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HONDURAS, A FISH EXPORTING COUNTRY: PRELIMINARY RECONSTRUCTED MARINE CATCHES IN THE CARIBBEAN SEA AND THE GULF OF FONSECA, 1950 – 2010

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ABSTRACT

The country of Honduras has coastal territory on both the Pacific and Atlantic coasts, presenting a wide diversity of ecosystems in both regions. These ecosystems support important fishing activities for national and international consumption. However, in recent years, most of the fisheries of Honduras were seriously affected by, or have even collapsed after, a significant decline of their stocks. Management decisions have played and continue to play a key role in the present situation, often relying on key data to understand fish extractions and the status of remaining stocks. Through comparisons of official catch data reported by the Food and Agriculture Organization of the United Nations (FAO) on behalf of Honduras and independent sources of information, the present paper estimated unreported landings and hence, reconstructed the total fisheries catch from 1950 to 2010 within the Exclusive Economic Zone (EEZ) of Honduras. The resulting time series of reconstructed catch indicated that the total estimated catch was 2.1 times the data reported by the FAO on behalf of Honduras. The unreported catches were composed of discards from the industrial shrimp fishery (45% of unreported catch), unreported artisanal (40%), subsistence (11%) and unreported industrial (4%), whilst catch from recreational fisheries was excluded due to lack of data. Although overexploitation in the coastal areas of Honduras has many causes, the results of the present paper puts into perspective the importance of a well-designed data collection and administration system (including accounting for discarded catch), as well as the biological, and even social, consequences that catch underestimation raises.

INTRODUCTION

The Republic of Honduras is located on the Central America isthmus, covering 112,000 km^2 of land. In the north it is bordered by the Caribbean Sea, in the southeast by Nicaragua, in the southwest by El Salvador and the Gulf of Fonseca, and in the west by Guatemala (Figure 1), thus having access to both the Atlantic and Pacific coasts. Even though Mestizos are, in proportion, the main ethnic group, Honduras was first populated by Amerindians, until the colonization in 1502 which brought both Spanish peoples and Caribbean slaves (*Garifaunas*), and thereafter an influx of racially and culturally diverse peoples ranging from farmers to pirates (Fielding 2000). Today the population is over 8,448,500,[1] with 90% Mestiza, 6% Amerindians and 1% Afro-Hondurans (Duke University Press, 2003).

[1] www.indexmundi.com

Figure 1. Map of the Exclusive Economic Zone (EEZ) of Honduras and its continental shelf. Note the very limited EEZ in Pacific waters.

On the Honduran Caribbean (Atlantic) coast lies the southern end of the Mesoamerican Barrier Reef System (Arrivillaga and Garcia 2004), boasting various mainland reef formations, mangroves, wetlands, sea grass beds and extensive fringing reefs around its offshore islands (Harborne 2001). On the Pacific coast of Honduras is the Fonseca Gulf, which contains 35% of Honduras' wetlands in addition to extensive mangrove forests (Soto *et al.* 2012). As a result of this habitat's variety, Honduras has a diverse and rich marine ecosystem, accounting for at least 500 species of fishes and over 125 different coral species (Humann and Deloach 2002), in addition to sea turtles and various marine mammals, all of which make Honduras a desirable place for tourism, divers, recreational fishers, and nature conservationists.

The Honduran coast accounts for more than 160 different fishing communities and over 10,000 fishers, employing a dozen or so different fishing gears (Box and Canty 2011, Vazquez *et al.* 2005). Fishers exploit lagoon systems, river mouths, coral reef banks, and other near-shore areas. Honduras's main fisheries on the Atlantic coast target Caribbean spiny lobster (*Panulirus argus*), southern white shrimp (*Litopenaeus schmitti*), blue crab (*Callinectes sapidus*), pink conch (*Lobatus gigas*), northern pink shrimp (*Farfantepenaeus duorarum*) and fishes of the snapper (Lutjanidae) and grouper (Serranidae) families, such as the yellowtail snapper (*Ocyurus chrysurus*) and misty grouper (*Hyporthodus mystacinus*). On the Fonseca Gulf, the most common marine fisheries exploit shrimps, e.g., western white shrimp (*Litopenaeus occidentalis*), blue shrimp (*L. stylirostris*) and whiteleg shrimp (*L. vannamei*); arks (*Anadara*); *Dicoides occidentalis* and weakfish (*Cynoscion squamipinnis)*, among others (DIGEPESCA; digepesca.sag.gob.hn).

Fisheries in Honduras have a long history of exploitation. The national industrial fleet started to fish in the late 1950s in the Caribbean Sea (FAO 2002), and before that, foreign ships were fishing and landing in Honduras, mostly from the United States. Thus, early industrial catches may actually be flag-mislabelled and could have been US catches. With the development of the United Nations Convention on the Law of the Sea, in the period from 1971 to 1982, the Honduran Exclusive Economic Zone (EEZ) was defined as waters 200 nm from shore for the Caribbean Sea (FAO Area 31), while the EEZ for the Pacific coast (FAO Area 77) was constrained due to the coastal features of the immediate neighbours, Nicaragua and El Salvador (Figure 1). Gradually, as international fisheries started to leave, a national industrial fishery begun to grow. The collapse of the industrial US conch fishery near Florida in 1975 was also an important push for the Honduras industrial fishery, which underwent a large development in order to supply the United States. The industrial fishery only occurs in the Caribbean Sea, since shore characteristics preclude the handling of large-scale boats in the Fonseca Gulf (Soto *et al.* 2012). Nowadays, 90 to 95% of the industrial marine product is exported, mainly to the United States (Espinoza 2007).

