

## RECONSTRUCTION OF TOTAL MARINE FISHERIES CATCHES FOR NEW CALEDONIA (1950-2007)<sup>1</sup>

Sarah Harper<sup>a</sup>, Lou Frotté<sup>b</sup>, Sarah Bale<sup>a</sup>, Shawn Booth<sup>a</sup>, and Dirk Zeller<sup>a</sup>

<sup>a</sup>*Sea Around Us Project, Fisheries Centre, University of British Columbia  
2202 Main Mall, Vancouver, V6T 1Z4, Canada*

<sup>b</sup>*Ecole Nationale Supérieure Agronomique de Toulouse, Auzeville-Tolosane  
F 31326 Castanet-Tolosan Cedex, France*

*s.harper@fisheries.ubc.ca; lou.frotte@hotmail.fr; s.bale@fisheries.ubc.ca;  
s.booth@fisheries.ubc.ca; d.zeller@fisheries.ubc.ca*

### ABSTRACT

Our reconstruction of total marine fisheries catches by New Caledonia for the 1950-2007 time period included estimates of commercial, subsistence and recreational fisheries. Commercial fisheries catches were obtained from the FAO and from government reports to which we added estimates of catches from the subsistence and recreational sectors. Catches of sea cucumber deemed for export as 'bêche-de-mer' were assessed separately but included in our reconstruction. Subsistence catches were, in part, based on per capita consumption rates and estimated separately for each of the three provinces of New Caledonia. Total reconstructed catches were estimated to be approximately 393,673 t, which is 3.5 times larger than the total catches presented by the FAO on behalf of New Caledonia. Almost half of this total was catches by the subsistence sector. This report illustrates the importance of the non-market economy in the fisheries of New Caledonia and highlights the need for more comprehensive accounting of marine fisheries catches that includes all fisheries sectors.

### INTRODUCTION

New Caledonia is located in the southwestern Pacific around 21°30'S, 165°30'E (Figure 1). The main island, 'La Grande Terre', and three smaller islands, make up approximately 18,000 km<sup>2</sup> of land area (Figure 1), with a total population of approximately 244,000 in 2008. The islands are divided into three provinces including the North Province, South Province and the Loyalty Islands Province (Figure 1). The Exclusive Economic Zone (EEZ) is approximately 1.7 million km<sup>2</sup>, and is host to commercial, subsistence and recreational fishing.

Commercial fisheries are defined here as those consisting of fish marketed locally or exported abroad. Commercial fisheries in New Caledonia target the Carangidae, Scombridae and Serranidae families. Some of these commercial catches are sold at the local markets (Loubens, 1978); however high-valued species such as tuna and dried sea cucumber ('bêche-de-mer') are exported. Commercial fisheries in New Caledonia, including the bêche-de-mer fishery, could be considered artisanal fisheries as the majority are small-scale (Labrosse *et al.*,



**Figure 1.** Map of New Caledonia showing the main island of Grande-Terre and smaller, Loyalty Islands. Inset map showing the Country's EEZ and location within the South Pacific.

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2000a). The exception to this is the offshore tuna fisheries, which operate on a larger scale.

Offshore fisheries for tuna began in the 1960s with exploitation by foreign fleets from Asia (Anon., 1985; Virly, 1996) and starting in the 1980s by a domestic New Caledonian fleet. Since the establishment of their EEZ in 1979, access agreements have allowed foreign fleets to fish in New Caledonia's waters. Japan was the first to formalize an access agreement with New Caledonia in 1979, followed by Taiwan in 1980 and then the USA and Korea in 1991 (W. Swartz, pers. comm., UBC Fisheries Centre). A small New Caledonian fleet started fishing offshore around 1980 (Virly, 1996).

