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A RECONSTRUCTION OF MARINE FISH CATCHES IN THE REPUBLIC OF GUATEMALA

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ABSTRACT

Guatemala is a small and impoverished Central American country with coastlines on both the Pacific Ocean and the Caribbean Sea. The fishing area on the Pacific side is the largest, with a continental shelf of 14,000 km² and an EEZ covering 93,000 km², whilst the Atlantic has more restrictions and less available fishing area due to a shorter coastline and territorial borders with Belize and Honduras. Fishing has occurred on an industrial scale since the mid-20th century, with the first fishing licenses granted to shrimpers in 1949. With little governance and poor regulation, the industry grew quickly and Guatemalan fisheries have been exhibiting signs of overfishing since the 1980s. This report reconstructs total fish catches for the time period 1950-2010, including unreported discards and artisanal catches that may have been left out of official reporting. We found that total reconstructed catches were 13.7 times the reported data, with the industrial sector accounting for 54.1% of the landings and industrial discards (from the shrimp fishery) contributing a further 11.7%. The artisanal sector contributes 31.6% of catches and subsistence 2.7%. In the Pacific, reconstructed catches were 13.2 times the reported total, and in the Atlantic 19.4 times. Under-reporting is a result of under- and non-reporting in all three sectors, which is due to a number of factors, including historically poor governance and a lack of proper industry infrastructure, as well as a high percentage of by-catch and discards from the industrial shrimp fishery. Coastal migration has also increased artisanal and subsistence fishing.

INTRODUCTION

Guatemala is a small country in Central America covering almost 110,000 km², bordered by Mexico in the north, Belize in the east, and Honduras and El Salvador in the southeast. The country also has coastlines on both the Pacific Ocean and the Caribbean Sea (Figure 1). The Pacific coastline is almost double the length of the Atlantic (FAO 2005).

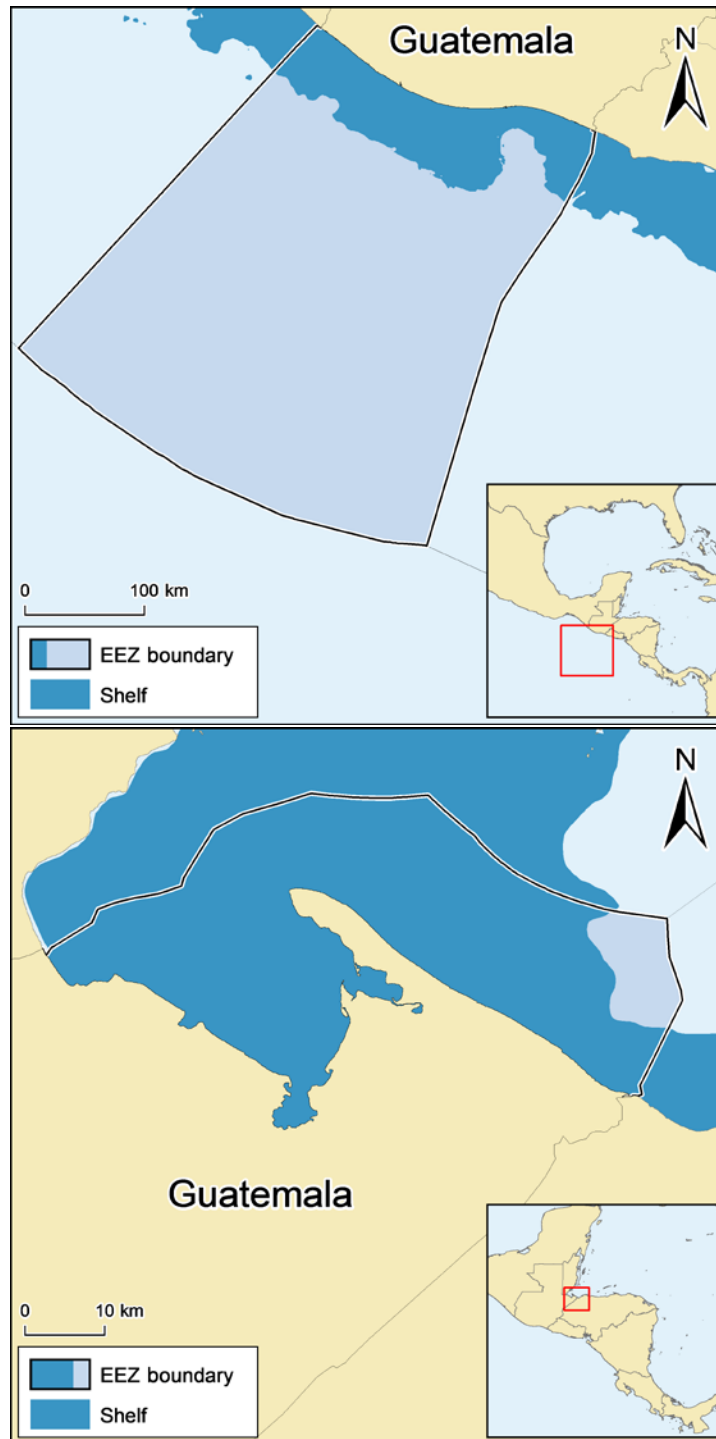


Figure 1. Exclusive Economic Zones (EEZ) and shelf waters (to 200 m depth) of Guatemala in a) the Pacific Ocean and b) The Caribbean Sea.

Fisheries are important to the country, providing food security, employment, nutrition and income, particularly in poorer areas (Velasco 2009). Despite the relatively small coastlines, Guatemala has an extensive EEZ, particularly on the Pacific coast, covering over 117,000 km² (www.seaaroundus.org). The continental shelf (to 200 m depth), where most fishing takes place, is much more extensive in the Pacific than the Atlantic, covering over 15,000 km². Due to the larger fishing area and having a greater

proportion of the coastal population (FAO 2000), Guatemala's fishing effort is largely focused on the Pacific, with mostly artisanal fishing occurring in the Atlantic, as industrial fishing is banned from the Bay of Amatique and limited to offshore areas (FAO 2000).

