

TIMOR-LESTE'S FISHERIES CATCHES (1950-2009): FISHERIES UNDER DIFFERENT REGIMES¹

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ABSTRACT

Timor-Leste (East Timor) became an independent country at the close of the 20th century, and thus the FAO's fisheries division only presents catch data for Timor-Leste from 1999 onwards. However, as a former colony of Portugal and afterwards, as a province of Indonesia, the fisheries sector was described in various technical reports. Here, we present estimates of Timor-Leste's fisheries catches from 1950 to 2009. During the Portuguese period (1950-1974), total fisheries catches were estimated to be approximately 51,000 tonnes. Commercial fisheries catches were estimated to have averaged 83 t·year⁻¹ from 1950-1965, but declined to 37 tonnes in 1973; however, small-scale catches were estimated to have increased from approximately 1,600 t in 1950 to 2,300 t in 1973. During the Indonesian period (1975-1998) fisheries catches were estimated to be approximately 72,000 tonnes. The commercial sector's catch expanded from 60 t in 1974 to 2,800 t in 1998, and the small-scale catches averaged approximately 2,050 t·year⁻¹. However, due to the armed conflict surrounding independence in 1999, the associated destruction of infrastructure, and the exodus of people to refugee camps, commercial catches were estimated to have declined to 400 t in 2000, but have since increased to approximately 2,000 t·year⁻¹ by 2009. Small-scale catches during this time increased in importance, increasing from approximately 2,500 t in 1999 to approximately 3,500 t·year⁻¹ by 2009. Overall, estimated total catches increased from approximately 1,600 t in 1950 to approximately 5,600 t in 2009.

INTRODUCTION

The Democratic Republic of Timor-Leste (East Timor) is a small country located in Southeast Asia with a current population of approximately one million people. It has been shaped by many conflicts, and it is still dealing with post-colonial reconstruction (Anon., 2006). East Timor is located on the eastern half of the Timor Island, but it also comprises the nearby islands of Atauro and Jaco and an exclave, Oecussi-Ambeno, within the Indonesian part of the Timor Island, known as West Timor (Gertil, 2002). Approximately 80 percent of its population resides in rural areas; and are engaged in subsistence agriculture, and the main population centre is Dili (Da Costa *et al.*, 2003).

East Timor's recent history is best described by considering three distinct time periods over the time period of concern (1950-2009). During the 1950-1974 time period, East Timor was a colony of Portugal, as it had been since the early 1500s. In 1975, East Timor declared its independence, but

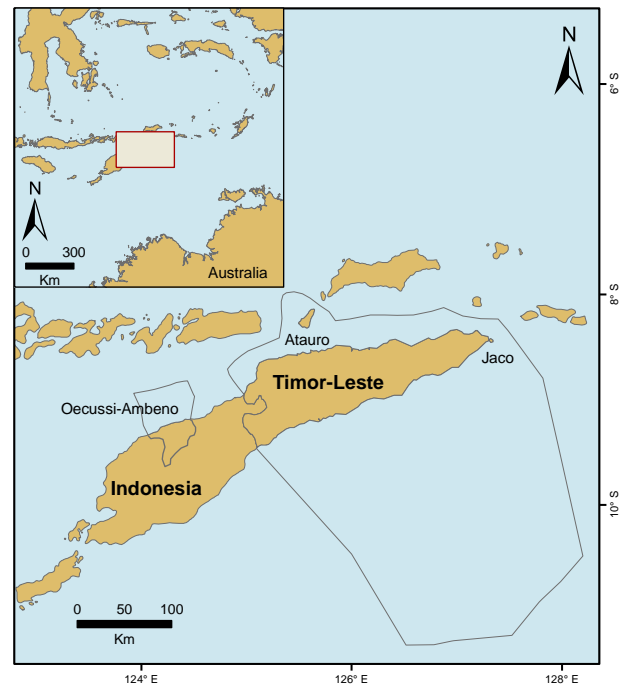


Figure 1. Map of Timor-Leste (East Timor) including islands of Atauro and Jaco, and exclave, Oecussi-Ambeno. Solid line demarcates the country's EEZ.

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was consequently invaded by Indonesia, which occupied the region until 1999. In 2000, the country gained its independence.

East Timor was exploited for its resources during the Portuguese and Indonesian periods. The Portuguese originally were attracted by sandalwood, which was the main product exported until the late 19th century, and they also established the capital, Dili, in 1769 (Anon. 2009a). Although the Japanese occupied the East Timor during the World War II, the Portuguese re-gained control over Timor, and, in 1953 the colony was declared an “Overseas Province” of the Portuguese Republic.

Indonesia invaded the country in 1975 with the help of United States, who feared that the FRETELIN, which had declared independence from Portugal, was communist (CIP, 1978; Burr and Evans, 2001; Povey and Mercer, 2002). Indonesians claimed it as their 27th province and largely controlled the economic resources during its period of occupation. Over the next 24 years (1975-1999) the East Timor’s guerrilla force FRETELIN fought Indonesian forces. The estimated number of Timorese killed or who died from illness and hunger vary from 60,000 to 200,000 (Taylor, 1995).

In 1999, due to international pressure, the Indonesian government entered into an agreement with Portugal and United States to hold a UN-sponsored referendum to determine the fate of East Timor. 78.5% of the East Timor population chose independence instead of being autonomous province of Indonesia. However, just after the referendum, Timorese militias, organized and supported by the Indonesian army, carried out a campaign of violence and destruction against pro-independence factions. In one month, 75 percent of the country’s infrastructure was demolished, about 2,000 Timorese were killed and 300,000 people fled westward. The violence came to an end on 20 September 1999 and, in 2002, Timor-Leste was internationally recognized as an independent state and became a member of the UN.

Currently, East Timor is one of the poorest nations in the world and is dependent on foreign funding (Pedersen and Arneberg, 1999). Problems such as a high illiteracy rate, lack of health care and sanitation, and hunger are a reflection that 40% of the population lives on US\$0.55 per day (Anon., 2007; Da Costa *et al.*, 2002; FAO/WFP, 2003). Even though Timor has received more donor funds per capita than anywhere else in the world, people are still dying from hunger and deficient health care (Povey and Mercer, 2002).

