Reconstruction of marine fisheries catches for the Republic of Kiribati (1950-2010)[1]

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Abstract

As an isolated and scattered group of islands in the South Pacific, the Republic of Kiribati (hereafter Kiribati) has one of the highest seafood consumption rates in the world. With limited resources and expensive imports due to the difficulties in logistics of transport to and from the islands, the country's marine resources play a very important role in the subsistence needs of the I-Kiribati people as well as in revenue generation of the country. Upon analysis of the reported data presented by the FAO on behalf of Kiribati (being the only global data source), it was found that there was little transparency in the data, as well as potential errors in reporting. We also utilized better spatial resolution data from the Forum Fisheries Agency (FFA) and the Western and Central Pacific Fisheries Commission (WCPFC). Due to the essential nature of marine resources for the I-Kiribati, it is important that greater transparency is applied to the monitoring and reporting of all Kiribati fisheries, not just industrial tuna fisheries. Large-scale industrial catches were deemed to be not truly domestic and were analysed separately. They were found to be relatively well reported via the FFA and WCPFC, with only discards being unreported. Total small-scale marine fisheries catches (artisanal and subsistence sectors) were estimated to increase from an average of 9,000 t·year^{-1} in the 1950s, to approximately 21,000 t·year^{-1} in the 2000s. However, in additional to our small-scale catch estimate, there is unaccounted catch within the reported data, which ranges from 1,400 t·year^{-1} to almost 12,000 t·year^{-1} during the time period of 1983-2005 (as well as the year 2007). Comparing the artisanal, subsistence and unaccounted catch to the non-industrial portion of the FAO data, the reconstructed data are 15% higher than the data reported by FAO on behalf of Kiribati. The fact that the FAO data contain catch which we are not able to account for highlights the issues of data accountability and accuracy faced by Kiribati's (and other small developing countries') fisheries department, which is handicapped by limited financial and technical resources.

Introduction

Kiribati is a Pacific island group which consists of 33 islands spread out over a large area. There are three separate island groupings which, starting from the west, are the Gilbert Islands, the Phoenix Islands, and the Line Islands (Figure 1). The islands total only 820 km^2 in land area (Anon. 2003) but are surrounded by 3.5 million km^2 of Exclusive Economic Zone (EEZ) waters (www.seaaroundus.org). The distance between the furthest eastern and western points of the EEZ is over 4,500 km (Gillett 2011a). This distance also results in the islands being split between two FAO statistical areas. The Gilbert Islands and a small portion of the Phoenix Islands' EEZ fall into the Western Central Pacific (FAO area 71). The majority of the Phoenix Islands' EEZ, as well as the islands themselves, and the Line Islands fall into the Eastern Central Pacific (FAO area 77; Figure 1). Kiritimati (Christmas) Island, which is one of three inhabited islands in the Line Islands, is the largest coral atoll

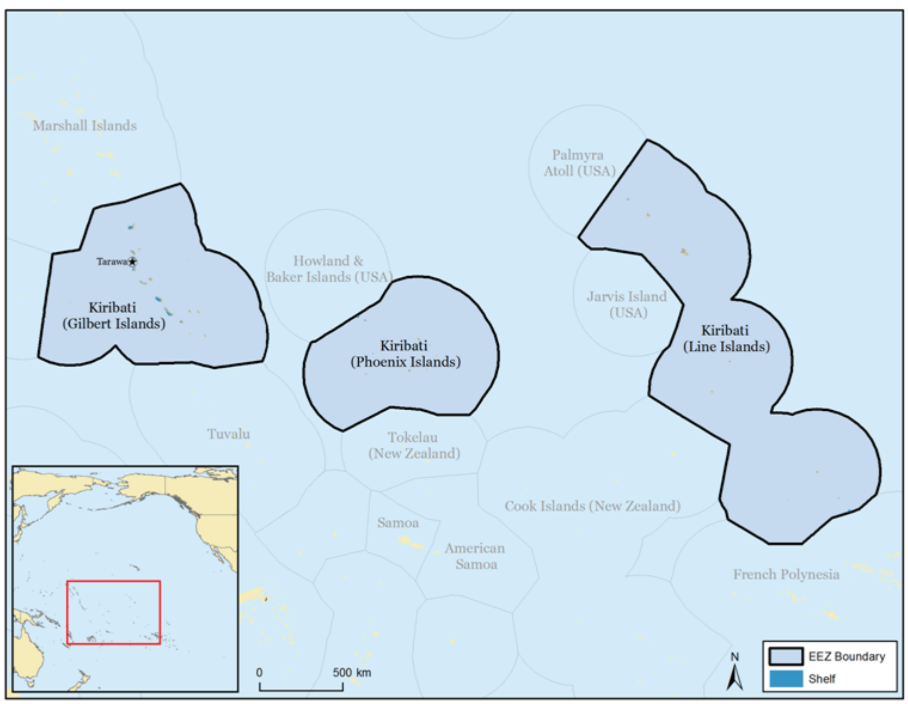

Figure 1. The three separate islands groups of Kiribati, and their respective Exclusive Economic Zones (EEZs).

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in the world and constitutes approximately 40% of the total land area of Kiribati (Anderson *et al.* 2000). South Tarawa, the official capital of Kiribati, is located on Tarawa Atoll (Gilbert Islands), and is home to approximately 40% of Kiribati's population (Dalzell *et al.* 1996). The people of Kiribati are referred to as I-Kiribati.

Kiribati became an independent republic in 1979 (Teiwaki 1988). Up until 1975, Kiribati and its southern neighbour Tuvalu (Figure 1) comprised the Gilbert and Ellice Islands Colony, which was under British control (Bertram and Watters 1984). In 1974, the Tuvaluans of Ellice Island held a referendum and a 92% majority voted in favour of separation (Bertram and Watters 1984). Tuvalu (Ellice Island) was officially separated from the Gilbert Islands (and the rest of Kiribati) in 1975 (Bertram and Watters 1984).

