manickchand-Dass and Fridtjof Nansen Surveys are available as total lengths. Standard lengths have been converted to total lengths.

The following information on reproduction, age, growth and mortality for the Whitemouth croaker, *Micropogonias furnieri* is taken from Manickchand-Heileman and Kenny (1990).

Age at Maturity: Males and females were found to be mature at Age II or 28cm for males and 32 cm for females.

Spawning Pattern: Year round spawning was observed but greater activity occured from February to August during the dry season.

Sex Ratio: Overall sex ratio of 1:1.3 male:female. Monthly sex ratios showed a higher proportion of females from March to October and of males from November to February.

Length-weight relationship: The length-relationship for males was $W=0.035TL^{2.66}$ and for females $W=0.030TL^{2.69}$ or $W=0.03TL^{2.64}$ for both sexes. Asymptotic weight (W_{∞}) was 3641.6g.

Age and Growth: Otolith reading showed the presence of six age groups for males and seven for females, while analysis of length-frequency distributions of combined sexes showed six age groups (Table19).

Growth Parameters: Von Bertalanffy growth parameters for Trinidad and Brazil are given in Table 20.

Mortality: Total mortality rate was estimated at 1.2/year, natural mortality rate at 0.4/year, and fishing mortality at 0.8/year.

Yield per recruit analysis showed the Whitemouth croaker to be fully exploited in Trinidad.

Table 19: Von Bertalanffy growth parameters of the croaker in Trinidad and Brazil waters

	Otoliths (TL ± SD)				Length-frequency distribution
Age group	Male	N	Female	N	(± SD)
I	22.0 ± 1.92	26	21.6 ± 2.09	23	22.3 ± 0.35
II	28.3. ± 1.85	21	29.4 ±2.71	34	27.3 ±1.65
III	33.6 ±1.49	14	34.2 ±1.89	18	31.6 ±1.65
IV	38.5 ±2.36	29	40.5 ±1.98	30	36.2 ±2.05
V	42.5 ±1.83	10	47.5 ±2.94	12	43.5 ±2.45
VI	45.6 ±2.79	10	51.6 ±2.90	14	49.5 ±1.70
VII	-- --	--	53.5 ±3.25	11	-- --

Table 20: Von Bertalanffy growth parameters of the croaker in Trinidad and Brazil waters

Area	Sex	L∞	K		Structure	Author
Brazil (33-29°S)	F	69.33	0.149	-2.79	scales	Vazzoler 1971
	M	89.57	0.076	-4.64		
Brazil (29-23°S)	F	60.10	0.219	-2.08	scales	Vazzoler 1971
	M	82.90	0.106	-2.97		
Brazil (4°S)	F	67.60	0.18	-9.42	scales	Rodrigues 1968
	M	68.60	0.18	-0.52		
Trinidad	F	82.90	0.13	-0.13	otoliths	This study
	M	65.30	0.16	-0.16		

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Appendix 1: Percentage composition of by-catch in type I trawl landings (1987-1991**)**

FAMILY	SPECIES	LOCAL NAME	% CONTRIBUTION OF SPECIES TO TOTAL BY-CATCH LANDED				
			1987	1988	1989	1990	1991
Ariidae		Catfish	30.4	0	0	0	0
Carangidae	*Caranx sp.*	Cavalli	0	7	0	0	0
Carcharhinidae		Shark	0	3.6	0	0	0
Centropomidae	*Centropomus sp.*	Brochet	16	0	0	0	0
Lutjanidae	*Lutjanus sp.*	Redfish	41.8	0	0	0	0
Megalopidae	*Megalops atlanticus*	Tarpon	0	0	0	3	0
Scaienidae	*Cynoscion sp.*	Salmon	0	75.6	56	71	100
Serranidae		Grouper	0	24.1	44	26	0
		Mixfish	11.7	0	0	0	0

Appendix 2: Percentage composition of by-catch in type II trawl landings (1987-1991)

FAMILY	SPECIES	LOCAL NAME	% CONTRIBUTION OF SPECIES TO TOTAL BY-CATCH LANDED				
			1987	1988	1989	1990	1991
Carcharhinidae		Sharks	0	5	0	0	9.0
Carangidae	*Decapterus sp.*	Jacks	0	0	4.9	0	0
Centropomidae	*Centropomus sp.*	Brochet	2	1.3	1.7	0	0.6
Clupeidae	*Harengula jaguana*	Herring	17.2	0	3.1	8.6	0.6
	Opisthonema oglinum	Joshua	4.3	3	0	6	5.0
	Sardinella brasiliensis						
Engraulidae	*Anchoa sp.*	Sardine	0	3.6	2.2	3.2	9.1
Gerreidae	*Diapterus sp.*	Blinch	2.4	6.8	3.2	3.1	0.9
Lutjanidae	*Lutjanus sp.*	Redfish	4.2	4.7	3.3	3.9	3.1
Portunidae		Cirri crabs	15.5	24.7	17.7	19.6	23.1
Sciaenidae	*Cynoscion sp.*	Salmon	4.4	9.4	23.9	7	16.4
	Micropogonias sp.	Cro-cro	5.5	5.6	2.9	10.6	2.8
Sphyraenidae	*Sphyraena gauchancho*	Bechine	0	0	0	1	1.1
MIXED		Mixfish	42.4	34.8	32.6	34.2	27.4

