

Trinidad and Tobago: Preliminary Reconstruction of Fisheries Catches and Fishing Effort, 1908-2002

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ABSTRACT

This paper describes the methodology used for the reconstruction of time series data on fisheries catches and fishing effort in Trinidad and Tobago from 1908 to 2002. The work described here is ongoing and preliminary in nature. Data are reconstructed separately for both islands and are fleet specific. Sources of information and data are listed and preliminary results provided. Major limitations to the reconstruction exercise are also discussed.

INTRODUCTION

Trinidad and Tobago are located at the southern end of the eastern Caribbean island chain (Figure 1) on the continental shelf off Northeast South America, some 8 miles east of Venezuela. The islands lie downstream of the outflow of 17 South American rivers, including the Amazon and Orinoco, and at the confluence of major ocean currents such as the North Equatorial current (Fabres, 1983). This has influenced species diversity and marine habitat types, which range from coral reefs to muddy bottom, brackish water. Not only has this contributed to the high productivity of surrounding waters, particularly around Trinidad, but it has also limited the extent of coral reefs, which are more abundant off Tobago.

Fishery development in Trinidad Pre 1950s

There is little documentation on fisheries in Trinidad and Tobago prior to the 1940s. In fact, fisheries attracted little attention following the establishment of the

Department of Agriculture in 1908, within which fisheries administration was imbedded (Anon., 1929). From Vincent's (1910) account of fisheries on the north-western coast of Trinidad, sport fishing seemed more popular than commercial fishing at the time. Commercial fishing was mainly of a subsistence nature. One central market existed in Port of Spain. Despite the high retail price of fish, the fishers were disadvantaged by the low prices they received from the 'middle-men', which may have acted as disincentive to fisheries development. Despite the apparent abundant resources around Trinidad (Vincent, 1910), development of the fishing industry was further hindered by lack of capital and inappropriate technology. As a result, Trinidad was dependent on imported processed fish, mainly from Canada and Venezuela (Vincent, 1910).

By the early 1940s imports had increased to 650,000 UK£. Compared to other colonies in the British West Indies, Trinidad and Tobago suffered the most severe depletion of market availability of fresh fish at the onset of the Second World War (Brown, 1942), due to gear shortage, transportation problems and lack of infrastructure. Moreover, the situation was exacerbated by the transfer of labor from the fishing industry to the more lucrative military bases in Trinidad, and the exclusion and closure of fishing areas in military training areas. The control of local fish prices also acted as a disincentive to development (Brown, 1942).



Figure 1: Map of Trinidad and Tobago, showing 200 nm EEZ, as well as its nearest neighbor, Venezuela.

To increase food security following WWII, a development program was implemented. Fleet mechanization was promoted with the introduction of outboard engines (Anon., 1948), larger vessels were constructed, and more fuel-efficient inboard engines introduced (Anon., 1947). Fishing trials were conducted with a variety of gear types, e.g., trammel and shark nets, otter trawl, bottom-longline (palangue), multiple troll lines, long lines, purse seines, and drift- and gillnets (Stockdale, 1945; Anon., 1947; Anon., 1948). Existing fishing gears were considered antiquated (Hunt, 1949), and a subsidization program considered to promote the adoption of more efficient gear (Anon., 1947). The supply of gear was improved, and efforts focused on increasing the industry's awareness of related regulations and promotion of co-operative organizations in the industry (Anon., 1948). The development program also included trials in fish processing, and experimentation with extraction of shark liver oil (Anon., 1946), as well as introduction of nets for the capture of turtles (Anon., 1947). Fish depots were established at Toco, Matelot, Grande Rivière, Sans Souci and Cumana and ice storage promoted through market guarantee. Despite these developments, however, the fishing industry was still largely of a subsistence nature by the late 1940s. Already then, however, there were reports of environmental concerns associated with the high level of discards from the beach seine fishery targeting shrimp, and pollution from the petrochemical and agricultural industries in the Gulf of Paria. The shrimp fishery, particularly off Cedros, had expanded considerably following WWII due to relocation of fishers displaced for the construction of a military base.

1950 - 1980

During the 1950s, development efforts initiated earlier continued. Subsidization of the industry increased, with the introduction of a fuel tax rebate system in 1956 facilitated under the Fishing Industry Assistance Regulations of 1952, and a loan scheme in 1957 to promote the entry of more boats in the fishery (Director of Agriculture, 1958). Improved infrastructure at the Port of Spain fish market and fishing facilities at Carenage, Toco and Blanchisseuse occurred throughout 1956. The use of small outboard motors with lower operation costs was promoted (Anon., 1958). A 1957 survey identified the lack of adequate harbor facilities as a major

constraint (Anon., 1958). The adoption of arrow-head fish-pots (early 1950s), and trawl nets (1954) were the major gear introductions in the 1950s, and an 18 m motor launch acted as a mother-ship for five artisanal trawlers operating in the Gulf of Paria (Anon., 1958).

Due to the development of the fishery off the south coast increased catches of fish were realized. This accounted for about 28% of total landings by the 1960s (Kenny and Lagois, 1961; Vidaeus, 1970). The fleet still consisted mainly of artisanal pirogues, most of which were mechanized as a result of duty free engine imports. A single, large sized trawler commenced operations in the Gulf of Paria, but contributions to overall landings were negligible. At this time also severe marketing problems acted as a disincentive to development, causing some fishers to limit their catches. Most boats operating off the south-western peninsula switched from targeting fish to shrimp, as they began to exploit the waters in the channel between Trinidad and Venezuela (Vidaeus, 1970). The establishment of a shrimp processing plant at Cedros, which provided a guaranteed shrimp market, and boat servicing facilities, promoted development of the shrimp fishery. Shrimp, being a high priced commodity, also made the switch in target species more profitable. A locally owned company, International Fisheries Ltd, provided landing and processing facilities for some 60 international trawlers, mainly of American origin, which fished along the continental shelf off the north-east coast of South America, as well as three locally owned large trawlers which caught shrimp off the Guianas. Following a temporary termination of the loan scheme for artisanal vessels in 1966, the development of the fleet of large trawlers (over 21 m) was promoted through a similar incentive. By 1972, however, the loan scheme for artisanal vessels, and, to a lesser extent, vessels targeting the deep-sea fishery, was re-instituted (Anon., 1973).

Between 1966 and 1972, fuel rebate subsidies amounted to over 570,000 US\$ (Anon., 1973). Correspondingly, the exemption of purchase tax on boats and engines over the same period was over 1.3 million US\$. By the beginning of the 1970s, fish landings had increased to a level which facilitated, for the first time, the export of more than 455 t of fish to Canada, England and other countries. Local investment in the industry was high, with only 20% of total investment contributed

by government. Fishers received higher prices for their fish, and efforts focused on development of the inshore fishery. Imports were however, still substantial. For example, approximately 80,000 UK£ were spent on imported salted and smoked fish in 1980. During the 1970s, there was considerable fisheries infrastructural development on both islands (Anon., 1973).