Kiribati is one of the poorest countries in the world, with an estimated *per capita* GDP of less than US$1,000 (Hannesson 2008). Kiribati's main export is copra, although exports tend to fluctuate dramatically, with declines largely attributed to poor pest control and declining crop yield (ADB 2002; Thomas 2003b). Kiribati's economy was previously principally dependent on the revenue brought in from phosphate mining on Banaba (Ocean) Island (Gilbert Islands), which is the only non-coral atoll of the country. In the late 1960s and early 1970s, the price of Banaba phosphate saw a dramatic increase, while at the same time imports continued to increase slowly, leading to a surplus in revenue (Bertram and Watters 1984). Once phosphate mining ended in 1979, the reserves of surplus income became an important source of revenue for Kiribati (Taumaia and Gentle 1983; Barclay and Cartwright 2007). Kiribati declared its EEZ in 1978, meaning that access fees from foreign fishing vessels were available to make up the deficit left from the termination of phosphate mining (Barclay and Cartwright 2007). The Government of Kiribati was eager to put major effort into developing the country's marine resources (Taumaia and Gentle 1983). In 1981, the government established Te Mautari Limited (TML), a company meant to develop a domestic pole-and-line tuna fishery (Gillett 2011a). However, the company mainly operated at a loss due to Kiribati's isolation from the nearest markets and the associated high transport and shipping costs (Gillett 2011a). The port in Betio, Tarawa, is insufficient in size to accommodate large vessels and the wharf in Kiritimati is too high for fishing vessels to dock at, as it was originally built for very large vessels bringing in rocket parts (Barclay and Cartwright 2007). Then, in 2001, TML, Kiritimati Marine Exports Limited (KMEL), and the Outer Islands Fisheries Project (OIFP), were joined together into Central Pacific Producers Ltd. (CPPL), which had a new processing plant in Betio (Barclay and Cartwright 2007; Gillett 2011a). In 1994, Kiribati gained ownership of a purse-seine vessel by signing a joint venture agreement with a Japanese fishing company (Barclay and Cartwright 2007). Kiribati has also run trials of longline fishing (mostly inside the EEZ) off and on, starting in the mid-1990s, without much success (Barclay and Cartwright 2007). Currently, there is a more substantial, national Kiribati fleet, due to an influx of vessels with foreign beneficial ownership being reflagged to Kiribati after 2008. In 2010, Kiribati registered 6 purse seines, 1 pole-and-line, 1 longline, 21 reefer carriers, and 9 bunkering vessels (WCPFC 2011a).

Another aspect of the large-scale fishery in Kiribati, is the large contingent of well trained I-Kiribati seamen. However, the majority of these men are trained to work on foreign fleets which operate in the Pacific Islands area (Sullivan and Ram-Bidesi 2008). I-Kiribati complete an eight to nine month course and are guaranteed a job at the end of training. The majority of trainees end up working on Japanese vessels but there are also I-Kiribati working on Korean and Taiwanese vessels. Currently there are no women in this program.

In addition to being a significant source of revenue, marine resources are a very important subsistence, and hence food security, resource to the I-Kiribati. Poor soils and inconsistent rainfall lead too often to shortages of food and fresh water (MacDonald 2001). With a lack of agriculture, the marine environment is an important food source. Kiribati's naturally harsh terrestrial environment, which is suitable for very few types of crops, is one of the reasons why Kiribati is said to have the highest *per capita* seafood consumption of any country in the world (Gillett 2011a), as they are not left with many other sources of domestic protein.

As in most Pacific Island countries, women's contribution to fishing in Kiribati is often understated and downplayed but the roles that they fill are extremely important (Harper *et al.* 2013). Women's roles in the fishing sector in Kiribati are mostly limited to fishing (reef gleaning) on the reef and in the lagoon, as well as selling fish on the roadside or in markets. However, times may be changing, as there are reports of some men taking their wives out fishing with them in recent years (Sullivan and Ram-Bidesi 2008). Regardless, the inshore resources that women collect contribute greatly to home consumption. As previously mentioned, many of the men take jobs on foreign vessels and are away for long periods. It is the woman's responsibility to provide for the family while her husband is away, as well as to take on community responsibilities and maintain the traditional patterns of village life (Schoeffel 1985). As well, in Tarawa, the majority of fish sellers are women, and they are responsible for the distribution of catch on the island (Tekanene 2006). They work long hours for little pay, often in unsanitary conditions, but continue the work as they are limited in their options (Tekanene 2006). It should be noted that (as an exception) there are no women fish sellers on Kiritimati Island, which is the second largest market for artisanal sales (Sullivan and Ram-Bidesi 2008). Women's involvement on Kiritimati is limited to inshore fishing.

In 2006, the Government of Kiribati declared the islands of the Phoenix Islands and surrounding ocean a marine protected area (MPA). In 2008, it was formally established under Kiribati law as the Phoenix Islands Protected Area (PIPA), with a total area of 408,250 km^2, making it the world's largest MPA at the time (De Santo 2012). The goal is to eliminate foreign commercial fishing in the area. Kiribati, with support from NGO partners Conservation International (CI) and the New England Aquarium, established an endowment fund (maintained by public and private contributions) that, in addition to allowing for substantial funding to manage the MPA, will compensate Kiribati for any loss of revenue from foreign access fees to fish in that part of the EEZ (Anon. 2006; Niesten and Gjertsen 2010; De Santo 2012). Lastly, the Phoenix Islands are all but uninhabited, with only a small population of less than 50 people, all government employees and their families stationed on Kanton Island. This population will also be allowed to continue subsistence fishing (Anon. 2006).

There has been some controversy over this protected area. In 2013, management of the PIPA came under scrutiny from scientists and politicians alike. Several articles were published (e.g., Pala 2013a; released in June) criticizing the organizations involved in the PIPA as well as the president of Kiribati, Anote Tong, for misleading the public in terms of what the PIPA has actually accomplished. According to these articles, the president and the organizations (CI and the New England Aquarium) were claiming until recently that the PIPA was closed off to all commercial fishing, or at least making it sound that way. Pala (2013a) reports that many officials of organisations who bestowed awards on President Tong for his creation of PIPA, as well as a large portion of the Kiribati population, believed that the area was entirely closed off to fishing. CI posted a press release to their website on September 24, 2013, combating the criticism they had received. CI acknowledged that there was a “misstatement” on their website which gave the impression that the entire MPA was closed off to fishing, but that when this was brought to their attention it was promptly corrected. CI goes on to clarify that the actions taken in regards to the PIPA are on target for what they set out to do. Although only 3% of the area has been closed to fishing, CI claims that the absolute area is large according to global standards and that these 3% represent critical reef habitats. Pala (2013a) argues that the 3% closed wasn’t being fished in the first place and that tuna fishing continues to increase in the rest of the reserve.