Subsistence fishing plays an important role in Pacific Island countries, often dominating the coastal fisheries sectors (Bell *et al.*; Labrosse *et al.*, 2006). On average, only about 20% of fishes and invertebrates taken from Pacific Island reef systems enter the market economy (Adams *et al.*, 1996). In New Caledonia, the majority of fishing is small-scale (subsistence and artisanal), and occurs mostly in reef and lagoon waters where a high diversity of fishes, mollusks and crustaceans have sustained thousands of years of exploitation. In these coastal waters, the majority of catches are taken by fishers on foot or in canoes, with spears, hand-lines, nets and a variety of trap types. Here we define subsistence fisheries as those used primarily for home consumption or those which are bartered locally, but never sold on the market or exported.

Recreational fishing in New Caledonia likely started in the mid 1960s at the same time as the artisanal fishery for skipjack started (Anon., 1985). The artisanal fishery uses small Tahitian-style boats targeting skipjack using pole-and-line (Anon., 1985). New Caledonia's recreational fishing fleet has over 11,000 registered vessels and fish using mainly hand-lines and spears (Dalzell *et al.*, 1996).

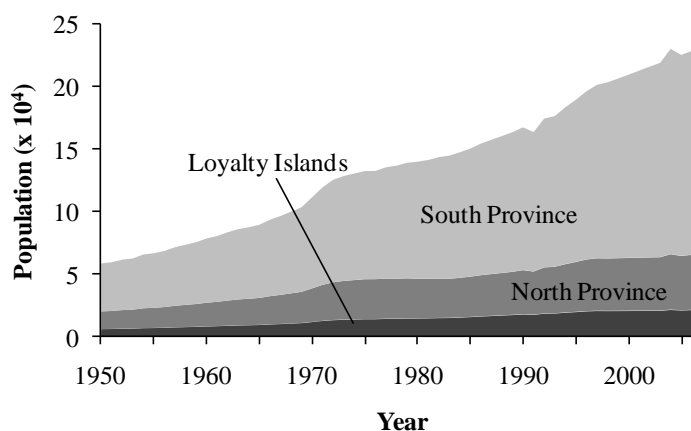
The purpose of this study was to estimate total marine fisheries catches in New Caledonia between 1950 and 2007, accounting for all fisheries sectors. FAO FishStat (Anon., 2009) offers time series data on marine fisheries landings from 1950 to 2007. FAO data have been the basis of many influential fisheries studies (e.g. Pauly *et al.*, 1998), however FAO do not seek to quantify or distinguish between fisheries sub-sectors (i.e., commercial vs. subsistence). Although several studies and reports relating to the fishing industry in New Caledonia have been published (Loubens, 1978; Hallier and Kulbicki, 1985; Palladin *et al.*, 1988; Blanchet, 1991; Dalzell *et al.*, 1996; Leblie, 1999), there have been no comprehensive reviews of all fisheries sub-sectors. Our aim in this report is to estimate total marine fisheries catches by accounting for fisheries sectors other than simply commercial and thereby provide a more comprehensive assessment of fisheries removals by New Caledonia.

## MATERIALS AND METHODS

Fisheries data were obtained from the FAO FishStat database, from Government reports and from independent studies. Anchor points for commercial, subsistence and recreational catches for the 1950-2007 time period were obtained and linear interpolations were made between anchor points to derive a complete time series of catches for each sector. All catches taken by New Caledonian fishers were assumed to have been taken from within New Caledonia's EEZ in FAO Statistical Area 71.

### Human population data

Human population data were used to determine per capita rates for recreational catches and for converting per capita subsistence rates into catch amounts. We obtained census data from an online population statistics database ([www.populstat.info](http://www.populstat.info); Accessed September 2009) for New Caledonia as a whole and for each of the three Provinces of New Caledonia (North Province, South Province and Loyalty Islands Province). In years when census data were not available, a linear interpolation was done to



**Figure 2.** Human population of New Caledonia by province, 1950-2007.

estimate the population for intervening years in order to derive a complete time series of population data from 1950–2007 (Figure 2).

### Commercial Fisheries

FAO data were used as the best estimate of commercial fisheries catches throughout the time period except in years when data from independent sources were available and provided a more comprehensive estimate. FAO catch statistics include sea cucumber catches which are almost entirely exported as bêche-de-mer. In this report we have dealt with the bêche-de-mer fishery separately (see ‘Bêche-de-mer’ section); therefore, sea cucumber catches were excluded here from the commercial fisheries catch estimates but were included in our overall assessment and comparisons.