Appendix 3: Percentage composition of by-catch in type III trawl landings (1987-1991)

FAMILY	SPECIES	LOCAL NAME	% CONTRIBUTION OF SPECIES TO TOTAL BY-CATCH LANDED				
			1987	1988	1989	1990	1991
Centropomidae	Centropomus sp.	Brochet	0	0	0	1.7	2.5
Clupeidae	Harengula jaguana Opistonema oglinum	Herring	1.2	2.1	2.8	2.3	1.5
Lutjanidae	Lutjanus sp.	Redfish	1.7	1.7	1.6	3.3	4.2
Portunidae		Cirri crab	5.1	4.1	2.4	3	2.2
Sciaenidae	Cynoscion sp. Micropogonias sp.	Salmon Cro-cro	2.1 12.9	1.3 14	2.5 14.1	1.4 10.6	1.9 8.2
MIXED		Mixfish	76.6	76.3	75.9	76.7	78.5

Appendix 4: Percentage composition of by-catch in type IV trawl landings (1987-1991)

FAMI LY	SPECIES	LOCAL NAME	% CONTRIBUTION OF SPECIES TO TOTAL BY-CATCH LANDED		
			1989	1990	November 1991-April 1992
Carangidae	Decapterus sp.	Jacks	4.3	0.5	0
Carcharhinidae		Shark	1.1	0	1.6
Gerreidae	Diapterus rhombeus	Blinch	0	0	3
Lutjanidae	Lutjanus sp.	Redfish	3.7	1.5	6.3
Sciaenidae	Cynoscion sp. Micropogonias sp.	Salmon Cro-cro	14.1 49.1	18 74	36.8 36.4
MIXED		Mixfish	25.8	4.7	13.5

Source: Data obtained from the N.F.C. Limited for 1989-1990, and from logbook returns for the period November 1991-April 1992.

Appendix 5: Catch and effort data collection sheet

Boat registration no.	**Tf-**		**Tf-**		**Tf-**		**Tf-**		**Tf-**		**Tf-**		**Tf-**		**Tf-**	
No. Of crew															**Type of fishing**	**Total boats fished / day**
Time departed															Trolling	
Time returned															Banking	
Type of fishing															Fish pot	
Fishing area															Fillet	
Species	Wt	Price	Wt	Price	Wt	Price	Wt	Price	Wt	Price	Wt	Price	Wt	Price	Trawling	
Carite															Italian seine	
King															Beach seine	
Cavalli															Palanque	
Red															Turtle net	
Herring															Switchering	
Shark															Harpoon	
Shrimp															Tide line	
Salmon															Spear fishing	
Moonshine															Trawling net	
Paqua															Other methods	
Ancho																
Jacks																
Bonito																
Mullet																
Cro-cro																
Jashua																

BEACH:……
DATE:……

RETURN OF FISH LANDED
Fisheries – B1

Appendix 6: Availability of landings/effort data (number of months) from trawling beaches for the period 1980-1996