Although Timor-Leste has a limited coastline, fishing has always been the main source of food and income for people living in coastal communities. Fisheries catches have included large tuna, flying fish, coral reef fish, and deepwater snappers (Felgas, 1952; ADB, 2004). However, the database of the United Nations Food and Agricultural Organization (FAO), lacks most of the catch information for the country. Since 1950, FAO requires that each member country report information concerning food and agriculture production, including fisheries (Pauly and MacLean, 2003).

Table 1. Data sources and methods used for estimating human population for East Timor, 1950 – 2009. Asterix (*) indicates year of linear interpolation. Italicized numbers indicate estimated values.

Period	Year	Population	Source
Portugese	1950	433,000	United Nations ⁴
	1951-1969	*	-
	1970	610,300	Populstat ³
	1971	<i>619,165</i>	1950-1970 trend carried forward
	1972	<i>628,030</i>	1950-1970 trend carried forward
	1973	<i>636,895</i>	1950-1970 trend carried forward
	1974	<i>645,760</i>	1950-1970 trend carried forward
Indonesian	1975-1979	*	-
	1980	555,400	Populstat ³
	1981-1989	*	-
	1990	747,800	Populstat ³
	1991-1998	-	1980-1990 trend carried forward
Independence	1999-2000	-	2001-2004 trend carried backward
	2001	787,342	Anon. (2003)
	2002-2003	*	-
	2004	923,198	Anon. (2006)
	2005	992,000	United Nations ⁴
	2006-2009	992,000	2005 value used

Resources were not directed to collect catch data during its colonial stage, and thus catches were not assessed and reported to FAO prior to 1999.

The FAO statistics have been used as baseline for many fishery studies (Pauly *et al.*, 1998), for food security policies, and development strategies. Nevertheless, reconstruction of fisheries catches, undertaken for several countries by the *Sea Around Us* Project have shown the incomplete nature of FAO's fishery statistics (Zeller *et al.*, 2006; Zeller *et al.*, 2007). This is largely due to the exclusion of illegal, unreported and unregulated catches (IUU; Bray, 2000), especially as it concerns to unreported catches. The *Sea Around Us* Project has detailed various cases in which whole fisheries sectors are not presented in FAO statistics, leading to underestimates in global fisheries statistics (e.g. Booth and Watts, 2007; Zeller *et al.*, 2006). Such a lack of data leads not only to underestimation of the total catch, but it may also lead to misinterpretation of the actual trends in marine fishery resources over time. The purpose of this study is to present a time series of fisheries catch data from 1950 to present for East Timor.

MATERIAL AND METHODS

East Timor's fisheries catch from 1950 to 2009 were considered to comprise two sectors, according to the end use of the catch. The commercial sector sells its fish in markets, whereas the small-scale catch is used for subsistence, even though there is some trade between communities.

Separate estimates were made for the commercial and small-scale sectors for each year, and thus total catches are estimated by adding the two sector's catches together. In order to take into account the changes that have occurred in East Timor throughout the study period, three different time periods were considered to reflect the political landscape that the fisheries operated in.

Human population data

The human population was reconstructed to serve as a baseline to help to estimate small-scale catches from 1950-1975. The anchor points of data were taken from census information available from *Populstat* (www.populstat.info) for 1970, 1980 and 1990 (Table 1), and from the *National Statistics Directorate* of East Timor for 2001 and 2004 (Anon., 2003; 2006). For 1950 and 2005 data were taken from population estimates provided by United Nations (Anon. 2009b).

For each of the three historical periods, interpolations between points of census data were made. For years when no interpolations could be made, the relative trend was carried forward or backwards to derive estimates of population by extrapolation. In order to

Table 2. Data sources and reconstruction methods used for estimating the number of commercial fishers for East Timor's Portuguese period (1950-1974). *Italicized* numbers indicate estimated values.

Year	Commercial fishers	Source
1950	<i>36</i>	a
1951	<i>39</i>	a
1952	<i>41</i>	a
1953	<i>44</i>	a
1954	<i>46</i>	a
1955	<i>49</i>	a
1956	<i>52</i>	a
1957	<i>55</i>	a
1958	<i>59</i>	a
1959	<i>63</i>	a
1960	<i>66</i>	a
1961	<i>70</i>	a
1962	<i>75</i>	a
1963	<i>79</i>	a
1964	<i>84</i>	a
1965	<i>90</i>	a
1966	<i>95</i>	a
1967	<i>101</i>	a
1968	<i>107</i>	a
1969	<i>114</i>	a
1970	116	FAO (1999)
1971	136	FAO (1999)
1972	138	FAO (1999)
1973	141	FAO (1999)
1974	<i>154</i>	a

^a Reconstructed by exponential model

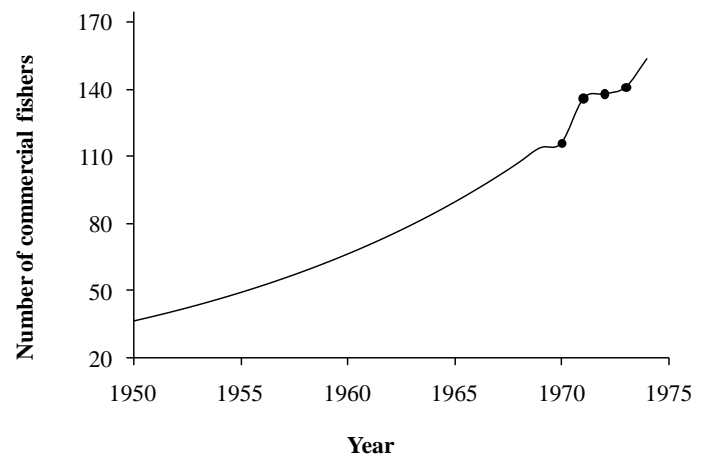


Figure 2. Number of commercial fishers estimated by fitting an exponential growth model ($y = 34.306e^{0.06x}$) to the available data, for East Timor's Portuguese period (1950-1974).

account for the gradual decrease in population after the Indonesian invasion, we used two different methods during the 1970s. For 1971-1974, we carried the 1950-1970 trend forward. From 1975-1979, we linearly interpolated between the 1974 derived population estimate and the 1980 assessed population. This resulted in a gradual decreasing trend after 1975, a reflection of the turmoil caused by Indonesia's annexation of East Timor.