**Table 1.** Taxonomic breakdown of commercial catches presented by Loubens (1978) for New Caledonia in 1975.

Common name	Taxon name	Proportion of catch (%)
Barracudas	Sphyraenidae	0.3
Blackbarred halfbeak	<i>Hemiramphus far</i>	0.5
Bluespine unicornfish	<i>Naso unicornis</i>	3.9
Bluespot mullet & Bluetail mullet	<i>Valamugil</i> spp.	9.4
Giant clam	<i>Tridacna gigas</i>	0.7
Golden-lined spinefoot	<i>Siganus lineatus</i>	2.9
Groupers	Serranidae	11.0
Indian mackerel	<i>Rastrelliger kanagurta</i>	3.2
Jacks & Trevallies	Carangidae	1.1
Japanese large-eye bream	<i>Gymnocranius euanus</i>	1.7
Leopard coral grouper	<i>Plectropomus leopardus</i>	5.3
Mangrove crab	<i>Goniopsis cruentata</i>	3.2
Misc. cephalopods	Cephalopoda	0.6
Mojarras	Gerreidae	0.4
Narrow-barred spanish mackerel	<i>Scomberomorus commerson</i>	3.2
Emperors	Lethrinidae	0.8
Other fish species	Misc. marine fishes	5.3
Other mollusc & crustacean spp	Misc. marine invertebrates	1.0
Other mullet species	Mugilidae	1.1
Parrotfishes	Scaridae	1.1
Silver grunt	<i>Pomadasys hasta</i>	0.3
Sky emperor	<i>Lethrinus mahsena</i>	5.7
Slender emperor	<i>Lethrinus variegatus</i>	1.7
Snappers	Lutjanidae	5.4
Spangled emperor	<i>Lethrinus nebulosus</i>	24.3
Trumpet emperor	<i>Lethrinus miniatus</i>	3.9
Wrasses	Labridae	1.0
Yellowfin tuna	<i>Thunnus albacares</i>	0.7

Commercial catch data for the 1976–1986 period were obtained from a report by Palladin *et al.* (1988). The data from Palladin *et al.* (1988) were similar to catches presented by the FAO but were used in place of FAO catches from 1981 to 1986 for all species except tunas. While Palladin *et al.* (1988) present tuna catch totals that are almost identical to FAO tuna totals, the FAO data present these catches by taxa, therefore we used the FAO data. A report by Hallier and Kulbicki (1985) presented Skipjack catches for 1981–1983, which were almost identical to those presented by the FAO. A report by Dalzell *et al.* (1996) presented commercial catches for New Caledonia’s coastal, reef and deep-slope, pelagic and invertebrate fisheries for 1993. While this report was detailed in its spatial description of fisheries sectors, the totals presented were thought to include

recreational catches. Therefore, we used the data as supplied to FAO to represent commercial catches for 1993.

Offshore fishing for tuna by foreign fleets started in New Caledonia in the 1960s when Japanese fleets began exploiting tuna stocks in and around New Caledonia. New Caledonian longliners began offshore operations two decades later, starting around 1980. A report by the South Pacific Commission (Virly, 1996) describes catches by the New Caledonian longline fleet as occurring almost entirely within the country’s EEZ, therefore Tuna catches presented by the FAO were assumed to have been taken within New Caledonia’s waters.

To improve the taxonomic breakdown of the commercial sector data, we applied Loubens (1978) detailed taxonomic composition of commercial catches from 1975 to the 'miscellaneous marine fishes' category as well as a species breakdown for the Mackerel and Mullet groupings, in all years when catches were reported for these categories (Table 1). For comparison of pelagic and non-pelagic catches, we grouped Albacore, Barracudas, Bigeye tuna, 'Mackerels, tunas and bonitos', 'Marlins, sailfishes, etc nei', Narrow-barred spanish mackerel, Shortfin mako, Skipjack tuna, 'Tuna-like fishes nei' and Yellowfin tuna as Pelagics and the remaining taxa as non-pelagics.