The artisanal fishery was also growing during that period, both on the Caribbean and Pacific coasts, with records of its presence back to Mayan culture (Mackenzie and Stelik 1996). Although there is no official data of its beginning, it is known that artisanal techniques were used for subsistence for many years, until the commercial aspect was developed. Artisanal fishers employ a range of different fishing crafts, from simple paddled canoes to high horsepower fiberglass boats, but also this category includes the bivalve collectors on the beach (Vazquez *et al.* 2005). In most cases artisanal fishing provides an essential source of employment, nutrition and income to coastal communities, especially in remote areas where few other economic alternatives exist. Due to its undeveloped market chain and processing infrastructure, the Pacific catches supply only the national market (Box and Bonilla 2009), while artisanal fishing on the Caribbean coast supplies both the national and international market.

Honduras's fishery has evidently declined in the past 20 years, reporting over 50% of their marine resources as overexploited (FAO; www.fao.org). The conch fishery was closed in 2003, remaining open only for a research program, the Honduras Queen Conch Research Study (Ehrhardt and Galo 2005). There was also an attempt to close the lobster fishery in 2013, whilst the Nassau grouper population collapsed in 2004, being commercially viable no longer. According to fishers, it is a consequence of the sum of juvenile overfishing, habitat destruction, migration and the use of harmful fishing gear (Korda *et al.* 2008). Fishers have to contend with a precarious infrastructure, poor product distribution systems, low resources and bounded markets, which itself is a consequence of the system, because their products do not achieve the food safety standards to be included in more profitable markets. In addition, the decrease of certain stocks leaves fisheries in a very frail situation.

Another phenomenon that threatens Honduran fishers is the depression of prices on the market for selling fish, which is of vital importance due to the high amount of fish exported abroad. Fishers are forced to increase fishing effort in order to maintain their income due to the decrease in value of the Lempira-Dollar equivalency (Box and Canty 2010). In 1991 the Dirección General de Pesca y Acuicultura department (DIGEPESCA) was created, to regulate and study Honduras's fishing activities. Although the department remains financially and technically limited, improvements have begun to be made. In order to improve fisheries' management in the future it is essential to understand the present situation of the fisheries, i.e., knowing what remains in the ocean and what has been taken. Official reports of catch data often omit important information from artisanal and subsistence fisheries, as well as discards and catch from poaching. The present study follows the lead of Zeller *et al.* (2007) and aims to reconstruct Honduras's historical catch, from 1950 to 2010, including the elements left out of official reporting, to gain a more accurate estimation of fish removals over the last 60 years.

MATERIALS AND METHODS

The catch reconstruction followed the principles described in Pauly (1998), by applying the method of Zeller *et al*. (2007), where reconstructed catch incorporates previously unreported catch in the commercial sector, their discards, and small-scale fisheries such as recreational and subsistence fisheries. Furthermore, the catch only includes marine wild capture fisheries, and thus aquaculture is not included, nor are mammal species, freshwater species, turtles, worms, or seaweed and algae. Reconstructed catch is then compared with the landing statistics of the Food and Agriculture Organization of the United Nations (FAO) which keeps a database of catch by fishing entity, major fishing area, species, and year from 1950 – 2010. For the present paper, we compare reconstructed catch to the FAO catch for Honduras in fishing areas 77 (Gulf de Fonseca) and 31 (Caribbean Sea), which are considered separately for the reconstruction of commercial fisheries (next section). Thereafter, we also estimate catch from the subsistence fisheries and discards.

Commercial fisheries

The Caribbean Sea (FAO Area 31)

National industrial fisheries began in Honduras in the late 1950s to early 1960s (FAO 2002), yet the FAO database still shows minimal catch in the 1950s. Since artisanal fishing in this region wasn't reported until recent years (CEMU, pers. comm.), the FAO landings starting in the early time period were assumed to be industrial fisheries, perhaps experimental fisheries prior to the commencement of full operations. This area should be inspected more thoroughly in future works to truly determine the origin or these catches.

Besides FAO data, from 2001 to 2010, a separately available national data source (DIGEPESCA) contained data on industrial fishery catches from FAO Area 31. These data were a subset of the FAO data for this region and due to the fact that, at least from 2001, FAO records included the main artisanal fishing activity (CEMU, pers. comm.), we can assume that the remainder of FAO catch unaccounted in DIGIPESCA data was artisanal catch. In the following sections, some simple assumptions were made to reconstruct both industrial and artisanal catch in FAO Area 31.

Artisanal catch

Artisanal fishing in Honduras is defined under the Fishing Law 1959 as craft fishing "*within three nautical miles from the shore using boats with capacity under 3 tones and applying basic fishing equipment*". According to this definition, all mid- and small-scale fisheries are located under this category, which means that no registration on dock or licenses are required for fishing, and in consequence, fishing activity in these sectors is highly unregulated.

To estimate total artisanal catch, we first estimated artisanal catch for 2001 – 2010 as previously stated, i.e., subtracting DIGEPESCA industrial data from FAO data in Area 31.

Since artisanal fisheries have been active presumably prior to the 1950s, we used catch data from the 2000s to estimate an average catch rate per fisher and extrapolate this rate back. First, we calculated the average annual tonnage by species group for the reported artisanal data (2001 – 2010) and divided this by the average number of fishers[2] for that time period, obtaining a composite catch rate per fisher by species

[2] A time series of artisanal fishers on the Atlantic coast was calculated using data from FAO (2002); the methodology is described in the section on subsistence fisheries.

group. This rate was then applied to the time series of fishers from 1950 – 2000. While the CPUE may have varied (notably, been higher in the previous time period), we assumed it constant in order to both be conservative and account for the fact that since the number of fishers was varied with total population, it properly represents the market demand of fish. This catch from 1950 – 2000, along with the 'actual' artisanal catch from 2001-2010 represents total reconstructed artisanal catch.