1980s - 2000

Trinidad and Tobago faced new challenges in the 1980s, with the pending restrictions on fishing areas for the offshore fleets and added responsibilities for conservation, assessment and management of its marine resources under the United Nations Convention on the Law of the Sea. Following the loss of access of the local fleet of large trawlers (10) to traditional fishing grounds due to declarations of EEZs, access was negotiated for waters of French Guyana, through an arrangement with the European Community. Vessels were, however, limited to the capture of 76 t within a 600 day period (Anon., 1973).

Fishery development in Tobago

Pre 1950s

Very little is documented on the fishing industry in Tobago prior to the 1950s. The main gear utilized during the 1940s were the beach seine for targeting pelagic species off the north-west coast, and the bank line for targeting deep water snappers off the west and south-east coasts (Brown, 1942; Rajkumar and King-Webster, 1957). Turtles were also captured for meat (green turtle: *Chelonia mydas*) and shell export (hawksbill: *Eretmochelys imbricata*).

1950 - 1980

As in Trinidad, new gear was introduced in Tobago during the 1950s. These included gillnets for catching flyingfish in the local 'drifting' fishery, and 'tight lining' (fishing at night with lights) for the capture of large pelagics (Caesar, 1988). Fishpots were introduced earlier, but the bamboo used for construction was replaced by chicken wire (Caesar, 1988). Foreign fleets from Grenada and St Vincent and the Grenadines also operated from the capital city, Scarborough, during the 1950s and 1960s (Caesar, 1988).

During the 1970s the Tobago Fisheries Division, after a period of experimentation, introduced fish aggregating devices to the drifting fishery. These increased catches considerably, and were rapidly adopted by

the fleet. They continue to be used in the drifting fishery. The Tobago Fisheries Division embarked on an awareness campaign in 1973 to increase the local demand for flyingfish, by introducing the processing methodology to the public (Caesar, 1988). The fiber-glass pirogue, introduced in 1977, eventually replaced the wooden boats because of the lower maintenance costs. Following the establishment of the National Fisheries Company Ltd. (NFC) in Trinidad, a Collector Vessel System was implemented towards the end of the 1970s. Industrial vessels from the NFC were stationed off south west Tobago and purchased flyingfish and associated species directly from the fishing boats at sea. This system was successful in increasing catches during 1979 to 1981 (Caesar, 1988). During the late 1970s two other fish processing plants, Pisces Limited and Roy Jacob's Enterprises were set up in Tobago.

1980 to 2002

In the 1980s, through a project funded by the United Nations, demersal longlines were introduced for the capture of sharks and other demersal fish. The existing local longline fishery benefited from the associated change in technology (Caesar, 1988). Other fish processing plants, Tobago Sea Products, Yeates processing and Stewart's processing plants were established in the 1980s. Two other fish processing plants, Terry Swan Ltd and Fresh Fish of Tobago were established in the 1990s. Towards the end of the 1980s, ice-boats were introduced to the flyingfish fishery. The fleet of ice-boats increased to 10 vessels by 2001, and Trinidad and Tobago became a member of the Western Central Atlantic Fisheries Commission *Ad-Hoc* working group on flyingfish. Trinidad and Tobago was also a participant in a regional project aimed at assessment and management related research on the flyingfish fishery in the eastern Caribbean (Oxenford *et al.*, 1993). The project resulted in an improved data collection system for the fishery in Tobago.

Fisheries statistical data collection

Trinidad

Prior to 1941 almost the entire fish supply to Port of Spain was from the north western peninsula. The focus of fisheries statistical data collection programs reflects Government's main objectives at the time. Accounts of fisheries landing statistics prior to the 1940s were limited to reports of

individual stakeholders (Vincent, 1910). Subsequent to this, Colonial Fisheries Advisors (Stockdale, 1945; Luke, 1957) reported on development and welfare in the region. Formal collection of fisheries statistics commenced in 1945 (Anon., 1946), some ten years before the establishment of the Fisheries Department (Fiedler *et al.*, 1957). At this time fishing was mainly a subsistence activity, with data collection aimed at assessing self sufficiency in food production, and fish import requirements of what was then a British colony. Documentation of fish landings and distribution from the major wholesale fish market was introduced in 1954 (Kenny, 1955), as the first step in development of an island-wide statistical data collection system. The quantities, species of fish landed, landing site as well as fish prices were recorded (Kenny and Lagois, 1961). By 1958, fisheries statistics were collected at 16 of the 53 landing sites and major markets (Anon. 1958). Additional details pertaining to the fishing trip were also recorded (Anon. 1958). This system, established in the 1950s and modified in the early 1960s, remained unchanged until the early 1990s.

In the early 1990s, analytical procedures of the existing system were refined under an FAO/UNDP Project entitled 'Establishment of Data Collection Systems and Assessment of Marine Fisheries Resources' (McClure, 1991). The program focused on species of major importance nationally and regionally. A standardized procedure for estimation of total landings was conceptualized and enhanced by the zonation of landing sites, based on similarities in fishery types and fishing practices. In the mid-1990s, under the CARICOM Fisheries Resource Assessment and Management Program (CFRAMP), an enhanced supervisory mechanism for field data collectors contributed to improved precision in reporting. To date, the statistical data collection system targets the artisanal fishery operating in areas within 15 miles from shore. Recent improvements have focused on refinement of estimates of shrimp landings by the trawl fleets.

Tobago

No accounts of the collection of fisheries statistics is documented prior to the early 1960s. The Tobago Fishing Co-operative Society, established at Charlotteville in 1959 (Kishore, 1990), kept records of the quantities and species of fish purchased from fishers in the area. Since market availability and

competitive pricing affected the selection of species and associated quantities sold to the co-operative, these records reflect, at best, underestimates of the actual quantities caught or landed, and provide an inaccurate estimation of the actual species composition in the catch.

During the 1960s, statistics were recorded daily at four beaches (Vidaeus, 1970) located at Plymouth, Castara, Speyside and Man-of-War Bay. This included information on trip duration, fishing methods or gear used, and landings and prices by major species groups for individual boats. The total number of boats fishing each day was also recorded. To promote fisheries development, and in particular the flyingfish component, the Government instituted a Collector Vessel System (see above) between 1979 and 1982 (Fabres, 1986). Since this provided a guaranteed market for the respective species, recorded transactions detailing the quantities by species purchased are thought a reliable representation of actual catches between 1979 and 1982. By the early 1980s data were collected at five landing sites (Jordan, 1986). However, there were some ten additional landing sites (Jordan, 1986) at which landings were not recorded, and no attempts were made to estimate total overall landings from recorded data.

Under the Eastern Caribbean Flyingfish Project, a data collection system targeting the flyingfish and associated pelagic fishery was implemented at Buccoo Point, Pigeon Point and Mt Irvine. Thereafter, and until the implementation of the CARICOM Fisheries Resource Assessment and Management Program (CFRAMP) in 1995, data collection focused on this fishery. In 1993, the system was expanded to include two additional landing sites, but reverted to the original three sites by the following year (Mohammed, 1998). Under CFRAMP, the data collection system was expanded to include large pelagic and reef species caught by trolling, fishpots and handlines (Alexander, 1998). Due to staff shortages, random stratified data collection was implemented. This resulted in four and eight days of data at each landing site per month. Data on the quantities and associated species of fish sold at the Scarborough fish market were recorded. Additionally, some data exists on fish purchases by the major processing plants. However, the completeness or accuracy of the information cannot be verified at this time.