### *Bêche-de-mer Fishery*

An export industry for bêche-de-mer has existed in New Caledonia since the mid-1800s (Conand, 1986/1991). The beche-de-mer fishery fluctuated substantially over the years, partly due to political and/or economic events such as the 1920s boom and WWII (Conand, 1991). The industry nearly vanished after WWII and was only re-established in the late 1970s or early 1980s. Reports of sea cucumber catches begin to appear in the FAO fisheries statistics in 1977. The report by Conand (1991) show that exports of bêche-de-mer were minimal between 1950 and 1980, after which large exports of over 1000 t (live weight) were reported. At this time 'bêche-de-mer' was one of the main fisheries export products. The processing of sea cucumber for export involves a smoking and drying process, which reduces the body weight by approximately 90% (Conand, 1991; Dalzell *et al.*, 1996). Using a conversion factor of ten, we converted the Dalzell *et al.*, (1996) estimate of 77 t (dry weight) for 1993 to a live weight. The resulting amount was the same as the amount presented in the FAO catches statistics for that year. The FAO data provided the most complete time series of sea cucumber catches, therefore these data were used for all years from 1977-2007.

### *Subsistence Fisheries*

To estimate subsistence catches for New Caledonia we used separate subsistence catch rates for each of the three Provinces--North Province, South Province and Loyalty Islands Province. These rates were, in part, based on the ethnic composition of the area. Consumption rates were presented by Loubens (1978) for people of Melanesian and Polynesian heritage (50 kg·person<sup>-1</sup>·year<sup>-1</sup>) and for people of European heritage (35 kg·person<sup>-1</sup>·year<sup>-1</sup>). A study by Labrosse *et al.* (2000b) presented subsistence catch rates for all three provinces for 1991.

*Loyalty Islands Province:* The consumption rate of 50kg·person<sup>-1</sup> was used as the 1950 subsistence catch rate for the Loyalty Islands Province as the population was and continues to be predominantly (97% in 1996; Anon., 1996) composed of Melanesians. We also assumed that seafood consumption in the Loyalty Islands at this time would have been almost entirely met through subsistence fishing.

*South Province:* Residents of the South Province were dominated by Europeans settling in and around the capital city, Noumea. We assumed a subsistence catch rate in 1950 of 35 kg·person<sup>-1</sup>, which was the catch rate given by Loubens (1978) for people of European heritage. A linear interpolation was done between the 1950 anchor point and the 1991 rate given by Labrosse *et al.* (2000b).

*North Province:* For the North Province, the 1991 rate given by Labrosse *et al.* (2000b) for the Islands Province was used as the 1950 anchor point as the North province also has a populations of predominantly Melanesians (78% in 1996 (Anon., 2001)) but may have had greater access to commercial catches landed at markets in the South Province.

For all three provinces a linear interpolation was done between the 1950 and 1991 anchor points and the 1991 rate was carried forward unaltered to 2007. The subsistence catch rates by province were then applied to the population of each province and summed to derive an estimate of total subsistence catches for New Caledonia from 1950-2007. The taxonomic breakdown of subsistence catches was derived using the species composition of commercial catches given by Loubens (1978; Table 1), excluding large pelagics (i.e. Yellowfin tuna). We assumed that species caught commercially for the local market would also have been caught by the subsistence sector to meet local consumption demands in areas where there was limited access to the marketplace.

## Recreational Fisheries

Catches were presented by Loubens (1978) for 'la pêche plaisancière' in 1975, which included estimates for both subsistence and recreational sectors. Recreational catches were estimated using the number of registered boats that fished occasionally (3000 boats in 1975) and a catch rate of  $0.6 \text{ t} \cdot \text{boat}^{-1} \cdot \text{year}^{-1}$ . This was used as the 1975 anchor point. Commercial catches presented in Dalzell *et al.* (1996) assumed to include recreational catches amongst the totals for reef, deep-slope, coastal and/or pelagic fisheries. To derive the recreational catch for 1993, we subtracted the commercial catches (FAO catches) from the total presented by Dalzell *et al.* (1996). We assumed that recreational fishing started in 1965, around the same time as the artisanal fishery for skipjack (Anon., 1985). Recreational catches were, therefore, set at zero in 1964.