Reports on Guatemalan fisheries tend to categorize the fleet by size and power of vessel, dividing between large-, medium- and small-scale (FAO 2000, 2005; Velasco 2009; Anon No Date). Large-scale boats are classified as being of a Gross Registered Ton (GRT) greater than 30, 15-45 m long and motors over 200 hp, often with freezing capabilities and operating bottom and mid-water trawls, longlines and purse seines. Medium-scale boats have a GRT less than 30, a length between 9 and 17 m and an engine power between 80-200 hp, also operating bottom and mid water trawls (FAO 2000). Small-scale boats are between 3.5 and 10 m, with the larger ones operating engines up to 75 hp and the fleet utilizing a range of gears, including handlines, trawls, gillnets, beach nets and traps, depending on the target species (FAO 2000). Large- and medium-scale boats make up what is classified as the industrial sector, with small-scale vessels contributing to the artisanal sector. A recreational sports fishery also exists, targeting large pelagics such as sailfish (*Istiophorus platypterus*), but fishing is operated under a catch-and-release program, with minimal mortality (Velasco 2009).

Within the industrial sector, several fisheries exist, the primary one targeting shrimp species (Anon No Date). This incurs a high by-catch and discard rate, not accounted for in official reporting. Other fishing activities include targeting tuna, although the fishery only officially began in 1999, and a pelagic fishery commercially targeting 15 species, including sharks, dolphinfish, snappers and groupers (Velasco 2009; Anon No Date). A small crustacean fishery also exists (FAO 2000). Small-scale fishers also target the shrimp and pelagic fisheries.

Fisheries are currently regulated by the Ministry of Agriculture, Livestock and Food (MAGA), with management duties performed by The Fisheries and Aquaculture Management Unit (UNIPESCA) (López Paredes 2005). The first national-level management plan was laid out in 1932, through decree-law number 1235, Ley que Reglamenta la Piscicultura y la Pesca ("Law which Regulates Fish Farming and Fishing"). Although this had many legal gaps and was very general, alongside some amendments and additional regulations in the 1960s and 1980s that clarified licensing, it regulated fishing and aquaculture in the country for more than 70 years.

In 2002, the decree was replaced by the publication of the General Law Governing Fisheries and Aquaculture (LGPA) in 2002, which aimed to regulate fisheries and aquaculture activities, harmonizing them both with advances in science and to monitor and adapt fisheries for the rational utilization of 'hydrobiological resources in public waters' (Velasco 2009; FAO 2005). The LGPA only has one regulation, published in 2005, which specifies restrictions on gear, minimum landing sizes, and fishing areas (Velasco 2009). This regulation also includes 'The Gentleman's Pact', a collective 'co-management' agreement amongst Caribbean fishers to delineate fishing in the Amatique Bay and reduce gear conflicts (Andrade and Midré 2011).

As with many countries around the globe, Guatemala's fisheries have exhibited overfishing. For example, the Pacific shrimp fishery, which began in 1949 with 2 boats, quickly grew and was showing signs of overfishing by the 1980s. A maximum catch of around 3,200 t in 1995 fell to 500 t in 2005, remaining around that level for subsequent years (Velasco 2009).

Catch data are reported by Guatemala to the FAO, however, inconsistencies occur in these data due to a number of factors, such as inaccurate reporting, changes in the national data collection system, changes in species classification and incomplete identification (Garibaldi 2012). Additionally, FAO data do not include information on discards and often catches from small-scale sectors are not captured by the statistics, including some subsistence fisheries and most recreational fisheries (Pauly 2007; Garibaldi 2012). Therefore, in most cases, reported data likely underestimate the total amount of fish caught.

This report is an attempt to reconstruct the total fish catches in Guatemala and account for catch that is missing from the reported data. The reconstruction covers the time series 1950-2010 and includes

fisheries in both oceans, following a catch reconstruction approach outlined by Zeller *et al.* (2007). Estimations of domestic catches within the EEZ from the industrial, artisanal and subsistence sectors are made, including discards and unreported landings, and are compared to the catch data reported by the FAO.

METHODS

Official national data were compiled from a variety of sources (Table 1) and used as a basis for the reconstruction in both the Pacific and Atlantic Oceans (Ixquiác-Cabrera, pers. obs.). The information was incomplete for the whole time series; therefore gaps were filled by interpolation between anchor points. For other unreported components such as discards, additional literature sources were used. Please note that tuna catches from large-scale (i.e., industrial) commercial operations were not included here, as they are being reconstructed separately from a global perspective as part of the *Sea Around Us*.

Table 1. Sources of catch data for industrial and artisanal fisheries in Guatemala, 1950-2010

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- No. 1 Bulletin of Fisheries Statistics and No.3 General Directorate of Renewable Natural Resources. Division of Wildlife. Department of Fisheries. Guatemala. C. A. Ministry of Agriculture, 1970
 - Evaluation of Penaeid Shrimp Fishery of, UNIPESCA/MAGA – Union of Exporters, Guatemala, 1999
 - Statistical Bulletin of Fisheries and Aquaculture 1991-2001, UNIPESCA-MAGA, 2003
 - Landing database of industrial shrimp fleet, DIPESCA, 2013
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Pacific

Industrial

With the exception of shrimp species, very few taxa were reported in the available national data before the 1990s. To reconstruct the Pacific industrial fisheries, shrimp species were treated separately, and 1991 was selected as an ‘anchor point’, as it was the earliest year most non-shrimp taxa were included.

Total industrial catch (shrimp excluded) was assumed to be zero tonnes in 1945 and a linear increase to the total in 1991 was applied. In order to apply a species breakdown to the newly estimated non-shrimp industrial catch, the general method used was to calculate the species composition in 1991 and apply it to the years 1950-1990. However, there were a few taxa with reported tonnages during this time period (1950-1990), and therefore these tonnages were taken into account first, with the 1991 breakdown being adjusted as necessary.

Shrimp fishery

Shrimp landings were recorded from 1960 onwards; however, the Pacific fishery has existed since 1949 when two boats were given licenses (Velasco 2009). Therefore, a catch of zero tonnes was assumed in 1949 and a linear extrapolation of the annual catch applied back from 1960. The species composition of the shrimp catch in 1960 was applied to the estimated annual catch of shrimp for each year from 1950-1959.

Artisanal

The same methods for estimating the annual industrial catches were applied to the artisanal fisheries, with 1992 used as the anchor point.

Subsistence

A *per capita* catch-derived subsistence consumption rate was estimated by assuming that a catch equal to 5% of the 2010 total artisanal catch was derived as subsistence catch by the total population of Guatemala in that year (www.populstat.info; World Bank). It was assumed that this 2010 subsistence consumption rate of 68.3 kg·person⁻¹·year⁻¹ was twice as high in 1950 (i.e., 136.6 kg·person⁻¹·year⁻¹), and a linear interpolation of the rate was applied between 1950 and 2010. Subsistence catch was estimated by applying the *per capita* rate against the total population each year. The species breakdown of the artisanal catch in each year was applied.