Another point of controversy is the endowment fund. Pala (2013a) re-iterated what was also claimed by CI, that the management plan called for 13.5 million dollars to be raised by the end of 2014 for phase two, which would allow an additional 25% of the PIPA to be closed to fishing. However, at the time, Pala (2013a) stated that the fund was still empty. In the September press release, CI stated that they had raised USD 2.5 million and that the government of Kiribati was matching that to bring the endowment to USD 5 million. Money is also an issue due to the fact that President Tong claims that revenue will be lost if the PIPA is closed, which is why it needs to be closed gradually, and that the planned USD 50 million is not enough. However, experts have claimed that since PIPA only represents 11% of Kiribati’s entire EEZ, vessels would still be able to catch the same amount of fish, albeit at a slight inconvenience. The PIPA illustrates some of the challenges that accompany large-scale conservation projects which also affect economic resources and therefore end up having many political implications.

The Food and Agriculture Organization of the United Nations (FAO) is the only source of world-wide, historic time series data on fisheries landings. The data that are presented by the FAO are submitted voluntarily to them by each member country. There are several issues with this process which the FAO, unfortunately, cannot avoid (Garibaldi 2012). This process depends entirely on the reporting country’s willingness and ability to accurately report their catches (Garibaldi 2012). In many instances, such as for small developing countries, the country simply does not have resources to accurately monitor and hence report catches, especially when the majority of these catches are small-scale and thus do not go through any official reporting channels (Pauly 1997). Furthermore, some countries perceive this reporting as onerous and of less immediate importance than reporting to and cooperating in RFMOs (Regional Fisheries Management Organizations), such as the WCPFC (Western and Central Pacific Fisheries Commission), which focus on tuna as a cash and revenue source. This unfortunately results in potentially excessive focus on tuna resources only, often at the expense of coastal resources. Therefore, the objective of this paper is to analyze and estimate the different aspects of the Kiribati fishery using a catch reconstruction approach as outlined in Zeller *et al.* (2007), and to see how it compares with the reported catch data which is presented by the FAO on behalf of Kiribati.

Methods

The marine fisheries catches of Kiribati were estimated using human population data, seafood consumption rates, WCPFC and Forum Fisheries Agency (FFA) reports and data, as well as grey literature. Part of this report will be to compare our findings with the data reported by the FAO to the global community on behalf of Kiribati. Upon the initial review of the FAO data for Kiribati, it was observed that within the reported data there were two years of outlying data which result in substantial ‘spikes’ in reported data. Therefore, the catches for these years (1987 and 1999) were treated as a potential reporting error and have been smoothed out by interpolating the value between adjacent years of the specific taxa which were causing these spikes (Figure 2). Large increases of the pooled groups of ‘marine fishes nei’ and ‘percoids nei’ were the main contributors. In 1987 ‘jacks, crevalles nei’ and ‘sharks, rays, skates, etc.’ also exhibited abnormal one year increases. For all comparisons in this report, the amended FAO data are used. Given that fisheries are embedded in and dependent on ecosystems, here we consider as ‘catch’ not only retained landings, but also discarded by-catch.

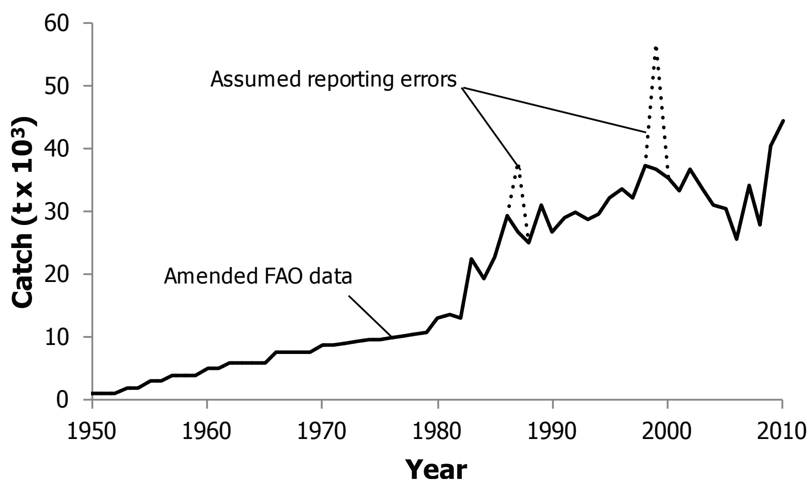

Figure 2. Amended FAO data with assumed reporting error in 1987 and 1999.

Human population data

Human population data were required in order to calculate annual domestic seafood consumption by the I-Kiribati, as part of the small-scale fishery estimate. Data for the years 1960-2010 were acquired from the World Bank database. The population for the years 1950-1959 was determined by linearly interpolating between the population in 1947 (Bertram and Watters 1984) and 1960 (Figure 3).

Large-scale commercial

Reported landings

Throughout the time period, Kiribati and Kiribati flagged vessels have been active in pole-and-line fishing, purse seining, and some longlining. FFA records for tuna catches by species and gear were available for the 1997-2010 time period (www.ffa.int). In addition to pole-and-line, purse seine, and longline catches, information on reported artisanal tuna catches was also included in the FFA data. Although those catches were labelled as 'other gear type' it was confirmed that these numbers corresponded to reported artisanal (small-scale) values through a WCPFC report (WCPFC 2011a). For the time period prior to 1997, catches for the individual fisheries (excluding artisanal) were available from the 2010 WCPFC Tuna Yearbook (2011b). The available data covers the time periods that the individual fisheries were active. Purse seine vessels were active during the time period 1994-2010, pole-and-line operated off and on from 1981-2009, and longline during 1995-2010. Total tuna catches of Kiribati were also available from this source, which corresponded to the FAO tuna totals and allowed for the calculation of the reported artisanal component for the entire time period. All references matched exactly or nearly exactly in their totals for each year which allowed the FAO tuna data to be completely disaggregated by gear type. In addition, information regarding marlin by-catch was also available in these reports and the data matched what was reported in the FAO data. Therefore, it was determined that all industrial landings were reported and only discards went unreported with respect to FAO (which traditionally does not ask for discards). Although the small-scale tuna component has been discussed here, as the reported artisanal tuna component is associated with reports of industrial catches, this sector will be discussed in greater detail when addressing the small-scale fisheries (see below).