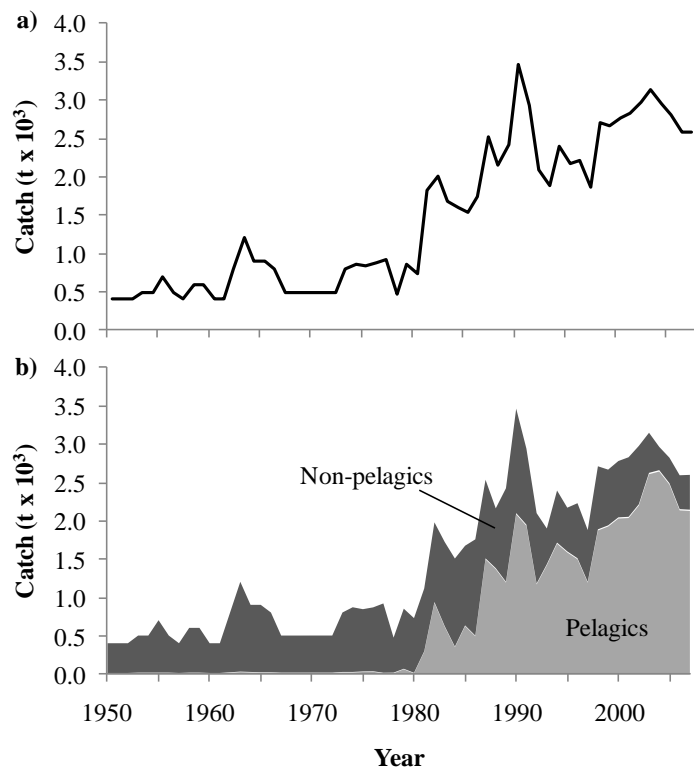
The two anchor points for recreational catches (1975 and 1993) were converted to per capita catch rates using population data obtained from Populstat ([www.populstat.info/](http://www.populstat.info/)). Linear interpolations were done from zero in 1965 to the first available anchor point in 1975 and between the 1975 and 1993 anchor points. The 1993 rate was carried forward, unaltered, to 2007. The complete time series of per capita recreational catch rates was then applied to the population of New Caledonia to derive recreational catch amounts from 1965-2007.

According to Dalzell *et al.* (1996), a large proportion of nearshore pelagics are taken by recreational fishers. Therefore, we applied the breakdown of nearshore pelagics presented in Dalzell *et al.* (1996) to 70% of our recreational catch estimates across the entire time period considered. Dalzell *et al.* (1996) describes that in New Caledonia 80% of the catches made by trolling along the coastal margins in the early 1990s are from the Scombridae family (Mackerels, bonitos, and tunas) followed by the Sphyraenidae (Barracudas) which make up 10% of the catch (Dalzell *et al.*, 1996). Catches of coastal pelagic species are dominated by Spanish mackerel (*Scomberomorus commerson*), Wahoo (*Acanthocybium solandri*), Kawakawa (*Euthynnus affinis*) and Yellowfin tuna (*Thunnus albacores*). We assumed that the remaining 30% of recreational catches were coral reef and lagoon species. The taxonomic breakdown for this portion of the recreational catch was estimated to be 10% each from the Serranidae, Lutjanidae and Lethrinidae families

## RESULTS

### Commercial Fisheries

Commercial fisheries sector catches, excluding the bêche-de-mer fishery, were estimated to be 84,760 t over the 1950-2007 time period (Figure 3a). Almost half of the commercial catches were pelagic species from the Serranidae and Scombridae families (Tunas, Mackerels and Groupers). Catches of reef-fish of the Lethrinidae family (Emperors and scavengers) were also substantial, contributing approximately 11,230 t to the commercial catch from 1950-2007. Pelagic and non-pelagic species catches