Total number of fishers: The main purpose of reconstructing the number of fishers was to combine the number of commercial fishers with catch rates (i.e., catch·fisher⁻¹) to estimate catches in some years when data were missing.

1950-1974 (Portuguese period): The total number of fishers was estimated by summing commercial and small-scale fishers. Data on the number of commercial fishers were reported by FAO as being 116 in 1970; 136 in 1971; 138 in 1972 and 141 in 1973 (FAO, 1999; Table 2). The number of fishers during years of lacking data were estimated by fitting an exponential growth model to the available data (Figure 2).

Table 3. Data sources and methods used for estimating the total number of fishers for East Timor, 1950 - 2009. Asterix (*) indicates year of linear interpolation. *Italicized* numbers indicate estimated values.

Year	Total Fishers	Source
1950-1974	-	Reconstructed ^a
1975-1986	*	-
1987	5581	BPS (1998a)
1988	5620	BPS (1998a)
1989	6410	BPS (1998a)
1990	6918	BPS (1998a)
1991	7152	BPS (1998a)
1992	7944	BPS (1998a)
1993	8284	BPS (1998b)
1994	8631	BPS (1998b)
1995	8580	BPS (1998b)
1996	8742	BPS (1998b)
1997	9066	BPS (1998b)
1998	<i>9366</i>	1974-1987 trend carried forward
1999	<i>2614</i>	2000-2001 trend carried backward
2000	4057	FAO ^b
2001	5500	JICA (2002)
2002-2009	<i>5500</i>	2001 value used

^a sum of commercial and small-scale fishers; ^b FAO - www.fao.org [Accessed July 27, 2009].

1999-2009 (Independence): Information on the total number of fishers was available for 2000 and 2001. In 2000, it was estimated that there were 4,057 fishers (Anon. 2009c) and in 2001, according to the Japan International Cooperation Agency (JICA), there were 5,500 fishers (JICA, 2002). For 1999, the 2000-2001 trend (an increase of 1,443 fishers·year⁻¹) was carried backward, and for 2002-2009 the 2001 value was used (Table 3). The decline from 9,366 fishers in 1998 to 2,614 in 1999 is a direct consequence of the Indonesian Deliberate destruction of infrastructure.

Commercial Fishery

The commercial catch was estimated by linear interpolation between catch anchor points and, in order to complete the time series during each period, we also applied the trends in years when catch data were lacking.

1950-1974 (Portuguese period): Commercial catch data were gathered from reports of a development plan carried-out by Presidência do Conselho Secretário Técnico of Portugal (PCST) for 1965 and 1968-1973 in Timor (PCST, 1965; 1967; 1968; 1971; Table 4). During this time catches decreased from 80 t·year⁻¹ in 1965 to 37 tonne·year⁻¹ in 1973, and this may be linked to the agricultural development plan, which led to an expansion of this sector with a consequential decrease in yearly landings of fish as fishers were leaving the fisheries sector to work in the agriculture sector (PCST, 1965; 1967).

The number of small-scale fishers were estimated by dividing the small-scale catch by the catch rate (catch·fisher⁻¹), which was assumed to be equivalent to the average amount caught by commercial fishers between 1950 and 1964 (1.53 t·year⁻¹; see 'commercial fisheries' below). During this time there were only non-motorized canoes, and our assumption implies similar efficiency between commercial and small-scale fisheries.

1975-1998 (Indonesian Period): For 1987-1997 from the East Timor's Central Board of Statistics (*Badan pusat statistik* – BPS) had information on the total number of fishers available (BPS, 1998a; 1998b; Table 3), which showed an increase in the number of fishers over time. Linear interpolation was used to fill-in the years from 1975-1986. For 1998, the 1974-1987 trend (an increase of 300 fishers·year⁻¹) was carried forward.

Years in which commercial catches were missing, had catches estimated by combining the number of commercial fishers with catch rates (i.e., catch·fisher⁻¹). Data on number of commercial fishers were gathered from an FAO report on number of fishers, for 1970-1973 (FAO, 1999, see Table 2), and reconstructed for the rest of the colonial period according to the method described above (see total fishers section). The commercial catch rates (catch·fisher⁻¹) were determined from anchor points of commercial catch, available for 1965 and 1968-1973, and number of fishers. For 1950-1964, the 1965-1968 trend (an increase of 0.08 t·year⁻¹) was carried backward. For 1966-1967 a linear interpolation was made between 1965 and 1968. For 1974, the 1972-1973 trend (an increase of 0.125 t·year⁻¹) was carried forward. The highest rate of 0.89 t·fisher⁻¹ was in

1965, and thereafter catches ranged from 0.14 t·fisher⁻¹ (1972) to 0.37 t·fisher⁻¹ in 1970. In 1965, 1968 and 1969, total catches were reported, but the catch rate was derived from the estimate number of fishers.

1975-1998 (Indonesian Period): Data on commercial catches were reported by the Fisheries Statistics of Indonesia for 1978, 1979, 1982 and 1985 (Anon., 1978; 1979; 1982; 1985; Table 5), and by the Central Board of Statistics of East Timor (BPS, 1998a; 1998b). Catches during this period were reported as 225 t·year⁻¹ in 1978 and increased steadily to 2,800 t·year⁻¹ in 1998. Information regarding commercial fisheries catches in 1998 was found in a project completion report on the Hera Port rehabilitation, prepared by the Asian Development Bank (ADB) (Anon., 2004), and were 2,800 fishers. For 1975-1977, linear interpolation was made between the derived value for 1974 and the value reported for 1978. For the rest of the years of missing data, simple linear interpolations were used to estimate catches.