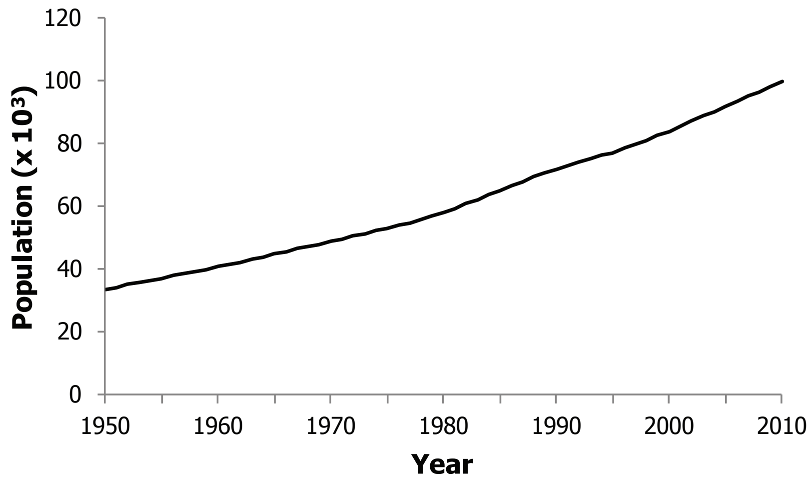

Figure 3. Estimated human population data of the Republic of Kiribati, 1950-2010.

Discards

Discards were calculated for the purse seine and longline fleets. Average discard rates of target species were available for these gear types which were specific to the SPC statistical area for foreign fleets. This was deemed to be a representative approximation for the Kiribati fleet. For purse seine catches, the discard rate of target species was 3.5% of the retained target catch and for the longline fleet it was 3.8% of the total catch (Lawson 1997). These discard rates were applied to the entire operating time period of each fleet. These discards are treated as unreported catch but identifiable as discarded catch.

Baitfish

The pole-and-line fleet requires the use of baitfish. An assessment of baitfish use in the pole-and-line fishery was carried out by the Australian Centre for International Agricultural Research (ACIAR) in 1990 (Rawlinson *et al.* 1992). Data on total baitfish usage by source were available from 1977-1990. The data from 1977-1980 were not used as this was carried out by the Japanese International Co-operation Agency (JICA), who was completing surveys on baitfish availability for the impending pole-and-line fleet that Te Mautari Ltd. launched in 1981 (Rawlinson *et al.* 1992). Data on baitfish use from 1981-1990 (excluding farmed baitfish) was accepted as the total baitfish used for these years. These values were then combined with the tuna catch data for the pole-and-line fleet for the corresponding years (WCPFC 2011b) to calculate an average tuna to baitfish ratio. The average tuna to baitfish ratio was used in combination with the tuna catch to determine the amount of baitfish used in each remaining year of pole-and-line activity (1991-1997 and 2009). We conservatively assumed that the baitfish used was included in the reported data.

Small-scale sectors

Due to the fact that all of the industrial catch is exported or landed outside of Kiribati (Gillett 2011a) and the majority of the fleet consists of joint venture or reflagged vessels, the industrial catch is considered separately to the small-scale sector which represents the truly domestic Kiribati fisheries. Therefore, all of the reported components of the large-scale industrial catch were segregated from the FAO data, in order to extract the reported domestic small-scale catches and allow for comparison after reconstruction. The small-scale sector consists of subsistence and artisanal catches (including artisanal tuna catches). Subsistence catches are defined as marine fisheries catches which are used primarily for home consumption. Artisanal catches are defined as catches which are primarily for sale at local markets as well as those made by small-scale fishers which are destined for export. Therefore, in order to calculate the small-scale catch, we determined how much seafood the I-Kiribati population consumes from both subsistence catch and purchases from the market (i.e., the demand) as well as what is being exported by the artisanal sector.

Consumption

The consumed catch was calculated using consumption rates (or catch derived consumption rates) and population data. Kiribati is said to have the highest *per capita* seafood consumption of any country in the world (Gillett 2011a). For 1950, a consumption rate of approximately 250 $kg \cdot person^{-1} \cdot year^{-1}$ was calculated from fish consumption data from a dietary survey (Turbott 1949) and used as the anchor point for the early time period. A second anchor point was derived from Gillett's (2009) small-scale catch estimate for 2007. Using Gillett's 2007 small-scale estimate and the 2007 population data from WorldBank, a domestic catch rate of approximately 205 $kg \cdot capita^{-1} \cdot year^{-1}$ was derived (i.e., a catch data based consumption rate). Interpolation was done between these two rates and the 2007 anchor point was kept constant from 2007-2010. These rates were then combined with the population data to estimate the small-scale (subsistence and artisanal combined) consumed catch for the entire time period.

Tuna

Tunas are not only important species for industrial fisheries (and hence foreign-exchange income) but also for the domestic small-scale sector. Schoeffel (1985) asserts that tuna are a major subsistence fishery in Kiribati. Gillett (2011b) estimates the small-scale tuna production of Kiribati at approximately 12,500 $t \cdot year^{-1}$ (in the late 2000s), making it the highest of all Pacific Island countries. From comparison of the different reports on tuna catches (WCPFC and FFA), we can see that there is a reported component of small-scale tuna catches within the FAO data. The 2007-2010 reported small-scale tuna figures are equal to the estimate by Gillett (2011b), suggesting that all small-scale tuna catches are reported for those years. Prior to 2007, the FFA data list the small-scale tuna catch at just over 2,000 $t \cdot year^{-1}$ for most years. As confirmation that the small-scale tuna catches did not only recently increase, a rough estimate based on Fisheries Division surveys in the late 1990s was calculated at approximately 10,000 $t \cdot year^{-1}$ (Gillett 2002). The results of this survey are also reflected in the reported data, as in 2000, the reported amount of small-scale tuna was 9,750 t. Although it appears that not all of the small-scale tuna catch is captured in the reported data, we assume that our consumption estimate includes the tonnage of all of the small-scale tuna catch.