In order to differentiate between reported and unreported artisanal catch, we assumed that the catch data for the years 2001 - 2010 represented 100% reporting of artisanal catch. Since it is unclear when the artisanal fishery began reporting their catch, we assumed that reporting was gradually implemented from 1990 to 2000, although this assumption should be revised and confirmed with relevant authorities on first opportunity. Thus, we assumed that reporting grew from 0% of catch reported in 1989 to 100% in 2001, and multiplied the total artisanal catch estimated above by these percentages to obtain total reported catch from 1990 – 2000. In cases where estimated artisanal reported catch for a certain species was higher than FAO data, we allocated this amount as unreported so that total reported artisanal catch was always less than or equal to FAO reported catch. Total unreported artisanal catch was then allocated by subtracting the reported amount from the totals.

Industrial catch

Industrial catch from 1950-2000 was estimated by subtracting estimated reported artisanal catch from FAO Area 31 data and for the years 2001-2010 DIGIPESCA industrial data were used. There were a few years where industrial catch data for certain species by DIGIPESCA were actually higher than FAO data and in these years we allocated these small amounts as unreported industrial catch.

Unregulated commercial catch

In addition to unreported data in the artisanal and industrial sectors from a lack of reliable reporting mechanisms, unreported catch from poaching, where catch is purposely unreported and sold via illicit or unregulated channels for profit, was also estimated. This generally occurs for higher valued species. Large inconsistencies were found between the FAO dataset 2011 and other sources of information, i.e., 4.8 to 10 times difference in magnitude, principally for lobster and finfish catch (FAO 2002, Heyman and Granados-Dieseldorff 2012). Thus, in order to be conservative, we estimated poaching at 15% of the industrial lobster catch and artisanal finfish catch (both reported and unreported portions of catch).

Pink conch (*Lobatus gigas*) dominated the catch of the Caribbean Sea by Honduras in the 1990s. However, in 2003, because of overexploitation, the Convention in International Trade in Endangered Species of Wild Fauna and Flora (CITES) formulated several management recommendations after which the conch fishery was permanently closed by the government (Ehrhardt and Galo 2005), remaining open only for research purposes ("Queen Conch Scientific Research Program") from 2006. Those captures were assigned to be exported as the only source of Honduras's conch. Notwithstanding, in 10 years of closure, conch has been widely available to local consumption in supermarkets and restaurants, all around the country, even on the Pacific coast (USAID 2011). This unregulated and presumably small scale fishery was not estimated due to lack of data yet in future iterations of this study we hope to include estimates.

Fonseca Gulf (77 FAO Area)

In the Fonseca Gulf, the depth of the fishing grounds and the quality of the landing zones do not allow the deployment of industrial ship sizes, therefore all FAO official data were considered as within the artisanal sector.

Unreported catch

Several reports of fishing activity in the Fonseca Gulf presented significantly larger catches than the FAO dataset 2011 for most of the taxa landed (Soto 2012; Vasquez 2005). These reports consist of an annual assessment repeated in 2004 and 2008. In consequence, for each major target group (crabs, clams, finfish and shrimp), the difference between the two periods of the study (2004 and 2008) and the FAO data for the same years was calculated, then, a ratio of that difference was built for each fishing group. Finally, an average ratio of FAO versus independent sources for each year and each group was computed. If upon extrapolating that rate back from 2004 resulted in a smaller amount than FAO reports, the rate was interpreted as invalid for 1950 to 2003. Then, following a more conservative assumption, a constant difference between the reported and the unreported data was assumed, for crab, fin fish, shrimp and clams, and this was extrapolated from 2010 to 1950. Catch data were linearly interpolated between 2004 and 2008, and the 2008 catch amount was carried forward, unaltered, for 2009 and 2010.

Species split

The taxonomic classification within the FAO dataset for Honduras was in general categories, e.g., 'marine fishes nei', 'panaeus shrimps nei', etc., and therefore, to specifically identify all marine products taken from the sea, these categories were split into families and in most cases up to species, on the basis of the quantitative or qualitative data, personal observations, and basic assumptions. The breakdown by species can be seen in Appendix Table A1 for FAO Area 77, Appendix Table A2 for artisanal catch in FAO Area 31, and Appendix Table A3 for industrial catch in FAO Area 31.

Subsistence fisheries

Catch within the subsistence fishery was estimated by multiplying the number of artisanal fishers by their per capita catch of fish for home consumption. This is based on the knowledge for some fisheries that artisanal fishers bring some catch home for their families and themselves to consume (Mackenzie and Stehlik 1996). There is also subsistence gathering of common Caribbean donax (*Donax denticulatus*), locally called *almejas* in Spanish or *ahis* in Miskito, which local women and children harvest to eat at home, usually in soups with rice and coconut milk, or fried with onions. These are intended only for subsistence and not sold in markets (Mackenzie and Stehlik 1996).