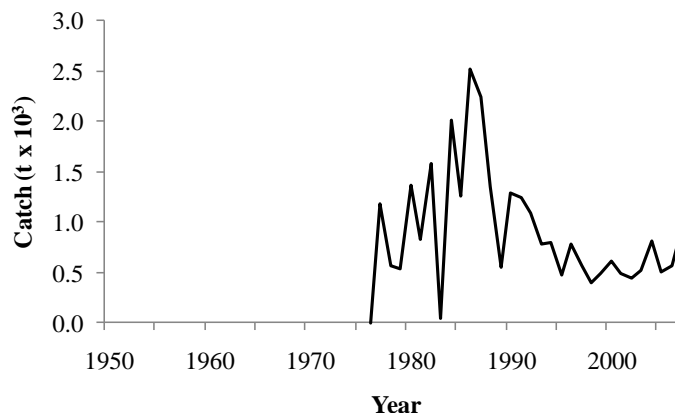


**Figure 3.** a) Commercial catches, excluding bêche-de-mer, by New Caledonia over the 1950-2007 time period. b) Commercial catches (excluding bêche-de-mer) divided into Pelagic and non-Pelagic species (see text for details).

were roughly equal when summed over the entire study period, however, Pelagic species have dominated the catch in recent decades (Figure 3b).

### *Bêche-de-mer Fishery*

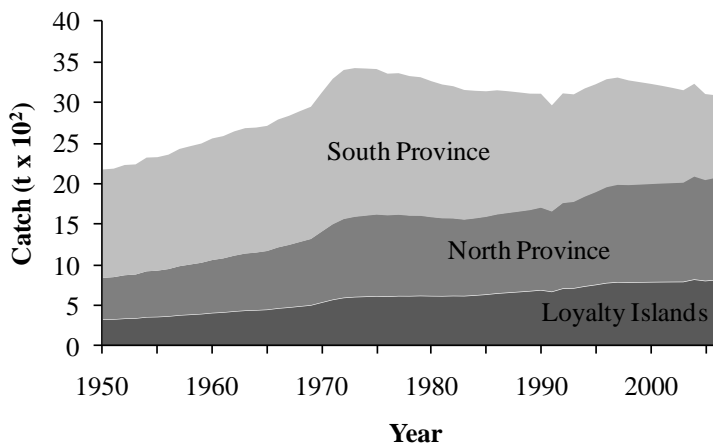
Catches of sea cucumber for export as bêche-de-mer totaled approximately 28,800 t over the period 1977-2007 (Figure 4). Catches fluctuated substantially from year to year, ranging between 42 t·year<sup>-1</sup> and 2,500 t·year<sup>-1</sup>. Due to the large annual fluctuations exhibited here, we consider this to be a 'pulse' fishery. Catches were highest during the mid-1980s to mid-1990s, averaging 1,500 t·year<sup>-1</sup>. Since the mid-1990s catches have been around 600 t·year<sup>-1</sup>.



**Figure 4.** Bêche-de-mer catches (live weight) in New Caledonia, 1950-2007.

### *Subsistence Fisheries*

Subsistence catches were estimated to be over 180,000 t over the 1950-2007 time period. Subsistence catches were estimated using province-specific subsistence catch rates, which gave catch totals for the North, South and Loyalty Islands provinces (Figure 5). Subsistence catches were approximately 2,000 t·year<sup>-1</sup> in 1950, increasing to about 3,400 t·year<sup>-1</sup> by 1975, and then were estimated to be just over 4,000 t·year<sup>-1</sup> by 2007.



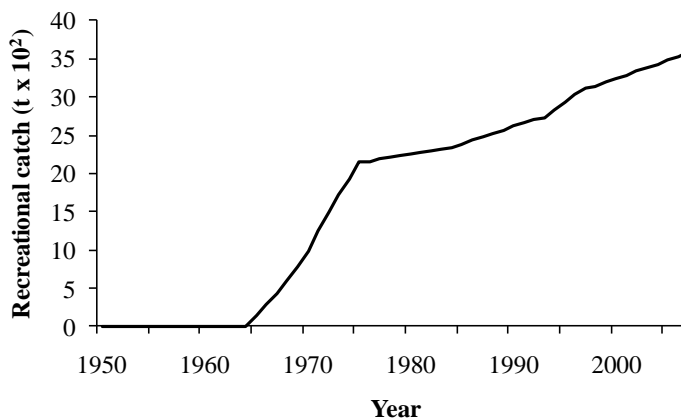
**Figure 5.** New Caledonia's subsistence catches estimated for the 1950-2007 time period.