Fisheries management and policy

The Fisheries Act of 1916 is the legislative basis for management. The authority of the Act extended three miles from the coast, and responsibility was held by the Governor in Council. A 1966 amendment, following Trinidad and Tobago's independence from Britain, included the management of turtles and corals, and conferred authority to the Minister in charge. A further amendment in 1975 specified new offences, increasing penalties and extended jurisdiction of the act to 12 miles from the coast. Jurisdiction was later extended to 200 nautical miles from the archipelagic baselines under the 1986 Archipelagic and Exclusive Economic Zone Act. This act also sought to regulate foreign fishing through specifications of an 'allowable catch', and introduction of a licensing system for associated vessels. From a conservation perspective, the Marine Areas Preservation and Enhancement Act of 1970 is also relevant, although its implementation has so far been limited to the reef areas off Tobago. Management of local fisheries has been limited to the trawl and gillnet fisheries, through regulations under the 1916 Act. Regulations pertain to areas of operation and gear specifications for different trawler types, as well as the exclusion of turtles caught incidentally (Conservation of Marine Turtle Regulations of 1994). To date, the exploitation of fisheries has followed an open access policy. A review of the existing marine fisheries policy in 1998 sought to update fisheries laws and legislation in keeping with international measures to assess, manage and conserve fisheries resources. The transition from open access to limited entry is to be undertaken through a licensing system.

Objective

The objective of this study was to assemble a time series of catch and effort data for Trinidad and Tobago from 1908 to 2002. However, the present study is still in progress, and the current report is thus preliminary in nature.

METHODOLOGY

Catches

Differences in the major species harvested, the development and implementation of statistical data collection programs, and the availability of time series data between Trinidad and Tobago, required that the reconstruction of catch and effort statistics be

conducted separately for both islands. The complexity of the fisheries (multi-species and multi-gear) contributed to aggregation of species in reported landings. Also, the tendency to report fish species by local names has resulted in uncertainties in species identification over the time period covered. Often only the most important commercial species were identified to the species level. Ramjohn (1999) was consulted for identification of species reported by local names. However, to address the problem over the entire time series of reconstructed data, it was necessary to confine reporting to the family level. Due to the variety of fleet types exploiting the resources (Figure 2), and the differences in the data collection programs reflecting the differences in fleet operations, the reconstruction was conducted separately for the respective fleets.

Trinidad

Artisanal multi-gear fleet

Prior to 1962, landings data are available for specific years at major markets from the following sources: 1908 (Vincent, 1910), 1933 (Anon., 1935), 1942 (Brown, 1942), 1945 (Stockdale, 1945), 1946 (Anon., 1946), 1954 (Kenny, 1955), and 1955 to 1960 (Kenny and Lagois, 1961). Based on estimates of the proportion of total landings sold at the major markets, estimates of total landings island-wide were derived from market records. These estimates were considered anchor points, around which estimates for missing years were interpolated. Information on species composition was limited to 1954 and 1957, with up to nine species groups being reported. The species composition prior to 1954 was based on inferences from details on the relative commercial importance in the available documents. The Fisheries Statistical Data Collection System contains landings data for Trinidad from 1962 to the present.

Data prior to 1995 are available in hard copy form only. Recorded data from 1995 to 2002 were adjusted based on the methodology in McClure (1991) to represent total landings. The methodology is based on a zoning system which groups landing sites according to similarities in fleet activity. It uses information on fleet distribution and target species by gear, derived from periodic boat censuses, to estimate landings at sites not incorporated in the data collection system. The species composition of estimated data is based on that of recorded data for similar gear types within the respective zone.

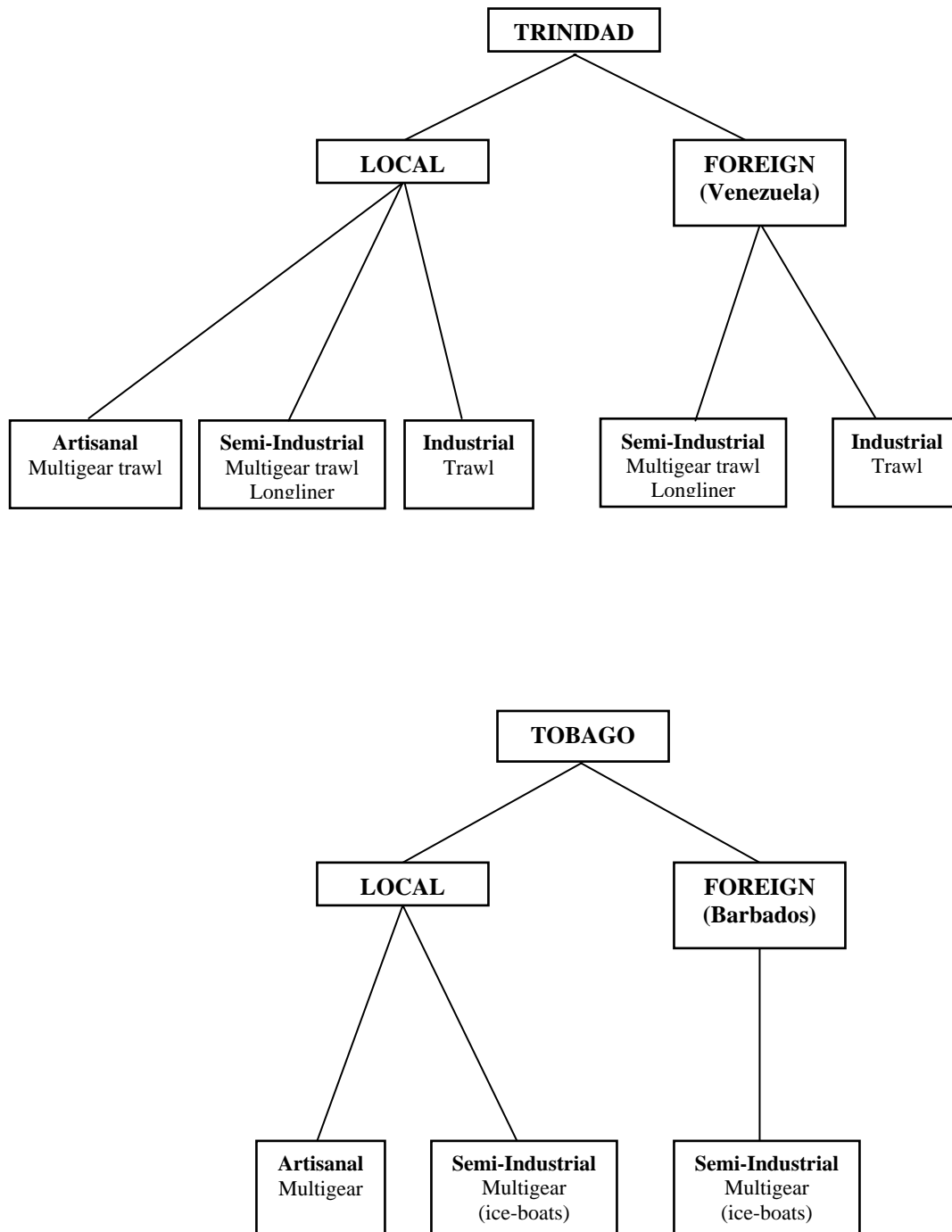


Figure 2: Fleet types operating in the EEZ of Trinidad and Tobago.

