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RECONSTRUCTION OF MARINE FISHERIES IN EL SALVADOR 1950-2010

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ABSTRACT

El Salvador has the most fishers per square kilometer of coastline for Central America and Mexico. Historically, the industrial shrimp fishery has been the most important economic fishery and has operated for over half a century; however, its impact on the ecosystem as a result of biomass removal has not been fully assessed. On the other hand, small-scale fisheries have been the most important fisheries in terms of domestic food production, but their landings have been significantly under-reported. We estimated total fishery removals (reported landings plus discards and unreported catches) for El Salvador for the period 1950-2010. We used secondary sources to estimate landings where data were unavailable, and estimated by-catch of shrimp and pelagic red crab fisheries, unreported catch of small-scale fisheries, unreported shark landings, and subsistence fisheries. We also estimated the proportion of utilized by-catch and discard rates for the different fisheries sectors. Our results suggest that for the time period 1950-2010 actual removals may have been 6.9 times those reported by FAO on behalf of El Salvador: 16 times for shrimp fisheries, 1.4 times for pelagic red crab, 1.8 times for artisanal fisheries (excluding sharks), and 8.5 times for the shark fishery. In addition, landings data reported to FAO masked a decrease in overall abundance of marine biomass over time, revealed by our reconstruction.

INTRODUCTION

El Salvador is the smallest of the Central American countries with a territory of 21,000 km^2. Its coastal access is restricted to the Pacific Ocean and it has an Exclusive Economic Zone (EEZ) of around 94,000 km^2 (www.searoundus.org). The continental shelf has a surface area of about 18,000 km^2 extending 15 to 45 nautical miles from the coast to a depth of about 200 m. For its small size, El Salvador has a sizeable population of over 6.8 million people, and has the highest population density of the Central American countries with a substantial proportion distributed along its coastline, which is practically entirely inhabited. El Salvador's EEZ lies within FAO statistical areas 77 and 87 (Figure 1). El Salvador's climate is characterized by a dry season between November and April and a wet season between May and October. Surface salinity may vary between 28 and 34% as a result of the heavy rains (200-1,800 mm). Average monthly temperatures can fluctuate between 25.8 and 27.2°C during the dry season and 27.3 to 28.1°C in the rainy season. Additionally, El Salvador has the largest estuarine areas of the Central American region, which include the Gulf of Fonseca and Jisquilisco Bay, with a total surface area of 160 km^2.

Figure 1. The Exclusive Economic Zone (EEZ) and shelf area to 200 m depth for El Salvador. Shown also are the FAO statistical areas and two main estuarine features in El Salvador.

El Salvador's main exports are agricultural products (coffee and sugar), with shrimp being the 3rd largest export (FAO 2001). Along the coastal regions, fishing is the primary economic activity at both the artisanal and commercial level, and represents a vital food source for many coastal and some inland communities (Cotsapas *et al.* 2000). As a result of its large coastal population, El Salvador has the highest density of fishing vessels per area of coastline (22.8 vessels·km^{-2}) in all of Central America and Mexico, which over time has had a substantial impact on it marine ecosystems (FAO and OSPESCA 2006). Management and monitoring of fisheries resources is done by the national Center for the Development of Fisheries and Aquaculture (Centro de Desarrollo de la Pesca y Acuicultura, CENDEPESCA) under the Ministry of Agriculture and Livestock (Ministerio de Agricultura y Ganaderia, MAG). Although the country experienced a civil war between 1980 and 1992, surprisingly, fishery statistics have been consistently collected and reported for the industrial fleet, which until the late 1990s consisted primarily of demersal shrimp trawlers. However, in the case of artisanal fisheries, information on landings is somewhat limited because of their occurrence across virtually the entire expanse of coastline and the lack of sufficient coverage by CENDEPESCA due to staff and financial limitations (Villegas *et al.* 1985; CENDEPESCA 2008). Additionally, there may be high levels of inaccuracy in the national fisheries statistics because much of the landings data reported is not directly collected by CENDEPESCA, instead being submitted by the various fishing companies or fishers cooperatives (Aldana *et al.* 2006).

Industrial fisheries

Historically, industrial fisheries have mainly focused on shrimp trawling, which has been El Salvador's most important commercial fisheries resource (Cotsapas *et al.* 2000). Following an early FAO exploratory cruise — the IZALCO in 1952 — the industrial shrimp fishery was established in 1955-56 with the support of FAO's fisheries development program; a year later, shrimp was being exported primarily to the US (Ellis 1968). Initially, only 4 boats were operating; however, by 1960, the number had grown to 53 and annual landings were around 4,000 tonnes (Villegas *et al.* 1985). In 1966, approximately 10 years after the fishery started, there were 68 boats and landings peaked at around 7,300 tonnes according to FAO statistics. The commercial fleet operates at depths between 10 and 200 m, and exploits 5 main species of shrimp of *Penaeus* spp. and *Farfantepenaeus* spp. that are grouped into 3 categories (red, brown, and white) and four other species *Xiphopenaeus* spp. and *Rimapenaeus* spp. (Table 1). Today, shrimp fisheries continue to be an important resource for El Salvador, but as a result of decreasing catches, new fisheries have developed over the years.

Table 1. Species of shrimp and crab exploited by El Salvador's fisheries.

Family	Species	Common name	Local name
Panaeidae	*Panaeus stylirostris* *P. occidentalis* *P. vannamei*	White shrimp	Blanco
	P. brevirostris	Red shrimp	Rojo
	Farfantepenaeus californiensis	Brown shrimp	Café
	Xiphopenaeus krpyeri *Rimapenaeus pacificus* *R. faoe* *R. byrdi*	Pacific sea bob	Camaroncillo or chacalin
Galatheidae	*Pleuroncodes planipes*	Pelagic red crab	Langostillo chileno or langostilla

In 1970, the FAO exploratory cruise SAGITARIUS discovered a great abundance of pelagic red crab (*Pleuroncodes planipes*) in waters deeper than those of shrimp. This species could be exploited with the same gear and methods as shrimp, presenting a good potential for development and, as a result of decreasing shrimp catches, a fishery for this resource opened up in 1979. This is a clear example of spatial expansion of fisheries following declines in previously exploited resources, as documented globally (Swartz *et al.* 2010). Landings quickly peaked at 14,000 t in 1981; however, pelagic red crab (PRC) was not as profitable as shrimp, and by 1984 the fishery almost completely halted. It was renewed in 2002 as a result of new market opportunities for both its flesh and for production of feed for aquaculture (FAO 2005). One unintended effect of this fishery was that because of the similar gear employed, PRC vessels spent part of the year targeting shrimp and therefore increased the overall effort on this already overexploited resource. The PRC fishery typically operates at greater depth compared to the shrimp fishery, in waters between 146 and 350 m (Villegas *et al.* 1985).

As of 2008, there are 59 bottom trawl vessels (12 - 24 m), 5 purse-seiners (45 – 75 m), and 4 pelagic long-liners (12 - 24 m), two of the latter owned by Spanish companies targeting tuna (López Mendoza 2009). Pelagic long-liners and purse-seiners did not start operating in El Salvador until 1999 and 2002, respectively. While bottom trawlers operate within the EEZ, pelagic long-liners and purse-seiners mostly fish in international waters (CENDEPESCA 2008). In fact, 99% of the purse-seine catch is caught in international waters (CENDEPESCA and MAG

2006). The introduction of purse-seiners in 2001 resulted in a substantial increase in landings and has now become the leading industrial fishery (FAO 2005). Please note that large-scale pelagic fisheries were not considered in this reconstruction. Additional work by the *Sea Around Us* is being done which deals specifically with these fisheries.