Exports

Bêche-de-mer (dried, processed sea cucumber) has been a fairly consistent export for Kiribati, due to the demand from the Asian market. All sea cucumber catches within the FAO data were assumed to be exported as dried *bêche-de-mer* product. This is based on the fact that I-Kiribati do not consume sea cucumber domestically (SPC 1995). Sea cucumber catches only appear in FAO data starting in 1997; however, the fishery was exploited starting in 1990 (SPC 1995). Although there are earlier reports of *bêche-de-mer* projects (SPC 1977), it appears from the literature that this was a period of start-up and assessment of the fishery with sporadic and unreliable catches, processing, and exporting. Therefore, sea cucumber catches are only estimated starting in 1990. The weight of *bêche-de-mer* exports was available for 1991-1994 (SPC 1995). A conversion factor of 10 was used to convert the dried product to wet weight of sea cucumber (Preston 2008). Missing values were estimated by interpolation. First, interpolation was done between zero tonnes in 1989 and 120 t in 1991, and then between 300 t in 1994 and 408 t in 1997.

Shark fin exporting is another industry which has been born out of the demand by the Asian market. Dried weights of shark fins from Preston (2008) from 1999-2006, were used along with Biery and Pauly's (2012) mean conversion factors (as the specific shark species were unknown) to calculate round weights of sharks used in the shark fin trade. Although sharks do not appear in the FAO data prior to 1986, there is evidence that there were shark fin exports in the early 1980s (Baaro 1993). In fact, the first mention of a shark fin export operation was in 1977 (SPC 1977). Therefore, we set an anchor point of zero tonnes in 1976, and interpolated to the first data point in 1999 (239.8 t), which was converted from Preston (2008). The export figure for 2006 (214.6 t) was kept constant and carried forward to 2010, with the exception of the year 2008, where the FAO reported catch was slightly lower (209 t) and thus accepted as the correct tonnage. There is a large tonnage of reported shark catch (FAO category 'sharks, rays, skates, etc. nei'), and although it is known that I-Kiribati do like to eat shark (Johannes and Yeeting 2000), it seems highly unlikely that they are consuming such large quantities. Since we do not know the exact reporting procedure followed by Kiribati when it comes to reporting shark fins, we will assume that the fin weight is converted to whole wet weight and entered into the data given to the FAO. Also, this still leaves a substantial amount of shark which is domestically consumed, and therefore the assumption seems reasonable.

Other invertebrates are also a common export items. Crustaceans, molluscs, and other marine invertebrates appear in many lists of export items (Jones *et al.* 2006; UN 2008). However, the exact quantity of these exports is not always clear. Given the relatively small amounts and variability of crustacean catches present in the FAO data, it is assumed that all of these are exported. Lobster, in particular, is a common item included in export lists and is said to be entirely exported and rarely retained for domestic consumption (Anon. 2003; Jones *et al.* 2006; Gillett 2009). Rock lobster was first noted to be exported in 1979 (SPC 1979), which is four years before crustaceans appear in the FAO data. Therefore, crustacean tonnages were interpolated from zero tonnes in 1978 to the 16 t reported in the FAO data in 1983. Mollusc catches are mainly made up of the ark shell *Anadara maculosa* and giant clams (*Tridacna maxima*, *T. gigas*, and *T. squamosa*) (Thomas 2003a; Preston 2008). *Anadara maculosa* has been reported to be caught in the order of 1,000-1,400 t·year^{-1} by subsistence collectors with an approximately equal amount caught by commercial divers (Preston 2008). As it is known that the ark shell constitutes the majority of the mollusc catch, it is assumed that 50% of the reported catches are for subsistence use and the other 50% for export (formal and personal consignment exports). We assume that mollusc export began in 1981 when molluscs first appeared in the FAO data, and therefore have no unreported mollusc exports.

The live reef food fish trade (LRFF), which primarily exports live fish to Hong Kong for use in restaurants, began in 1996 (Sommerville and Pendle 1999; Preston 2008). Three companies were involved at the start, two of which were foreign-based (China Star and South China Sea), and the third was the locally based Marine Product Kiribati Ltd. (MPK) (Awira 2006). Another company, Lucky Bright (Asia) Co. Ltd. (a joint venture), began operation in 2003 and was the only company involved that year (Anon. 2003). In 1999, China Star and MPK pulled out of the business due to cases of ciguatera poisoning in Hong Kong from fish exported from Kiribati (Awira 2006). It is assumed that 'South China Sea' continued operating and exported a shipment in 2001 (as there are records of exports for 2001, 2003, and 2004 as well) but pulled out of operations after that. The 2003 shipment is entirely attributed to Lucky Bright and it is assumed that the 2004 catch was by them as well. However, all LRFF operations ceased in 2004 due to an outbreak of ciguatera poisoning (Preston 2008). Quantities of export for 1996-2001 were obtained from Awira (2006). Awira (2006b, in Preston 2008) provided the export numbers for 2003 and 2004. As the LRFF is very well documented, it is assumed that all exports are reported. Groupers (Serranidae) and wrasses (Labridae, essentially humphead wrasse *Cheilinus undulatus*) are known to be the major taxa associated with this trade, with groupers estimated to compose the majority of the catch (Awira 2006). Therefore, since the total yearly catches are small, it was assumed that all LRFF were from the family Serranidae.

Another export sector is the aquarium fish trade. Although it is known that there has been an active ornamental fish trade in Kiribati since 1980 (Awira 2006), we do not consider this sector part of our reconstruction.

Information regarding the earlier years of colonization on the Phoenix Islands indicated that there was a small fish export business which transported fish to Hawaii via planes that used Kanton as a stopover destination on route between Hawaii and Australia or New Zealand (Stone 2013, p. 22). Exports stopped in 1959 due to the introduction of long-range aircraft. Exports were estimated to be up to 8 t per month. At a maximum, this would be 96 t·year^{-1} and therefore we conservatively estimated 50 t·year^{-1} from 1950-1958 and 25 t in 1959 as exports declined and stopped sometime during this year. With no information indicating the species composition of these exports, we used an assumed composition of 20% each of Serranidae, Lutjanidae, Lethrinidae, Scombridae, and miscellaneous marine crustaceans.

It has been pointed out that the Fisheries Division has included a small amount of personal consignment exports in their estimates (Gillett and Lightfoot 2001; Gillett 2009). However, these have not been included separately as most of the types of marine products which are exported this way have already been estimated individually (crustaceans for example) and it is assumed that our estimates cover this small amount of personal consignment export.