As a preliminary exercise, the estimation procedure described above is being applied on recorded data for 1963, 1975, 1985 and 1993, to facilitate estimation of total catches, disaggregated by the species components for the respective years. The selected years will serve as anchor points, around which data for missing years will be estimated by interpolation. Such data will be disaggregated into the respective species components, based on interpolation of the relative species contributions to overall total catch for the years selected as anchor points.

Artisanal trawlers

The otter trawl was introduced in 1953. Over the period examined, artisanal trawlers operated both in the Gulf of Paria off Trinidad's south coast and in the waters off the northeast coast of Venezuela. The target species comprised shrimp, and the by-catch consisted mainly of groundfish species. The traditional fishery in Venezuelan waters, conducted mainly by vessels from the south-western peninsula was legitimized in 1972, and a formal agreement between Trinidad and Tobago and Venezuela signed in 1977 (Kuruvilla *et al.*, 2000). Initially, 60 artisanal vessels were allowed to fish in Venezuelan waters, but by 1990 this was increased to 70. A reciprocal arrangement allowed Venezuelan vessels to fish off the north and east coasts of Trinidad. A new agreement, based on co-operation in exploitation and management of the area south of Trinidad, was negotiated in 1997. This excluded fishing by artisanal trawlers from Trinidad in the area allowed under the previous agreement. Data collection of the associated trawl fleet is incorporated under the national data collection system for the artisanal fleet (which includes also the multi-gear fleet). Total landings are estimated in a similar manner as for the artisanal multi-gear fleet, however, recorded data do not include the associated discarded by-catch. Here, these data are reported separately by fishing area, as the associated catches during the period of the agreement with Venezuela do not represent catches within the EEZ of Trinidad and Tobago. The by-catch (landed and discarded combined) associated with shrimp catches in the EEZ of Trinidad and Tobago will be estimated. The landed component of the by-catch, incorporated in the statistical database, was therefore excluded from this analysis.

Semi-industrial trawlers

Although there is no data collection system targeting this fleet, since landings occur at one major site also utilized by the artisanal fleet, data are incorporated in the national data collection system for the artisanal fleet. The fleet was gradually introduced from the early 1980s, and data are available on the shrimp and landed component of the by-catch since 1987. Shrimp catch estimates from 1987 to 1991 were available from Maharaj *et al.* (1993). Estimated catches for 1993 to 2001 were available from L. Ferreira and S. Soomai (pers. comm.). The landed component of the by-catch, comprising mainly juvenile fish, is incorporated in statistics for the artisanal multi-gear fleet in the associated database. The discarded component is not recorded in the on-going statistical data collection program.

Industrial trawlers

In 1969, an industrial fleet comprising some 33 vessels existed. Nine locally owned vessels exploited the shrimp resources in the Gulf of Paria, while an additional 24 vessels, owned by NFC, exploited the fishing grounds off the Brazil-Guyana shelf. These vessels landed their catch in Trinidad for processing and exporting (Kuruvilla *et al.*, 2000). Amos (1990) indicated 56 and 63 vessels flagged by Trinidad and Tobago, operating on the Brazil-Guyana shelf in 1975 and 1976, respectively. Between 1977 and 1985, however, the uncertainty in securing access to these fishing grounds affected operations of the respective fleets. Amos (1990) reported no vessels operating in the area as of 1977, and by 1985, the NFC had sold its fleet. Some of the vessels were purchased by nationals of Trinidad and Tobago, and operated locally (Gulf of Paria and north coast of Trinidad), and by 1985, 25 industrial trawlers operated in the waters off Trinidad and Tobago. At the Fisheries Division there are no records of the catches of this fleet prior to 1998. Attempts at implementation of a logbook system for data collection in 1991 were unsuccessful. Maharaj *et al.* (1993) estimated a total shrimp catch of 1000 t and associated by-catch of 300 t. Data on shrimp and the landed component of the by-catch have been collected since 1998 under a similar arrangement as for the semi-industrial trawl fleet. Estimation of total landings, available for 1998 to 2001, is based on the estimation procedure outlined for the artisanal multi-gear fleet. Catches between 1991 and 1998 were estimated by interpolation between the respective

estimates. The average annual catch per vessel in 1991 was assumed the same for the period 1987 to 1991. The associated annual estimated catch was taken as the product of the average annual catch per vessel and the number of vessels. The numbers of industrial trawlers in 1987 and 1995 were 25 and 21, respectively, and estimates for years with missing data were derived by interpolation. Although the shrimp to by-catch ratio is comparably less than for the artisanal and semi-industrial fleets, there is nevertheless some discarding which is not accounted for in the data collected.

Semi-industrial multi-gear fleet

Currently there is no data collection system targeting this fleet. The associated vessels were introduced to the fishery in 1986. Based on the number of vessels operating each year, the average number of trips per boats each year, and the fish hold capacity (1.5 t), estimates of maximum annual total catch were derived. The number of vessels was taken from vessel registration records, and the number of active vessels and average number of trips derived from interviews with vessel owners and key informants. This fleet is comprised of vessels targeting pelagic resources using pelagic handlines, and others targeting demersal resources using handlines and fishpots. The species composition of catches from the respective components of this fleet was assumed the same as for artisanal vessels which utilize similar gear, and fish in the same area as the multi-gear fleet.

Semi-industrial longliners

A data collection system, based on reporting of trip details (catch by species, effort, area of fishing) by vessel-captains or owners, was implemented in 2001. However, these vessels were present in the fishery since late 1986. Estimates of landings from 1987 to 1992 were taken from Chan A Shing (1993). The information is based on data obtained from the state-owned National Fisheries Company (NFC), a major trans-shipment port set up in 1972 and operating under Taiwanese management. Both local and foreign vessels land at this port. Data provided in this report pertain to locally flagged vessels which operated within the Exclusive Economic Zone of Trinidad and Tobago and on the high seas. Data were adjusted for the respective species, based on Conversion Factors from the International Commission for the Conservation of Atlantic Tunas (ICCAT) listed

in Table 1 (Kebe, 2001). Catches pertain to locally owned and locally flagged, as well as locally owned and foreign flagged vessels. Catches from 2001 were taken from a trip reporting system implemented for the fleet in 2001. In all instances, data were recorded according to the respective species landed.

Table 1: Conversion factors for adjusting dressed weight to whole weight, according to ICCAT.