Atlantic

Reports on fishing in the Guatemalan Caribbean indicate that almost all fishing in the Atlantic zone is artisanal, with no industrial fishing permitted in the Bay of Amatique (FAO 2000). However, for the purposes of this reconstruction, any fishing activity using a trawl was considered to be industrial (Martín 2012). Therefore, although reported as artisanal, all shrimp reported landings were categorized as industrial.

Industrial

Reported catches were only available starting in 1994 so the Atlantic shrimp fishery was also assumed to have started in 1949 and the same extrapolation methods to determine annual catch as for the Pacific fishery applied.

Artisanal

As in the Pacific, national catch data for the Atlantic artisanal fishery were unavailable until the 1990s. The same technique from the Pacific reconstruction was employed to carry back catches to 1950, with shrimp catches removed and species proportions from 1994 used to estimate the catch composition.

Subsistence

The same method as for the Pacific subsistence fishery were applied. Catch composition was calculated using the same species breakdown present in the artisanal catch.

Both oceans

By-catch and discards

By-catch was calculated for the shrimp fisheries using ratios for Caribbean countries determined by Lopez (1999). The estimation of a 1:19 shrimp to by-catch rate for the Guatemalan Pacific fishery was assumed to be too high, so a more conservative figure of 1:10.22 was obtained by calculating the mean by-catch rate of neighboring Central American countries with Pacific shrimp fisheries. An estimate for the Atlantic fishery in Guatemala did not exist, so the average by-catch ratio of 1:4.63 from other Caribbean shrimp fisheries was used.

Lopez (1999) calculated a 20% by-catch discard rate for Guatemala, which was applied to the by-catch for both oceans. Thus, retained by-catch (i.e., 80% of total by-catch) was treated as unreported landings.

As no specific information on the Guatemalan shrimp fishery in either ocean was available, information on by-catch and discard species composition from Costa Rica (Trujillo *et al.* 2012) was used to disaggregate species in the Pacific catch, whilst data from Belize (FAO 1968) was used to estimate the Atlantic species breakdown.

Species composition

In both the Pacific and Atlantic fisheries, a large proportion of the reported artisanal catch (97.4% of the Pacific and 46.8% of the Atlantic artisanal catch) was categorized as 'fish in general'. This high uninformative category was disaggregated into taxa using a proportional estimate constructed for each ocean using local information on targeted species (Ixquiác-Cabrera, pers. obs.) and data from the reported industrial catch.

Recreational

As sports fishing in the country is mostly catch and release, the contribution of recreational fisheries to Guatemala's overall retained catch was deemed to be negligible and not included in the reconstruction.

RESULTS

Pacific

The total Pacific reconstructed catch for Guatemala was 13.3 times the FAO reported landings for the same time period (Figure 2a). The catch trend was characterized by several large fluctuations.

The industrial sector contributed the most to the catch, with 57.1% of the total reconstructed landings. Artisanal catches made up 28.2%, with the subsistence sector contributing 2.3%. The discards of the shrimp fishery (also from the industrial sector) made up 12.4% (Figure 2a).

Total catches grew steadily from 2,400 t in 1950 to 49,000 t in 1981. With some large fluctuations, catches remained relatively stable throughout the 1980s, increasing again throughout the 1990s to a high of almost 69,000 t in 1996. Catches thereafter began to decline, amounting to only 24,700 t in 2009, but immediately increased again to 43,800 t in 2010 (Figure 2a).

Cusk-eels (Ophidiidae, 23.9%) and drums and croakers (Sciaenidae, 18.5%) made up more than 40% of the Pacific total catch (Figure 2b), followed by snappers (Lutjanidae, 13.4%), Penaeidae (7.3%; *Xiphopenaeus kroyeri*, 3.6%), and grunts (Haemulidae, 7.3%). As well, other crustaceans (excluding Penaeidae) contributed 8.9% to the catch.

Pacific industrial

Total catches in the industrial sector over the time period amounted to approximately 1.28 million t, which contributed 69.5% of the total catch in the Pacific (Figure 2a; 57.1% being landings and 12.4% discards). Discards from the shrimp fishery totaled 229,000 t or 17.9% of the total industrial catch. Overall, catches increased over the time period with a high degree of annual fluctuation, rising from 1,200 t in 1950 to 42,100 t in 1981. Catches remained variable throughout the 80s and 90s, dropping to a low of less than 18,200 t in 1987, but rapidly rising to a high of 56,800 t in 1996. The reconstruction exhibited a sharp drop to 19,100 t the next year 1997, followed by an immediate recovery to 54,300 t in 1998. Catches then declined to 7,200 t 2009, and again recovered to 23,300 t in 2010.

Elements of the shrimp fishery by-catch were the biggest contributor to the overall industrial catch, with cusk-eels and drums and croakers making up almost 60% (34.4% and 24.9%, respectively). Targeted shrimp species were 8.8% of the industrial catch, or 12.5% of the sector total including discards. Of the shrimp species, *Xiphopenaeus kroyeri* (Atlantic seabob) was the most prevalent, making up 42% of the shrimp catch, although only 5.2% of the total industrial catch. Snappers (6.9%) were another large contributor, as were other crustaceans (17.0%, excluding the seabob).

Pacific artisanal

The artisanal sector made up 28% of the total Pacific catch (Figure 2a). The reconstructed catch rose steadily from 870 t in 1950 to over 11,000 t in 1996. Catches then showed a sharp increase to 25,000 t in 2002, tailing off to an average of 19,000 t-year⁻¹ over the last 5 years of the reconstruction. Snappers (28.4%) were the most important taxa, followed by grunts (21.4%).

Pacific subsistence

Subsistence catches were small, totaling 43,000 t and contributing only 2.3% of the Pacific catch (Figure 2a). Catches showed a steady increase from 380 t in 1950 to 980 t in 2010.

Atlantic

Although the Atlantic catch was much smaller than the Pacific, the discrepancy between the reconstruction and reported catch within the Atlantic was much greater, with the reconstruction estimating a total catch 19.4 times the data reported by FAO for the same time period (Figure 3a). Catches steadily increased from 360 t in 1950 to 3,800 t in 1994, after which the rate of increase grew faster, with catches reaching to 6,700 t in 2001 and maintaining an average 6,200 t-year⁻¹ throughout the 2000s (Figure 3a).

Anchovies (Engraulidae) were overwhelmingly dominant in the catch, making up 59.4%. Mojarras (Gerreidae, 11.2%) were the second most prevalent, followed by snappers (Lutjanidae, 7.7%), cusk-eels (Ophidiidae, 5.5%) and shrimps (Penaeidae, 5.3%; Figure 3b).