The FAO (2002) indicates that there were 9,132 fishers on the Atlantic coast, and 11,700 artisanal fishers in the bay of Fonseca. Fisher population was assumed to change over time with the same rate of Honduras's national population from 1950 - 2010, obtained from Populstat (www.populstat.org). The subsistence catch per fisher was taken from a specific study conducted in the neighbouring country of Guatemala: 70 $kg \cdot fisher^{-1} \cdot year^{-1}$ (Trujillos *et al.* 2012). This estimate is actually quite conservative considering that the fisher presumably shares the catch with their family. We assumed this amount was composed of various finfish as in artisanal operations, using the species breakdown of 'marine fishes nei' in Appendix Table A1 for FAO Area 77 and Appendix Table A2 for FAO Area 31. Furthermore, we estimated an additional amount of catch of donax clam, adding an additional 5 kg of clam to the aforementioned estimate, resulting in a total of 75 $kg \cdot fisher^{-1} \cdot year^{-1}$ used for estimation.

Discards

According to literature on the Fonseca Gulf (Soto *et al.* 2012), there is no significant shrimp discard activity, because the great majority of the fish caught is consumed, and thus is considered as part of the subsistence fishery. Furthermore, trawls are not used as a gear in the artisanal fisheries, rather trammel and cast nets (Box and Bonilla 2009; Heyman and Granados-Dieseldorff 2012; Mackenzie and Stehlik 1996).

Lopez Martinez and Morales Bojorquez (2012) reported a shrimp fishery discard rate of 0.69 to total catch, which we applied to the FAO shrimp landings for 1950-2010 to estimate discards for the industrial shrimp fishery. Landed by-catch was assumed to already be present in the reported data. Artisanal shrimp by-catch was not included due to the absence of reliable information, and to prevent overestimation in case part of this catch was accounted as "subsistence fishery".

In recent years Jamaica's fishery was reported as collapsed, and from 2010 Honduras started to illegally sell by-catch from the shrimp fishery that would have been previously discarded (CEMU, pers. comm.), so the 'untargeted' fish of Honduras became one of Jamaica's main resources of fish. As a consequence, in 2010, 80% of the total industrial discards of shrimp was considered as 'exported to Jamaica'.

According to Morales (1995), the main components of the discards from the shrimp fishery were blue crab (*Callinectes sapidus*) and jacks (*Caranx*), as well as some catch of whitemouth croaker (*Micropogonias furnieri*), rock shrimps (Sicyonia), and Atlantic seabob (*Xiphopenaeus kroyeri*). Hence, we assumed discards were composed of 20% blue crabs and 20% jacks, 10% of each of the other three species, and the remaining 30% were 'marine fishes nei'.

Although the fishery targeting finfish uses selective gear, discards were not accounted for in order to remain conservative and avoid double counting these catches in subsistence and unreported fisheries. No independent sources existed for information on discards in the crab, squid or other marine crustacean fisheries, yet we assumed discards from these fisheries were minimal.

Other considerations

There was no available information about the impact of the recreational fishing on the area. In the Gulf of Fonseca, no records were found about recreational fishing and local experts claim that it does not occur to a significant extent (CEMU, pers. comm.). On the Caribbean coast, there is at least one known international fishing tournament that from 1999 to 2007 did not have a 'catch and release' policy. Furthermore, it is important to note that the Bay Islands are an important area for other recreational fishing activities; however, they were not considered in this study due to a lack of information. With the increasing presence of tourists, some fishers are starting to build organizations to exploit this new tourist activity (BICA, pers. comm.), and hence this sector will be included in future iterations of the report.

RESULTS

Honduras reconstructed catches are 2.1 times the data reported by the FAO on behalf of Honduras. Overall catches grew throughout most of the time period, but suffered declines in the late 2000s. Rising steadily from 2,770 t in 1950, catches peaked at 31,200 t in 1986 before declining and rebounding in a series of annual fluctuations; on the whole, catches declined to about 13,700 $t \cdot year^{-1}$ in the late 2000s (Figure 2a).