Species	Conversion Factor
Yellowfin tuna	1.13
Bigeye tuna	1.13
Billfish	1.20
Swordfish	1.33
Sailfish	1.20
Blue marlin	1.20
Wahoo	1.20
White marlin	1.30
Mixed Fish	1.13
Albacore	1.13

Tobago

Artisanal multi-gear fleet

Limited data are available for this fleet, and point estimates of total catches were derived using information from the following documents: 1957 (King-Webster, 1957; King-Webster and Rajkumar, 1958); 1962 to 1968 (Vidaeus, 1970; Horsford, 1975); 1972 to 1976 (Horsford, 1975; Ramsaroop, 1978). Catches for years with missing data were estimated by interpolation between anchor points. Estimates of total catches for the main fishery targeting flyingfish and associated large pelagic species were taken from Pandohee (1993, 1994) and Mohammed (1996, 1998) for the period 1988 to 1997. Total catches from troll lines, fish pots, bank lines and beach seines were estimated for 1988 to 1998 based on recorded catches, and effort statistics were derived from data on the number of boats at respective landing sites (Potts *et al.*, 1988).

Barbados semi-industrial ice-boat fleet

Traditionally, boats from Barbados have fished in the EEZ of Trinidad and Tobago primarily for flyingfish and associated large pelagics. Their catches are not captured in the data collection system in Tobago. A bilateral fishing agreement signed in 1991, allowed simultaneous fishing of up to 13 Barbadian vessels at any given time over a four month period from January 01, to April 30, 1991. However, since the expiration of the agreement, the Barbados fleet has continued to fish in the waters of Trinidad and Tobago. Based on the mean catch rate of 415 kg/day

from a single logbook return during the period of the agreement, the number of vessels which applied for licenses under the agreement, and the allowed fishing period, a crude estimate of 70 t was derived for 1991.

Estimation of by-catch in the local shrimp-trawl fishery

Annual by-catch for the respective fleets of the trawl fishery was estimated based on the ratio of by-catch to shrimp. For the artisanal fleet (Types I and II), Maharaj (1993) estimated a ratio of by-catch to shrimp of 14.7:1 for 1987, and Kuruvilla *et al.* (2000) estimated a ratio of 12.2:1 for 1999. For the semi-industrial fleet (Type III trawlers), Amos (1990) estimated a 1990 by-catch to shrimp ratio of 12.1:1 for the entire Gulf area, while Kuruvilla *et al.* (2000) estimated a ratio of 9.10 for 1999. The annual ratio of by-catch to shrimp for artisanal trawlers (1988 to 1998), and for semi-industrial trawlers (1991 to 1998) was estimated by interpolation between available estimates from the above sources. Estimates of total by-catch were derived as the product of the by-catch to shrimp ratio and the associated total catch of shrimp for the respective fleets.

Maharaj (1993) and S. Soomai (pers. comm.) provided details on the quantity of by-catch by weight for the artisanal fleet from which the corresponding species composition was derived for 1987 and 1999, respectively. Similarly, the species composition of by-catch in the semi-industrial fleet was derived using information from Amos (1990) and Soomai (unpublished data) for 1990 and 1999, respectively. The complete species composition of by-catch of the artisanal and semi-industrial fleets was estimated by interpolation between available estimates from these sources.

Estimation of catches of flyingfish utilized as bait in Tobago

Starting in 1995, estimates of the quantity of flyingfish utilized as bait were recorded. Based on the relative proportions of flyingfish bait to catches of large pelagic species, estimates of the quantity of flyingfish utilized as bait from 1988 to 1997 were derived.

Estimation of catches of marine turtles

Turtle shells were traditionally exported from Trinidad (Anon., 1973). Estimates of the quantities of turtle meat sold at the major markets were available for 1947 (27.27 t), 1969 (5.34 t), 1970 (3.98 t) and 1971 (6.64 t)

from Anon. (1973). These figures however, represent minimum estimates as turtles were sold at other beaches that have not been included in the data collection program.

Brown (1942) documented the capture of green turtles (*Chelonia mydas*) and hawksbill turtles (*Eretmochelys imbricata*) off Tobago by a few fishers using turtle nets. Catches ranged between 20 to 40 turtles per fisher per month, with the main season being April to September. King-Webster (1957) noted the capture of turtles with spears from three boats. A catch of two turtles per day was expected. Fishers claimed to target turtles only during the legal season (October-May).

Estimation of catches from fishing tournaments

Data from fishing tournaments were available from the Trinidad and Tobago Game Fishing Association. The data covered landed catches of target species, and by-catch species to a lesser extent, from 1991 to 2001 for the following tournaments conducted in Trinidad over the period: Citibank Kingfish Tournament, the Royal Bank Wahoo Tournament, the Scotia Bank Funfish Tournament, the Teacher's Scotch Whiskey Kingfish Tournament and the Winfield Aloeng Tournament. Data were available from 1981 to 2001 for the Carib International Game Fishing Tournament conducted annually in Tobago.

Fishing effort

Trinidad

Point estimates of the number of boats by type were derived from the following sources: 1942 (Brown, 1942), 1946 (Anon., 1948), 1957 (Anon., 1958), 1959 (Kenny, 1960), 1968 (Vidaeus, 1970), 1980, 1991 and 1998 (Fisheries Division Vessel Census, unpublished data). Except for the most recent data from 1991 to 1998, these statistics represent mainly the artisanal multi-gear fleet and possibly also the artisanal trawl fleet. Additional information was taken from Maharaj (1993) for the trawl fleet, and from coast guard sightings and unpublished notes of briefings for fishing negotiations for the foreign fleet from Venezuela. The number of multi-gear vessels operating in the respective years was derived from interviews with key industry representatives, and the number of semi-industrial longliners was taken from Chan A Shing (1993) and the national report submitted to the ICCAT for 2002 (Anon., 2003).

Tobago

All data sources were as stated above, except those for 1988 and 1998, which were taken from Potts *et al.* (1988, 2002). The estimate for 1957 also considered information in King-Webster and Rajkumar (1958).

Assigning fishing days

It was assumed that unmechanized vessels fished 15 days per month from February to July, and did not fish November to January due to rough seas. The associated total number of fishing days was 90. Vessels switching to the demersal fishery from August to October were assumed to fish 15 days per month, excluding one month for vessel maintenance. Mechanized vessels targeting large pelagics were assumed to fish on average 10 days per month between November and January, and on average 20 days per month otherwise (150 days per year). Vessels primarily targeting the offshore pelagic fishery, and shifting to the demersal fishery during the pelagic off-season, were assumed to fish 15 days per month from August to October, excluding one month for vessel maintenance. For vessels that target large pelagics year round, it was assumed that these fish 20 days per month for 11 months per year. The total number of fishing days was 220. It was assumed that sloops fished at least 20 days per month from July to March, with July to December being the best season for red fish (snapper), and November to March being the best season for grouper. All vessels not specified as targeting large pelagics year round were assumed to focus on this fishery from November to July, and to switch to targeting demersal and reef resources from August to October, with one month of no fishing activity. The total number of fishing days devoted to the pelagic fishery was 150 days, and to the demersal fishery was 30 days. Vessels targeting the beach seine or demersal fishery year round were assumed to fish 15 days per month from January to December. Semi-industrial launches or ice-boats which target large pelagics from November to July were assumed to fish 20 days per month. These were assumed to target demersals from August to October, at 20 days per month, excluding one month for vessel maintenance.