Small-scale (artisanal) fisheries

Article 25 of El Salvador's general law governs artisanal fisheries and defines them as fishing conducted in waters less than 40 fathoms (73 m) in depth, from boats smaller than 10 m, and where the majority of the product is consumed fresh (Cotsapas *et al.* 2000). Artisanal fisheries have always been present in El Salvador in some form or another; however, it wasn't until the 1950s that they started taking on more of a commercial role (Fuentes 1976). Traditionally, they were practiced in coastal and estuarine areas in man-powered wooden canoes and employed a variety of 'primitive' gear such as hand lines, cast nets, or traps (Fuentes 1976). This occupation is usually passed from father to son, and most artisanal fishers have little or no schooling having gone out to sea from a young age (Beltrán 2001).

The majority of artisanal catch is consumed locally, and for the most part (around 70%) fresh. In the 1960s, technological advancements such as fiber glass boats and outboard motors allowed artisanal fisheries to expand their range. They now operate along the entire coastline, as far out as 80 nautical miles, although usually keeping within the extent of the continental shelf. The boats employed are usually smaller than 25 ft (8 m), with outboard motors of 45 hp with the exception of shark fishers who use larger and more powerful boats. According to CENDEPESCA, as of 2008 there were 3,743 artisanal boats and over 13,000 fishers participating in some type of fishing activity, employing a variety of methods such as gill nets, hand lines, long-lines, cast nets, or traps (CENDEPESCA 2008).

Although, the exploitation of shrimp has been carried out mainly by the industrial sector, artisanal fisheries have also targeted this resource, over time having played an ever increasing role. In the early 1990s, the artisanal sector significantly increased its commercial activity on shrimp, creating some conflict with the industrial sector, as a result of competition for the same resource (FAO 2001). Please note that for the purposes of the *Sea Around Us* project, all bottom trawling is considered industrial (following Martín 2012) and therefore the artisanal shrimp fisheries of El Salvador are defined as industrial within the present study. There is one more sector of the artisanal fisheries called the 'morralleros' who work in combination with the industrial shrimp fisheries by trans-shipping what industrial shrimpers call 'trash-fish' from the industrial vessels to the artisanal boats and taking it back to shore for marketing. CENDEPESCA estimates that 600 boats and 1,200 fishers practice this activity year-round on a full-time basis (about 10% of the artisanal fleet), with some others doing it on a part-time basis when their catches falter (López Mendoza 2009). Also note that the 'morralla' component is considered industrial within this report as it is actually the industrial vessels that are catching the fish, which they otherwise would discard. However, the importance of artisanal fisheries in El Salvador is still evident when considering that since the early 1990s artisanal fisheries have accounted for over 50% of total fisheries production and for nearly 30% of value (CENDEPESCA and MAG 2001, 2006).

Shark fisheries

In the coastal zones of El Salvador, sharks have probably been caught for as long as artisanal fisheries have been around. However, these were mostly by-catch and the animals were not consumed because of the local belief that sharks fed on human flesh (Campos 2000). It wasn't until the 1970s that a commercial shark fishery developed, fueled by the rising Asian demand for

shark fins, as well as for liver oil, cartilage, and meat for local and regional consumption (Campos 2000). The fishery was also enabled by the earlier technological improvements in the artisanal fisheries sector. As of 2008, there were 1,115 artisanal boats that specifically targeted sharks (nearly a third of the artisanal fleet) using larger boats measuring between 8 and 12 m in length and more powerful outboard engines of up to 75 hp that allow them to navigate further away from the coast into waters where the resource was more abundant (CENDEPESCA 2008). These boats operate anywhere between 10 to 80 nautical miles from the coast and may remain for up to 3 days at sea (CENDEPESCA 2008).

According to CENDEPESCA, there are 7 main artisanal landing sites[1] for shark along the Salvadorian coast; however, it is estimated there are another 67 communities where sharks are landed illegally (CENDEPESCA 2008). In El Salvador, sharks have been almost exclusively exploited by the artisanal fleets and it was not until the turn of the century that a small portion of the industrial fisheries started landing sharks as a result of longline operations. There are currently 4 industrial pelagic long-line vessels that target shark and other pelagic species (CENDEPESCA 2008). Although industrial long-liners frequently fish within the EEZ waters, they may fish in international waters anywhere from Mexico to Ecuador.

METHODS

We estimated El Salvador's total marine catches for the years 1950-2010 using the catch reconstruction methodology in Zeller *et al.* (2006) and Zeller *et al.* (2007). The procedure for reconstructing likely total catches is based on a suite of 'hard data points' taken from a variety of sources, such as in country or regional reports, national statistics, or scientific literature, which are then augmented by local expert knowledge and assumption-based estimates, and connected by interpolations where data gaps exist. As a starting point, we compared the FAO landings data (FISHSTAT 2010 data)[2] to national reported landings, when available, in order to determine our 'reported' data baseline. Official national landings data were available for 1992 to 2006 in the Annual Fisheries and Aquaculture Statistics Reports (2001-2006) produced by the Fisheries and Aquaculture Development Center (CENDEPESCA). Another two periods of national landings data (1958-1970 and 1974-1984) were obtained from secondary sources, Tilic and McCleary (1971) and Villegas *et al.* (1985), respectively. We found FAO and national landings data to be comparable[3] (Figure 2), but used the FAO landings data as our reported data baseline because the entire time series from 1950 to 2010 was available. Although the times series in the graph (Figure 2) contain tuna catches, during this reconstruction we excluded the tuna (bigeye tuna, skipjack tuna, and yellowfin tuna) as those fisheries are being reconstructed as a separate portion of the *Sea Around Us* project. We then calculated the amount of catch not reflected in the reported landings data (i.e., unreported catch), as a result of either general under-reporting or discards. We did this for each of the different fishing sectors and came up with an estimate of total catch as opposed to reported landings. In this study, we describe the different components of El Salvador's fisheries in the following terms: catches (total volume of organisms caught, whether landed or discarded at sea), landings (reported part of catch that is brought ashore), and discards (unused part of catches returned to the sea). In El Salvador, there is an additional component associated with the industrial shrimp fisheries called the 'morralla' or 'trash fish' that is neither retained nor discarded by the shrimp vessels; instead this portion of the catch is

[1] La Libertad, El Triunfo, La Herradura, Isla Tasajera, Acajutla, El Tamarindo, and Garita Palmera.

[2] http://www.fao.org/fishery/statistics/software/fishstat/en)

[3] National data matched FAO relatively well once IATTC tuna data was incorporated and nominal red pelagic crab landings were used instead of the product weight given in the 10 year summary tables in CENDEPESCA's annual fisheries statics reports.

picked up by artisanal vessels directly from the trawlers and taken back to land for distribution in local markets. There is an entire subsector within the artisanal fisheries sector that is dedicated to this activity called 'morralleros'. Only some of the catch by this sector is thought to be reported.

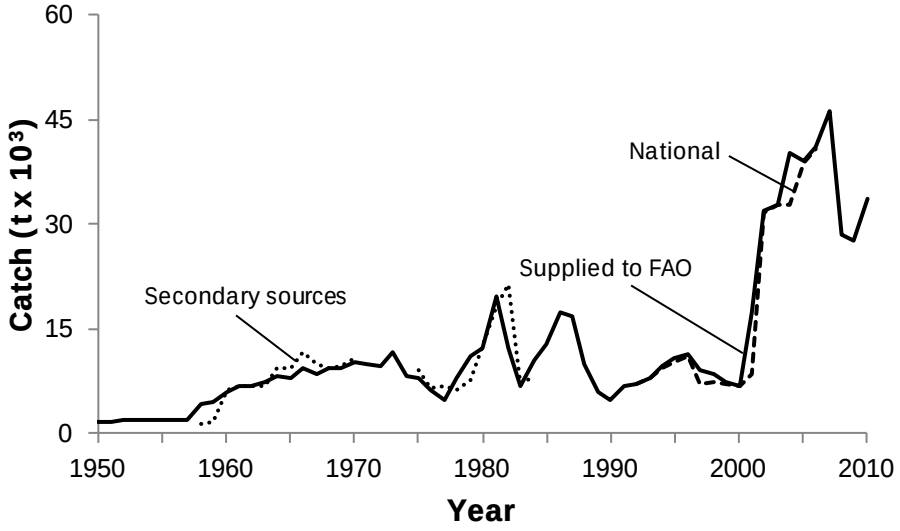

Figure 2. Landings data from FAO, National, and secondary sources (including tuna).