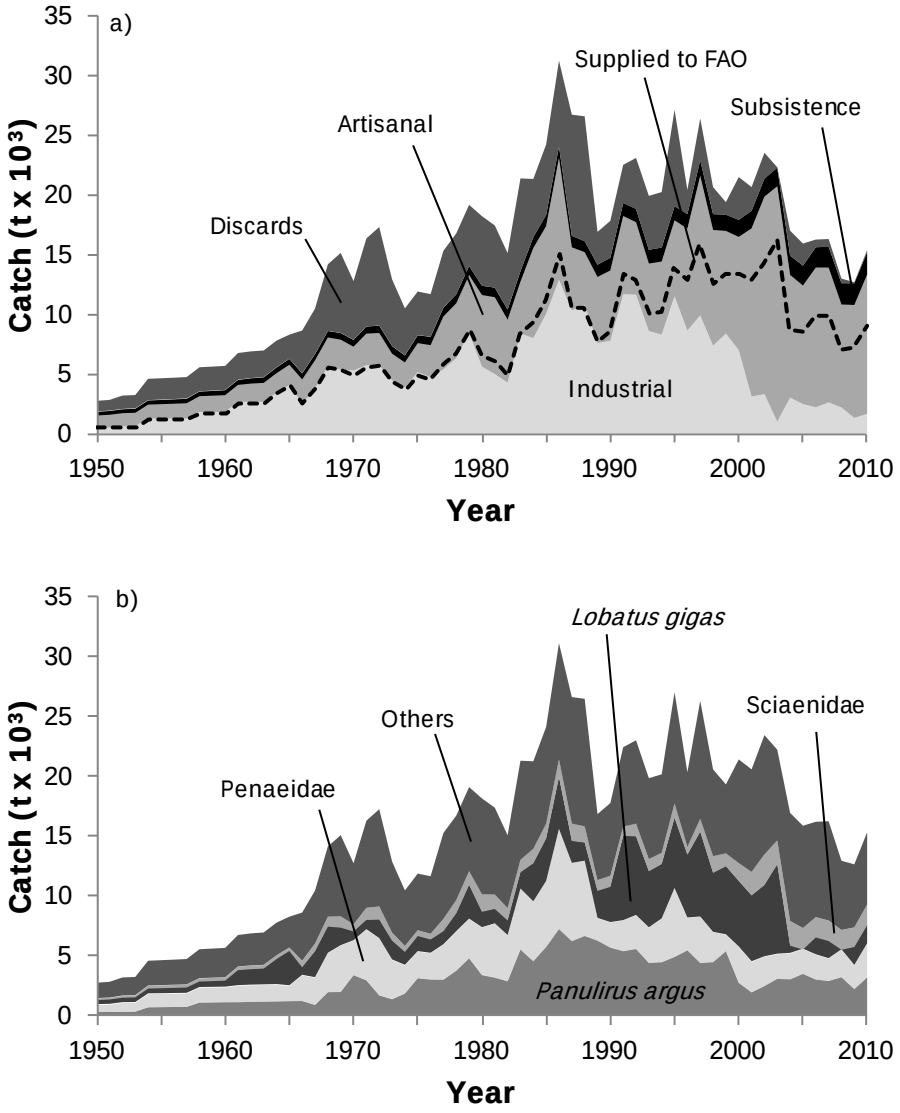

Figure 2. Reconstructed total catch from 1950 -2010 within the EEZ of Honduras a) by sector with data reported by FAO on behalf of Honduras overlaid as a dashed line graph, and b) by major taxonomic group. 'Others' represents 113 additional taxonomic categories.

Catch in the Caribbean Sea (FAO Area 31) accounted for about 82% of catch, while catch in the Gulf de Fonseca accounted for the remaining 18%. The trend for the Caribbean Sea was similar to the trend for the whole of Honduras, except for the fact that declining catches in the 1990s and 2000s were more pronounced. This was due to the increase in catch in the Gulf de Fonseca during the latter part of the time period, which masked the strong decline of catch in the Caribbean Sea.

The unreported catches were composed of discards from the industrial shrimp fishery (45% of unreported catch), unreported artisanal landings (40%), subsistence catch (11%), and unreported industrial landings (4%), whilst catch from recreational fisheries was not included due to lack of data. As can be seen in Figure 2b, spiny lobsters (Palinuridae) accounted for 20% of total catch, entirely composed of Caribbean spiny lobster (*Panulirus argus*). Penaeid shrimps (Penaeidae) contributed 18% of the catch, composed of

catch from 10 different species, followed by 16% of catch from true conchs (Strombidae), entirely from the species of pink conch (*Lobatus gigas*). Catch of drums and croakers (Sciaenidae) followed, adding another 6% of the catch, composed of weakfish (*Cynoscion squamipinnis*), whitemouth croaker (*Micropogonias furnieri*), and other drums and croakers. The remaining 39% was composed of 113 different taxa belonging to 41 families or higher taxonomic classifications.

DISCUSSION

The reconstructed total catch for Honduras was 2.1 times the FAO reported landings, which is similar to the unreported fraction described for Costa Rica's fishery reconstruction of 2.6 (Trujillo *et al.* 2015), but importantly smaller than the ratio found for Belize of 3.5 (Zeller *et al*. 2011).

As can be seen in Figure 2a, industrial catch (and resulting industrial discards) declined quite dramatically in the 1990s and 2000s, a trend also found in the number of industrial fleet licenses in DIGEPESCA records. Artisanal catch and subsistence catch increased over time, due to the increase in population in Honduras and subsequent increase in demand for food, especially as nearly all industrial catch is exported elsewhere. As Fonseca Gulf and other small-scale fisheries are not part of the Honduras exporting activity, low attention is paid to develop them from both the government and various Honduran NGOs.

Regarding discards from the industrial shrimp fishery, it is interesting to note that while discards accounted for nearly one fourth of all biomass taken from the sea from 1950 – 2010, and were attributed solely to industrial operations, discards from the artisanal shrimp fishery are nearly all consumed by the coastal populations in the Pacific and Caribbean. Morales (1997) has already described the little attention the industrial shrimp discards received and the potential profits that could be obtained from this resource. Indeed, in 2010 these products were illegally exported to other countries for human consumption, which is still a current phenomenon (CEMU, pers. comm.). Artisanal shrimp by-catch could be represented in the catch of the estimated subsistence fishery, a sector which accounts for 6% of total catch.

It is crucial to highlight that, in spite of all efforts presented in the present report, the resulting figures are estimates made to be as conservative as possible. They are likely minimums, yet we still believe them to be more accurate than reported data. In fact, the reliability of the record system (and the reported data) has been put into question after data losses in 2000 (CEMU, pers. comm.). Hence, these estimates are necessary given this low data confidence.

The average of the tonnes caught per year reflects a general pattern of a relative low productivity in the first 20 to 30 years of the study (1950-1980) in all of Honduras's fisheries, then an important increase, in most cases of over 10 times of catch weight, and a slight decrease in the last 20 to 10 years (1990-2010). The initial behavior could be explained by the development in fisheries technology as well as an artefact of the development of its data collection system. The decrease of annual catch in the latter years of the study is also reflected in the shrinking size of the registered industrial fleet in the last years (DIGEPESCA). The described phenomenon of the Lempira-Dollar equivalence decline causes rises in fuel prices (Box and Canty 2010); that, together with over exploitation, makes long fishing trips a challenging decision in terms of cost-profits balance, and more fishers are switching to other activities when possible due to the recent economic unreliability of the fishing practice.