RESULTS

Preliminary estimates of total catches for the respective fleets are shown in Figure 3. Currently, data are missing for the artisanal multi-gear fleet prior to 1995, for the trawl fleets prior to 1987, for the semi-industrial multi-gear fleet post 1999, and for Venezuelan trawlers post 1996. Data from the Venezuelan multi-gear fleet operating in the EEZ of Trinidad and Tobago are lacking also, and efforts are focused on obtaining an estimate. However, despite these data gaps, it is evident that the Venezuelan trawlers obtain catches in excess of the local fleets, and that the artisanal fleet accounts for the major proportion of total catches of local vessels.

As of June 2003 catch statistics for Trinidad and Tobago currently in the FAO FISHSTAT database (Figure 4) were disaggregated into 26 species groups. However, statistics for all categories were not available each year. Prior to 1983, catch data were available for less than ten species groups, beginning with four groups in 1950. Between ten and 17 species groups were represented from 1983 to 1995, and from 1996, an increasing number of species groups were reported. A review of the percentage total catch in the aggregate unidentified category ('marine fish nei') indicates a general improvement in the level of dis-aggregation of reported catches from 1950 to the mid 1990s (Figure 4b). However, from the early 1990s onwards the unidentified category accounts for an increasing proportion of overall catch, when both marine fish nei and demersal percomorphs nei are considered. The proportion of total catches reported only as aggregate, unidentified category decreased from 50% to 30% between 1950 and 1994, but increased to 60% by 2001 (Figure 4b).

The available data for the artisanal multi-gear fleet comprised up to 97 species groups between 1995 and 2002. Estimated catches for this fleet increased from 4,186 t in 1995 to 9,165 t in 2002. Estimates for the pre 1995 period are currently being developed. The percentage of catch in the aggregate fish category for this fleet has declined from 6.98% to 2.24% between 1995 and 2002.

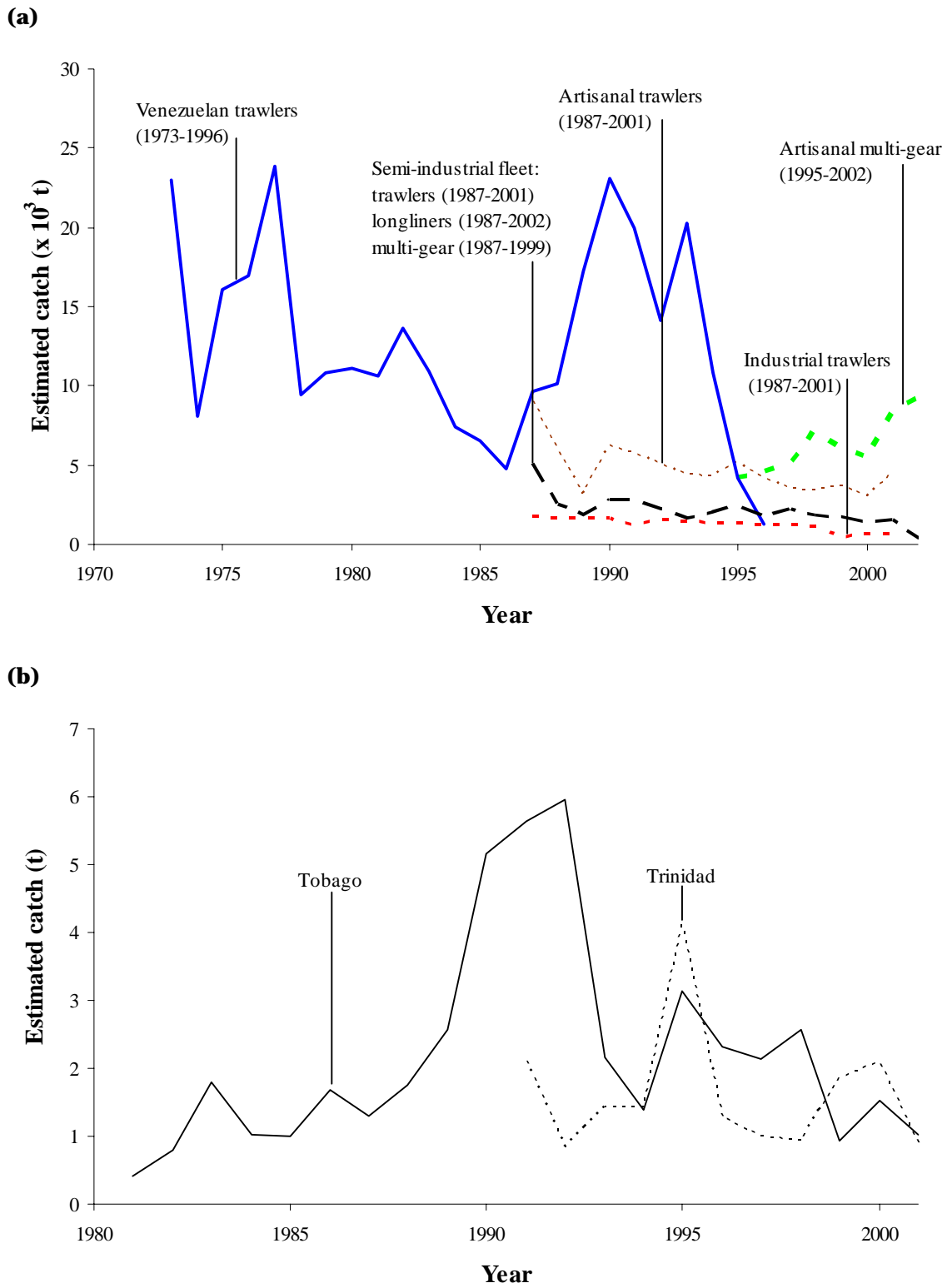


Figure 3: Preliminary estimates of total catch from national sources by gear type (a) and island (b)

