Fisheries Centre

The University of British Columbia

Working Paper Series

Working Paper #2015 - 23

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Year: 2015

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Abstract

Countries voluntarily report their fisheries catches to the Food and Agriculture Organization (FAO) since 1950; however in most cases these figures are under-representations of actual marine fisheries catches for a variety of reasons. Nicaragua has had a difficult political and economic past, and in this context, it is likely that its fisheries catches have not been well reported. Our catch reconstruction illustrates that total marine fisheries catches by Nicaragua within the Nicaragua EEZ are around 3.4 times the data reported by the FAO on behalf of Nicaragua for the 1950-2010 time period. This is largely due to discards from shrimp trawling fleets that are not accounted for in official records, and, given the ecosystem focus of modern fisheries policy and management, illustrates the importance of accounting for all fisheries catches, rather than only landed catches.

Introduction

Nicaragua lies in the heart of Central America, with Honduras to the north, Costa Rica to the south, the Caribbean Sea to its east, and the Pacific Ocean to its west (Figure 1). It is the largest country in Central America, with a land area of approximately 130,000 km², and an Exclusive Economic Zone (EEZ) of around 127,500 km² (www.seaaroundus.org). The name Nicaragua stems from *Nicarao*, the name of the chief of a group of indigenous peoples living near the Pacific coast in the 16th century, and *agua* which is Spanish for water (Staten 2010).

Figure 1. Map of Nicaragua's EEZ, showing both Pacific and Caribbean areas.

Nicaragua contains three main geographic regions. The Pacific coastal region is the most economically developed (most of Nicaragua's population live there), and the coastal plains' volcanic soils support the country's commercial agricultural production of coffee, cotton and sugar (Staten 2010). The Caribbean lowlands comprise more than half of the country's land area, but support less than 10% of the population; the high rainfall, tropical rainforests and swamps, and frequent flooding and storms have earned this region the name 'Mosquito Coast' (Staten 2010). The central mountains run north-west to south-east, and are also an ideal location for much of the country's coffee production (Staten 2010). Nicaragua contains the two largest lakes in Central America, Lake Managua and Lake Nicaragua, the latter of which was originally considered for the site of the cross-isthmus canal prior to it being established in Panama (Staten 2010).[1] Lake Nicaragua is unique in Central America because some species of fish and euryhaline species of sharks such as *Carcharhinus leucas* journey almost 180 km up the San Juan River (Rio San Juan) from the Caribbean Sea to reach this lake (Thorson 1971). Nicaragua's population consists of roughly 69% mestizo (mixed Amerindian and white), 17% Caucasian, 9%

[1] In June 2013, Nicaragua's National Assembly granted a 50-year concession to a Hong Kong based Nicaragua Canal Development Company to build a Nicaragua Canal connecting the Atlantic to the Pacific Ocean. In January 2014, the development company and the Nicaraguan President Daniel Ortega stated that construction of the canal would begin in December 2014, and that it will be completed in 2019 (Titcomb 2014).

black, and 5% Amerindian.[2] The primary export markets for Nicaragua's fisheries products are the U.S. (over 80%), the European Union, and Japan (FAO 2012).

Nicaragua has a long and tumultuous political history. After Spanish colonization in the 15th century and the loss of much of the indigenous population to slavery and disease, Nicaraguans revolted with the first uprising against their Spanish rulers in 1811 (Staten 2010). Nicaraguans declared their independence from Spain in 1821, and officially became an independent republic in 1838.[2] By that time, the coffee boom in Nicaragua in the late 19th century and the expansion of many large coffee estates began tipping the balance of power towards wealthy coffee plantation owners aligned with president José Santos Zelaya López. In 1893, when president Zelaya was in office, he instituted many policies which promoted the development of agricultural commodities which, along with coffee, were produced solely for export. This 'agro-export' model (Staten 2010) became widely used throughout the next century.

In the early 20th century, control of the country repeatedly changed hands while under a U.S. occupation, which had arrived in 1912 on request during an internal power struggle. One man who detested seeing his country under U.S. occupation was Augusto César Sandino, who raised a guerilla army of peasants and fought the U.S. occupiers from 1927-1933, until the financial toll of the fighting became too much for both parties and the U.S. withdrew. Anastasio Somoza García was the man in control of the Nicaraguan National Guard at the time of the U.S. withdrawal, and in 1934, Somoza ordered the National Guard to assassinate Sandino. In 1935, he publicly turned his eye towards the presidency. Somoza and his two sons Luis and "Tachito" would rule Nicaragua for the next 43 years.

Under the Somoza's rule, wealth became concentrated in the hands of a few Somoza supporters and agro-business elite, with massive social and economic inequalities throughout the country. *Continuismo*, the Somoza process of maintaining re-election or placing an easily manipulated person in power, was prolific throughout the 43 years the family was in power (Staten 2010). A growing opposition to the Somoza rule known as the Sandinistas, after Augusto César Sandino, began to draw support from the peasant population of Nicaragua in the 1960s due to the loss of their land to the elites. When a massive earthquake struck Managua in December 1972, and rampant corruption associated with rebuilding was traced to the Somoza rule, even his supporters began to turn against him.