1975-1998 (Indonesian Period): Data on commercial catches were reported by the Fisheries Statistics of Indonesia for 1978, 1979, 1982 and 1985 (Anon., 1978; 1979; 1982; 1985; Table 5), and by the Central Board of Statistics of East Timor (BPS, 1998a; 1998b). Catches during this period were reported as 225 t·year⁻¹ in 1978 and increased steadily to 2,800 t·year⁻¹ in 1998. Information regarding commercial fisheries catches in 1998 was found in a project completion report on the Hera Port rehabilitation, prepared by the Asian Development Bank (ADB) (Anon., 2004), and were 2,800 fishers. For 1975-1977, linear interpolation was made between the derived value for 1974 and the value reported for 1978. For the rest of the years of missing data, simple linear interpolations were used to estimate catches.

Table 4. Data sources and methods used for estimating commercial marine fishery catch (t) for East Timor's during the Portuguese period (1950-1974). Values in *Italics* are estimated.

Year	Commercial catch (t)	Source	Commercial Fishers	Source	Commercial catch (t·fisher ⁻¹)
1950	<i>76^a</i>	-	<i>36^b</i>	-	<i>c</i>
1951	<i>78^a</i>	-	<i>39^b</i>	-	<i>c</i>
1952	<i>79^a</i>	-	<i>41^b</i>	-	<i>c</i>
1953	<i>81^a</i>	-	<i>44^b</i>	-	<i>c</i>
1954	<i>82^a</i>	-	<i>46^b</i>	-	<i>c</i>
1955	<i>83^a</i>	-	<i>49^b</i>	-	<i>c</i>
1956	<i>84^a</i>	-	<i>52^b</i>	-	<i>c</i>
1957	<i>85^a</i>	-	<i>55^b</i>	-	<i>c</i>
1958	<i>86^a</i>	-	<i>59^b</i>	-	<i>c</i>
1959	<i>86^a</i>	-	<i>63^b</i>	-	<i>c</i>
1960	<i>86^a</i>	-	<i>66^b</i>	-	<i>c</i>
1961	<i>86^a</i>	-	<i>70^b</i>	-	<i>c</i>
1962	<i>85^a</i>	-	<i>75^b</i>	-	<i>c</i>
1963	<i>84^a</i>	-	<i>79^b</i>	-	<i>c</i>
1964	<i>82^a</i>	-	<i>84^b</i>	-	<i>c</i>
1965	80	PCST	<i>90^b</i>	-	0.89 ^d
1966	<i>77^a</i>	-	<i>95^b</i>	-	-
1967	<i>74^a</i>	-	<i>101^b</i>	-	-
1968	70	PCST	<i>107^b</i>	-	0.65 ^d
1969	68	PCST	<i>114^b</i>	-	0.60 ^d
1970	43	PCST	116	FAO (1999)	0.37
1971	32	PCST	136	FAO (1999)	0.24
1972	19	PCST	138	FAO (1999)	0.14
1973	37	PCST	141	FAO (1999)	0.26
1974	<i>60^a</i>	-	<i>154^b</i>	-	^e

^aEstimated using commercial fishers and commercial catch rate; ^b Estimated using exponential growth model; ^c 1965-1968 trend carried backward; ^d Estimated using catch anchor point, and estimated number of fishers; ^e 1972-1973 trend carried forward

1999-2009 (Post-independence): For the post-independence period the data were taken from the Asian Development Bank report on the Hera Port rehabilitation (Anon., 2004). This report detailed fisheries catch data over time, for 2001 (950 t·year⁻¹) and 2004 (2,044 t·year⁻¹) (Table 6). Linear interpolation was done to fill in the years of missing data. The value of 2003 was used as the best estimate for each year after, since data were lacking.

Small-scale Fishery

The estimates of small-scale catches are considered in a different manner than commercial catches. Here, we present the methods of estimating small-scale catches over the entire time period. Small-scale catches are usually not reported in fisheries statistics and thus are very scarce in the literature. Thus, small-scale catches were reconstructed through per capita rates and the human population data.

For 1988, 1997, 2001 and 2003, total catch were reported to be 3,000 (Da Costa *et al.*, 2003), 4,000 (Anon., 2004), 3,800 (JICA, 2002) and 5,206 (Anon., 2004) t·year⁻¹, respectively; and commercial catches were reported as being 637 (Anon, 1988), 2,423 (BPS, 1998b), 950 (Anon, 2004), 2,044 (Anon, 2004) t·year⁻¹ respectively (Table 7). Thus, small-scale catches were estimated by difference (i.e., small-scale = total catch - commercial catch). In order to form anchor points of small-scale *per capita* catch rate (i.e., t·person·year⁻¹) for the small-scale sector, the subsistence catch (Table 7) was divided by the population (Table 8). These anchor points of *per capita* catch rates were interpolated to fill in the years with no data (Table 8).

From 1950-1974 we assumed that the *per capita* rates for the year 2000 (0.0036 t·year⁻¹) would be the most representative of the catch rates, since the fishery infrastructure was destroyed and the catches were made mostly by the artisanal fishers in dugout canoes. This is most likely a conservative assumption considering that the inshore fishery resources must have been available in higher levels in earlier times than in the present, resulting in higher catch rates. The fact that the 1950s is the only period that some marine catch in East Timor is reported as having been exported (53 t

Figure 5. Data sources and methods used for estimating marine fishery catch (t)

Year	Catch (t)	Source
1974	60 ^a	-
1975 -1977	-	-
1978	225	Anon. (1978)
1979	499	Anon. (1979)
1980 -1981	-	-
1982	397	Anon. (1982)
1983 -1984	-	-
1985	494	Anon. (1985)
1986	-	-
1987	580	Anon. (1987)
1988	637	Anon. (1988)
1989	645	BPS (1998a)
1990	803	BPS (1998a)
1991	944	BPS (1998a)
1992	1,358	BPS (1998a)
1993	1,851	BPS (1998b)
1994	2,002	BPS (1998b)
1995	2,165	BPS (1998b)
1996	2,315	BPS (1998b)
1997	2,423	BPS (1998b)
1998	2,800	Anon. (2004)

^a Value estimated according to method described for the colonial period

Table 6. Data sources and methods used for estimating commercial marine fishery catch (t) for East Timor's post-independence period (1999- 2009). Asterix (*) indicates year of linear interpolation.