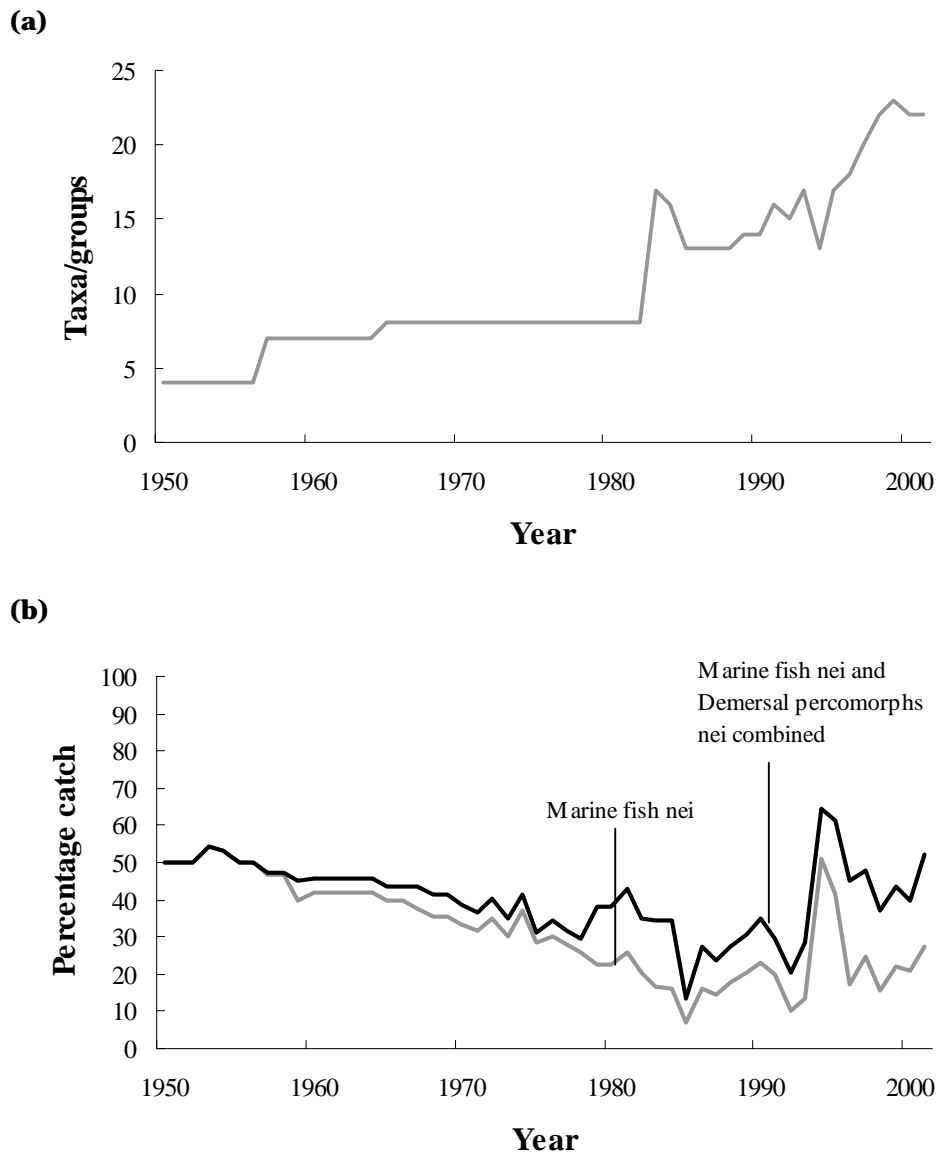


Figure 4: FAO FISHSTAT statistics for Trinidad and Tobago, showing the number of taxa or groups reported by FAO for Trinidad and Tobago (a), and the percentage of catch being reported as aggregate groups (b). The notation 'nei' refers to 'not elsewhere indicated'.

Shrimp catches of the trawl fleets have declined since 1987, from a peak of 2,042 t to the lowest level of 881 t (Figure 5a). This is attributed mainly to declining catches of the industrial fleet. By-catch of the shrimp trawl fleet (Figure 5b) is considerably higher than the targeted shrimp catches, with total by-catch declining from 13,712 t in 1987 to 4,099 t in 2001, with the greatest proportion of the total by-catch taken by the artisanal fleet (ranging from 62% in 1987 to 75% in 1999). The by-catch of the artisanal and semi-industrial trawl fleets comprised 49 and 46 family groups, respectively. The species composition of the by-catch from the industrial fleet has not yet been examined.

Estimated catches from the local semi-industrial longline fleet increased from 0.09 t in 1987 to 351 t in 2002. The main species captured are yellowfin tuna (0.03 t – 222 t) and swordfish (4 t – 180 t). However, several other species are also landed, including bigeye tuna (*Thunnus obesus*), albacore (*T. alalunga*), skipjack tuna (*Katsuwonus pelamis*), dolphinfish (*Coryphaena hippurus*), sailfish (*Istiophorus albicans*), blue marlin (*Makaira nigricans*), white marlin (*Tetrapturus albidus*), Serra Spanish mackerel (*Scomberomorus brasiliensis*), frigate mackerel (*Auxis rochei rochei*), wahoo (*Acanthocybium solandri*) and several species of sharks.

DISCUSSION

Based on the data reconstructed so far, it is difficult to assess the relative importance of catches by local and foreign fleets in the EEZ of Trinidad and Tobago. Particular attention will be placed on the pre-1987 and post 1995 period in the time series. The present assessment has shown that data submitted to the FAO consists of estimates of total catches for the artisanal multi-gear fleet and all trawl fleets in Trinidad. In contrast, catches from the semi-industrial multi-gear and longlining fleets in Trinidad, as well as all fleets in Tobago are not included. Obviously, foreign catches are also not included in reports to FAO, as they are expected to be reported by the flag country of the vessels.

The procedure for adjusting recorded to estimated total catches by fleet, gear and species is continuously being refined. More recent refinements, to eliminate overestimation of catches, pertain to the trawl fleet, and fleets which capture blue marlin

and sailfish off Trinidad's north coast (L. Ferreire, Fisheries Officer, pers. comm.). Such refinements are due to improvements in the data collection system, and consideration of species distributions in assessing the likelihood of specific fleets targeting certain species. Unfortunately, this results in some inconsistency in interpretation of current, compared to historic data, since the refinements are applied to the most recent years only.

Bait species used in trolling are sprats, ballahoo and several species of sardines, locally called sardines rouges, anchois, sardines dorees, cha-cha, small coulihou and sardines cailleux. (Vincent, 1910). Pices of mackerel, bonito and mullet may also be used. Mackerel, among others, are used for the 'ligne dormante', and jelly-fish (genus *Physalia*, local name 'galère') are used at specific times to catch a large carangid locally called 'paoua'.

It appears that discarding was a common practice at all beaches where beach seining was practiced, as fishers were reluctant to spend time freeing small fish entangled in the nets. Specifically at Cedros in the late 1940s, where between 45-100 beach seines operated regularly, the quantity of fish discarded was estimated at between 300 – 3000 tonnes.

The field identification of landed species uses either local names or the FAO common names. This leads to discrepancies in the assignment of scientific names, particularly for the artisanal fleet. This situation is also complicated by the variation in local names given to the same species at different landing sites. Some local names correspond to FAO common names, but refer scientifically to different species. A more accurate representation of the breakdown of catches is therefore provided by family groups.