Shrimp fisheries

For the shrimp fishery landings, national data were available for 1960-2006 (Guevara 2009) and from FAO for 1950-2010 (FISHSTAT 2010 data); a further two years of data (1958 and 1959) were available from the Organization of American States (OAS 1974). Landings data were comparable from approximately 1980 onwards, but from 1960 to 1974 FAO reported higher landings than the national data. We assumed this was because national landings may have been reported in product weight in that earlier period and FAO converted these to nominal weight (whole wet weight). In effect, when a standardized[4] conversion factor was applied to the national data it fit the FAO data pattern relatively well. Therefore, we took the FAO data to be the best representation of shrimp landings and used it as our baseline for the reconstruction of shrimp catches. However, we did adjust the FAO numbers for 1950-1956 since they appeared to have carried back the 1000 t shrimp landing estimate from 1957, which was the year the industrial fishery started. In order to determine a more realistic catch for the years where the industrial shrimp fishery was not operative, we derived a ratio of artisanal shrimp landings to total reconstructed artisanal landings (see below) from 1960, which was the earliest available estimate of artisanal shrimp landings, then applied this ratio to our reconstructed artisanal landings for years 1950-1956. Total shrimp fisheries catch comprised four components: landed shrimp, retained by-catch (non-target species landed by the shrimp vessels), 'morralla', and discards. As mentioned previously, all final shrimp and related catch (by-catch, discards, and 'morralla') estimates are considered industrial in this report.

[4] Used a general conversion of 65% tail to whole weight not specific to each individual species of shrimp. Source: Guevara (2009). El Salvador: Estado del recurso "Camarón", FIINSPESCA. San Salvador, FAO-OSPESCA.

We first estimated total catch for the shrimp fishery from 1950 to 1991 by using the percentage of invertebrates from total catch, 5.7%, reported by Cole and Wieme (1970); this corresponded to a total catch to shrimp ratio of 17.54 (100/5.7). We take this to be a conservative estimate since all invertebrates were lumped together and therefore the actual shrimp catch would have been smaller. From 1992 onwards, we applied a 14.75 total catch to shrimp ratio, which was the average of eight different shrimp by-catch studies conducted in El Salvador from 1992-2009 (Table 2; note that by-catch to shrimp ratios were converted to total catch to shrimp ratios). This ratio would be equivalent to 6.8% (100/14.75) of shrimp of the total catch, which would appear to be in accordance with a regional FAO study of by-catch (FAO and CIP 1997) that report a general range of 3 to 10% for the Central American Pacific with the associated by-catch making up 90 to 97% of total catch. Nonetheless, the percentage of shrimp noted above seems high when compared to the early 1968 shrimp catch percentage and it is likely that this is due to an overall decrease in fish abundance as a result of benthic impacts from decades of trawling activity rather than an increase in shrimp (Fuentes and Hernández 2004). This is consistent with Foer and Olsen (1992), who report that associated by-catch significantly dropped over time from more than 300 kg per hour trawled in 1958, to 15 kg in 1975, and less than 10 kg by the 1980s. In fact, a detailed national by-catch study in 2004 reported the shrimp catch at 4.06% (CCCNPESCA 2004 as cited in López Mendoza 2009). Furthermore, Ulloa (1984) estimated that shrimp by-catch is 17 to 30 times higher than reported (cited in Villegas *et al.* 1985). We therefore consider that both of the shrimp by-catch ratios employed to be conservative estimates.

Table 2. By-catch to shrimp ratios from 8 different studies used to estimate total catch and discards for El Salvador's shrimp fisheries after 1991.

Year	Ratio	Source
1992	9:1	Foer and Olsen (1992)
1996	5:1	López (1998)
1999	23:1	López (2000)
2002	8:1	López and Mariño (2002)
2003	8:1	Fuentes and Hernández (2004)
2004	25:1	CCCNPESCA (2004)
2007	22:1	Barahona and Henríquez (2007); Pacheco and Siu (2007)
2009	10:1	(López Mendoza 2009)

In regards to the retained portion of the by-catch, we found two studies that estimated the marketable portion of fish from the total catch. These studies reported a 13% and a 16% catch of marketable fish from total catch for 1968 and 1984, respectively (Cole and Wime 1970, Ulloa 1984a as cited Villegas *et al.* 1985). However, when we looked at the volume of fish landed by shrimp fisheries reported in the national data, this volume was always lower than that of shrimp. This indicated that although marketable fish may be caught in the percentages listed above it does not necessarily mean that all of it is retained and landed; in fact, Villegas *et al.* (1985) comments on this same disparity. Furthermore, it is reported that shrimp trawler holds are mainly designed to store shrimp and that typically boats only retain fish in the last few days of the trip when they are headed back to port (Ellis 1972; OAS 1974). We therefore used the fish landings in the national data reported by the shrimp industry from 1950-2008, which seemed to better represent the amount of landed by-catch. The proportion of landed by-catch out of total by-catch in 2008 was carried forward to 2010. Although these catches are reported by the

shrimp industry, they are deemed to be not included in the FAO data. Therefore, we considered the landed shrimp by-catch to be unreported catches.

The practice of 'morralla' was likely present to some degree even in the earlier period whereby a few artisanal fishers purchased the non-marketable shrimp from the shrimp trawlers (D. Zambrano, pers. comm., GTRT[5]), but we were not able to establish the year when the large-scale practice of picking up the 'trash-fish' started. Therefore, we assumed that the practice began in 1979 when retained fish for production of fish meal began to be reported as zero by the shrimp vessels and thus become available to artisanal fleet. Since we could not determine the degree to which the practice took place, we set 1978 to zero and scaled the percentage of 'morralla' out of the total shrimp fishery linearly to 47.48% by 1995, around the time it seems to be common practice in the literature (FAO and CIP 1997). In regards to discards, we assumed that before 1979, the portion of the catch that what was not reported either as shrimp or landed by-catch was discarded at sea until the practice of picking up the 'morralla' started.

Total unreported catch was defined as the total reconstructed catch minus reported shrimp landings and would therefore be represented by the landed by-catch, 'morralla' and discards. Since a portion of the 'morralla' may have been reported as artisanal catch under the miscellaneous fish category, we assumed, conservatively, that 20% of the 'morralla' was reported, while the remaining 80% was unaccounted for in the reported landings. The portion that was estimated as unreported may have been used for fishmeal or other animal feed. In fact, when we plotted the total volume of available 'morralla' against our reconstructed artisanal landings, the former was several fold larger indicating that a considerable portion of utilized 'morralla' was unreported (Figure 3).

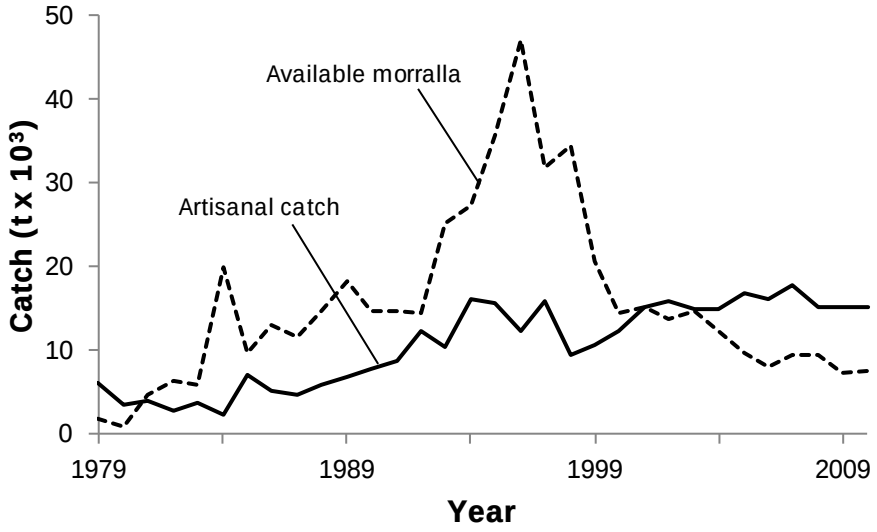

Figure 3. Estimated available 'morralla' after 1979, the year we assumed the practice started compared to reconstructed artisanal catch showing a significant amount of fish and other by-catch available that cannot be accounted for entirely by artisanal landings between 1980 – 2001.