Year	Commercial catch (t)	Source
1998	2,800	Anon. (2004)
1999	*	-
2000	1,602	2001-2003 trend carried backward
2001	950	Anon. (2004)
2002	*	-
2003	2,044	Anon. (2004)
2004-2009	-	2003 value

Table 7. Data sources of total catch and commercial catch used for estimating small-scale *per capita* catches rates for East Timor, from 1950 - 2009. Asterix (*) indicates year of linear interpolation.

Year	Total Catch (t)	Source	Small-scale catch (t)	Source
1950-1974	*	-	-	-
1975-1987	*	-	-	-
1988	3,000	Da Costa <i>et al.</i> (2003)	2,363	Total Commercial
1989-1996	*	-	-	-
1997	4,000	Anon. (2004)	1,577	Total Commercial
1998	*	-	-	-
1999-2000	*	-	-	-
2001	3,800	JICA (2002)	2,850	Total Commercial
2002	*	-	-	-
2003	5,206	Anon. (2004)	3,162	Total Commercial
2004-2009	*	-	-	-

in 1950; 50 t in 1951; 22 t in 1952 and 25 t in 1953) (Felgas, 1956), adds some validity to this assumption. For 1998, the 1988-1997 trend (a decrease of 0.0002 t-year⁻¹) was carried forward. And for 1999-2000 the 2001-2003 trend (a decrease of 0.00001 t-year⁻¹) was carried backward unaltered. From 2004-2009, the 2003 *per capita* catch rate was used. Multiplying the estimated *per capita* catch rate of each year by the corresponding population produced estimates of the small-scale catch for the whole period of study.

Table 8. Population data and methods used in calculating per capita small-scale catches (t). Asterix (*) indicates year of linear interpolation.

Year	Population	Small-scale catch rate (t-person ⁻¹ .year ⁻¹)	Methods
1950-1974	-	0.003	2000 value used
1975-1987	-	*	-
1988	709,320	0.003	Small-scale / Population
1989-1996	-	*	-
1997	882,480	0.0017	Small-scale / Population
1998	-	0.0016	1988-1997 trend carried forward
1999-2000	-	-	2001-2003 trend carried
2001	187,342	0.0036	Small-scale / Population
2002	-	*	-
2003	877,913	0.0036	Small-scale / Population
2004-2009	-	0.0036	2003 value used

Taxonomic breakdown

Data concerning the species composition of catches are very limited. Catches as presented by the FAO on behalf of East Timor are only for the year 2000, and are reported as mainly in the miscellaneous marine fishes category. Therefore, we used two sets of data to better represent the taxonomic breakdown of catches. We used information from Cook (2000) and from Anon. (1985) to derive percentages of catches. Cook (2000) data concerned a market survey in Dili and Anon. (1985) reported catches by taxa. We applied these percentages to the catch totals to estimate catch by taxa.

RESULTS

Human Population

The population of East Timor has grown from approximately 433,000 people in 1950 to a current population of approximately 992,000 people. However, during this time, there were two periods when the population declined (Figure 3). The first population decline was a result of the conflict related to the Indonesian invasion, and occurred gradually in the years following 1974. This decline was then offset by a policy to increase food production (Pedersen and Arnsberg, 1999), which resulted in population growth from 1980 to 1998. The second decline, in 1999, was a result of 175,000 people leaving East Timor for refugee camps, a further 200,000 people displaced within East Timor and about 2,000 being killed by Indonesian militias (Mendonça, 2002).

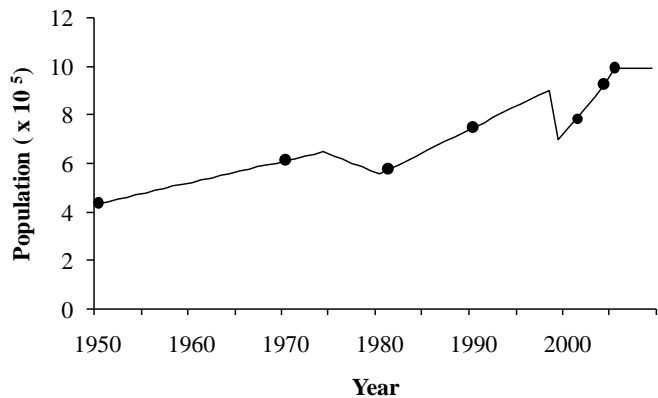


Figure 3. Human population reconstructed for Timor-Leste, 1950-2009. Hard data, found in the literature, are indicated by anchor points (•).

The years following 1999 show rapid population growth due to the return of refugees and a high fertility rate associated with a young age structure of the population. By the first half of 2001 the population was estimated to have risen again, as people returned to East Timor, to around 87% of its estimated pre-crisis level, in 1998 (Anon., 2003).

Total fishers

The number of fishers was estimated to have risen from 1,061 fishers in 1950 to 1,682 in 1974 (Figure 4). The number of fishers then declined from 9,366 in 1998 to 2,614 in 1999. Since 1999 the number of fishers grew to approximately 5,500.

Commercial Fishery

1950-1974 (Portuguese period): The commercial catch during the colonial period is relatively low, averaging 80 t·year⁻¹, and was caught by artisanal fishers. Even after the development plan carried out by Portugal from 1965-1974 in East Timor (PCST, 1965; 1967; 1968; 1971), which included the purchase of powered boats and engines, fishery catches were still decreasing until 1973, from 80 t·year⁻¹ in 1965 to 37 t·year⁻¹ in 1973 (Figure 5). This is most likely a reflection of the importance placed on agriculture during the years of development (PCST, 1974).