Mendoza and Lárez (1996) examined catches of the artisanal medium range fishery off northeastern Venezuela, through a series of interviews and landing controls. Results of the study indicated considerable declines in catch per unit effort of three important species between 1981 and 1992. Over this period, catch per unit effort (in weight of catch per handline per fishing day) of the red snapper (*Lutjanus purpureus*) off Trinidad's east coast declined by 40%. Declines in CPUE in excess of 50% were also observed for the

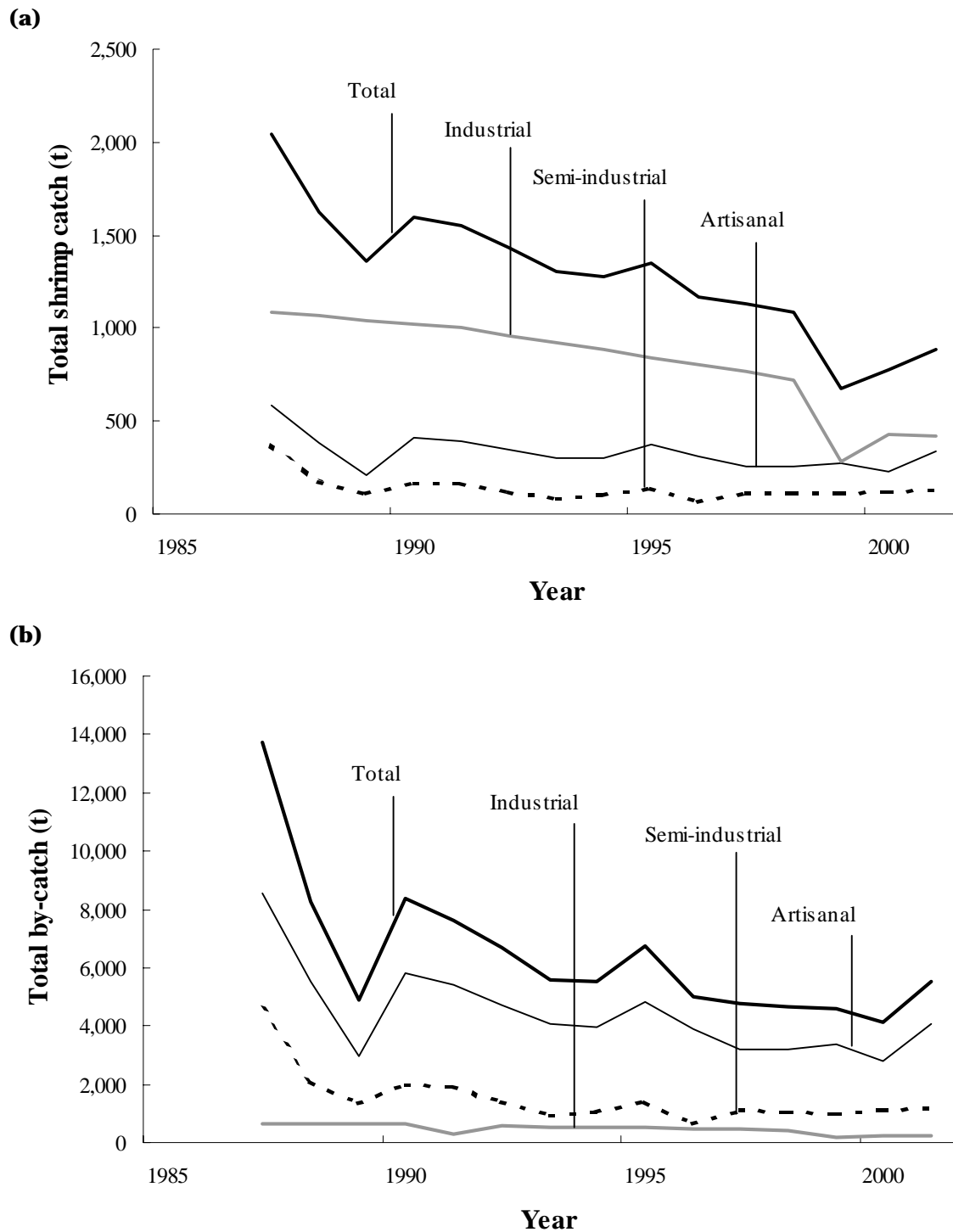


Figure 5: Shrimp catches of the various trawl fleets of Trinidad and Tobago (a), and the associated by-catch (b).

yellowedge grouper (*Epinephelus flavolimbatus*) and vermillion snapper (*Rhomboplites aurorubens*) off the north coast of Trinidad. Confirmation of illegal fishing activity of Venezuelan vessels was obtained from a reliable but confidential source as a regional meeting in 2000. During the period 1997 to 1999, thirty-six Venezuelan boats fished between 120 and 160 miles off the east coast of Trinidad. They targeted the red snapper (*Lutjanus purpureus*) using handlines and landed the catch at night in Port of Spain for subsequent export. The operation was coordinated by a national of Martinique and there are no records of the catch. In 2000, there were also 120 Venezuelan vessels fishing within the 200 nm zone, using live bait fishing to catch carite (*Scomberomorus brasiliensis*) and surface longlines and hook and line to catch dolphin fish (*Coryphaena hippurus*) and billfishes (Istiophoridae). An unknown number of Venezuelan boats targeting billfishes also operate off Trinidad's north coast.

There is some uncertainty regarding interpretation of historic data of catches. Amos (1990) provided estimates of shrimp landings in Trinidad and Tobago from 1962 to 1989. In the absence of a system for estimating total catches from recorded data at the time, it was assumed that the statistics represent recorded data, and therefore are likely an under-estimate of total catches. Prior to 1978, a bilateral agreement between Trinidad/Tobago and Brazil allowed for shrimp fishing in the waters of the Guyana-Brazil shelf by trawlers from Trinidad. Statistics on shrimp catches between 1962 and 1978 may therefore reflect catches taken from both the waters of Trinidad and Tobago, and the Guyana-Brazil Shelf.

By-catch estimated by the present study concurs with Kuruvilla *et al.* (2000), who estimated annual discards of 8,800 t of by-catch. Certainly, it appears that this applies to the late 1980s, early 1990s period, as more recent estimates indicate about 5,500 tonnes as total by-catch (discarded and landed) for 2001. Several assumptions were made with respect to the point estimates of by-catch to shrimp ratio, as well as the species composition of the by-catch for the artisanal and semi-industrial fleets. This involved some measure of duplication, particularly for the landed component of the by-catch. Based on the ratio of by-catch to shrimp, and the ratio of landed by-catch to shrimp for the

respective fleets in Kuruvilla *et al.* (2000), the percentage of total by-catch landed is 10%, 29% and 33% for the artisanal, semi-industrial and industrial fleets, respectively, assuming of course that all shrimp are landed. Presently, data on the landed component of the by-catch is adjusted based on the procedure applied to data on the artisanal multi-gear fleet for estimating total landings. However, the species composition of the landed component of the by-catch is dictated by the size of fish, species composition, fish prices and market demands. Therefore, these data cannot readily be utilized for estimating the species composition of the discarded component of the by-catch. This provides the rationale for utilizing quantities, and species composition, of the entire by-catch sampled, to arrive at total estimates of by-catch for the respective fleets. Limited data are available on the species composition of the by-catch. The 1990 estimate for the semi-industrial fleet is based on a one month study, however, the species composition of the by-catch is known to vary temporally and spatially. This could not be considered in the present study.

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