[5] Grupo de Trabajo Regional de Tiburones (Sharks Regional Working Group).

Pelagic red crab fishery

National and FAO landings of pelagic red crab were identical. It is reported that pelagic red crab is fished with similar gears and methods as those of shrimp fisheries (bottom trawls) but in deeper waters beyond 100 m. Thus, it would be expected to have similar (or slightly smaller) by-catch. However, information on by-catch for this fishery was very limited and we could only find one source addressing this topic and reporting an annual average by-catch rate (by-catch as a percentage of total catch) of 28%[6] with much variation across the time of year and depth fished, ranging from 0 to 98%. We therefore applied this by-catch rate to the entire time series (1979-2010). We assumed all by-catch was discarded as this fishery takes place at a greater depth than that of shrimp and therefore, vessels operate too far from shore for access by the morralleros.

Artisanal fisheries

Data for artisanal landings were available for 1964-1970 (Tilic and McCleary 1971), 1972 (Fuentes 1976), 1975-1984 (Villegas *et al.* 1985) and 1992-2006 (CENDEPESCA and MAG 2001, 2006). For years where no data were available, we linearly interpolated between years. Although Tilic and McCleary (1971) provide artisanal landings from 1964-1970, values prior to 1970 appeared unrealistically high, therefore we used their 1970 value as an anchor point. For our 1950 starting point, we calculated a catch rate of reported artisanal landings to the number of fishers, reported in Salas *et al.* (2007) for 1976 and applied this rate (0.3 $t \cdot fisher^{-1} year^{-1}$) to the estimated number of fishers in 1950 (2254 fishers). The number of fishers in 1950 was estimated by using the percent of fishers in the total population for 1976 (5,000/4,123,000 = 0.12%) and applying it to the 1950 population (1,859,000). Population data was retrieved from Populstat (www.populstat.info/). We then adjusted artisanal landings for under-reporting by 60% (100/40 or a factor of 2.5) for 1950-1984 as estimated in Villegas (1985). In 2002, a new reporting system for artisanal fisheries was introduced and reported catches were estimated to have increased by 138% as a result of the improved reporting.[7] Therefore, we adjusted landings for the years 1992-2001 by a factor of 2.38 and interpolated from 1984-1992. We used the national reported landings for 2002-2006, since these would have been estimated using the new reporting system. For years where FAO reported landings were higher than our reconstruction, we accepted the FAO value. As no data were available for 2007-2010, we accepted the FAO values for this period. However, FAO landings for 2008 and 2009 appeared to be unrealistically low, therefore we interpolated from 2007-2010.

Shark fishery

FAO data for shark landings were only available from 1992 to 2010. For this time period, FAO and national landings were the same except for 2006, where they differ by 13 t. In order to estimate shark catches for the entire 1950-2010 time series, we used a percentage of shark in the artisanal catch based on Fuentes (1976) estimate of 17.4% for 1974 and applied this to years where we had artisanal catch data (1964-1970, 1972, 1975-1984). As mentioned before, we adjusted the values from 1964-1969 reported by Tiric and Mclain (1971) as these appeared to be

[6] Associated by-catch was broken down into 38% fish, 41% crustaceans, and 21% mollusks, but no information on species or retention given. An assumption was made to apply the fish breakdown of the shrimp discards to the fish portion of the pelagic red crab by-catch.

[7] This improved reporting was the result of the project "Sistema de mejoramiento de las estadísticas pesqueras, con énfasis en la pesca artesanal marina individual" funded by the Japan International Cooperation Agency (JICA); however, from 2003 onwards reporting of artisanal landings by CENDEPESCA has not adhered to the project's established protocol due to a lack of personnel and financial limitations and the reported statistics are estimated based on the 2002 numbers - (FAO ND).

too high. Therefore, we applied the 17.4% to the adjusted values. Since the vast majority of shark were taken by artisanal fisheries, as a proxy, we divided estimated shark landings by FAO's MMF ('marine fishes nei') and derived a percentage that we could then apply to MMF in order to derive shark landings for years where we did not have independent artisanal catch data. The percentages varied between time periods: for 1950 to 1963 we used the averaged proportion of sharks to MMF for years 1964-1970 (13.6%) and applied this rate retroactively. For 1971, 1973, and 1974[8] we interpolated between years. We interpolated linearly between our 1985 estimate and that for 1991. The 1985 estimate was derived using the average shark landings calculated as a percentage in relation to the FAO MMF category (11%) for the preceding 5 years (1980-1984). Our 1991 estimate was the average of the succeeding 5 years (1992-1996), which was 16.3%. For the 1992-2010 time period, we used the reported shark landings in the FAO data and adjusted the time series for under-reporting following the procedures described for artisanal landings (i.e., we applied under-reporting factors of 2.5 and 2.38 to the periods 1950-1984 and 1992-2001, respectively). A slight adjustment was made to the artisanal method for the intervening years (1985-1991); instead of using an interpolated rate, this period was adjusted using the same under-reporting factor of 2.38.

However, when comparing shark catches to artisanal landings from 2002 onwards, they did not increase as would be expected from the implementation of the new reporting system. Therefore, we assumed shark landings had not been adjusted accordingly after 2001 and we adjusted by the 2.38 factor previously used for artisanal fisheries as a result of under-reporting. This decision was based on the fact that when we looked at the percentage of shark landings in the artisanal catch over time, there was a sudden decrease in this percentage after 2002 that did not reflect the long term trend from 1974 to 2001. During this time period, the percentage of shark landing in the artisanal catch showed a steady decrease from 18.9% to 15%; however, in 2002 this percentage drops suddenly to 7.55% and averages 8% for the next 5 years. This coincides with the adjusted artisanal landings reporting system implemented in 2002 by CENDEPESCA; however, although total artisanal landings went up by 138%, shark landings remained similar to pre-2002 numbers.

Despite shark resources fluctuating from year to year based on annual landings, the combined average over the period of 2002-2010 is most likely a result of under-reporting rather than changes in the resource. Furthermore, even though there is evidence that shark resources have been decreasing in abundance over time due to increased fishing pressure, such a sudden and sustained overall decrease from one year to the next seems unreasonable. The final step in the reconstruction of shark catches was to convert the entire time series from product weight (skinless trunk) to whole wet weight (nominal weight). This was based on a personal communication by a local shark specialist informing that landing data provided to CENDEPESCA was of fresh skinless trunks (D. Zambrano, pers. comm.). We therefore used a conversion factor of 1.73 (trunk minus skin), which was the average of conversion factors for 3 species of shark most commonly caught in El Salvador, i.e., silky shark (*Carcharhinus falciformis)*, black tip (*Carcharhinus limbatus)*, and scalloped hammerhead (*Sphyrna lewini*).[9]

Before pelagic long-liners started operating in 2001, all sharks taken were assumed to come from artisanal fisheries, while after 2001, where national data were available, artisanal fisheries still accounted for over 95% of shark landings (R. Donadi, pers. obs.). Several species of shark

[8] We could not use the Fuentes (1976) 1974 shark landings figure as a sound estimate of total shark landings by artisanal fisheries for that year, because the landing sites sampled were only a few. However, we assumed that the proportion of shark landings was representative across the fishery.

[9] http://www.fao.org/docrep/005/x3690e/x3690e00.htm

are landed in El Salvador (Table 3), the most common being the silky shark (*Carcharhinus falciformis*) that makes up about 70% of landed catch, followed by the scalloped hammerhead (*Sphyrna lewini*) making up anywhere from 4 to 12% of catches (Campos 2000). It is very likely that national shark landings are significantly under-reported as a result of a shortage of personnel and the many communities along the coast where sharks are landed, as well as the lack of information on shark by-catch in other fisheries (CENDEPESCA 2008). Shark catches were broken down by the percentages shown in Table 3.