Tachito Somoza's repression of any dissent was brutal, and the torture and murder of anyone suspected of having Sandinista ties was commonplace. When U.S. president Carter came to office in 1977, he strongly opposed Somoza's human rights record, and cut economic and military funding to Nicaragua which impaired the ability of the National Guard to fight the Sandinistas (Staten 2010). Finally, the opposition movement swelled and violent revolts spread across the country until, in July 1979, the Somoza dictatorship was overthrown.

Elite agro-businessmen and National Guardsmen also fled Nicaragua for the U.S. after the Sandinista victory in 1979. The Sandinistas were nationalistic, anti-classist, and socialist-minded, and they implemented many agrarian reforms towards state-controlled enterprises, and the fisheries sector was also subjected to these changes (Lopez 1998). Due to these policies, they were widely regarded in the U.S. as the newest communist Cold War threat, and the Reagan administration in the U.S., through the CIA, organized the exiled National Guards and business elite into opposition forces called 'Contras' (Staten 2010). With direct U.S. support, the 'Contras' waged a bloody civil war in Nicaragua, in violation of the U.S. Boland Amendment to the War Measures Act which prohibited financial resources being used to topple other governments (Staten 2010). In 1984, mines were placed in the ports and shipping lanes of the Pacific and Atlantic coasts by CIA operatives, damaging both Nicaraguan and other international vessels (Staten 2010). In 1986, when a 'Contra' supply plane was shot down, the pilot's testimony and documents seized from the plane exposed the Reagan administration of being in violation of the Boland Amendments.

By the mid-1980s, the 'Contra' war began to impact the food production sector due to agricultural and economic infrastructure being directly targeted (Staten 2010). By the late 1980s, economic production declined, inflation shot up 36,000%, and necessary austerity measures taken by the Sandinistas began to turn their supporters against them (Staten 2010). Throughout the 1980s, a peace agreement had shuffled along until finally, in 1987, President Daniel Ortega of the Sandinistas agreed with other Central American leaders on the Arias Peace Plan, which effectively kicked out all foreign interventionists (Staten 2010). A change in the U.S. presidency and an associated withdrawal of funding for the 'Contras' finally brought them to the bargaining table, and a peace agreement was reached in 1989 (Staten 2010).

In 1990, the Nicaraguan public elected the government of Violeta Barrios de Chamorro, who was neither aligned with the U.S., the 'Contras' or the Sandinistas. The Nicaraguan public was weary of war and voting for the Sandinistas would have further continued the U.S. embargo that had been in place since 1985 (Staten 2010). With the lifting of the embargo in 1990, the Nicaraguan economy began to recover.

Due to its difficult political past, Nicaragua is the poorest country in Central America, and although the country's economy grew at approximately 4% in 2011, it still has prevalent poverty and underemployment.[3] Nicaragua's economy has moved from agricultural products such as coffee, bananas, sugarcane, cotton, rice, corn, tobacco, soy, and livestock, to textiles and apparel, which now accounts for almost 60% of exports.[3]

Several of Nicaragua's leaders were ardent supporters of the 'agro-export' economic model. This became the dominant model for commodities production throughout Nicaragua, and shrimp and lobsters in Nicaragua's fisheries sector were pursued in a similar fashion (Sequeira 2002; FAO 2012). Although landings data for fisheries have been reported since 1950, it is reasonable to assume that in the context of Nicaragua's political and economic

[2] CIA World Fact Book (2012) Nicaragua [online]. Available from: https://www.cia.gov/library/publications/the-world-factbook/geos/nu.html [accessed 24 July, 2012].

[3] CIA World Fact Book (2012) Nicaragua [online]. Available from: https://www.cia.gov/library/publications/the-world-factbook/geos/nu.html [accessed 24 July, 2012].

past, fisheries data have not been reported accurately, especially for non-export products. Unreported catches are generally interpreted as zero catches (Pauly 1998), which can be a dangerous mistake for fisheries managers to make. Historical catch time series assist in providing historical trends from which large-scale changes can be observed (Pauly 1998). Here, we reconstruct the historic fisheries catches for Nicaragua for 1950-2010, taking into account all data and information sources available to us.

Methods

Data presented by the FAO on behalf of Nicaragua, 1950-2010, were obtained from the FishStat capture database (March 2013 version, 2011 dataset) for FAO areas 31 and 77. Although Nicaragua reports catches for FAO area 87 as well, this area is outside the Exclusive Economic Zone (EEZ) of Nicaragua, and data for FAO area 87 are accepted at face value, and not considered further in the present context.

Artisanal and industrial fishing

In Nicaragua, vessels greater than 15 m in length are categorized as industrial, while anything less than 15 m in length is considered artisanal (FAO 2012). Additionally, the three nautical miles which lie adjacent to Nicaragua's coastline is for the exclusive use of the artisanal (small-scale commercial) fishers (FAO 2012). On the Pacific coast, 72% of artisanal vessels are powered by an outboard motor, whereas on the Caribbean side, only 48% carry one (FAO 2012). In this study, we assume that the reported data represents the artisanal and industrial fishing sectors. However, because of the diverse nature of artisanal fisheries, it is likely that some of the landings from this sector go unreported. In fact, a recent report by Nicaragua's Central Bank notes that approximately 18-30% of artisanal landings go unreported in any given year (FAO 2012).