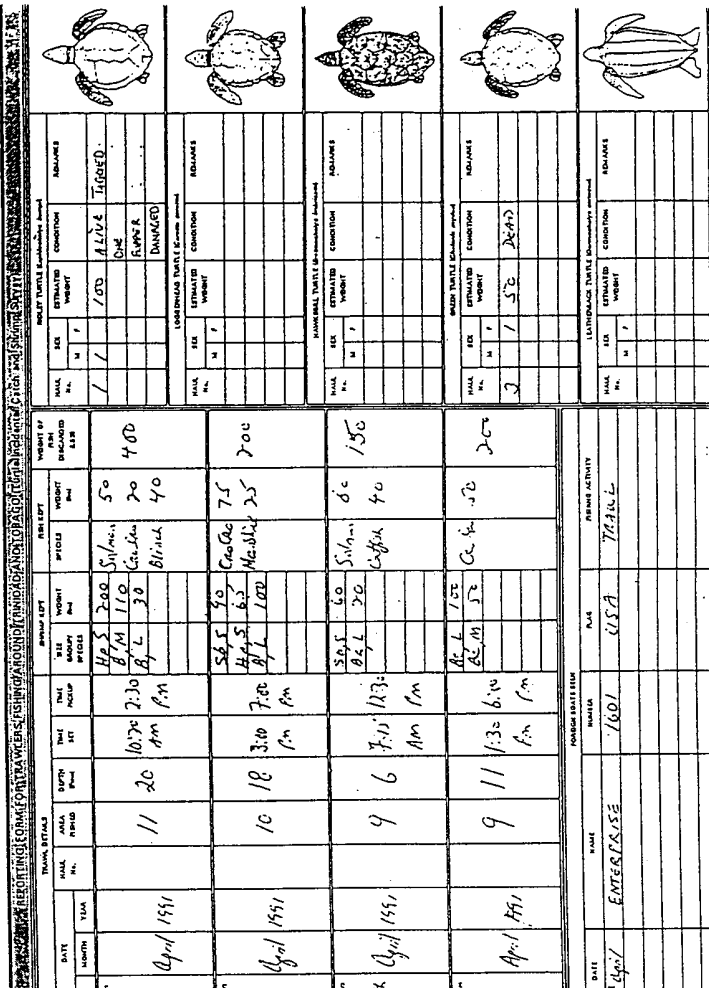
Year	Port of Spain	Orange Grove	San Fernando	Otaheite	Bonasse *	Fullerton*	Icacos*
1996	no trawling	10	0	12	11 no Oct	12	11 no Dec
1995	no trawling	11	0	12	6 Jun-Jul	2 Nov-Dec	12
1994	no trawling	12	0	10	10 no Jul, Aug	4 Jan-Apr	11 no Oct
1993	no trawling	11	0	12	12	12	12
1992	no trawling	11	10	12	12	11 no Dec	10 no Sep, Oct
1991	no trawling	11	12	12	12	12	12
1990	no trawling	12	11	12	12	12	11 no Sep
1989	11 + Jan estimate T: Jan	12	12	12	12	11 no Oct	12
1988	no trawling	12	12	12	12	12	12
1987	no trawling	12	11	11	11 no Jul	12	12
1986	12 T: Jan, Aug	12	12	12	12	12	11 no Feb
1985	12 T: Mar, Apr, May, Jun, Jul, Aug, Sep, Dec	12	12	12	12	12	10 no Feb, May
1984	no trawling	12	12	9	12	12	12
1983	no trawling	12	10	11	12	12	12
1982	11 no Aug T: Jan, May, Dec	0	10	0	0	0	0
1981	10 no Sep, Oct T: Jan-Aug	12	11	0	12	12	0
1980	12 T: Jan-Dec	12	12	0	12	12	0

* Trawling season from Dec-Jun, T=Months during which trawling data was recorded

Appendix 7: Shrimp and groundfish categories recorded at enumerated landing sites

Beach	Species name	Beach	Species name
Bonasse	Grouper	Orange valley	Tarpon (grant-te-cye)
Bonasse	Sea catfish	Orange valley	Weakfish (salmon)
Bonasse	Serra mackerel (carite)	Orange valley	Whitemouth croaker (cro-cro)
Bonasse	Shark	Otaheite	Bachin
Bonasse	Shrimp (large)	Otaheite	Barracuda
Bonasse	Shrimp (medium)	Otaheite	Bonito
Bonasse	Shrimp (small)	Otaheite	Crevalle jack (cavalli)
Bonasse	Snapper (red)	Otaheite	Grump
Bonasse	Snook	Otaheite	King weakfish (german salmon)
Bonasse	Weakfish (salmon)	Otaheite	Kingfish
Bonasse	Whitemouth croaker (cro-cro)	Otaheite	Misc (whitefish)
Fullerton	Grouper	Otaheite	Shrimp (large)
Fullerton	Sea catfish	Otaheite	Shrimp (medium)
Fullerton	Shrimp	Otaheite	Shrimp (small)
Fullerton	Shrimp (large)	Otaheite	Snapper (red)
Fullerton	Shrimp (medium)	Otaheite	Snapper (small red)
Fullerton	Shrimp (small)	Otaheite	Tarpon (grant-te-cye)
Fullerton	Shrimp, honey	Otaheite	Weakfish (salmon)
Fullerton	Shrimp, red (medium)	Otaheite	Whitemouth croaker (cro-cro)
Fullerton	Shrimp, white (large)	San Fernando	Ancho
Fullerton	Shrimp, white (medium)	San Fernando	Anchovy (sardine)
Fullerton	Shrimp, white (small)	San Fernando	Atlantic bumper (plato)
Fullerton	Weakfish (salmon)	San Fernando	Atlantic cutlassfish
Icacos	Grouper	San Fernando	Atlantic spadefish (paqua)
Icacos	Mullet	San Fernando	Bachin
Icacos	Sea catfish	San Fernando	Blinch
Icacos	Shrimp (large)	San Fernando	Bonefish (banaan)
Icacos	Shrimp (medium)	San Fernando	Bonito
Icacos	Shrimp (small)	San Fernando	Crevalle jack (cavalli)
Icacos	Shrimp, honey	San Fernando	Grouper
Icacos	Shrimp, white (large)	San Fernando	Herring
Icacos	Shrimp, white (small)	San Fernando	Jashua
Icacos	Snook	San Fernando	Kingfish
Icacos	Tarpon (grant-te-cye)	San Fernando	Misc (whitefish)
Icacos	Weakfish (salmon)	San Fernando	Moonfish (silverfish)
Orange valley	Ancho	San Fernando	Mullet
Orange valley	Atlantic spadefish (paqua)	San Fernando	Sea catfish
Orange valley	Choice fish	San Fernando	Sea/swimming crab
Orange valley	Crevalle jack (cavalli)	San Fernando	Serra mackerel (carite)
Orange valley	Grouper	San Fernando	Shark
Orange valley	Herring	San Fernando	Shrimp (large)
Orange valley	Jacks	San Fernando	Shrimp (medium)
Orange valley	Misc (whitefish)	San Fernando	Shrimp (small)
Orange valley	Moonfish (silverfish)	San Fernando	Snapper (red)
Orange valley	Mullet	San Fernando	Snapper (small red)
Orange valley	Plato	San Fernando	Snook
Orange valley	Pompano (zelwon)	San Fernando	Tarpon (grant-te-cye)
Orange valley	Sea/swimming crab	San Fernando	Weakfish (salmon)
Orange valley	Serra mackerel (carite)	San Fernando	Whitemouth croaker (cro-cro)
Orange valley	Shark		
Orange valley	Shrimp (large)		
Orange valley	Shrimp (medium)		
Orange valley	Shrimp (small)		
Orange valley	Snapper (red)		
Orange valley	Snook		