Table 3. Species of sharks caught in El Salvadorian fisheries. Source: Campos (2000). Diagnóstico de la pesquería de tiburón en Centroamérica, ProAmbiente.

Common name	Scientific name	Range	Percent contribution
Silky or gray	*Carcharhinus falciformis**	Pelagic	70
Scalloped hammerhead	*Sphyrna lewini**	Coastal-pelagic	11
Black tip reef shark	*Carcharhinus limbatus**	Coastal-pelagic	5
White nosed	*Nasolamia velox**	Pelagic	5
Bigeye thresher	*Alopias superciliosus*	Pelagic	1
Thresher	*Alopias vulpinus*	Pelagic	1
Galapagos	*Carcharhinus galapagensis*	Pelagic	1
Oceanic white tip	*Carcharhinus longimanus*	Pelagic	1
Smalltail shark	*Carcharhinus porosus*	Coastal	1
Tiger shark	*Galeocerdo cuvier*	Coastal-pelagic	1
Nurse shark	*Gynglimostoma cirratum*	Coastal	1
Blue shark	*Prionace glauca*	Pelagic	1
Great hammerhead	*Sphyrna mokarran*	Coastal-pelagic	1

* Frequently caught.

Subsistence fisheries

Information on subsistence fisheries were not readily available, both for catches retained by commercial fishers for personal consumption and for subsistence fishers operating independently of the commercial sector. We estimated the portion of the catch retained by commercial fishers, considered here to be subsistence catch, using an estimate from a Nicaraguan study (Heyman and Graham 2002). This study estimated that each artisanal fisher retains approximately 66 kg per year for personal consumption, which we assumed to be the same in El Salvador. We then multiplied this estimate by the number of fishers in El Salvador. To get the number of fishers for the entire time series, the proportion of fishers in 1976 (0.12%) and 2000 (0.21%) were applied, fixed, to the population from 1950-1976 and 2000-2010, respectively. We then interpolated linearly from 1976-2000. Population data were available for 1950-2000, 2005, and 2010 and we interpolated where data were missing. It is important to note, however, that these estimates exclude any subsistence fisheries operating outside of commercial artisanal fisheries since no information was readily available. Therefore, we consider our estimates of subsistence catches to be rather conservative.

RESULTS

Our results indicate a considerable difference between the landings reported by FAO on behalf of El Salvador and our estimates of total catches (Figure 4a). Based on our reconstruction approach, the reported landings underestimate total catches by a factor of 6.9 for the 1950-2010 time period considered here. Under-reporting was prominent across most of the time series with the highest levels present during the 1960s. However, starting in the late 1990s, under-reporting decreased down to around 1.9 times by 2010 (Figure 4a). Although reporting improved over the

time period, there is a large decrease in reported landings in 2008 and 2009, with reported landings increasing again in 2010. For this 2 year period the reconstructed total catch is 6.7 times higher than the FAO data, as opposed to the average 1.9 times in the surrounding years. Unreported catch from the shrimp fishery was the most prominent component of total reconstructed catch accounting for 90% of unreported catch, followed by artisanal fisheries excluding sharks (5.3%), shark fisheries (2.5%), PRC (1.5%), and subsistence (1%). Reconstructed catches from the shrimp fisheries were 16 times larger than reported landings (Figure 5), while reconstructed PRC, artisanal, and shark catches were larger by 1.4, 1.8, and 8.5, respectively. Of the reconstructed catch, the industrial sector constitutes 86.3%, artisanal 13% (505,300 t), and subsistence 0.76% (29,600 t; Figure 4a). The total reconstructed catch is dominated by discard species; *Synodus scituliceps* is the largest contributor to the total catch representing 11.7%, followed by *Pleuroncodes planipes* (10.0%), other shrimps and prawns (9.4%), *Squilla biformis* (7.5%), *Syacium ovale* (5.6%), and *Plesionika trispinus* (5.5%; Figure 4b). Of the retained catch, *Pleuroncodes planipes* is the primary species caught (9.8%), followed by *Xiphopenaeus riveti* (7.8%), other Penaeidae (7.3%), and *Carcharhinus falciformis* (5.2%).

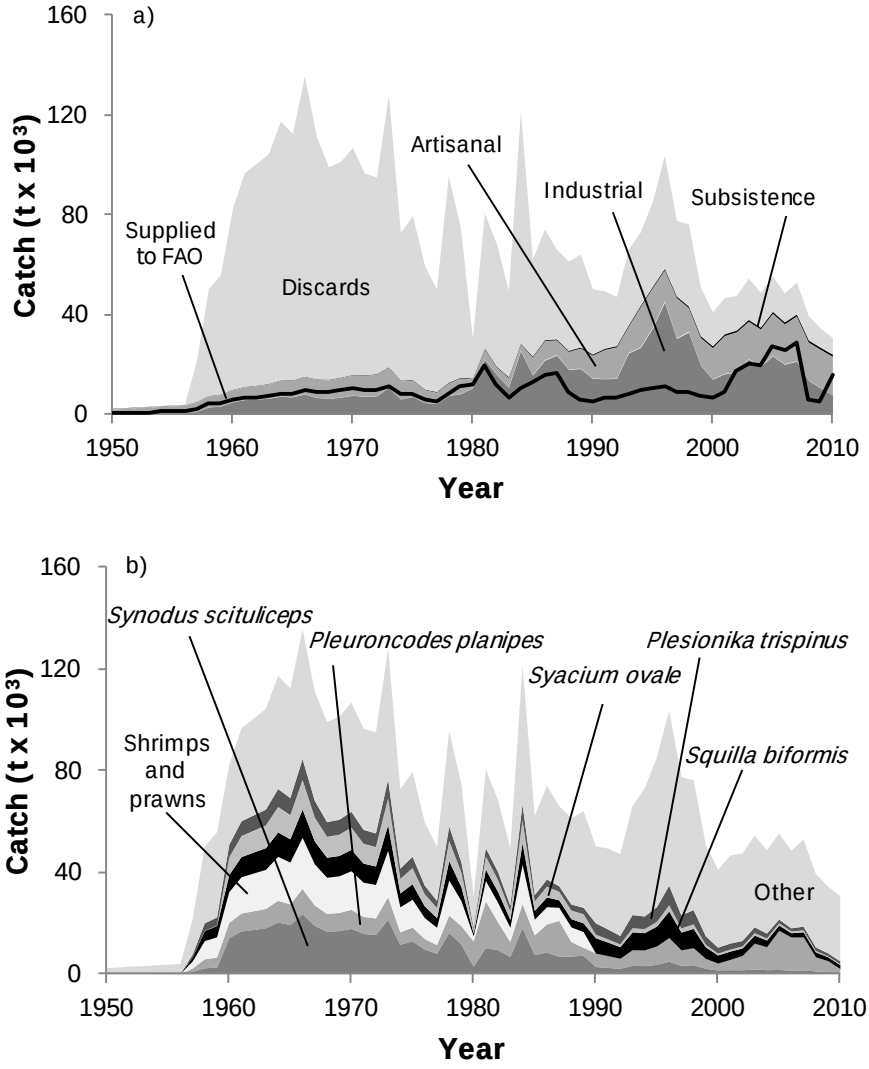

Figure 4. a) Total reconstructed catch by sector for El Salvador, with data as presented by the FAO on behalf of El Salvador overlaid as line graph, 1950-2010; and b) total reconstructed catch by major taxa.