The fishery was limited to the inshore areas, and relied on traditional methods and knowledge. During this period, Atauro Island and Dili were the main fishing spots and the inshore marine resources of these areas supported some export of dried fish and shellfish. Offshore areas were not utilized for fishing (Felgas, 1956).

1975-1998 (Indonesian Period): It was during the Indonesian occupation that East Timor's marine fishery reached its peak, with the 1990s representing the largest of fishery landings. Commercial catches rose from 101 t·year⁻¹ in 1975 to 2800 t·year⁻¹ in 1998 (Figure 6).

Despite the violence, a complex administrative structure was implemented in East Timor during the Indonesian rule (Pedersen and Arnsberg, 1999). From 1978 to 1982 there was development of the infrastructure, with 14 public markets and 1,264 km of roads being constructed, and also, by the 1980s, there were investments in fishponds, fish markets, hatcheries and the fishing fleet.

The construction of the Hera Port, near Dili, in 1990, with a boatyard and fish market, helped to develop the commercial fishery by supporting offshore fishing vessels (ADB, 2003). While, for 1987, the records indicate a commercial catch of about 600 tons of fish (Anon., 1987), in

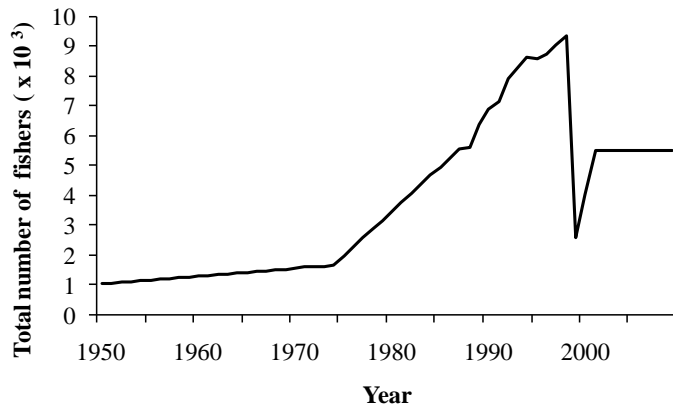


Figure 4. Total number of fishers in East Timor, 1950-2009.

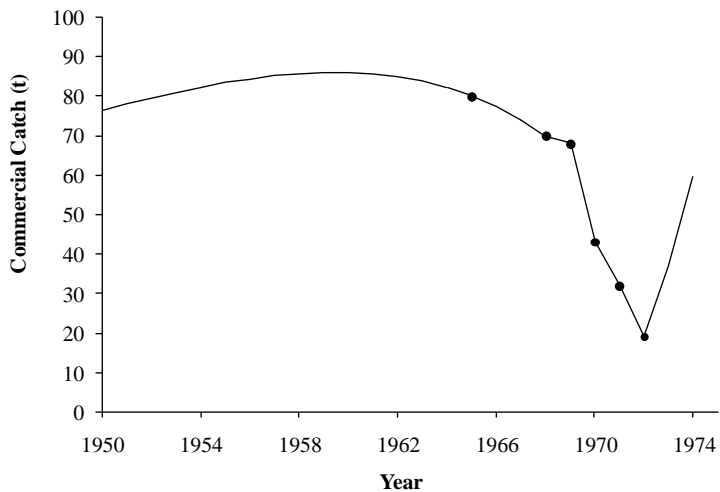


Figure 5. Commercial catch, Portuguese period, 1950-1974.

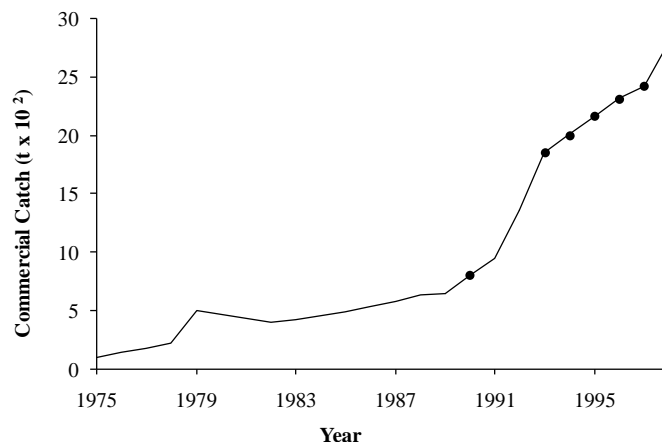


Figure 6. Commercial catch, Indonesian period, 1975-1998.

1997, it had increased to 2,400 tons (BPS, 1998b), with about 60% of fish landings being made in Dili at a rate of about 4 t-days⁻¹ (Cook, 2000). At that time, there were 995 dugout canoes, 402 small boats and 630 boats with outboard motors (Pedersen and Arneberg, 1999). However, the commercial fishery was dominated by Indonesians from Sulawesi, who landed all the yellowfin tuna (*Thunnus albacores*) of export quality (Cook, 2000), as the local people were not allowed to fish in deep waters (ADB, 2004; 2003).

1999–2009 (Post-independence):

After 1999, there was a sharp drop of commercial catch landings as a result of the post-referendum conflicts (Figure 7). The catches declined from the reported value of 2,800 t·year⁻¹ in 1998 (Anon., 2004), to the estimated amount of 403 t·year⁻¹ in 2000. In retaliation Indonesian militias destroyed nearly 90% of the boats, fishing gear and onshore processing infrastructure (Anon., 2009d). All the commercial fishing boats left East Timor, with about 24 moving

to Atauro Island and the rest being destroyed (ADB, 2003). Wooden boats other than dugouts were built outside the country, mostly in Sulawesi. Less than 10% of the number of powered fishing crafts that were present in 1997 were thought to have been operational during a FAO mission in 2000 (Cook, 2000). The broken engines could not be repaired as there were no spare parts available, nor were there qualified personal to do the repairs as many skilled laborers had left the country (Cook, 2000).