Tuna fisheries and Nicaragua's EEZ

Tunas are far-ranging pelagic species, often found away from the continental shelves, and subsequently, outside of a country's EEZ. As this reconstruction focuses on marine fisheries captures within Nicaragua's EEZ, we adjust the FAO reported landings accordingly to account for (i.e., exclude) catches of large pelagics taken outside the Nicaraguan EEZ. The Inter-American Tropical Tuna Commission (IATTC) Data Report #10 (Watters 1999), which details the geographic distribution of fishing in the eastern Pacific, demonstrates that the majority of the reported fishing for three species, yellowfin tuna (*Thunnus albacares*), bigeye tuna (*T. obesus*) and skipjack tuna (*Katsuwonis pelamis*), which are reported by the FAO on behalf of Nicaragua, is undertaken in international waters. Six industrial tuna vessels registered under Nicaragua's flag operate within the framework of the IATTC (FAO 2012). These IATTC data, however, deal only with industrial tuna fishing fleets, and there are likely catches of tuna by small-scale fisheries within Nicaragua's EEZ. For the IATTC industrial catches which do appear in Nicaragua's waters, it is unknown how much of those are taken by Nicaraguan flagged vessels, and how much are taken by foreign fleets, as these data details were not available to us.

To adjust the amounts assumed to be caught within Nicaragua's EEZ by Nicaraguan flagged vessels, we assumed (based on Watters 1999) that in 1976, at the time when Nicaragua first reports catches of tuna, 5% of the reported industrial catches came from within its EEZ. We also assumed that in 1999, 2% of the reported industrial catches were coming from within its EEZ, and we interpolated linearly between these points. We applied this same interpolation rate (i.e., we extrapolated the rate of change of the proportion) forward for reported catches between 2000 and 2010. Nicaragua reports catches of bigeye tuna; however, these are almost all caught outside its EEZ (Watters 1999), and therefore not included in this reconstruction, as we deemed all bigeye tuna catches to occur outside EEZ waters. Black skipjack (*Euthynnus lineatus*) is another species reported by Nicaragua, however, because the amounts reported are very small, we assume these to be taken incidentally by the industrial tuna fisheries within the EEZ, and therefore their reported numbers are accepted as is. Between 1980 and 1998, Nicaragua reported no tuna catches.

It is important to note that the adjusted FAO landings time series (which exclude the tuna assumed to be caught outside Nicaragua's EEZ) are used in all calculations and comparisons throughout this report. Note that large-scale tuna catches by all countries throughout the Pacific are being reconstructed separately.

Lobster and shrimp fisheries

Nicaragua's lobster fishery has five different fleets: an artisanal trap fishery, artisanal SCUBA diver fishery, industrial trap fishery, industrial SCUBA diver fishery, and lastly, a foreign industrial trap fishery (WCAFC 2001). As lobster traps and SCUBA diving are very selective fishing methods, we assumed no significant by-catch from these fishing sectors (Kelleher 2005). To derive a breakdown of lobster catches attributed to the artisanal and industrial sectors, we use the anchor points in Ehrhardt (1994) of 20% artisanal and 80% industrial in 1979. We assumed that this same breakdown applied in 1950, and thus carried back these percentages unaltered. During the revolution and subsequent 'Contra' years, the breakdown varied between the two sectors. Therefore, we used the anchor points of 67% artisanal and 33% industrial in 1983, and 52% artisanal and 48% industrial in 1989 (Ehrhardt 1994). We use the INPESCA (2011) breakdown of 51% artisanal and 49% industrial in 2010, and interpolated linearly between these four points.

Reported shrimp landings have fluctuated over the years, as well as the split between the artisanal and industrial fisheries, and the types of shrimp products recorded by INPESCA. Nicaragua defines their sectors by vessel size. However, for the purposes of *Sea Around Us*, this reconstruction uses the definition that all gears dragged through the water (thus including all trawl gear) are considered industrial. It is assumed that the artisanal shrimp fishery also uses trawl gear and thus all shrimp catches and associated by-catch/discards are classified as industrial catch here.

For the purpose of this report, we assumed that all catches of lobsters and shrimp were comprehensively reported due to the export-oriented nature of these fisheries.

By-catch and discards from shrimp fisheries

A noteworthy portion of Nicaragua's fisheries landings are composed of shrimp. Shrimp trawl fisheries are typically associated with high rates of discards (Gillett 2008). For the purpose of this reconstruction, by-catch is defined as non-target catch (i.e., anything that is not shrimp). Although Kelleher (2005) defines discards as any part of the catch which was returned to the sea, for the purpose of this reconstruction, we assumed that no target catch of shrimp was returned to the sea, and so the term 'discards' applies only to rejected non-target catch, as defined by Lopez (1998). To first estimate the amount of by-catch produced by the Nicaraguan shrimp trawl fisheries, we separate the Caribbean catches from those of the Pacific, and examine them separately.