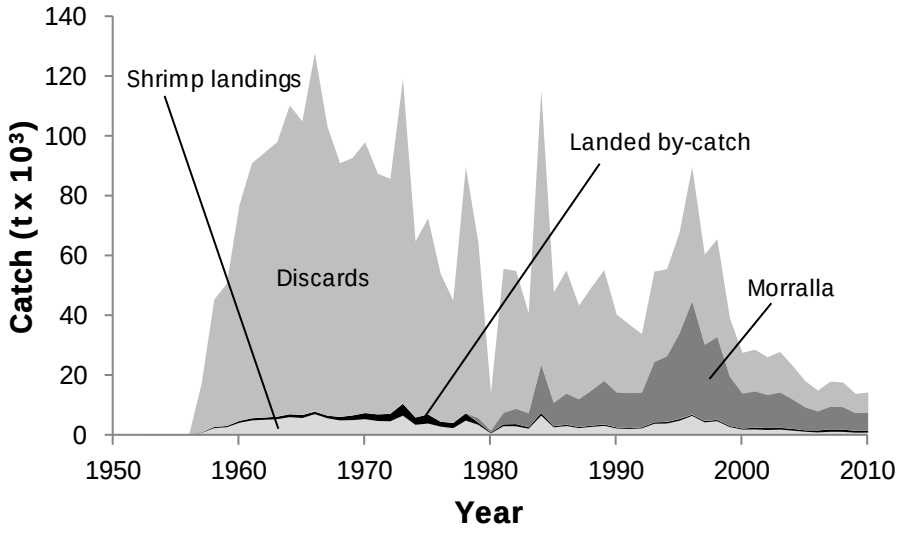

Figure 5. Reconstructed shrimp catch 1950—2010 showing the four different components of the fishery (landed shrimp, landed by-catch, by-catch handed over to morralla fishers, and discards) and a decrease in overall biomass over time. Notice the start of 'morralla' utilization in 1979 and its increase over time resulting in a reduction of discards.

Total discards were estimated at 2.6 million tonnes over the 1950-2010 time period. The average annual discard rate was 55% (discards as a percentage of total catch) and showed a decreasing trend over time from nearly 90% in the late 1950s and early 60s to about 22% by 2010. The total volume of discards also exhibited a decrease over time. Shrimp fisheries on their own accounted for nearly 98% of all discards with 2.56 million tonnes. Discards decreased after 1978, once morralleros' started operating. The average shrimp discard rate for years since 100% of morralla were picked up (1995-2010) was 48.2%, corresponding to an average rate of utilized by-catch of 54.8% for this same time period.[10] The remainder of total discards (50,000 tonnes) was from the PRC fishery, while discards by the artisanal fisheries were minimal and were considered negligible. It is worth noting that prior to the start of the industrial shrimp fishery (1957) discards were less than 10%.

DISCUSSION

Our estimated total catch suggests an overall decrease in catch over time from an estimated peak in 1966 of over 135,000 t to around 30,600 t in 2010. This contrasts with the increase in reported landings over time. A decrease in catch over time is likely due to an overall decrease in abundance of both shrimp and associated by-catch as a result of decades of intense trawling activity (Foer and Olsen 1992). However, apart from by-catch and discards not being reported, the likely overall decline of coastal fisheries resources not reflected in FAO reported landings may have been masked by several factors. For example, the introduction of new fisheries such as PRC in the late 1970s, which had both significant landings and less by-catch, or the start of the

[10] These results do not include the 20% morralla assumed to be reported within the artisanal catch in order to remain conservative.

pelagic tuna purse seine fishery in 2002, which fishes exclusively outside EEZ waters and has produced over 40% of total reported landings with relatively little by-catch since it started operating. In addition, improved reporting (e.g., implementation of new reporting system for the artisanal fleet in 2002) and the likely fact that part of the 'morralla' was being reported under artisanal fisheries would all have contributed to the increases in reported data over time, as reflected in the FAO data, creating the appearance that El Salvador's marine fisheries were in a healthier state that in reality, as a result of continuous degradation over decades. Furthermore, since FAO and national reporting tends to mainly focus on the status of commercial species, they may have neglected to report on various categories of fish and other marine biota potentially enhancing the masking effect of declining fisheries resources.

Although certain time periods have seen a marked decrease in landings, such as the sudden drop in 1998 as a result of knock-on effects from hurricane Mitch (López Mendoza 2009), other decreases in landings may have been due to inaccurate reporting, for example, the decreasing trend in artisanal catches between 1972 and 1977. In relation to this time period, Villegas *et al.* (1985) mentions that internal strife within the country during the 1970s leading up to the country's civil war and changes in the administration of fisheries may have produced inaccurate estimates of total catches, especially in the artisanal sector and may have been the reason behind the decrease in artisanal landings. However, after 1984, artisanal landings once again start to increase, possibly due to the intensification of the practice of picking up 'morralla', but also because of an increase of artisanal fishers resulting from an influx of people displaced by the civil war to coastal areas (Villegas *et al.* 1985; FAO ND).

Reconstructed catches suggest a decrease over time in industrial catches from its peak in 1966 of 128,000 t to 14,500 t in 2010 (Figure 4a). This is consistent with the literature marking a continual decline of both shrimp and associated by-catch in the industrial fishery as a result of long term impacts from bottom trawlers (Cole and Wieme 1970; OAS 1974; Villegas *et al.* 1985; Foer and Olsen 1992; Windevoxhel *et al.* ND). Studies as early as 1968 (Cole and Wieme 1970; Ellis 1972) have reported heavy exploitation of shrimp stocks and associated demersal fish by-catch and were recommending the implementation of effort reduction measures nearly 40 years ago. Interestingly, effort has stayed more or less consistent since the 1960s, but has invariably led to a degraded resource (Guevara 2009), which explains the severe declines in catches over time. A 100 fold decrease in shrimp CPUE between 1953 (305 kg·trawl hr^{-1} during the Izalco exploratory survey) and 1984 (3 to 5 kg·trawl hr^{-1}), as well as a significant decrease in demersal fish in the 12 years between the Izalco survey and the 1976 Sagitarius survey (Villegas *et al.* 1985; MARN 1997). Furthermore, Villegas *et al.* (1985) report a decrease in average size of retained commercially valuable fish between two studies (Ramiréz and Miller 1975; Ulloa 1984), where in the former fish above 17 cm were retained, this size having dropped to 12 cm in the latter. He concludes that both shrimp and commercially valuable demersal fish caught as by-catch in industrial shrimp fisheries were severely over exploited by 1984 and recommends that effort reduction measures take place.

It is also probable that this marked decrease in shrimp landings (the principal economic fisheries resource) and demersal fish, combined with population increases led to the practice of picking up 'morralla' by artisanal fisheries, as a response to the population's dietary needs, as well as having contributed towards the opening of new fisheries, such as pelagic red crab in the late 1970s. In the 1990s both 'camaroncillo' (pacific seabob) and shrimp aquaculture start taking on a more important commercial role reflecting the decrease in shrimp resources (Guevara 2009; López Mendoza 2009). The search for alternative fisheries such as pelagic longliners and tuna purse seiners by the turn of the century may also be a result of a decrease in shrimp stocks over time. However, this leads to the problem of fisheries expansion, which may cover economic

deficits for a time, but does not solve the essential problem of the stock's decline nor makes up for the necessary effort reduction. Economic necessity for El Salvador's artisanal fishers has led to an increase in the targeting of shark as a result of the lucrative fin market.

Reconstructing shark landings was complicated by the lack of official landings data prior to 1992. Since the vast majority of shark is taken by artisanal fisheries, shark landings were likely subject to the same degree of under-reporting as the artisanal catch. Furthermore, reported landings represent product weight rather than nominal weight. These factors combined with a lack of coverage of many clandestine landing sites, suggests that shark catches in El Salvador are grossly underestimated. In addition, export and import data for sharks, shark fins, and other shark products between 2001 and 2006 indicate that in certain years total exported shark was greater than landings and imports combined, suggesting a further source of unreported shark landings. Unfortunately, trade data were insufficient to investigate this discrepancy.