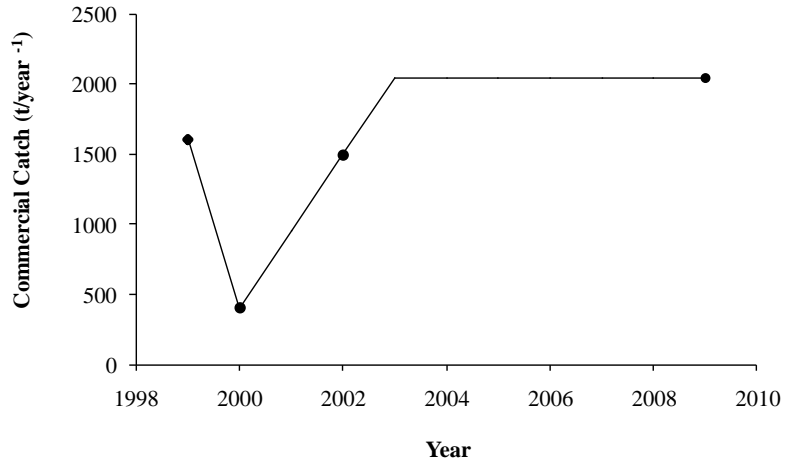


Figure 7. Commercial catch, Post-independence period , 1999-2009.

The destruction of the Hera Port ice machine, which used to produce up to 17 tonnes of ice per batch, led to a decline in effort. Without any other substantial source of ice supply, the remaining fishers that had larger canoes or boats were unable to travel further or fish for longer periods. Salting fish was not an effective solution since there was also a shortage of salt (Cook, 2000). The three main public markets of Dili, where fish used to be sold, were all burnt, as well as landing sites and markets at Manatutu and Ambeno.

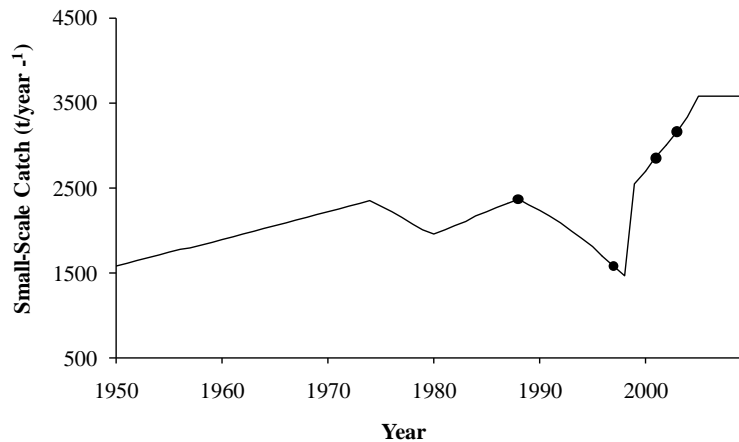


Figure 8. Small-scale catch for the entire study period (1950-2009). Solid circles (•) represent values reconstructed from hard data.

After 2001, with the return of the refugees and rebuilding of infrastructure by various international agencies and volunteers, the industry slowly moved toward recovery (Cook, 2000). The Hera Port was rehabilitated in 2003 (ADB, 2003) and is now being managed by an Australian company. As a result, in 2003 the catches had already largely recovered, having risen to 2,044 tonnes·year⁻¹ (Anon., 2004).

Small-scale Fishery

The average catch taken by the small-scale fishery sector, mainly for subsistence use during the colonial period, was approximately 2,000 t·year⁻¹ (Figure 8). The slight and constant increase over the years

follows the trend in population growth. Between 1975 and 1980, catches decrease from 2,275 t·year⁻¹ to 1,945 t·year⁻¹, rising again from 2,000 t·year⁻¹ in 1981 to 2,363 t·year⁻¹ in 1988. The fluctuation and the years of declining catches are a function of the population changes that occurred as a result of the Indonesian invasion.

From 1989 to 1998, small-scale catches decreased from 2,302 t·year⁻¹ to 1,457 t·year⁻¹, which contrasts with the growth in population. This might be a reflection of the construction of public markets by the Indonesians, where people could formally sell part of their catch. In fact, the commercial sector expanded during this time period. However, some decline in small-scale catches might be because of the Indonesian investments in East Timor's agriculture, including wet rice production, irrigation systems, cattle importation and fishponds (Pedersen and Arnsberg, 1999). This may have made the small-scale fishers less dependent on fisheries as a source of nourishment and income, and some may have become involved in agriculture, as it happened before, back in the Portuguese time period.

In 1999, with the destruction of the fisheries infrastructure, fishing fleet and the consequential decline of the commercial sector, the small-scale catch increased abruptly to 2,535 t·year⁻¹. After this time fisheries resources once again became one of the main sources of food for coastal communities. Small-scale catches continued to increase up to approximately 3,600 t·year⁻¹ following 2005. In 2002, it was estimated that 50% of the fishermen were involved in fishing as their primary source of food and income (Anon. 2009d).

Total Reconstructed Catch

Overall, the total reconstructed marine fisheries catches in East Timor increased over the period considered in this study, from 1,648 t in 1950 to 5,617 t in 2009. The largest increase occurs after 1990, and reflects a significant increase in the commercial catch. Estimated total catches increased from 3,038 t·year⁻¹ in 1990, to 4,136 t·year⁻¹ in 1999. By the year 2000, just after the post-referendum conflicts, estimated total catches declined to 3,096 t·year⁻¹, and were caught primarily by the small-scale sector. Total catches exceeded 4,500 t in 2002. Several times, an increase in one of the marine fishery sectors considered (small-scale and commercial) is followed by a decrease in the other. For the period when East Timor's total catch is reported in the FAO records (409 t in 1999; 363 t in 2000; 357 t in 2001; 350t for 2001-2007; Anon. 2009c), our reconstructed total catch indicates an average amount approximately 13 times bigger (4,136 t in 1999; 3,096 t in 2000; 3,800 t in 2001; 4,503 t in 2002; 5,206 t in 2003; 5,369 t in 2004 and 5,617 t for 2005-2007). The fact that records as presented by the FAO on behalf of East Timor report the same amount for the last nine years suggests that it is very likely that no re-assessment has actually been done during this time.