Appendix 8: Trawler Logbook form



form.

Appendix 9: Number of shrimp length frequency samples for the artisanal (type II) and semi-industrial (type III) trawl fleets operating in the Gulf of Paria over the period 1992-1996.

MONTH	ARTISANAL (Type II)																												SEMI-INDUSTRIAL (TYPE III)														
	Southern Gulf of Paria (Area 10)															Northern Gulf of Paria (Area 11)															Gulf of Paria (Areas 10 & 11)														
	1992			1993			1994			1995			1996			1992			1993			1994			1995			1996			1992			1993			1994			1995			1996		
	U	S	T	U	S	T	U	S	T	U	S	T	U	S	T	U	S	T	U	S	T	U	S	T	U	S	T	U	S	T	U	S	T	U	S	T	U	S	T	U	S	T	U	S	T
J				2	8	10					2	2	1	3	4	1		1	3	2	5							1		1				3		3				2		2	2		4
F					3	3	1	6	7							1		1	1		1	2	1	3							2		2	4		4	5	2	7						
M				1	4	5		8	8				1	1	2					4	4	2	1	3					1	1				2	2	4	8	1	9				2		2
A				1	4	5		5	5				1	3	4				3	1	4	4		4							1		1	1		1	7		7						
M	1	2	3	1	6	7		8	8				2	8	10	1	5	6	3		3	1	2	3		1	1				8		8	3	3	6	5		5				4	1	5
J		3	3				3	7	10				4	4	8		2	2				1		1	1		1	3		3	2		2				2	1	3				4		4
J	1	2	3	1	1	2		6	6				8	8	16	1	3	4							1		1	8		8	4	1	5	2	1	3	2		2	1	1	2	8		8
A		2	2	1	4	5	2	4	6		2	2	7	9	16		1	1							1		1	8		8		1	1	5	2	7	6		6	1		1	5	1	6
S		3	3		1	1	1	3	4		2	2	7	9	16		4	4		2	2				2		2	4		4		1	1	1	2	3	3		3	7	1	8	4		4
O	2	4	6		3	3		2	2	2	5	7	6	6	12		7	7		1	1	1		1	2		2	6		6	2	1	3	1	1	2				6		6	6		6
N	2	7	9	1	2	3		4	4		9	9	8	8	16	1	4	5				2		2		2	2	8		8	2	3	5	2	1	3	2		2	1		1	8		8
D	2	4	6								5	5	4	4	8	1	5	6							2		2	6		6	5		5							1	2	3	6		6
TOTAL	8	27	35	8	36	44	7	53	60	2	25	27	49	63	112	6	31	37	10	10	20	13	4	17	9	3	12	44	1	45	26	7	33	24	12	36	40	4	44	19	4	23	49	2	51

(U=samples from UNSORTED catches, S=samples from SORTED catches, T=TOTAL samples)