For the Caribbean shrimp trawl fishery, we used the anchor point of the ratio of shrimp:by-catch of 1:4.6 (Lopez 1998), and multiplied this by the amount of *Penaeus* shrimp landings reported to the FAO for this area. This rate was applied as a constant value to the Caribbean *Penaeus* shrimp catches from 1950-2010. It should be noted that this ratio is likely an underestimate, as it is well-known that shrimp trawl fisheries in earlier decades had larger amounts of by-catch than in more recent years. We assumed that 100% of the by-catch was being discarded in 1950. This discard rate was held constant from 1950 to 1971. In 1972, by-catch began being utilized by the company NICAMAR which processed fish into patties and snacks for regional markets (Sanchez 1998 in Lopez 1998). Thus, we assumed that the by-catch discard rate changed to 80% in 1972 (i.e., 20% was being utilised). We used the Lopez (1998) by-catch discard rate in the Caribbean shrimp trawl industry of 69% as our anchor point for 1998, and interpolated linearly between these two anchor points. This interpolated rate of discarding was carried forward for the 1999-2010 time period.

For the Pacific shrimp trawl fishery, three separate groups of shrimps are recorded in FAO landings: Northern nylon shrimp (*Heterocarpus vicarius*), squat lobsters or *langostinos* (*Pleuroncodes* spp.) and *Penaeus* shrimps. As Lopez (1998) notes, in deep-water shrimp fisheries such as those for *Heterocarpus* and *Pleuroncodes* species, approximately 80% of the catch is the target species, which gives us a shrimp:by-catch ratio of 1:0.25. This rate was applied as a constant value to the *Heterocarpus* and *Pleuroncodes* shrimp landings for the 1950-2010 time period. For the *Penaeus* shrimps, we used the shrimp:by-catch ratio of 1:7.7 (Lopez 1998), and applied this value as constant to all *Penaeus* shrimp landings for 1950-2010. Again, this is likely to be a conservative estimate. We added the amounts of by-catch from the *Heterocarpus, Pleuroncodes* and *Penaeus* shrimp fisheries to obtain a total amount of by-catch from the Pacific shrimp trawl fisheries. We again assumed that 100% of the total by-catch was discarded in the 1950-1971 time period. In 1972, when NICAMAR began utilizing part of the by-catch, we used the assumption that the by-catch discard rate fell to 60%, and we used the anchor point in Lopez (1998) of 50% for 1998 and interpolated linearly between these two estimates. This interpolated rate of discarding was carried forward for the 1999-2010 time period.

All of the landed by-catch is assumed to be unreported, as there was no export focus on these products. It is possible that some of it may have been reported, but to what extent or in what capacity is unknown. Therefore, we assume that the under-reporting which is likely to take place in the artisanal fisheries roughly accounts for any possible reporting of landed by-catch derived here.

Marine fishes

For all other FAO reported fisheries landings other than shrimp, lobsters and tunas, we used the data in INPESCA (2006) to derive a breakdown for artisanal and industrial fisheries catches. Based on these data, we assumed that the Caribbean catches comprised 85% artisanal and 15% industrial catches, and the Pacific catches were 95% artisanal and 5% industrial.

From 1950 to the early 1990s, 'marine fishes nei' is the only other category reported in FAO data besides shrimp, lobsters and tunas. To give more useable detail to this uninformative taxonomic category, we used the breakdown provided in INPESCA (2011), which details the registered landings of the principal varieties of fish caught in both the Pacific and Caribbean.

To assign some taxonomic information to the landed and discarded by-catch, we used the breakdown in Lopez (1998), which details the by-catch composition in both the Caribbean and Pacific shrimp trawl fisheries (Table 1). The 'fish' category of this by-catch is further broken down by using the data gathered by INPESCA (2011), which details the types of fish commonly caught as by-catch in both the Pacific and Caribbean (Table 2). As this still left a large component of unclassified 'fish', the information from INPESCA used for the breakdown of the reported 'marine fishes nei' catch for each FAO area was also applied to the remaining miscellaneous marine fish in the by-catch in each respective area. Although this is an assumption, the breakdown applied was only at the family level and therefore should be broad enough to be fairly representative of the actual composition.

Subsistence fishing

Data on human population were obtained from the World Bank (www.worldbank.org), and from Populstat (www.populstat.info), and where data were unavailable, linear interpolations were made. To determine *per capita* fish consumption rates, we started with an anchor point given by Nietschmann (1972), of 4.98 kg·capita^{-1}·year^{-1}, which focused on the dietary habits of the Miskito indians of the Caribbean coast. Many indigenous and especially peasant groups (which were numerous during the Somoza reign) obtained some portion of their diet from hunting and fishing (Nietschmann 1972), and so this anchor point may be representative of not just the Miskito, but of a larger subset of the population as well. To account for the fact that the Miskito have slightly higher fish consumption rates than urban and other rural populations (Jentoft 1986), we assumed that in 1950, the average *per capita* fish consumption rate was 20% lower than Nietschmann's (1972) anchor point (i.e., 3.98 kg·capita^{-1}·year^{-1}), and that in 2010, it was 50% lower than Nietschmann's (1972) anchor point (i.e., 2.49 kg·capita^{-1}·year^{-1}), and interpolated linearly between these points. Furthermore, we assumed that all landings by artisanal fishers, as well as a portion of the industrial shrimp landings (30%), were to remain in country for domestic consumption. These catches were subtracted from the calculated demand in order to estimate the subsistence catches which would supply the remaining seafood for consumption. All of the subsistence catches are considered unreported.