However, in relation to shark landings in El Salvador, Cotsapas *et al.* (2000) mention that "because of the emphasis on shark fins, it is possible that shark catches are drastically under-estimated (if mainly fins are landed and weighed and not whole fish)" after observations at fishing ports near Acajutla, where sharks dominated much of the catch. Furthermore, the fact that CENDEPESCA does not collect statistics directly and cannot monitor the vast majority of communities where sharks are landed suggests there is ample potential for a black market in fins to be operating within El Salvador, as is the case in other Latin American countries (Jacquet *et al.* 2008; Watson 2009). In fact, FAO reports that national statistics reflect a recent increase in shark landings putting El Salvador as the second Central American country in terms of landings of sharks (FAO 2005). This increase in landings and worries about an increasing number of reports of Taiwanese vessels practicing 'fining' within EEZ waters have prompted CENDEPESCA to develop a national plan of action for the management and conservation of sharks[11] in order to better manage the resource. Previous to these efforts, however, the fishery was completely unregulated.

Although, overall discards and under-reporting were substantial across the entire time series, they have significantly improved over time as a result of increased utilization of shrimp by-catch and better reporting of artisanal fisheries after 2002. The reduction of discards in the shrimp fishery, the principal source of discards, is directly related to the start of the practice of the 'morralleros' at the end of the 1970s (see Figure 5), but an overall decrease in species abundance has most likely also played a significant role (Fuentes and Hernández 2004). It should also be noted that the introduction in 2002 of tuna purse seiners, a fishery with lower by-catch and discards, significantly increased total national landings by about 40%; thus, creating the false impression of an overall reduction in by-catch and discards, while in reality it is likely that neither the selectivity nor by-catch utilization have improved since then in the other fisheries, particularly for industrial shrimp. The selectivity of fishing gear is in fact a primary concern for CENDEPESCA and various initiatives are currently being implemented such as the use of TEDs (Guevara 2009); however, these are mainly geared towards single species management (e.g., endangered sea turtles) rather than towards an ecosystem based management approach for which sheer removals of marine organism including many juveniles - be they discarded or commercialized - as well as, long term benthic impacts should be of great concern.

Although we consider our overall shrimp by-catch estimates to be conservative, it is important to point out that our estimated discard rate of 48.2% between 1995-2010 is significantly higher than the Kelleher (2005) estimate of 25.9% for El Salvador; this is significant because shrimp

[11] Plan de Acción Nacional para la Conservación y Ordenación de los Tiburones en El Salvador. CENDEPESCA (2008)

fisheries are the primary source of by-catch in El Salvador and account for over 98% of discards according to our reconstruction approach. The main reason for the disparity between Kelleher's discard ratios and our estimates is attributed to Kelleher's discard ratios being based on a single study by López (1998) that happened to report the lowest by-catch to shrimp ratio of the various studies that were used for our reconstruction. Whereas the by-catch to shrimp ratio used in Kelleher's study was 5:1, we used a combined average (14.75:1) of eight different estimates with a range of 5:1 to 23:1. Reasons for variation in by-catch to shrimp ratios are various and include different areas sampled, marked seasonal differences, depth or bathymetric variations, type of substrate being trawled, or even daily variation if fishing takes place during day or night (Allsopp 1980). Therefore, we consider that using a combined average of the various estimates provides a more accurate measure of overall by-catch rates.

Furthermore, since discards in the shrimp fishery have decreased over time, we examined the overall discard percentage from 1995-2010 in order to better compare to Kelleher (2005) more recent estimate, in this way eliminating higher discards rates from earlier years, which would have increased our estimated discard rate to 75.8% for the period 1950-2010. Since the López (1998) study was based on 1996 data we went back to 1995, consequently this also being the year where our scaled 'morralla' reached 100% and therefore by-catch utilization at its maximum, thus allowing us to compare over 10 years data. Furthermore, using our discard estimates of 48.2% we calculated an overall by-catch utilization rate for 1995-2010 of 54.8%, which falls within the range given by FAO and CIP (1997) "Report of the regional workshop for by-catch utilization in shrimp trawl fisheries" for by-catch utilization rates for the Central American Pacific of 40 to 60%, lending support to our overall findings of this fisheries' reconstruction. In addition, our results suggest that a substantial portion of the 'morralla' remains unaccounted for, as can be seen by comparing reconstructed artisanal catch with estimated available morralla (see Figure 3).

An important aspect of El Salvador fisheries which was not explicitly covered in the reconstruction is the contribution by women to the overall catch. In El Salvador, as in many countries of the world, women have an important but often overlooked role in the fisheries sector. Women are involved directly---fishing close to shore or in estuaries, and indirectly--cleaning and process fish, mending nets and cleaning boats, and selling the catch in local markets. Yet these contributions are often underestimated or deemed less important than the direct fishing activities, which are dominated by men—often for high valued species. A study in El Salvador looked deeper into this issue and revealed some of the reasons why this occurs. National surveys that collect socio-economic data are not necessarily designed to capture those working informally and indirectly in the fisheries sector, where women tend to dominate (Gammage 2004). These surveys are further male-biased as they are often completed by the "head of the household" (usually the man, as women typically do not identify themselves as household heads even though they may be instrumental in supporting the family; Gammage 2004). This failure to indentify women as fishworkers limits the support they receive (legal, financial, or political) and further marginalizes them in fisheries management and decisions-making (Gammage 2004). While this reconstruction provides a more comprehensive estimate of marine fisheries catches, more work is needed to be able to account for the underestimated contribution by women to food and livelihood security in the fishing communities of El Salvador.

We suggest that the reconstructed catch estimates presented here may be more 'accurate' (i.e., closer to the unknown true value) than the official statistics supplied to FAO by El Salvador, especially for earlier time periods. Our reconstruction approach based on conservative estimates — no matter how uncertain their accuracy — may contribute significantly to our understanding

of historic catch levels and ecosystem-wide trends in El Salvador's fisheries and may serve as comparative baselines for future studies. Nonetheless, we recommend that national monitoring and statistical collection programs be improved to better reflect total catch by all fisheries sectors in the future.

CONCLUSION

Based on our estimate of total reconstructed catch, we conclude that fisheries resources in El Salvador have suffered substantial reductions due to the long-term impacts from benthic trawling, mainly by the country's industrial shrimp fisheries. Shrimp has been El Salvador's most important economic fisheries resource, but decades of mismanagement have resulted in overexploitation and a significant decrease in landings over time. Moreover, our catch reconstruction illustrates that total estimated removals are likely much greater than the total landings reported by FAO on behalf of El Salvador and show an overall decrease from 1950-2010. Reported landings, on the other hand, show an increase in catch overtime as a result of fisheries expansion and increased utilization of shrimp by-catch (i.e., 'morralla'). This apparent increase in reported catches may suggest that El Salvador's fisheries are in a healthier state than our reconstruction results indicate, where total catches are shown to decrease overtime and thus clearly suggest a certain degree of over exploitation. The introduction of new fisheries in the later part of the century, as well as alternative forms of exploitation by small-scale fisheries (e.g., picking up 'morralla' and increased targeting of sharks), are likely the response to a decrease in shrimp catches over time due to overexploitation. There is a clear decrease in discards over time that, although linked to the increased utilization of shrimp by-catch by the 'morralleros' sector, is also a direct result of a decrease in overall abundance of marine biota reflected in the decreased catch despite an increase in effort. For the shark fishery, a lack of monitoring and control over the resource suggests that both historic and current reported landings are severely under-estimated and that there may be a substantial amount of Illegal, Unreported and unregulated (IUU) shark catch, most likely as a result of the illegal fin trade market operating in Central America.

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Appendix Table A1. FAO landings versus total reconstructed catch in El Salvador, 1950-2010, as well as catch by sector with discards shown separately (in tonnes).