Tourism is a growing industry in the Bay Islands, rising in 2012 to a total of 2 million foreign visitors. Considering the 92.7% tourist preference of marine products for consumption (Zuniga Lopez 2009), it would be reasonable to think that tourist consumption could affect the fishing industry. But even though an illegal market exists, where tourists can buy lobster and conch directly from fishers (CEMU, pers. comm.), the main marine product for tourist consumption is tilapia, *Oreochromis aureus*, from aquaculture farming. Tilapia is preferred instead of wild animals because of its reliability (Green and Engle, 2000).

One of the main problems that artisanal fishers have to deal with is the precarious infrastructure that supports them. In a country where temperature is always over 18° C, most of the fishers are not provided with proper freezing conditions or processing supplies, which usually forces them to sell to intermediate buyers who, of course, pay less for their products. This phenomenon was described as one overexploitation factor by Box and Canty (2011). Sadly, Honduras is not the first low resource country which overexploits its rich ecosystem in order to supply other countries, in exchange of unfair rewards (Atta-Mills *et al.* 2004). This catch reconstruction estimates that catch is double the controlled-reported landings, which generally is translated in lower and unregulated pay mechanisms that not only impact the fishing community's economy, but also increases the exploitation factor to the ecosystem. Building fishers' organizations and leadership, creating bonding between the ecosystem services and its users, offering sustainable fishing alternatives and generating trust in management and reporting landing systems could be the initial steps in restoring the sustainability of the Honduran fisheries. Fortunately, some of these changes are already beginning to take place (PROLANSATE, BICA and CEMU, pers. comm.).

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REFERENCES

Arrivillaga A, García M (2004) Status of coral reefs of the Mesoamerican Barrier Reef Systems Project Region, and Reefs of El Salvador, Nicaragua and the Pacific Coasts of Mesoamerica. pp. 473-491 *In* Wilkinson C (ed.), Status of Coral Reefs of the World: 2004. Australian Institute Marine Science.

Atta-Mills J, Alder J, and Sumaila, UR (2004) The decline of a regional fishing nation: the case of Ghana and West Africa. pp. 13-21 *In* Natural Resources Forum 28(1). Blackwell Publishing Ltd.

Box SJ and Bonilla-Mejia I (2008) Estado de conservación y explotación del Mero Nassau (*Epinephelus striatus*) en la costa atlántica de Honduras. DIGEPESCA.

Box SJ and Canty SWJ (2011) The Long and Short Term Economic Drivers of Overexploitation in Honduran Coral Reef Fisheries Due to Their Dependence on Export Markets. Proceedings of the 63rd Gulf and Caribbean Fisheries Institute, Gulf and Caribbean Fisheries Institute. pp 9.

Box SJ and Salgado Bonilla R (2009). Evaluacion de las Practicas Pesqueras en Pesquerias de Pequeña Escala del Golfo de Fonseca, Honduras, Centro de Estudios Marinos. pp 39.

Centro de Estudios Marinos Utila (CEMU), technical advisor of DIGEPESCA, National Agreement 2014.

Ehrhardt NM and Galo M (2005) Informe sobre los resultados de las investigaciones relacionadas con el caracol Strombus gigas y su pesquería en Honduras. Ginebra. pp. 1-37.

Espinoza E (2007) FAO – TCP / RLA / 311 Project 'Mejoramiento de los mercados internos de productos pesqueros en América Latina', Caso de Honduras. Tegucigalpa (Honduras).

Euraque DA (2003) The Threat of Blackness to the Mestizo Nation: Race and Ethnicity in the Honduran Banana Economy, 1920s and 1930s. pp. 229-249 *In* Striffler S and Moberg M (eds.), Banana Wars: Power, Production and History in the Americas. Duke University Press.

FAO (2002) Resumen Informativo sobre pesca por paises: Honduras. FID/CP/HND. Roma, UN.

Fielding S (2000) Recent demographic and migration changes: impacts on natural resources of the Honduran Bay Islands. Unpublished report to the Wildlife Conservation Society and Summit Foundation

Fiscalización DC (1959) Ley de Pesca Decreto N 154. D. G. d. P. y. Agricultura. Tegucigalpa. pp 13.

Green BW and Engle CR (2000) Commercial tilapia aquaculture in Honduras. *Tilapia aquaculture in the Americas*, *2*, 151-170.

Gobert B, Berthou P, Lopez E, Lespagnol P, Turcios MDO, Macabiau C and Portillo P (2005) Early stages of snapper–grouper exploitation in the Caribbean (Bay Islands, Honduras). Fisheries Research 73(1-2). pp 159-169.

Harborne AR, Afzal DC, et al. (2000) Honduras Caribbean coast. Marine Polution Boletin 42(12). pp 1221-1235.

Heyman WD and Granados-Dieseldorff P (2012) The voice of the fishermen of the Gulf of Honduras: Improving regional fisheries management through fisher participation. *Fisheries Research*, 125-126, pp.129–148.

Humann P and Deloach N (2002) Reef Fish Identification: Florida Caribbean Bahamas, 3rd edition. New World Publications Inc., Jacksonville, FL. pp 481.

Korda RC, Hills JM, et al. (2008) Fishery decline in Utila: Disentangling the web of governance. Marine Policy 32(6). pp 968-979.

Lopez Martinez J and Morales Bojorquez E (2012) Efectos de la Pesca de Arrastre en el Golfo de California. Centro de Investigaciones Biológicas del Noroeste, S.C. y Fundación Produce Sonora. Mexico. pp 466.