<u>Subsistence versus artisanal</u>

As a result of the type of information used, the small-scale catch was calculated as a whole, rather than by the individual sectors. Therefore, it was necessary to disaggregate the catch into an artisanal and subsistence component in order to match the global patterns for fisheries sectors, as used by *Sea Around Us*. Several reports spanning the 2000s indicate that the subsistence catch contributed 60-70% (or about two-thirds) to the small-scale sector (Gillett and Lightfoot 2001; Gillett 2009). It was therefore assumed that from 2000-2010, the subsistence catch comprised 65% of the small-scale catch and the artisanal sector contributed the remaining 35% (including exports). For the early period, the artisanal sector began in 1960 (Tekanene 2006) and therefore the contribution of the artisanal sector was set to zero from 1950-1959, and then interpolated to a proportion of 35% in 2000. The subsistence sector therefore does the opposite, contributing 100% from 1950-1959 and then decreases to 65% in 2000. These percentages were applied to the total combined small-scale catch of consumed landings and artisanal exports.

<u>Sports fishing</u>

There is a small tourist sports fishery on Kiritimati atoll (Preston 2008). The main target of this fishery is bonefish. The sports bonefish fishery has been placed under a catch and release program, which is said to be followed by tourists in all areas, and was therefore not estimated as we assumed a zero or near-zero mortality rate (Anon. 2003).

Reported versus unreported

Large-scale commercial

Reporting coverage of large-scale commercial catches was quite good. All landed tuna and by-catch is included in the FAO data. It was also assumed that baitfish for the pole-and-line fleet was included. The only item deemed not reported in the FAO data was a small amount of discards from the purse seine and longline fleets.

Small-scale sectors

Reported small-scale catches within the FAO data were compared to our reconstruction of the small-scale sector. Reported amounts of small-scale tuna were determined by analysis of tuna catches as a whole, as described in the 'large-scale commercial' section of the methods. This reported small-scale tuna and all other non-industrial taxa formed the small-scale FAO baseline. Upon comparison of the reported small-scale catches (from the FAO data) and our reconstruction, it was found that for the years 1950-1982, 2006, and 2008-2010, catches were under-reported. It was assumed that for these years both the artisanal and subsistence sectors were equally under-reported and therefore reported and unreported catches were allocated proportionally between the subsistence and artisanal sectors.

For the years 1983-2005 and 2007, reconstructed small-scale catches were lower than the small-scale FAO data as determined here. No documentation as to where these catches are coming from or what they are used for could be found. Although there are some sectors which may not have been accounted for in our estimate, such as tourist seafood consumption, sports fishing which is not catch and release, and additional reef fish exports, the contribution of these sectors would likely be relatively small and nowhere near the magnitude of the difference seen between the FAO data and our reconstruction. Therefore, although we cannot be certain what the explanation for this difference is, we speculate that it is unlikely for these to be truly domestic Kiribati catches, and that these may be foreign catches taken, for example, under flag of convenience (here to mean a foreign vessel fishing under the flag of Kiribati). It is possible that there are foreign vessels which are flagged under Kiribati and are reporting their catches as Kiribati landings. We have no direct evidence for this, but there have been reporting issues concerning foreign fleets fishing within Kiribati waters. China was recently under scrutiny by the WCPFC for a discrepancy in the reported tonnage of bigeye tuna catch within Kiribati's waters, which China stated should be reported by Kiribati (Williams 2011). Although this may not be the most satisfactory explanation for the discrepancy in catches, a foreign, Kiribati-flagged vessel is the most likely explanation given the available information. Therefore, for the years 1983-2005 and 2007, all subsistence and artisanal catches are deemed reported. The remaining difference between our estimate and the FAO data is classified as 'unaccounted catch'. Due to the fact that the origin of this catch is still unknown, it will remain in the small-scale sector for analysis purposes. As stated earlier, although it appears that not all of the small-scale tuna catch is captured in the reported data, we assumed that our consumption estimate includes the tonnage of all of the small-scale tuna catch. Theoretically, we would then assume that our reconstruction should be higher than the FAO data as it contains small-scale tuna that does not appear to be captured in the reported data. However, there is a 22 year period (1983-2005) where there was 100% reporting coverage, leading to a taxonomic discrepancy. It appears that the tonnage is included in the FAO data but is not distinguished correctly taxonomically. At this time we are not able to sort out this discrepancy and therefore, small-scale tuna may be slightly underestimated in our reconstruction. This is an area for further study.

Total catches in the time period 1983-2005 and 2007 were high enough to account for the total estimated tonnage of catch; however, additional sources provided better species information which was used to partially disaggregate some of the highly aggregated taxonomic groupings in the FAO data. For example, sea cucumber exports were estimated for 1990-2010. Although there were no sea cucumber catches recorded in the FAO data for the years 1990-1996, we have no evidence to suggest that these exports were not recorded, and therefore it is assumed that these exports are included in the reported data and were simply included in a miscellaneous category ('marine fishes nei'). Shark fin exports were estimated for the 1977-2010 time period. Sharks did not appear in the FAO data until 1986. Again, as the reported data is sufficient in tonnage compared to our total reconstructed catch, it is assumed that for 1983-1985, sharks caught for fin export were grouped under the 'marine fishes nei' category. However, for 1977-1982, shark catches are considered unreported, as there was under-reporting of catches occurring from 1950-1982. Crustaceans first appear in the FAO data in 1983 and therefore all additionally estimated catches fall outside of the complete reporting coverage time period. From 1979-1982, crustacean exports are considered unreported. No additional mollusc catches were estimated for export and therefore they are all reported. Also, all live reef food fish trade exports are assumed to be reported (under 'percoids nei).

Spatial allocation

All catches reported by Kiribati to the FAO have been within the Western Central Pacific (FAO area 71). However, the country spans both area 71 and area 77 (Eastern Central Pacific). Although an overwhelming majority of the population lives in the Gilbert Islands, there are inhabited islands in area 77 and these I-Kiribati are landing subsistence catches; therefore, there must be some catches in area 77. As well, there are reports that in recent years the industrial fishing fleet has shifted its fishing grounds towards the east and does, now, also fish in the Eastern Central Pacific (area 77).