Atlantic industrial

The Atlantic industrial sector only included the Penaeidae shrimp fishery and was a relatively small component of fishing in the Atlantic, contributing 29.5% to the total catch (24.6% landings and 4.9% discards; Figure 3a). Discards totaled 16.5% of the industrial catch. Catches grew steadily from 40 t in 1950 to a peak of 2,100 t in 1998, after which there was a sharp decrease to 640 t in 2004. Between 2004 and 2010, catches showed some recovery, increasing again to a peak of 1,600 t in 2008.

Penaeidae shrimp landings contributed only 17.5% of the industrial catch, with by-catch and discards contributing over 80%. Mojarras (Gerreidae) made up 38.1% of the total industrial catch (46% of the discards), with cusk eels (Ophidiidae, 18.6% of total industrial catch) and snappers (Lutjanidae; 18.6% of total industrial catch) also making large contributions (Figure 3b).

Atlantic artisanal

The artisanal sector contributed the most to the Atlantic catch, with 64.8% of the overall reconstruction (Figure 3a). Catches increased consistently from 220 t in 1950 to 2,200 t in 1994, before increasing more rapidly throughout the 1990s. Catches leveled off in the 2000s, at an average of over 4,800 t-year⁻¹.

The catch was dominated by anchovies (Engraulidae), which made up 84%. The next largest taxa were snappers (Lutjanidae), grunts (Haemulidae) and catfish (Ariidae), contributing only 3.1% of the catch each.

Atlantic subsistence

Subsistence catches made up 5.8% of the total reconstructed catch (Figure 3a). Annual catches grew steadily throughout the time period from 97 t in 1950 to 250 t in 2010.

Reconstructed total catch

The overall reconstructed catch for Guatemalan fisheries (both coasts combined) for 1950-2010 was 13.7 times the data reported by FAO on behalf of Guatemala (Figure 4a). Catches grew relatively steadily from 2,800 t in 1950 to 51,900 t in 1981, with a fluctuating pattern throughout the 1960s and 1970s. Catch growth levelled out during the 1980s, with fish removals averaging 40,400 t·year⁻¹, before growing quickly during the 1990s, to 73,700 t in 1996. Overall removals then began to decline, with some significant fluctuations between years, reaching a lowest point of 30,900 t in 2009. However, in the following year catches increased by two thirds to 50,300 t (Figure 4a).

Cusk-eels (22.2%), drums and croakers (16.8%) and snappers (12.9%) were the most prevalent taxa making up over half of the total catch (Figure 4b). Shrimp (7.1%, Atlantic seabob 3.3%), grunts (6.7%), and anchovies (5.5%) were other major contributors.

Industrial catches for the whole of Guatemala amounted to almost 1.34 million t and made up 65.8% of the total catch (Figure 4a). Discards from the shrimp fishery contributed 17.8% of the total industrial catch. Catches fluctuated greatly during the time period, peaking every 2 or 3 years, followed by an immediate sharp decrease. Overall, however, there was a general growth from 1,200 t in 1950 to a high of 58,500 t in 1996. After 1996, catches continued to fluctuate in a steady downward trend, with peaks in 1998, 2003 and 2010 (Figure 4a).

Reconstructed artisanal catch totaled 641,000 t for the time period and was 31.6% of the total catch (Figure 4a). Catches grew consistently between 1950 (1,090 t) and 1995 (11,400 t) before increasing much more quickly to over 29,600 t in 2002. Catches fluctuated throughout the 2000s, decreasing slightly, but with another peak of almost 30,000 in 2005, remaining generally high with an average of more than 25,000 t·year⁻¹ for the period 2003-2010 (Figure 4a).

The total reconstructed subsistence catch was 54,000 t, constituting 2.7% of the total catch, and grew consistently from 480 t in 1950 to 1,230 t in 2010 (Figure 4a).

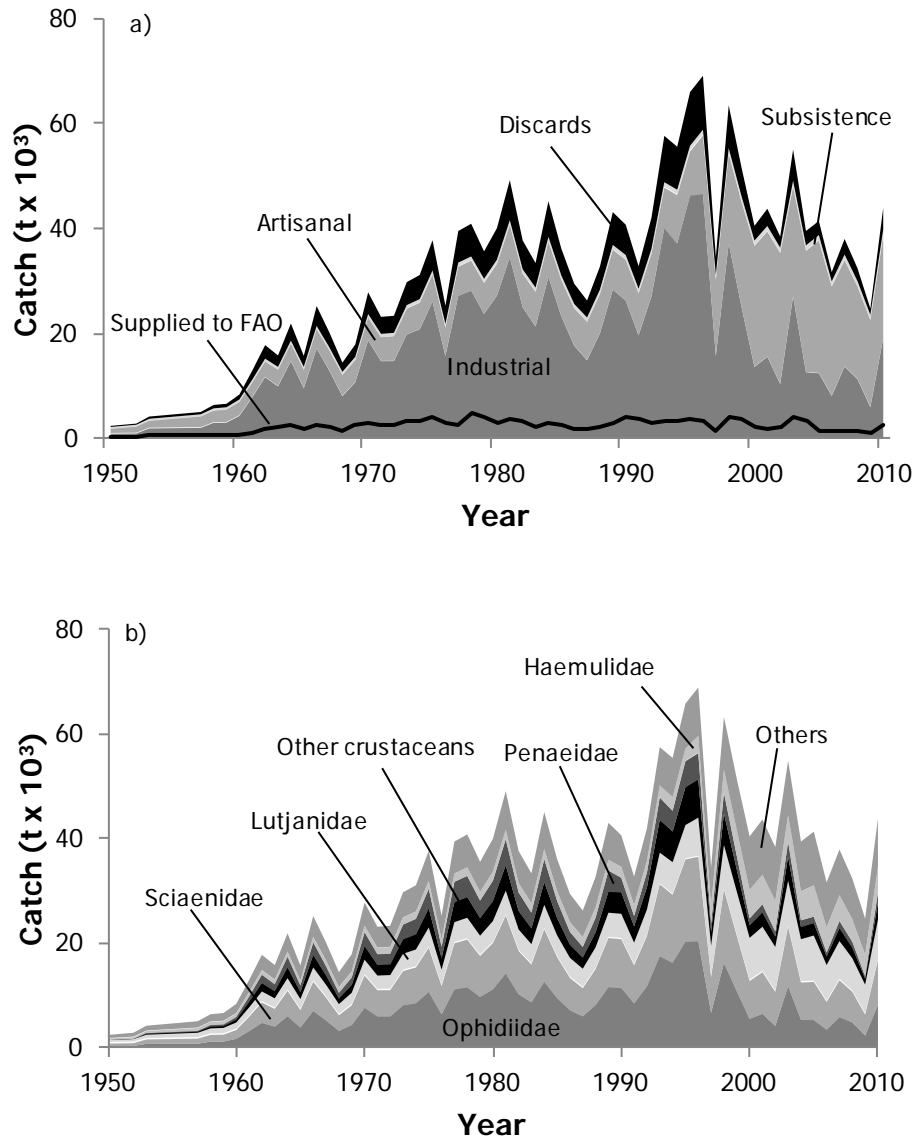


Figure 2. Reconstructed Guatemalan fisheries catch estimate in the Pacific, 1950-2010, a) by sector, with data reported by FAO overlaid as a line graph, and discards shown separately; and b) by major taxa. 'Others' includes 64 additional taxonomic categories.