Table 1. Composition of by-catch in the Nicaraguan Caribbean and Pacific shrimp trawl fisheries based on the target shrimp species.

Taxon	Caribbean	Pacific
Penaeus spp.	65% 'fish', 35% molluscs, crustaceans, and small amounts of echinoderms	75% 'fish', 25% molluscs & crustaceans
Heterocarpus & *Pleuroncodes* spp.	N/A	90% crustaceans, 5% molluscs, 5% fish (namely *Peprilus* spp. and hake)

Table 2. Composition of 'fish' (as per Table 1) in the by-catch of the Caribbean and Pacific shrimp trawl fisheries

Caribbean	%	Pacific	%
Centropomidae	19.0	Plueronectiformes	49
Lutjanidae	3.0	Haemulidae	25
Serranidae and Sciaenidae	0.5	Centropomidae	2
Other[1]	77.5	Lutjanidae	1
		Other[1]	23

[1] Other was disaggregated further using INPESCA (2011).

A total subsistence catch was calculated, and so to assign that catch to the two coasts we used the proportions from the reported FAO data to determine the amount of landings coming from each coast. From this, we derived a breakdown of 40% being attributed to the Pacific coast, and 60% to the Caribbean coast and assigned these same proportions to the subsistence catch. To provide taxonomic detail to the catches attributed to subsistence fishing, we then applied the same INPESCA (2011) breakdowns used for 'marine fishes nei' in the reported data for each FAO area to the subsistence catches from each coast, respectively.

Results

The reconstructed total catch for Nicaragua fishing in their own EEZ for the 1950-2010 time period was 3.7 times the landings reported by the FAO on behalf of Nicaragua which were deemed to be inside the EEZ (Figure 2a). Annual catches increased from 7,200 t in 1950 to a peak in 1973 at approximately 52,000 t, then declined in 1986 during the 'Contra' period to around 18,500 t. Catches peaked again in 1999 at approximately 50,000 t, declined again, and then rebounded slightly, averaging 31,000 t·year^{-1} for the entire time period (Figure 2a). The artisanal and subsistence sectors accounted for 11.1% and 18.3%, respectively, of the reconstructed total catch, the industrial sector (landed) contributed 26.0%, and discards (all industrial) accounted for 56.8% of reconstructed catches (Figure 2a). Fish from the family Lutjanidae contributed the largest proportion to the overall catch with 27.0% (Figure 2b). Other major contributors included Centropomidae (14.4%), Penaeidae (10.0%), other molluscs (8.7%), other crustaceans (8.5%), Palinuridae (5.5%; *Panulirus argus* is 5.3% alone) and Scombridae (4.6%).

On the Caribbean coast, the reconstructed total catch within the EEZ was 3.6 times the FAO data for Area 31 and was 62% of the reconstructed catch (for both oceans) within the EEZ for the 1950-2010 time period. Catches increased from 4,800 t in 1950 to a peak of 35,100 t·year^{-1} in 1972-1973. Catches decreased to a low of 9,000 t in 1989 before increasing to a second peak of 30,500 t·year^{-1} in 1998-1999. Catches decreased again to an average of 22,600 t·year^{-1} in the late 2000s. The catch was comprised of snappers (Lutjanidae; 25.0%), snooks (Centropomidae; 22.3%), Penaeidae (11.8%) and other miscellaneous molluscs and crustaceans with 10.3% and 9.6%, respectively. These groups were largely derived as by-catch in the shrimp trawl fishery.

On the Pacific coast, the reconstructed total catch was 3.1 times the FAO reported landings for Area 77, within the EEZ, over the 1950-2010 time period, and was 38% of the reconstructed catch (within the EEZ). In the Pacific, changes in catch trend are not as pronounced. The catch increases steadily from just under 2,500 t in 1950 to over 7,800 t in 1965. Catches jumped to almost 16,500 t in 1966 and remained relatively stable at 15,800 t·year^{-1} from 1967-1981. Catches then exhibited a fluctuating increasing trend to a peak in 1999 of 22,700 t. Catches then declined to 17,100 t in 2006 and averaged 19,500 t·year^{-1} for the rest of the time period. The catch was comprised of Lutjanidae (30.2%), Scombridae (11.5%), Haemulidae (9.0%), Penaeidae (6.2%) and other miscellaneous crustaceans and molluscs (9.2% and 6.0%, respectively). Again, these were largely attributed to by-catch in the shrimp trawl fishery, which discarded an

estimated 37% of the reconstructed catch in the Pacific over the time period. All tuna catch which was taken outside of the EEZ was taken from the Pacific, and not included in the data presented here.