The pole-and-line fleet was assumed to operate solely in FAO area 71 from 1981-1997. This is based on the fact that all baitfish trials were run in the Gilbert Islands group (Rawlinson *et al*. 1992). It should be noted that in 1990, the Kiribati pole and line fleet did also operate within the Fiji and Solomon Islands EEZs due to poor conditions within Kiribati waters that year (Rawlinson *et al*. 1992). It was assumed that the fleet obtained 20% of that year's catch from Kiribati waters, and 40% each from the Fiji EEZ and the Solomon Islands EEZ waters. Despite this fact, all baitfish estimated in this report was caught within the Kiribati EEZ (due to the nature of the reference used) and for these years, was caught within area 71. However, in 2009 when the fleet began operating again after a 12 year hiatus, a spatial distribution map shows that the pole-and-line catch for that year was obtained from FAO area 77, with approximately 20% being caught within Kiribati's EEZ and 80% on the high seas. All baitfish used in 2009 was allocated to the Kiribati EEZ within area 77.

Information regarding the Kiribati-flagged longline fleet was difficult to find. As well, the available information is often contradictory. According to the FFA data, all longline catches from 1997-2010 were made within the Kiribati EEZ. Data from the SPC (P. Williams, pers. comm., Secretariat of the Pacific Community) covering the time period of 1990-2010, allocated all of the longline catch into the Gilbert Islands portion of the EEZ. However, at the same time, a WCPFC report (2011) describes the longline fishery during 2010, as operating mostly in the eastern high seas, as well as around the Cook Islands. Information regarding activity of the fleet prior to 2010 only discusses the issues involved in trying to build a longline fleet and the fact that Kiritimati (Line Islands) would be the ideal location to run the fleet out of. Therefore, from 1995-2008, all longline catches are allocated to within the EEZ in area 71 as the SPC data indicate, whereas the 2010 catches are all allocated to area 77, with 90% of the catches assigned to outside the EEZ and the other 10% within the EEZ. Discards were allocated using the same methods.

Purse seine catches were allocated by combining the information present in the FFA data, SPC data, and the distribution maps from the 2011 WCPFC report. The FFA data were used to allocate the catch to either within the EEZ, in the high seas, or in another country's EEZ (country not specified), for the time period of 1997-2010. Due to previous minor adjustments of total catches, proportions were utilized for certain years as exact totals would not match. The SPC data were used to determine that the catches from 1994-1996 (not covered by the FFA data), all came from outside the EEZ. According to the WCPFC report (2011), prior to 2009, all purse seine catches were within FAO area 71. The SPC data were also used to confirm this, and for 2009 and 2010, provided data to allocate the catches within the EEZ into areas 71 and 77. For the catches outside of the EEZ for 2009-2010, the distribution maps were used to determine which area the catches were taken from, as well as to confirm the proportion taken from the high seas versus another country's EEZ, as was provided by the FFA data. Discards were also allocated according to the above methods.

Small-scale catches which were not initially calculated for a specific island group were allocated between the three island groups in the two FAO areas based on population proportions. The population of Kanton in the Phoenix Islands was allocated to area 77, even though the EEZ of the islands spans both areas, as the majority of the EEZ as well as the islands themselves fall into area 77. As we were only allocating subsistence catch to the Phoenix Islands (early time period Phoenix artisanal catch calculated separately), the catch for this island group was determined by multiplying the population by the consumption rate time series that was used to calculate the total catch. Information from the colonial period of Kiribati indicates that there was a resettlement initiative that moved inhabitants to the Phoenix Islands in the early part of the time period. The population of the Gilbert Islands had expanded and the administration had decided to resettle part of the population on other islands. By 1940, 729 inhabitants of the Gilbert Islands had been transferred to the Phoenix Islands (Pala 2013b). The population peaked in the mid-1950s at approximately 1,300 people but by the early 1960s all inhabitants had been evacuated with most moving to the Solomon Islands. Therefore, we linearly interpolated the population from 729 in 1940 to 1,300 in 1955 and then to zero in 1964. Population information for all islands was available for six years: 1982, 1985, 1990, 1995, 2000, and 2005 (Bertram and Watters 1984; ADB 2002; SPC 2007). The Phoenix Islands remained uninhabited up to 1982. Interpolation of the population was performed between the six anchor points starting with the point of zero in 1982 up to the last point of 41 in 2005. The Phoenix Islands had one additional point of information in 2010 (24 inhabitants) and therefore one more interpolation was done. Using the full population time series for the Phoenix Islands group along with the consumption time series, a subsistence catch for the islands was calculated. This tonnage was removed from the subsistence total and the remaining subsistence catch and the artisanal catch were split between the Gilbert Islands and Line Islands. As the population for these islands was only available for the six years, the relative proportion of the islands' populations to each other was used as opposed to the actual population numbers. The six anchor points of data were turned into proportions of the total population of the Gilbert Islands and Line Islands only. Interpolation was done between all the anchor points: 1982, 1985, 1990, 1995, 2000, and 2005. The 2005 proportions were kept constant and carried forward to 2010. From 1964-1981 the 1982 anchor point was used. From 1950-1963, population migration routes did need to be considered. Working backwards, we assumed that from 1956-1963 the increase in proportion of the population in the Gilbert Islands and Line Islands was proportional to their respective populations as the majority of the Phoenix population was moving to the Solomon Islands and not to one of the other Kiribati Island groups. However, from 1950-1955, the increase in population in the Phoenix Islands was directly due to a decrease in the population in the Gilbert Islands, and thus the relative proportions of the Gilbert to Line Islands was adjusted to reflect this. Overall, as the Gilbert Islands contain such a large portion of the population, the changes make only minor differences in the proportions. Subsistence and artisanal catches were individually allocated to the two FAO areas using these proportions, with reported and unreported catches within each sector also being proportionally allocated. Subsistence catches for the Phoenix Islands were also proportionally allocated as reported and unreported, but artisanal catches in the early time period were all considered unreported. Although these assumptions may not be entirely valid, they are mostly for accounting purposes and do not affect the overall catch assigned to the Phoenix Islands. Due to the transparency issues in the reported data, these assumptions were for simplicity sake. Finally, the unaccounted catch in the years 1983-2005 and 2007 was kept in area 71, as it is unknown where this catch was taken from.

Taxonomic composition

Large-scale commercial

The SPC, FFA, and WCPFC data provided good species breakdown for the large-scale commercial tuna catches. For most years, this information corresponded perfectly with the FAO data. From 2007-2010, a 'tuna-like fishes nei' category was included in the FAO data and so the alternative sources were used to disaggregate the catch into specific tuna taxa. Baitfish catches were known to contain mostly species from the Clupeidae family. Due to the fact that the various baitfishing techniques brought up different species compositions (Rawlinson *et al.* 1992), catches were only classified to the family level (Clupeidae). Discards for the purse seine and longline fleets were disaggregated proportionally by target species.