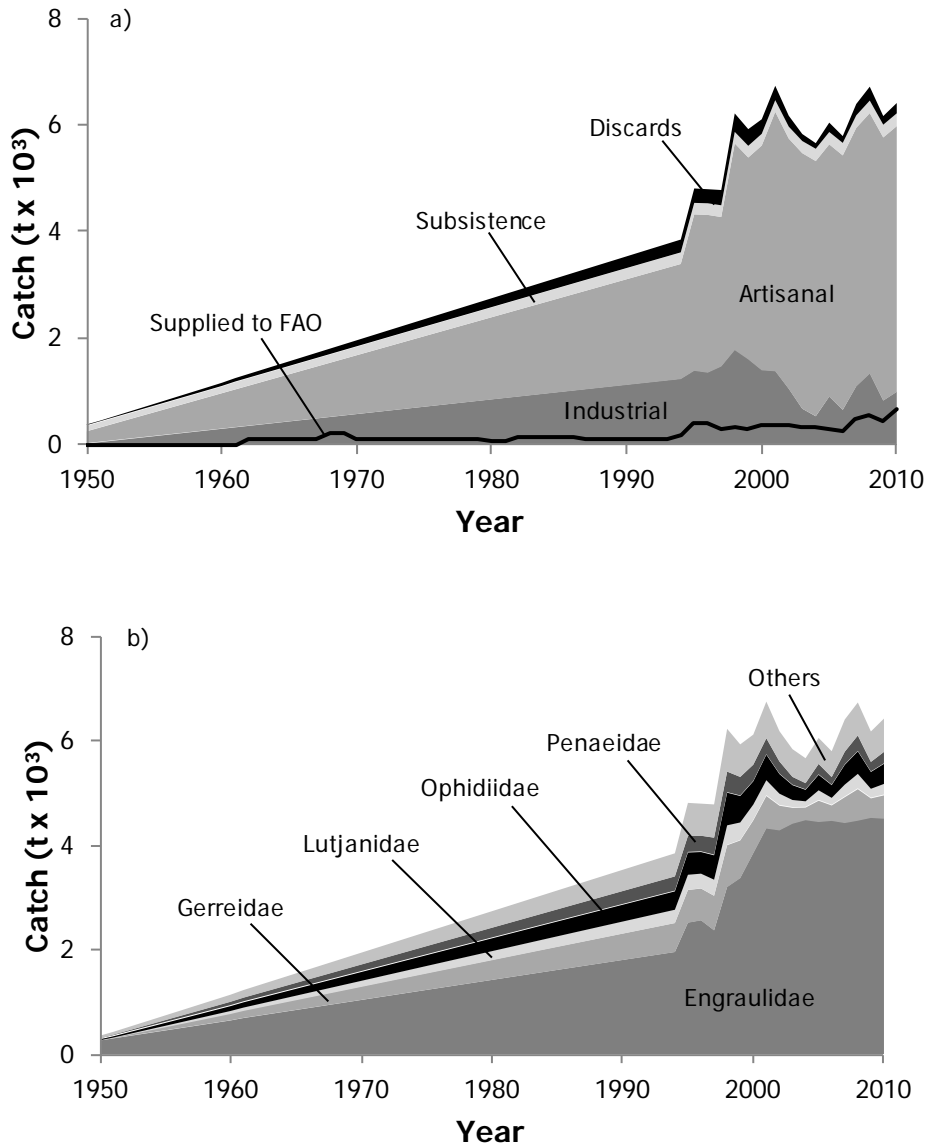


Figure 3. Reconstructed Guatemalan fisheries catch estimate in the Atlantic, 1950-2010, a) by sector, with data reported by FAO overlaid as a line graph, and discards shown separately; and b) by major taxa. 'Others' includes 17 additional taxonomic categories.