### *Recreational Fisheries*

Catches by the recreational sector totaled just over 100,000 t from 1965-2007 (Figure 6). We assumed that the recreational sector started in the mid-1960s, therefore catches were estimated to be zero from 1950-1964. The main species caught in the recreational sector were from the Scombridae family.

### *Total reconstructed catch*

Our reconstruction of total marine fisheries catches for New Caledonia from 1950-2007 was estimated to be 393,673 t (Figure 7). This total included estimates of commercial, subsistence and recreational catches, which together were 3.5 times larger than the total presented by the FAO on behalf of New Caledonia (Figure 8). We assumed that catch data supplied to FAO represented only catches from the commercial fisheries sector. The reconstructed catch for 1950 was estimated to be approximately 2,500 t·year<sup>-1</sup>, increasing steadily to 10,000 t·year<sup>-1</sup> by the late 1980s and remaining around this level throughout rest of the study period, with only minor year to year fluctuations.



**Figure 6.** Recreational fishery catches by New Caledonia, 1950-2007.

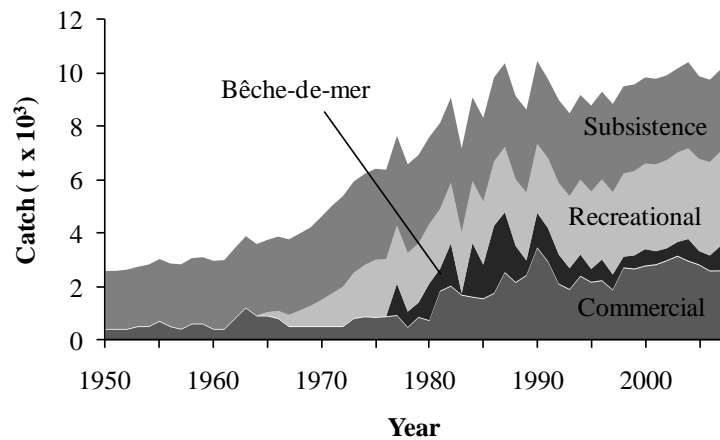
## DISCUSSION

Total reconstructed catches of New Caledonia's marine fisheries from 1950-2007 were estimated to be approximately 393,673 t. This catch total is 3.5 times larger than total catches presented by the FAO on behalf of New Caledonia. Total catches, as supplied to FAO, were approximately 110,000 t over the 1950-2007 time period, and represented commercial catches only. Our estimates of subsistence and recreational fisheries sectors together added almost 200,000 t to the total.

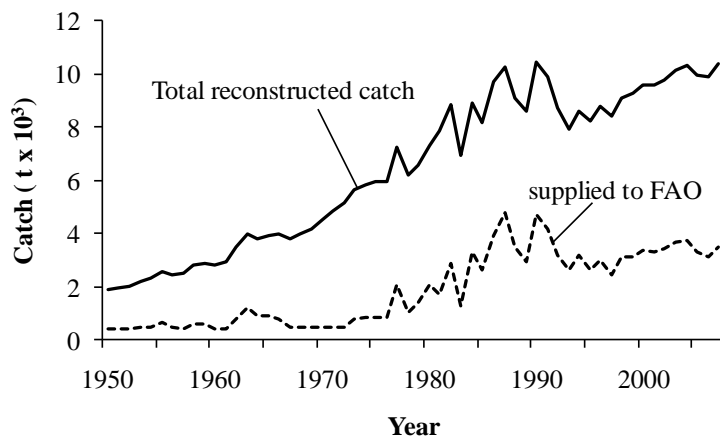
Commercial catches for New Caledonia were well documented between 1976 and 1986 by Palladin *et al.* (1988) and Hallier and Kulbicki (1985) and in 1993 by Dalzell *et al.* (1996). Independent reports of commercial catches prior to 1976 and for the recent period (1990s and 2000s) were not readily available. In years when we had data from both the FAO and from independent reports, catches were found to be similar in magnitude, giving confidence in our use of the data supplied to FAO as the best estimate of commercial catches in years when no other data were available. While independent reports were available for the commercial fisheries sector, there was a considerable deficiency in data for the subsistence and recreational sectors. These sectors were largely unaccounted for in government reports and by independent studies. Subsistence fisheries are a dominant factor in New Caledonia's coastal marine resource exploitation, yet very little data exist documenting yields or landings (Dalzell *et al.*, 1996).