Year	FAO landings	Total reconstructed catch	Industrial	Artisanal	Subsistence	Discards
1950	710	2,460	11	2,140	149	157
1951	712	2,720	13	2,360	153	190
1952	813	3,020	15	2,640	157	212
1953	814	3,260	16	2,860	159	233
1954	916	3,570	18	3,130	166	254
1955	917	3,820	19	3,350	171	276
1956	918	4,070	21	3,570	182	297
1957	1,900	21,520	1,132	3,790	188	16,408
1958	4,100	50,160	2,944	4,360	195	42,660
1959	4,400	55,640	3,283	4,580	196	47,583
1960	5,900	82,180	4,981	4,800	202	72,195
1961	6,700	96,430	5,887	5,020	201	85,321
1962	6,900	100,160	6,135	5,240	209	88,581
1963	7,400	104,070	6,416	5,630	218	91,808
1964	8,300	116,960	7,229	6,230	226	103,273
1965	8,000	111,990	6,970	6,510	234	98,270
1966	9,300	135,080	8,114	6,800	241	119,928
1967	8,600	110,810	6,760	7,080	243	96,726
1968	9,200	98,830	6,336	7,370	252	84,872
1969	9,300	100,880	6,843	7,650	261	86,119
1970	10,301	106,430	7,638	7,940	271	90,586
1971	9,900	96,260	7,183	8,280	285	80,517
1972	9,601	94,690	7,395	8,450	294	78,551
1973	11,501	127,440	10,757	7,860	302	108,515
1974	8,111	72,530	6,139	7,150	311	58,935
1975	7,862	79,340	7,161	6,290	327	65,559
1976	6,059	59,520	4,733	4,990	330	49,465
1977	4,745	49,980	4,316	4,360	351	40,955
1978	8,029	95,210	7,534	4,890	370	82,411
1979	11,020	74,390	8,240	6,090	389	59,668
1980	12,141	30,400	10,610	3,380	408	15,996
1981	19,272	80,240	22,027	3,960	433	53,815
1982	11,565	68,070	16,021	2,670	443	48,937
1983	6,808	49,590	10,782	3,680	461	34,660
1984	10,480	120,860	25,506	2,290	478	92,585
1985	12,631	62,020	15,719	7,020	489	38,795
1986	16,074	73,920	21,629	7,580	512	44,197
1987	16,314	65,920	23,708	5,780	533	35,898
1988	9,222	61,100	17,987	6,910	554	35,651
1989	5,799	63,940	18,297	7,950	579	37,115
1990	4,886	50,130	14,442	8,970	604	26,109
1991	6,820	49,270	14,232	11,430	624	22,985
1992	6,912	47,050	14,373	12,360	647	19,673
1993	7,990	65,990	24,601	10,380	676	30,334
1994	9,740	72,850	26,824	16,000	706	29,320
1995	10,748	85,010	34,528	15,730	723	34,022
1996	11,466	103,320	44,987	12,390	756	45,189
1997	9,089	77,340	30,382	15,960	786	30,211
1998	8,535	76,030	32,955	9,370	819	32,884
1999	7,261	50,810	19,733	10,730	847	19,501
2000	6,759	40,980	14,061	12,370	858	13,692
2001	8,618	46,550	16,232	14,970	875	14,473
2002	16,964	47,460	16,967	15,730	891	13,870
2003	20,427	54,320	22,085	14,810	908	16,523
2004	19,411	48,650	19,136	14,680	925	13,909
2005	26,922	55,130	23,446	16,630	942	14,116
2006	25,929	48,410	20,044	15,830	957	11,584
2007	28,379	52,790	21,261	17,720	973	12,829
2008	5,740	39,380	13,545	15,050	989	9,797
2009	5,233	34,390	10,583	15,120	1,004	7,683
2010	16,087	30,640	7,786	15,130	1,020	6,707

Appendix Table A2. Total reconstructed catch in El Salvador, 1950-2010, by major taxa (in tonnes).

Year	*Synodus scituliceps*	*Pleuroncodes planipes*	Shrimps and prawns	*Squilla biformis*	*Syacium ovale*	*Plesionika trispinus*	Other
1950	9	13	27	15	0	11	2,380
1951	10	16	32	18	0	13	2,630
1952	11	18	36	20	0	14	2,920
1953	13	19	40	22	0	16	3,160
1954	14	21	43	24	0	17	3,450
1955	15	23	47	26	0	19	3,690
1956	16	25	51	28	0	20	3,930
1957	889	1,360	2,789	1,521	22	1,116	13,820
1958	2,310	3,536	7,252	3,954	56	2,903	30,150
1959	2,577	3,944	8,089	4,410	63	3,238	33,320
1960	14,096	5,983	12,273	6,691	6,830	4,912	31,390
1961	16,659	7,071	14,505	7,908	8,071	5,805	36,410
1962	17,296	7,342	15,059	8,210	8,380	6,027	37,850
1963	17,925	7,609	15,607	8,509	8,685	6,247	39,490
1964	20,164	8,559	17,556	9,571	9,770	7,027	44,310
1965	19,187	8,145	16,706	9,108	9,296	6,686	42,860
1966	23,416	9,940	20,388	11,115	11,345	8,160	50,720
1967	18,886	8,017	16,443	8,965	9,150	6,581	42,770
1968	16,571	7,034	14,428	7,866	8,029	5,775	39,120
1969	16,815	7,138	14,640	7,981	8,147	5,860	40,300
1970	17,687	7,508	15,400	8,396	8,569	6,163	42,710
1971	15,721	6,673	13,688	7,462	7,617	5,478	39,620
1972	15,337	6,510	13,354	7,280	7,431	5,345	39,440
1973	21,188	8,994	18,448	10,057	10,265	7,383	51,100
1974	11,507	4,885	10,019	5,462	5,575	4,010	31,080
1975	12,800	5,434	11,145	6,076	6,202	4,461	33,220
1976	9,658	4,100	8,409	4,584	4,679	3,366	24,720
1977	7,996	3,394	6,962	3,796	3,874	2,787	21,170
1978	16,091	6,830	14,010	7,638	7,796	5,607	37,240
1979	11,595	7,222	9,988	5,445	5,618	3,998	30,520
1980	2,915	9,919	2,132	1,162	1,412	853	12,000
1981	10,170	18,383	8,197	4,469	4,927	3,281	30,810
1982	9,390	10,880	7,853	4,281	4,549	3,143	27,970
1983	6,692	5,976	5,680	3,097	3,242	2,273	22,620
1984	18,034	9,435	15,619	8,515	8,738	6,251	54,270
1985	7,464	7,777	6,284	3,426	3,616	2,515	30,940
1986	8,452	10,989	7,013	3,823	4,095	2,807	36,740
1987	6,738	14,143	5,340	2,911	3,265	2,137	31,390
1988	6,894	5,724	5,872	3,201	3,340	2,350	33,720
1989	7,247	3,076	6,310	3,440	3,511	2,525	37,830
1990	2,808	5,387	0	6,023	1,361	4,422	30,130
1991	2,472	4,742	0	5,303	1,198	3,893	31,660
1992	2,116	4,059	0	4,539	1,025	3,332	31,980
1993	3,263	6,258	0	6,998	1,581	5,138	42,750
1994	3,157	6,324	0	6,737	1,530	4,946	50,160
1995	3,663	7,346	0	7,817	1,775	5,739	58,670
1996	4,862	9,474	0	10,411	2,356	7,643	68,570
1997	3,250	6,233	0	6,970	1,574	5,117	54,200
1998	3,537	6,784	0	7,587	1,714	5,570	50,840
1999	2,098	4,023	0	4,499	1,016	3,303	35,870
2000	1,473	2,825	0	3,159	714	2,319	30,490
2001	1,570	4,148	0	3,226	761	2,368	34,480
2002	1,526	5,764	0	2,917	739	2,141	34,370
2003	1,856	10,262	0	3,143	899	2,308	35,860
2004	1,569	9,159	0	2,595	760	1,905	32,660
2005	1,664	15,520	0	2,027	806	1,488	33,620
2006	1,371	13,201	0	1,618	664	1,188	30,370
2007	1,501	13,111	0	1,939	727	1,424	34,090
2008	1,096	5,674	0	1,904	531	1,398	28,780
2009	859	4,376	0	1,500	416	1,101	26,140
2010	721	1,384	0	1,547	350	1,136	25,500