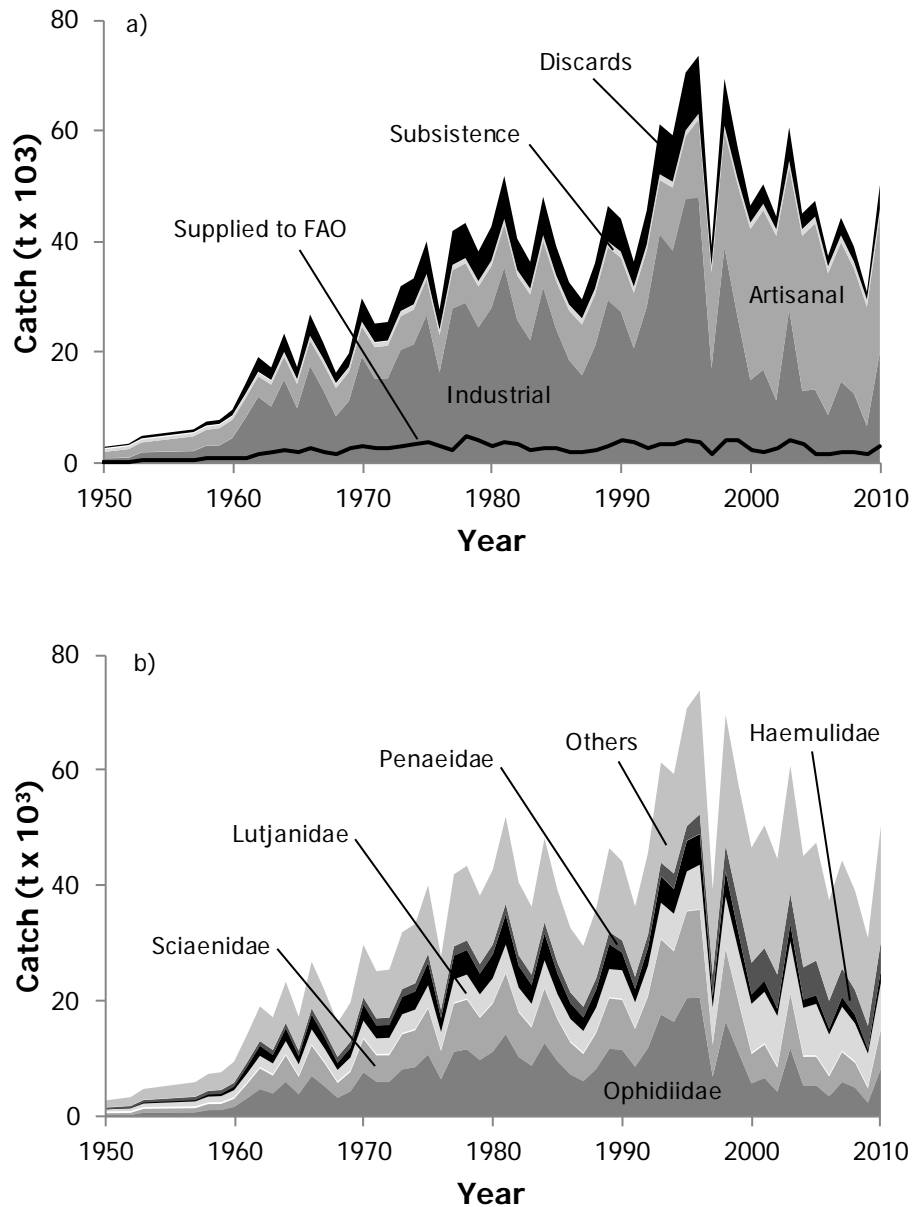


Figure 4. Reconstructed Guatemalan fisheries catch estimate in the combined Pacific and Atlantic, 1950-2010, a) by sector, with data reported by FAO overlaid as a line graph, and discards shown separately; and b) by major taxa. 'Others' includes 83 additional taxonomic categories.

DISCUSSION

Guatemala is a poor country that places little emphasis on regulation of its marine fisheries, and as a result, has large industrial and artisanal fisheries that are mostly unaccounted for. Our reconstruction demonstrates a total catch for 1950-2010 that is more than 13 times the tonnage reported by the FAO on behalf of Guatemala. Although the industrial sector dominates, with 54% of the landings, there is also a large artisanal sector, which became increasingly more dominant in the later part of the time period, with almost 70% of the total catch during parts of the 2000s.

The total catch grew steadily throughout the time period until the late 1990s, in line with the population growth throughout the same time period. The large contribution of the artisanal fishery is unsurprising for a developing country, where small-scale fisheries provide a critical source of employment and food, and poorly regulated fisheries offer easy access to alternative employment (Defeo and Castilla 2005). The growing coastal population, which has seen a faster growth rate in poorer rural areas (CIESIN 2012), would find artisanal fishing an attractive option if land-based employment opportunities were unavailable and could not support the growing population.

The stall of overall catch increases in the late 1990s and subsequent decline through the late 2000s indicates that, like the majority of fisheries across the world, Guatemalan fisheries are suffering from overfishing. The country's population continued to increase, as most likely did the effort from artisanal fisheries, but catch returns declined. Overfishing in Guatemala was noticed as early as the 1980s, with indications observed in the Pacific shrimp fishery (Velasco 2009). In the Atlantic, an influx of migrants to the Caribbean coast has been blamed for increasing fishing pressure beyond stock capacity and resulting in diminishing landings (Andrade and Midré 2011). A lack of regulation enforcement may also contribute to the overfishing and a greater proportion of catches being unreported by unlicensed fishers. In the Caribbean shrimp fishery, fishers estimate that although there are less than 20 boats with licenses, there are at least 60 trawlers operating, with new entrants undeterred by the licensing regulations due to a lack of enforcement (Andrade and Midré 2011).

Although the catch largely grew over the time period, the reconstruction suggested a high degree of fluctuation between years, which may in part be as a result of unreliable catch data. Fisheries governance in Guatemala is complex, and until relatively recently with the enactment of the LGPA in 2002, was open to a large number of loop holes (Velasco 2009). Available national reporting data comes from a number of sources (Table 1), rather than a consistent, unilateral one. As such, the availability of consistent data for several species was patchy, in many cases missing various years or only covering a part of the time series (Ixquiac-Cabrera, Pers. Obs.). Other factors, such as overfishing or seasonal climate anomalies (e.g., El Niño), may also contribute to the annual variations.

That the total reconstructed Atlantic catch was more than 19 times larger than the reported FAO data demonstrates the lack of regulation in the region, as well as the degree of potential overfishing occurring. Guatemala as a whole lacks organized fishing harbor facilities for either the industrial or artisanal sectors, making accurate reporting of fish that is processed through them extremely difficult (FAO 2000, 2005). The majority of fish is landed either through privately built wharfs, or wherever boats can be landed, with only a minority passing through the dilapidated naval or commercial port facilities (FAO 2000). Compounding the issue, many artisanal fishers, such as the local Garifuna on the Atlantic coast, will sell their catch directly on the beach (Andrade and Midré 2011), thus completely bypassing any monitoring option.

Although it was not estimated by the reconstruction, Guatemalan fishers are also known to fish outside of the Atlantic EEZ in the EEZ waters of Belize, including in an area of territorial uncertainty (Andrade and Midré 2011). Guatemalans are reported to account for 12% of fisheries offences caught by Belizean authorities, including gear and closed area infractions (Belize Government 2005).

Fisheries management is of low political priority and only has a small budget, despite its national importance (Velasco 2009). Although there have been recent attempts to improve the laws and regulations governing fisheries, there appears to be little political will to support effective enforcement. However, more effective enforcement of current regulations and better systems of recording catch data, including artisanal fisheries would certainly improve management, lower illegal and unreported catches and reduce the discrepancy between the reported and reconstructed catch profiles.

ACKNOWLEDGEMENTS

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Appendix Table A1. FAO landings vs reconstructed total catch (in tonnes), and catch by sector with discards shown separately for Guatemala Pacific, 1950-2010.