In our estimation of New Caledonia's marine fisheries, subsistence catches were consistently higher than commercial catches, underlining the importance of the non-market economy in the fisheries of this country. The lack of studies concerning subsistence fisheries required us to estimate subsistence catches based on assumptions about consumption rates and the amount of this that was supplied through subsistence fisheries. Subsistence catch amounts for 1975 and 1993 were reported by Loubens (1978) and Dalzell *et al.* (1996), respectively. Catch amounts presented in these studies were also estimated and were similar to our estimates for the same years.

The per capita subsistence catch rate averaged over all three provinces varied from 37 kg·person<sup>-1</sup>·year<sup>-1</sup> in 1950 and 17 kg·person<sup>-1</sup>·year<sup>-1</sup> in 2007. Based on the data presented by Labrosse *et al.* (2000b), subsistence catch rates varied substantially by province with the Loyalty Islands (Islands Province) having the highest per capita subsistence catch rate. This high per capita rate likely reflects a lower dependence on commercial catches due to limited access to the markets where commercial catches are sold (i.e. the



**Figure 7.** Reconstructed catch (commercial, recreational and subsistence catches) and FAO catch taken in FAO statistical area 71 over the time period 1950-2007.



**Figure 8.** Total reconstructed catch for New Caledonia and total catches presented by the FAO, 1950-2007.

Noumea market in the South Province. The decrease in subsistence catch rates observed over the study period may reflect the increase in industrialized fishing fleets and improved infrastructure for the distribution and storage of seafood products that occurred over the past forty years (Adams and Dalzell, 1994).

The domestic offshore fishery developed more recently than the coastal fisheries and is much less developed than the distant water fleets (Japanese, American, Korean and Taiwanese) targeting offshore species. The increase in catches of pelagic species by New Caledonia since the late 1980s was due to the development of a domestic fishery for deep-slope and offshore species, encouraged by assistance from the French government (Palladin *et al.*, 1988; Blanchet, 1991; Labrosse *et al.*, 2000a). The majority of tuna caught by this fishery are exported and rarely enter into the local seafood supply (Anon., 1985; Palladin *et al.*, 1988).

Despite the expansion of offshore fisheries, the primary supply of local seafood remains from the lagoon and reef fisheries that operate informally or on a small-scale (i.e. subsistence and artisanal fisheries). The reef and lagoon systems of New Caledonia are still described as intact ecosystems, with healthy populations of large predators and other fish. Many threatened species including turtles, whales and dugongs seek refuge in New Caledonian waters, some of which are protected as a World Heritage Site (UNESCO, 2009). However, coastal development, agriculture and logging are placing increasing pressure on these productive reef and lagoon systems that provide food to much of the population (Adams *et al.*, 1996; Labrosse *et al.*, 2000a). The importance of maintaining these relatively intact ecosystems is inextricably linked to the food security of the people of New Caledonia who depend on local access to seafood as their main source of protein. Better accounting of fisheries removals by the subsistence sector is urgently needed in order to highlight the importance of this fishery sector and in turn sustain food supplies over the long term. The people of New Caledonia are heavily reliant on seafood for their way of life, maintaining the system that provides this valuable commodity is imperative. Proper accounting in fisheries is fundamental to this process and currently New Caledonia documents less than a third of what is being removed from its water's.

## ACKNOWLEDGMENTS

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