Mackenzie CL and Stehlik LL (1996) "The Crustacean and Molluscan Fisheries of Honduras." Marine Fisheries Review 58(3). pp 12.

Martín JI (2012) The small scale fleet in the reform of the Common Fisheries Policy. Policy Department B: Structural and Cohesion Polices, European Parliament: Directorate-General for Internal Policies of the Union - Fisheries, Brussels (Belgium). 44 p.

Morales L and Nieto E (1990) Informe preliminar del censo de Pescadores artesanales costa pacifica de Honduras (Golfo de Fonseca). Tegucigalpa, Honduras: Ministry of Natural Resources.

Morales L (1997) La fauna de acompañamiento del camaron en Honduras. Iinforme del Taller Regional Sobre la Utilizacion de la Fauna de Acompañamiento del Camaron (FAC). E. Garcia Rodriguez. Tegucigalpa, Dirección General de Pesca y Acuicultura. pp 4.

Pauly D.(1998) Rationale Reconstruction Catch Time Series. EC Fisheries Cooperation Bulletin 11(2). pp 4-7.

Perez A (2009) Fisheries management at the tri-national border between Belize, Guatemala and Honduras. Marine Policy 33(2). pp 195-200.

PROLANSATE: Fundación para la Protección de Lancetilla, Punta Sal y Texiguat. 1990.

Soto L (2012) Informe de Evaluacion de la Actividad Pesquera en el Golfo de Fonseca, Honduras. Proyecto de Desarrollo Pesquero/ Actividades Acuicolas en el Golfo de Fonseca. Tegucigalpa, Agencia Española de Cooperación Internacional para el Desarrollo. pp 126.

Trujillo P, Cisneros-Montemayor AM, Harper S, Zylich K and Zeller D (2012). Reconstruction of Costa Rica's marine fisheries catches, 1950-2010. Fisheries Center Working Paper #2015-31, University of British Columbia, Vancouver. 16 p.

USAID (2011) The current status of exploitation and conservation of the queen conch *Strombus gigas* in the gulf of Honduras and the bay islands. The Nature Conservancy and Center for Marine Ecology. pp. 1-75.

Vásquez, et al. (2005) Informe de evaluación y ordenación de recursos pesqueros en el Golfo de Fon seca, Honduras (Septiembre 2004-Agosto 2005). San Lorenzo, Valle, Honduras. pp 182.

Zeller D, Booth S, Davis G and Pauly D (2007) Re-estimation of small-scale fishery catches for US flag-associated island areas in the western Pacific: the last 50 years. Fishery Bulletin 105(2): 266-277.

Zuniga Lopez V (2009) Evaluación del conocimiento y apreciación del visitante buceador sobre las especies de peces comerciales en Utila, Islas de la Bahía. Tesis. e Ingeniera en Desarrollo Socioeconómico y Ambiente en el Grado Académico de Licenciatura. Zamorano. pp 29.

Appendix Table A1. Allocated species composition of Honduras catch inside its EEZ (FAO Area 77), by FAO taxonomic categories, 1950 - 2010.

FAO taxonomic category	Taxon name	Common name	Species composition (%)
Marine fishes nei	*Cynoscion squamipinnis*	Weakfish	29.0
	Mugil curema	White mullet	7.0
	Serranidae	Sea basses or groupers and fairy basslets	6.0
	Ariidae	Sea catfishes	6.0
	Lutjanidae	Snappers	6.0
	Bagre pinnimaculatus	Red sea catfish	5.0
	Bagre panamensis	Chilhuil sea catfish	5.0
	Lutjanus colorado	Colorado snapper	5.0
	Haemulidae	Grunts	4.0
	Carangidae	Jacks and pompanos	3.0
	Gerreidae	Mojarras	3.0
	Polynemidae	Threadfins	3.0
	Sciaenidae	Drums or croakers	3.0
	Scombridae	Mackerels tunas and bonitos	3.0
	Centropomidae	Snooks	2.0
	Lobotes pacificus	Pacific tripletail	2.0
	Nematistius pectoralis	Roosterfish	2.0
	Carcharhinidae	Requiem sharks	1.5
	Dasyatidae	Stingrays	1.5
	Sphyraenidae	Barracudas	1.5
	Sphyrnidae	Hammerhead and bonnethead and scoophead shark	1.5
			100.0
Marine crabs nei	*Callinectes arcuatus*	Arched swimming crab	50.0
	Dicoides occidentalis		50.0
			100.0
Penaeus shrimps nei	*Litopenaeus occidentalis*	Western white shrimp	17.0
	Litopenaeus stylirostris	Blue shrimp	16.0
	Litopenaeus vannamei	Whiteleg shrimp	20.0
	Penaeus	Penaeus shrimps	17.0
	Rimapenaeus byrdi	Carabali shrimp	15.0
	Xiphopenaeus kroyeri	Atlantic seabob	15.0
			100.0
Venus clams nei	*Anadara*	Arks	44.4
	Anadara tuberculosa	Pustulose ark	44.4
	Donax	Donax clams	11.1
			100.0

Appendix Table A2. Allocated species composition of Honduras artisanal catch inside its EEZ (FAO Area 31), by FAO taxonomic categories, 1950 - 2010.