Year	FAO landings	Reconstructed total catch	Artisanal	Industrial	Subsistence	Discards
1950	200	2,444	869	986	381	209
1951	200	2,662	1,042	1,015	392	213
1952	200	2,877	1,216	1,043	400	217
1953	500	4,215	1,390	1,990	410	426
1954	500	4,431	1,564	2,019	419	430
1955	600	4,647	1,737	2,047	428	434
1956	600	4,863	1,911	2,076	438	438
1957	601	5,079	2,085	2,105	447	442
1958	800	6,418	2,258	3,051	457	651
1959	800	6,634	2,432	3,080	467	655
1960	800	8,391	2,606	4,367	478	940
1961	1,100	12,935	2,780	7,903	528	1,725
1962	1,700	17,775	2,953	11,713	537	2,571
1963	2,100	15,817	3,127	9,964	547	2,180
1964	2,400	21,876	3,301	14,771	556	3,248
1965	1,800	15,735	3,475	9,600	566	2,094
1966	2,600	25,190	3,648	17,184	576	3,781
1967	2,100	20,118	3,822	12,888	586	2,822
1968	1,500	14,451	3,996	8,105	596	1,755
1969	2,400	17,891	4,169	10,769	606	2,346
1970	2,900	27,792	4,343	18,718	617	4,114
1971	2,700	23,137	4,517	14,762	627	3,231
1972	2,600	23,339	4,691	14,778	638	3,232
1973	3,100	29,741	4,864	19,865	649	4,363
1974	3,253	31,072	5,038	20,804	660	4,570
1975	3,880	37,687	5,212	26,066	670	5,740
1976	2,979	25,243	5,386	15,740	680	3,438
1977	2,374	39,432	5,559	27,196	689	5,987
1978	4,824	40,808	5,733	28,173	699	6,203
1979	4,183	35,569	5,907	23,741	708	5,213
1980	3,057	39,973	6,080	27,195	717	5,981
1981	3,805	49,081	6,254	34,495	727	7,605
1982	3,413	37,646	6,428	24,995	737	5,486
1983	2,186	33,355	6,602	21,337	747	4,669
1984	2,759	45,083	6,775	30,780	757	6,770
1985	2,510	36,101	6,949	23,287	766	5,099
1986	1,849	29,443	7,123	17,694	776	3,851
1987	1,808	26,248	7,297	14,934	784	3,234
1988	2,250	32,696	7,470	20,060	793	4,373
1989	2,998	43,019	7,644	28,355	801	6,219
1990	4,195	40,643	7,818	26,264	810	5,751
1991	3,634	32,754	7,991	19,674	818	4,271
1992	2,776	41,950	8,165	27,052	827	5,906
1993	3,262	57,496	7,744	40,118	836	8,798
1994	3,256	55,434	9,296	37,133	844	8,161
1995	3,838	65,821	8,457	46,320	853	10,191
1996	3,263	68,900	11,197	46,608	861	10,235
1997	1,490	34,483	14,539	15,716	869	3,359
1998	3,996	63,296	17,089	37,191	876	8,139
1999	3,760	51,414	20,114	24,987	885	5,428
2000	2,101	40,420	23,056	13,678	893	2,794
2001	1,750	43,655	23,897	15,587	902	3,269
2002	2,268	38,386	24,944	10,419	911	2,112
2003	3,936	54,896	20,953	27,097	920	5,926
2004	3,135	39,435	23,135	12,654	929	2,716
2005	1,340	41,340	25,255	12,474	938	2,673
2006	1,464	31,633	20,763	8,169	947	1,754
2007	1,554	37,918	20,286	13,723	955	2,954
2008	1,446	32,371	17,611	11,352	963	2,444
2009	1,109	24,721	16,527	6,028	972	1,195
2010	2,422	43,840	19,595	19,143	980	4,122

Appendix Table A2. Primary taxa (in tonnes) of Guatemalan Pacific fisheries.

Year	Ophidiidae	Sciaenidae	Lutjanidae	Crustacea	Penaeidae	Haemulidae
1950	389	466	428	157	138	278
1951	397	498	483	164	140	318
1952	404	530	536	171	143	358
1953	793	850	663	306	281	409
1954	801	881	717	312	283	449
1955	809	913	771	319	286	488
1956	816	945	825	325	289	528
1957	824	977	879	332	292	568
1958	1,213	1,297	1,006	467	429	619
1959	1,221	1,329	1,060	473	432	659
1960	1,753	1,681	1,212	656	619	701
1961	3,217	2,755	1,553	1,160	1,137	781
1962	4,796	3,906	1,904	1,698	1,695	854
1963	4,065	3,409	1,817	1,458	1,437	877
1964	6,059	4,855	2,248	2,136	2,141	960
1965	3,906	3,349	1,893	1,405	1,381	954
1966	7,053	5,619	2,543	2,472	2,493	1,063
1967	5,264	4,369	2,256	1,872	1,861	1,063
1968	3,273	2,978	1,933	1,200	1,157	1,060
1969	4,375	3,791	2,195	1,574	1,547	1,125
1970	7,674	6,168	2,874	2,689	2,712	1,237
1971	6,026	5,019	2,617	2,138	2,130	1,240
1972	6,029	5,038	2,690	2,143	2,131	1,275
1973	8,138	6,570	3,140	2,857	2,876	1,362
1974	8,524	6,871	3,266	2,990	3,013	1,410
1975	10,706	8,460	3,716	3,728	3,784	1,502
1976	6,412	5,421	2,961	2,286	2,266	1,445
1977	11,167	8,840	3,910	3,891	3,947	1,591
1978	11,569	9,156	4,030	4,030	4,089	1,642
1979	9,724	7,869	3,725	3,412	3,437	1,642
1980	11,154	8,910	4,061	3,897	3,943	1,711
1981	14,183	11,102	4,674	4,921	5,013	1,821
1982	10,232	8,313	3,970	3,594	3,617	1,774
1983	8,708	7,252	3,735	3,085	3,078	1,780
1984	12,627	10,071	4,534	4,408	4,463	1,905
1985	9,510	7,870	4,005	3,362	3,361	1,873
1986	7,182	6,214	3,670	2,581	2,539	1,848
1987	6,032	5,402	3,543	2,197	2,132	1,852
1988	8,157	6,950	3,983	2,917	2,883	1,942
1989	11,599	9,429	4,692	4,079	4,100	2,057
1990	11,438	9,357	4,723	4,186	2,814	2,089
1991	8,494	7,315	4,172	3,158	2,089	2,086
1992	11,746	9,668	4,917	4,302	2,889	2,198
1993	17,497	13,794	5,956	6,320	4,304	2,311
1994	16,230	13,046	6,152	5,908	3,993	2,637
1995	20,268	15,770	6,511	7,295	4,986	2,431
1996	20,356	16,191	7,418	7,394	5,008	3,320
1997	6,681	6,833	5,891	2,675	1,644	3,640
1998	16,187	14,086	8,447	6,090	3,982	4,377
1999	10,795	10,662	8,322	4,256	2,656	4,979
2000	5,556	7,241	8,105	2,478	1,367	5,444
2001	6,502	8,003	8,530	2,822	1,599	5,634
2002	4,201	6,536	8,419	2,050	1,033	5,882
2003	11,785	11,396	8,682	4,613	2,899	5,159
2004	5,401	7,116	8,126	2,422	1,329	5,547
2005	5,315	7,323	8,708	2,439	1,307	5,978
2006	3,488	5,335	6,864	1,689	858	4,824
2007	5,876	7,066	7,338	2,532	1,445	4,921
2008	4,861	5,901	6,234	2,100	1,196	4,277
2009	2,376	4,016	5,519	1,216	584	4,065
2010	8,198	8,601	7,567	3,326	2,017	4,868

Appendix Table A3. FAO landings vs. total reconstructed catch (in tonnes), and catch by sector with discards shown separately for Guatemala Atlantic, 1950-2010.