Discussion

Reconstructed total catches for Nicaragua within their EEZ were approximately 3.4 times the landings reported by the FAO (adjusted for EEZ waters only) on behalf of Nicaragua. Discards accounted for a large portion (approximately 40%) of this reconstructed total catch. After the revolution and throughout the 1980s, catches fell to low levels, largely because the Sandinista government was engaged in the 'Contra' civil war, and much of the economic and agricultural infrastructure had been directly targeted by the 'Contras' (Staten 2010). This trend of decreased catches throughout the 1980s is much more evident on the Caribbean coast, where U.S. economic interests were more heavily invested and catches were more heavily impacted by the U.S. embargo.

The discards from the shrimp trawl fishery that we present here are likely to be an underestimate. Kelleher (2005) notes that tropical shrimp trawl fisheries are the largest source of discards in the world's marine fisheries. The reason for this is that the fishing grounds are often not in close proximity to markets (Kelleher 2005); the fishers would require on-board freezing facilities or vast quantities of ice to preserve the by-catch. This makes the retention of the by-catch impractical for fishers. Additionally, regulations to reduce by-catch have very little enforcement (Kelleher 2005).

Although unreported subsistence fishing has been found to be at very high levels in some other fisheries reconstructions, the smaller amount found here is not surprising. Livestock is a heavily produced commodity in Nicaragua, and red meat factors much more prominently in Nicaraguan diets as a protein source than fish does (Speedy 2003).

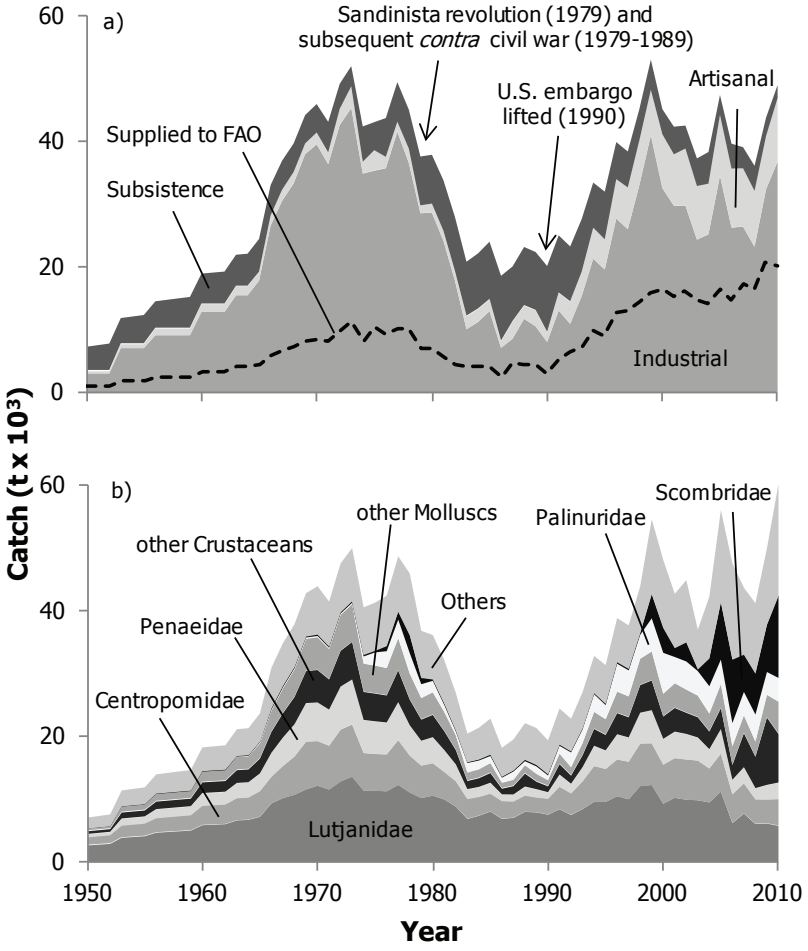

Figure 2. Total reconstructed catch for Nicaragua, 1950-2010, a) by sector with adjusted FAO landings laid overtop as a line graph, and b) by major taxonomic group. 'Others' contains 25 additional taxonomic categories.

Although the foreign industrial trap fishery for lobster takes catches from the EEZ of Nicaragua, those catches are landed in foreign ports, and we assume (maybe optimistically) are accounted for in their FAO reported landings. Although fishing effort (including for lobster) decreased in Nicaragua during the 'Contras' war, it is important to note that the fisheries resources in its EEZ were likely still exposed to fishing pressure from foreign countries (WCAFC 2001).

Data and anchor points on shark by-catch were hard to come by, however this issue should not be overlooked. In a report on utilization of by-catch, it was noted that although by-catch was being reduced due to shrimp trawler vessels being converted to longline vessels, this created a new problem of increased shark by-catch in longlines of up to 35,000 lbs (approximately 16 t) per trip (Cisneros 1997). While much of this shark by-catch was likely taken in the longline and purse-seine industrial tuna fishing fleets outside of Nicaragua's EEZ (Román-Verdesoto and Orozoco-Zöller 2005), it is likely that considerable amounts still came from the small-scale tuna fishery operating within Nicaragua's EEZ.