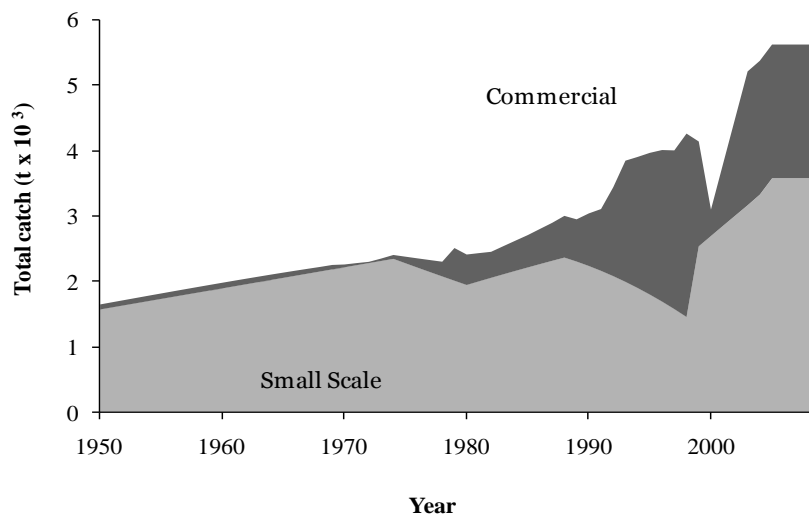


Figure 9. Total reconstructed catch for the period 1950-2009, including commercial and small-scale catches.

Taxonomic details

Fisheries catches of East Timor were dominated by large pelagics, such as tunas and tuna-like species, which represented 33% of the reconstructed total catch. Reef fishes were also important, as can be seen by the importance of Red snapper (*Lutjanidae*; 10%), Yellow tails and Fusiliers (*Caesionidae*; 10%) and the yellowfin surgeonfish (*Acanthurus xanopterus*; 7%). Other important taxa throughout the time period included Sardinellas, Halfbeaks (*Hemiramphus*), Indian Mackerel (*Rastrelliger kanagurta*) and Needle fishes (*Belonidae*), which together represented 16% of the total reconstructed catch. The remaining 24%

of the reconstructed catch was composed of fish from the following families and genera Leiognathidae, Mugilidae, Serranidae, Elasmobranchii, Rajidae, Scomberoides, Exocoetidae, *Chirocentrus*, Haemulidae, Lethrinidae, Sphyræna, Carangidae, *Siganus*, *Scarus* and *Trachurus*.

DISCUSSION

This is the first time that the East Timor's marine fisheries catches are estimated for the period from 1950 to the 21st century. In face the importance of the fishery resources to the country's food security, the present study may provide some insights and directions for future fisheries management plans and policies for East Timor. Total catches were estimated to be approximately 177,000t over the entire study period, and were 13 times bigger than FAO totals for years when data were supplied to the FAO.

The few years of catch statistics presented by FAO indicates that marine fisheries in East Timor have been scarcely assessed over the years, with minimal data being supplied to the FAO. Contrasting with our estimates, it is very likely that what has been reported to FAO only accounts for commercial sector and strictly for what is formally sold at the markets. However, since FAO statistics report the same value from 2005-2007, it is also possible that no actual assessment has been made, at least lately.

Thus, in association to the improvements made by the international agencies to the country's marine fishery infrastructure, there should also be investments in establishing the means for assessing, monitoring and reporting the catches in order to better understand and predict the real and sustainable potential of the fisheries resources for food security.

In contrast to what many policy makers and aid personnel (Da Costa *et al.*, 2003; FAO/WFP, 2003) suggest, East Timor's fishery potential is not very high, and is not underexploited. Although Timor-Leste lies at the core of the Coral Reef Triangle, the most biodiverse part of the world, it lacks shallow waters. East Timor has a limited continental shelf compared to other countries in the Coral Triangle, with depths of 200m located 1 nautical mile from shore (Anon., 2004; Da Costa *et al.*, 2003). A few reefs and sea grass beds are mainly restricted to Dili's proximities and Atauro Island, which are, essentially, the places where fisheries take place (Pedersen and Arneberg, 1999). Thus, a different viewpoint of East Timor's fisheries may be that the East Timorese have not exploited much of their coastline because there is not much to be exploited (Cook, 2000).

As a result, potential for demersal or seabed fisheries, such as reef fishing or prawn trawling is restricted by its seascape, which could be already over-fished by small-scale fishers.

In April 2000, the FAO's mission (Cook, 2000) assessed the inshore fishery condition in order to identify potential projects for funding by donors. The survey examined the size and amount of catches of the main species on sale at the street market in Dili, and recorded an average amount of 500kg of fish being landed per day into Dili, mostly coming from coral reef shallow seabed areas. Reef emperors (Lethrinidae) smaller than 12 cm and rabbitfish (Siganidae) smaller than 15 cm were often seen, was taken as an indication that reef areas were overfished. Pelagic fishes, usually fished offshore, such as yellowfin, bigeye and albacore tuna, were rarely seen during the three, one-hour survey periods, but small pelagic fishes, such as the Indian mackerel (*Rastrelliger kanagurta*), were regularly present. Also, in a survey undertaken between 2005 and 2006, at Beloi, a village located at Atauro Island, the studied reefs did not present as much fishes as expected. A large number of small fishes was found, but groupers and snappers of larger sizes (>40cm) were rarely seen during dives. Local fishermen confirmed the wide exploitation of the reefs for fishery by the local communities, and the reefs were also noted to be in a poor state (Dutra & Taboada, 2006).

Deep water fishing has never been well developed in East Timor, and this may be partly due to due to East Timor being under a monsoon regime, whose heavy rains and onshore winds make the conditions unfavorable for eexploiting open waters. From November to April, the amount of fish in the north coast declines and Atauro Island, the place where the more active fishers are found, is exposed to both the SE and NW monsoon winds (Cook, 2000; Pedersen and Arneberg, 1999). Therefore, East Timor's marine

fishery resource potential should be carefully considered in regards to the differences between inshore and offshore sources, and the factors that affect fisheries catches.

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