Year	FAO landings	Reconstructed total catch	Industrial	Artisanal	Subsistence	Discards
1950	0	350	20	220	97	13
1951	0	430	55	265	100	11
1952	0	509	82	309	102	16
1953	0	588	109	353	104	21
1954	0	667	136	397	107	27
1955	0.25	746	164	441	109	32
1956	0.25	825	191	485	111	38
1957	0.25	904	218	529	114	43
1958	0.25	983	245	573	116	48
1959	0.25	1,063	273	617	119	54
1960	0.25	1,142	300	661	122	59
1961	0.25	1,232	327	706	134	64
1962	100	1,311	354	750	137	70
1963	100	1,390	382	794	139	75
1964	100	1,469	409	838	142	80
1965	100	1,548	436	882	144	86
1966	100	1,627	464	926	147	91
1967	100	1,707	491	970	149	97
1968	200	1,786	518	1,014	152	102
1969	200	1,865	545	1,058	154	107
1970	100	1,945	573	1,102	157	113
1971	100	2,024	600	1,147	160	118
1972	100	2,104	627	1,191	163	123
1973	100	2,183	654	1,235	165	129
1974	100	2,263	682	1,279	168	134
1975	100	2,342	709	1,323	171	140
1976	100	2,421	736	1,367	173	145
1977	100	2,500	763	1,411	176	150
1978	100	2,579	791	1,455	178	156
1979	100	2,658	818	1,499	180	161
1980	50	2,738	845	1,543	183	166
1981	50	2,817	872	1,587	185	172
1982	150	2,896	900	1,632	188	177
1983	150	2,975	927	1,676	190	182
1984	150	3,055	954	1,720	193	188
1985	150	3,134	982	1,764	195	193
1986	150	3,213	1,009	1,808	197	199
1987	95	3,292	1,036	1,852	200	204
1988	82	3,371	1,063	1,896	202	209
1989	82	3,450	1,091	1,940	204	215
1990	100	3,528	1,118	1,984	206	220
1991	100	3,607	1,145	2,028	208	225
1992	100	3,686	1,172	2,073	211	231
1993	92	3,765	1,200	2,117	213	236
1994	179	3,844	1,227	2,161	215	241
1995	390	4,808	1,383	2,936	217	272
1996	390	4,794	1,347	2,962	219	265
1997	285	4,779	1,463	2,807	221	288
1998	328	6,223	1,770	3,882	223	348
1999	292	5,927	1,596	3,791	225	314
2000	366	6,113	1,392	4,220	227	274
2001	360	6,744	1,374	4,870	230	270
2002	345	6,180	1,043	4,699	232	205
2003	330	5,835	672	4,797	234	132
2004	315	5,662	532	4,788	237	105
2005	304	6,049	898	4,736	239	177
2006	264	5,796	651	4,776	241	128
2007	483	6,401	1,090	4,853	243	215
2008	536	6,727	1,329	4,892	245	261
2009	428	6,173	824	4,940	247	162
2010	647	6,419	986	4,990	249	194

Appendix Table A4. Primary taxa (t in tonnes) of Guatemalan Atlantic fisheries.

Year	Engraulidae	Gerreidae	Lutjanidae	Ophidiidae	Penaeidae	Others
1950	261	20	16	6	6	48
1951	300	25	24	12	12	57
1952	338	37	32	18	18	66
1953	376	50	39	24	23	75
1954	414	62	47	30	29	84
1955	453	75	54	36	35	93
1956	491	87	62	42	41	102
1957	529	99	69	48	47	111
1958	568	112	77	55	53	120
1959	606	124	85	61	59	129
1960	645	137	92	67	64	138
1961	691	149	100	73	70	148
1962	730	161	108	79	76	157
1963	768	174	115	85	82	166
1964	806	186	123	91	88	175
1965	845	199	130	97	94	184
1966	883	211	138	103	100	193
1967	921	224	146	109	105	202
1968	960	236	153	115	111	211
1969	998	248	161	121	117	220
1970	1,037	261	168	127	123	229
1971	1,075	273	176	133	129	238
1972	1,114	286	184	139	135	247
1973	1,152	298	191	145	141	255
1974	1,191	311	199	151	146	264
1975	1,229	323	206	158	152	273
1976	1,268	335	214	164	158	282
1977	1,306	348	221	170	164	291
1978	1,344	360	229	176	170	300
1979	1,382	373	237	182	176	309
1980	1,421	385	244	188	182	318
1981	1,459	398	252	194	187	327
1982	1,498	410	259	200	193	336
1983	1,536	422	267	206	199	345
1984	1,574	435	275	212	205	354
1985	1,613	447	282	218	211	363
1986	1,651	460	290	224	217	372
1987	1,689	472	297	230	223	381
1988	1,727	484	305	236	228	390
1989	1,765	497	312	242	234	399
1990	1,803	509	320	248	240	407
1991	1,841	522	328	255	246	416
1992	1,879	534	335	261	252	425
1993	1,917	547	343	267	258	434
1994	1,956	559	350	273	264	443
1995	2,519	630	424	307	297	631
1996	2,564	614	413	299	289	615
1997	2,372	666	465	325	314	637
1998	3,203	806	622	393	380	818
1999	3,374	727	505	355	343	623
2000	3,853	634	443	309	299	575
2001	4,330	626	486	305	295	701
2002	4,295	475	374	232	224	580
2003	4,423	306	282	149	144	530
2004	4,491	243	218	118	114	477
2005	4,456	409	295	199	193	497
2006	4,478	296	242	145	140	495
2007	4,436	497	377	242	234	615
2008	4,482	605	428	295	285	631
2009	4,535	375	320	183	177	582
2010	4,519	449	383	219	212	637