FAO taxonomic category	Taxon name	Common name	Species composition (%)
Marine fishes nei	*Balistes capriscus*	Grey triggerfish	2.2
	Balistes vetula	Queen triggerfish	2.2
	Calamus bajonado	Jolthead porgy	2.2
	Calamus calamus	Saucereye porgy	2.2
	Calamus nodosus	Knobbed porgy	2.2
	Canthidermis sufflamen	Ocean triggerfish	2.2
	Caranx latus	Horse-eye jack	2.2
	Caranx ruber	Bar jack	2.2
	Cephalopholis cruentata	Graysby	2.2
	Coryphaena hippurus	Common dolphinfish	2.2
	Ginglymostoma cirratum	Nurse shark	2.2
	Haemulon aurolineatum	Tomtate grunt	2.2
	Haemulon flavolineatum	French grunt	2.2
	Haemulon plumierii	White grunt	2.2
	Heteropriacanthus cruentatus	Glasseye	2.2
	Holocentrus rufus	Longspine squirrelfish	2.2
	Katsuwonus pelamis	Skipjack tuna	2.2
	Lachnolaimus maximus	Hogfish	2.2
	Lutjanus apodus	Schoolmaster snapper	2.2
	Lutjanus griseus	Grey snapper	2.2
	Lutjanus jocu	Dog snapper	2.2
	Lutjanus mahogoni	Mahogany snapper	2.2
	Lutjanus synagris	Lane snapper	2.2
	Mycteroperca microlepis	Gag	2.2
	Sargocentron coruscum	Reef squirrelfish	2.2
	Scarus coelestinus	Midnight parrotfish	2.2
	Scarus coeruleus	Blue parrotfish	2.2
	Scarus guacamaia	Rainbow parrotfish	2.2
	Scarus iseri	Striped parrotfish	2.2
	Scarus taeniopterus	Princess parrotfish	2.2
	Scarus vetula	Queen parrotfish	2.2
	Scomberomorus cavalla	King mackerel	2.2
	Seriola dumerili	Greater amberjack	2.2
	Seriola fasciata	Lesser amberjack	2.2
	Sparisoma aurofrenatum	Redband parrotfish	2.2
	Sparisoma chrysopterum	Redtail parrotfish	2.2
	Sparisoma rubripinne	Redfin parrotfish	2.2
	Sparisoma viride	Stoplight parrotfish	2.2
	Sphyraena barracuda	Great barracuda	2.2
	Thunnus albacares	Yellowfin tuna	2.2
	Thunnus atlanticus	Blackfin tuna	2.2
	Serranidae	Sea basses or groupers and fairy basslets	0.9
	Acanthocybium solandri	Wahoo	0.4
	Ocyurus chrysurus	Yellowtail snapper	0.4
	Acanthurus bahianus	Ocean surgeon	0.4
	Albula vulpes	Bonefish	0.4
	Caranx crysos	Blue runner	0.4
	Caranx hippos	Crevalle jack	0.4
	Centropomus undecimalis	Common snook	0.4
	Diapterus rhombeus	Caitipa mojarra	0.4
	Epinephelus itajara	Goliath grouper	0.4
	Euthynnus alletteratus	Little tunny	0.4
	Haemulon sciurus	Bluestriped grunt	0.4
	Hypoplectrus nigricans	Black hamlet	0.4

	Istiophorus albicans	Atlantic sailfish	0.4
	Lutjanus cyanopterus	Cubera snapper	0.4
	Megalops atlanticus	Tarpon	0.4
	Mycteroperca bonaci	Black grouper	0.4
	Haemulidae	Grunts	0.4
	Lutjanidae	Snappers	0.4
	Pomadasys corvinaeformis	Roughneck grunt	0.4
	Rachycentron canadum	Cobia	0.4
	Scomberomorus maculatus	Atlantic Spanish mackerel	0.4
	Sphyraena barracuda	Great barracuda	0.4
			100.0
Penaeus shrimps nei	*Farfantepenaeus aztecus*	Northern brown shrimp	20.0
	Farfantepenaeus duorarum	Northern pink shrimp	20.0
	Litopenaeus schmitti	Southern white shrimp	20.0
	Penaeidae	Penaeid shrimps	40.0
			100.0

Appendix Table A3. Allocated species composition of Honduras industrial catch inside its EEZ (FAO Area 31), by FAO taxonomic categories, 1950 - 2010.

FAO taxonomic category	Taxon name	Common name	Species composition (%)
Marine fishes nei	Lutjanidae	Snappers	36
	Serranidae	Sea basses or groupers and fairy basslets	16
	Etelis oculatus	Queen snapper	3
	Lutjanus analis	Mutton snapper	3
	Lutjanus buccanella	Blackfin snapper	3
	Lutjanus campechanus	Northern red snapper	3
	Lutjanus purpureus	Southern red snapper	3
	Lutjanus vivanus	Silk snapper	3
	Ocyurus chrysurus	Yellowtail snapper	3
	Rhomboplites aurorubens	Vermilion snapper	3
	Cephalopholis fulva	Coney	2
	Epinephelus adscensionis	Rock hind	2
	Epinephelus guttatus	Red hind	2
	Epinephelus itajara	Goliath grouper	2
	Epinephelus morio	Red grouper	2
	Epinephelus striatus	Nassau grouper	2
	Hyporthodus flavolimbatus	Yellowedge grouper	2
	Hyporthodus mystacinus	Misty grouper	2
	Mycteroperca bonaci	Black grouper	2
	Mycteroperca interstitialis	Yellowmouth grouper	2
	Mycteroperca tigris	Tiger grouper	2
	Mycteroperca venenosa	Yellowfin grouper	2
			100
Penaeus shrimps nei	*Farfantepenaeus aztecus*	Northern brown shrimp	20
	Farfantepenaeus duorarum	Northern pink shrimp	20
	Litopenaeus schmitti	Southern white shrimp	20
	Penaeidae	Penaeid shrimps	40
			100