Independent data were difficult to come by for this reconstruction, likely due to the difficult political climate in the country for many years. Additionally, "the lack of comprehensive studies or databases on the sociological or economic

factors affecting Caribbean fisheries" and "the lack of comprehensive databases that provide estimates of total catch, indices of abundance, and age composition of populations" (Anon. 1990) were identified as existing problems for Caribbean fisheries by 1990, when the presidency of Violeta Barrios de Chamorro started and the U.S. embargo was lifted. This highlights the importance of governance in the ability to implement fisheries accounting practices and monitoring of catches.

Acknowledgements

We would like to thank *Sea Around Us*, a scientific collaboration between the University of British Columbia and The Pew Charitable Trusts.

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

Year	FAO landings[1]	Reconstructed total catch	Industrial	Artisanal	Subsistence	Discards
1950	900	7,220	3,160	350	3,710	2,610
1951	900	7,480	3,160	350	3,970	2,610
1952	900	7,730	3,160	350	4,220	2,610
1953	1,800	11,820	7,180	620	4,030	5,990
1954	1,800	12,060	7,180	620	4,270	5,990
1955	1,800	12,310	7,180	620	4,520	5,990
1956	2,600	14,500	9,220	1,060	4,220	7,680
1957	2,600	14,740	9,220	1,060	4,460	7,680
1958	2,600	14,970	9,220	1,060	4,690	7,680
1959	2,600	15,200	9,220	1,060	4,920	7,680
1960	3,400	18,930	12,910	1,240	4,780	10,750
1961	3,400	19,100	12,910	1,240	4,940	10,750
1962	3,400	19,260	12,910	1,240	5,110	10,750
1963	4,100	21,950	15,560	1,440	4,950	12,900
1964	4,100	22,110	15,560	1,440	5,110	12,900
1965	4,500	24,480	17,870	1,370	5,240	14,740
1966	5,800	33,090	26,610	1,630	4,850	22,440
1967	6,700	37,010	30,560	1,800	4,650	25,660
1968	7,400	39,760	33,320	1,880	4,560	27,800
1969	8,300	44,310	37,970	1,800	4,540	31,470
1970	8,500	46,070	39,540	1,980	4,550	33,020
1971	8,100	43,220	36,370	1,980	4,870	30,250
1972	10,000	49,310	42,590	2,720	4,000	26,250
1973	11,300	52,140	45,300	3,620	3,220	27,480
1974	8,229	42,480	34,880	1,970	5,640	20,400
1975	10,419	43,180	35,340	3,350	4,490	20,060
1976	9,775	43,830	35,730	1,890	6,200	19,510
1977	11,181	49,570	41,540	1,700	6,330	22,770
1978	12,602	45,160	36,540	2,380	6,240	18,280
1979	7,915	37,670	28,580	1,280	7,820	15,000
1980	6,917	37,950	28,690	1,450	7,810	15,700
1981	5,751	33,870	24,200	1,590	8,090	13,240
1982	4,514	27,990	17,870	1,490	8,640	9,960
1983	4,170	20,830	10,160	2,050	8,620	5,580
1984	4,221	22,160	11,310	2,050	8,810	5,910
1985	4,080	24,040	13,050	1,840	9,150	6,630
1986	2,410	18,580	7,210	1,000	10,360	3,810
1987	4,813	20,070	8,660	2,690	8,720	4,100
1988	4,540	23,190	11,820	2,080	9,290	5,520
1989	4,468	22,390	10,640	2,490	9,260	5,010
1990	2,938	20,150	8,140	1,480	10,530	3,880
1991	5,453	25,060	13,130	2,780	9,140	6,750
1992	6,335	23,270	11,020	3,490	8,760	5,260
1993	7,339	27,670	15,440	3,790	8,440	7,690
1994	9,829	33,500	21,360	4,920	7,220	10,800
1995	9,141	32,050	19,650	4,770	7,640	9,860
1996	12,834	39,980	27,740	6,310	5,930	13,450
1997	12,969	38,480	26,050	6,670	5,750	12,710
1998	14,510	45,240	33,010	7,220	5,010	16,170
1999	19,201	53,180	40,950	7,400	4,830	17,570
2000	20,188	45,250	32,580	8,670	4,000	13,330
2001	16,365	42,450	29,770	8,260	4,420	13,680
2002	18,799	42,620	29,800	9,150	3,670	13,030
2003	14,896	37,370	24,400	8,550	4,410	11,740
2004	18,240	38,390	25,220	8,100	5,070	9,780
2005	25,364	47,520	34,520	9,820	3,180	12,400
2006	24,796	39,730	26,290	9,460	3,970	7,320
2007	23,088	39,170	26,470	9,330	3,370	8,360
2008	22,912	36,180	23,260	8,910	4,010	5,960
2009	28,192	43,910	32,400	8,570	2,940	8,170
2010	33,174	49,110	36,800	10,240	2,070	8,840

[1] FAO reported landings is adjusted to reflect only those amounts assumed to be caught within Nicaragua's EEZ

Appendix Table A2. Reconstructed total catch (in tonnes) by major taxa for Nicaragua, 1950-2010. 'Others' contain 25 additional taxonomic categories.

Year	Lutjanidae	Centropomidae	Penaeidae	Crustacean	Mollusc	Palinuridae	Scombridae	Others
1950	2,700	1,290	500	420	420	-	70	1,730
1951	2,820	1,330	500	420	420	-	80	1,820
1952	2,950	1,380	500	420	420	-	80	1,900
1953	3,910	1,940	1,100	930	930	-	110	2,540
1954	4,030	1,980	1,100	930	930	-	110	2,620
1955	4,150	2,030	1,100	930	930	-	120	2,700
1956	4,700	2,330	1,400	1,190	1,190	-	140	3,070
1957	4,820	2,380	1,400	1,190	1,190	-	140	3,150
1958	4,930	2,420	1,400	1,190	1,190	-	140	3,220
1959	5,040	2,460	1,400	1,190	1,190	-	150	3,300
1960	5,880	3,110	2,000	1,690	1,690	-	160	3,790
1961	5,960	3,140	2,000	1,690	1,690	-	170	3,840
1962	6,040	3,170	2,000	1,690	1,690	-	170	3,890
1963	6,640	3,560	2,400	2,030	2,030	100	180	4,270
1964	6,720	3,590	2,400	2,030	2,030	100	190	4,320
1965	7,210	4,110	2,800	2,350	2,350	200	190	4,530
1966	9,320	4,290	3,800	3,310	3,310	200	310	6,480
1967	10,160	5,180	4,500	3,870	3,870	200	320	6,830
1968	10,680	6,160	5,100	4,330	4,330	200	300	6,860
1969	11,530	7,690	6,100	5,080	5,080	200	270	6,930
1970	12,110	7,190	6,100	5,160	5,160	200	330	7,720
1971	11,500	7,070	5,700	4,790	4,790	200	300	7,180
1972	12,790	8,350	6,800	5,680	5,680	200	320	7,820
1973	13,550	8,420	7,100	5,970	5,970	200	360	8,510
1974	11,340	6,060	5,230	4,440	4,440	1,150	350	7,610
1975	11,330	5,910	5,180	4,390	4,390	2,120	360	7,700
1976	11,230	5,960	5,040	4,300	4,300	2,700	910	8,060
1977	12,240	7,220	6,000	5,060	5,060	2,960	1,360	8,860
1978	11,040	5,960	4,790	4,070	4,070	3,270	2,950	9,870
1979	10,170	5,210	3,930	3,360	3,360	2,230	1,100	7,520
1980	10,530	5,240	4,120	3,530	3,530	1,850	330	7,080
1981	9,950	4,420	3,450	2,990	2,990	1,130	330	6,930
1982	8,810	4,080	2,660	2,270	2,270	640	280	5,970
1983	6,860	3,220	1,530	1,290	1,340	1,550	200	4,580
1984	7,370	3,030	1,570	1,370	1,360	1,430	240	5,080
1985	8,030	2,900	1,710	1,530	1,530	1,160	290	5,770
1986	6,880	2,860	1,040	890	890	840	210	4,640
1987	7,050	2,630	1,090	1,320	950	1,340	240	4,970
1988	7,980	2,640	1,410	2,040	1,280	670	300	5,860
1989	7,890	2,420	1,300	1,180	1,180	1,230	300	5,890
1990	7,550	2,560	1,020	920	920	780	270	5,410
1991	8,400	3,620	1,920	1,630	1,630	1,270	270	5,770
1992	7,480	3,480	1,510	1,280	1,280	2,390	250	5,230
1993	8,420	4,470	2,240	1,880	1,880	2,200	270	5,770
1994	9,560	5,760	3,200	2,660	2,660	2,820	280	5,950
1995	9,550	5,310	2,920	2,450	2,450	2,270	300	6,180
1996	10,460	5,900	3,980	3,350	3,350	4,460	350	7,040
1997	9,980	6,040	3,830	3,190	3,260	4,160	350	6,950
1998	12,060	6,860	4,860	4,340	4,150	3,800	380	7,490
1999	12,220	6,730	5,220	4,690	4,560	5,270	3,940	11,980
2000	9,280	6,260	4,070	3,520	3,550	6,530	4,070	10,850
2001	10,200	6,390	4,180	3,620	3,870	4,200	1,520	8,670
2002	9,900	6,470	4,040	3,350	3,630	4,490	3,140	9,940
2003	9,810	6,380	3,650	3,160	3,390	3,920	370	6,360
2004	9,470	5,460	3,040	2,650	2,810	4,380	4,510	9,890
2005	11,180	6,120	3,870	3,240	3,770	3,910	9,200	14,740
2006	8,300	4,590	2,290	2,340	2,920	3,730	10,190	15,360
2007	8,840	4,860	2,540	5,390	2,780	3,750	6,040	10,690
2008	7,280	3,940	1,770	4,980	2,360	4,340	6,610	11,240
2009	7,330	3,840	2,320	10,700	3,580	3,640	7,610	12,260
2010	7,190	4,260	2,620	7,710	5,090	3,800	13,140	17,840