Small-scale sectors

Information on the species composition of small-scale catches in Kiribati was not readily available. The limited information available was either only to the family level and corresponded fairly closely to the FAO data, or was too specific and too small of a sample to be able to extrapolate to the entire catch (i.e., SPC 1995; Awira *et al.* 2008). Therefore, the taxonomic breakdown of the FAO data was used to disaggregate reconstructed catches. Although there is information indicating that not all of the small-scale tuna may be represented in the reported data taxonomically, we also know that there are definitely years when it is fully incorporated. Therefore, we chose to not estimate any additional tuna taxonomically and the proportion of small-scale tuna may be slightly underestimated. Hence, small-scale tuna catches, as well as artisanal exports, have already been assigned taxonomically and are not included in this section. For reported exports, or specific years of reported exports, where the appropriate taxonomic category was not present, that item was assumed to have been reported under a miscellaneous category. It should also be noted that tuna and reported exports were removed from the FAO data before calculating taxonomic composition proportions. For the subsistence, artisanal, and unaccounted catch sectors, the data were divided into three separate time periods in terms of methodology used.

The first time period was 1950-1982. In this period, the species composition for the reported components of the subsistence and artisanal sectors were taken to be proportional to the FAO data. FAO taxonomic categories were adjusted to their corresponding scientific name (usually at family level), if appropriate. The unreported catch was broken down by using the average taxonomic breakdown from the FAO data for the years 1981 and 1982, as these years provided the greatest taxonomic disaggregation.

The next time period was 1983-2005 and 2007. This time period included the unaccounted catch sector as well. With that in mind, it should be noted that the reported tuna was not included in the calculation of taxonomic composition proportions for this time period. Reported and unreported tuna have already been taxonomically assigned as well as assigned by sector. All tuna is accounted for and therefore should not be allocated to the unaccounted catch. All remaining reported catches, by taxonomic category, in the FAO data for this time period were assigned proportionally to the remaining subsistence and artisanal sector catches and the unaccounted catch. The only unreported data in need of a taxonomic breakdown for this time period was the additional inshore estimate for the year 2000. The original proportions from the reported data for the inshore species in 2000 were used to assign a breakdown to this catch.

The last time period was 2006 and 2008-2010, and only contains subsistence and artisanal catches. As in the first time period, the FAO catches were assigned proportionally to the reported subsistence and artisanal portions. The average FAO taxonomic breakdown of 2008-2010 was used to breakdown the unreported portions for 2006 and 2008-2010.

After applying these breakdowns, it was noted that the FAO data contained large amounts of aggregated fish categories, such as 'marine fishes nei' and 'percoids nei' which are uninformative in analyses. Even within the few external species breakdowns available, there was a large miscellaneous fish category present as well, constituting up to 57% of the breakdown (SPC 1995; Pratchett *et al.* 2011). In order to reduce the amount of unclassified catch, the average species breakdown of the reported catch for the years 1986-2010 (the years with the greatest disaggregation of catch), excluding the 'marine fishes nei' and 'percoids nei' taxonomic categories and invertebrate categories, as well as the initially excluded catches (tunas, exports), was applied to the 'marine fishes nei' and 'percoids nei' catches of both the reported and unreported components of the artisanal and subsistence sectors and the unaccounted catch, with 5% of these categories remaining as 'marine fishes not identified' in order to account for less common fish families. This is clearly an approximation, and more detailed taxonomic compositions (at least at the family level) should be obtained in regular intervals, and applied to Kiribati catch data.

Foreign vessels

Kiribati licenses a large number of foreign vessels to fish in their waters. No specific information as to number of vessels or tonnage of fish caught could be found prior to 2001. Specific information was found within Kiribati country statement reports for the post-2000 time period (Tumoa 2006; WCPFC 2011a); however, this information was not all inclusive as certain agreements were excluded from the reports. Therefore, total foreign catch was not estimated. From the information that was available, it was seen that the number of licensed foreign fishing vessels in Kiribati waters during the time period of 2001-2010 ranged from 273-450 with the number of support vessels ranging from 6-114 (Tumoa 2006; WCPFC 2011a). These numbers do not include US or FSM arrangements for all years. Countries with vessels licensed to fish in Kiribati waters include Japan, South Korea, Taiwan, Vanuatu, China, New Zealand, Papua New Guinea, Panama, Philippines, Singapore, Spain, the United States, and the Federated States of Micronesia (Tumoa 2006). Estimates of total purse seine catches by foreign licensed vessels range from 81,000 to 333,000 t·year^{-1} and longline catches range from 3,000 to 17,000 t·year^{-1} (Tumoa 2006; WCPFC 2011a). It should also be noted that information on spatial distribution was only available for some of the fleets for a few of the years. Therefore, it could not be determined which FAO area most of the catches were coming from and these catches were not included in this reconstruction at this time. However, as part of *Sea Around Us*, reported catches by countries in areas outside of their home FAO area will be spatially allocated and so these catches will be at least partially accounted for during that allocation. Also, global work on tuna fisheries is being completed which will also account for these fleets.

There is another known incident of foreign fishing which occurred in the Phoenix Islands. In 2001, a Samoan boat stopped in the Phoenix Islands to catch sharks for their fins using longlines (Stone 2013; pp. 9-10). Even though this one boat fished for just three months (engine trouble caused it to have to leave the islands), it managed to remove almost all of the adult sharks around 4 of the islands. This raid has had a negative effect on islanders who fish the sharks for both their fins as well as for consumption purposes. Although there was no information on tonnage removed, it is important to include this event in our estimate as it had a large impact on the ecosystem and local population. Therefore, we assume that 100 t of shark was fished during this incident. This includes the fin weight and discarded carcasses. As it is unknown what species of shark these were, we used the mean fin weight to round weight ratio of 3% (Biery and Pauly 2012) to estimate that 3 t of shark fins were landed and 97 t of shark carcasses were discarded.

Results

Large-scale commercial

The reconstructed total large-scale commercial catch of Kiribati increased from an average of over 1,200 t·year^{-1} in the 1980s to over 7,800 t in 1998. Catches then stayed relatively constant at 5,500 t·year^{-1} from 1999-2008 and then rapidly increased to

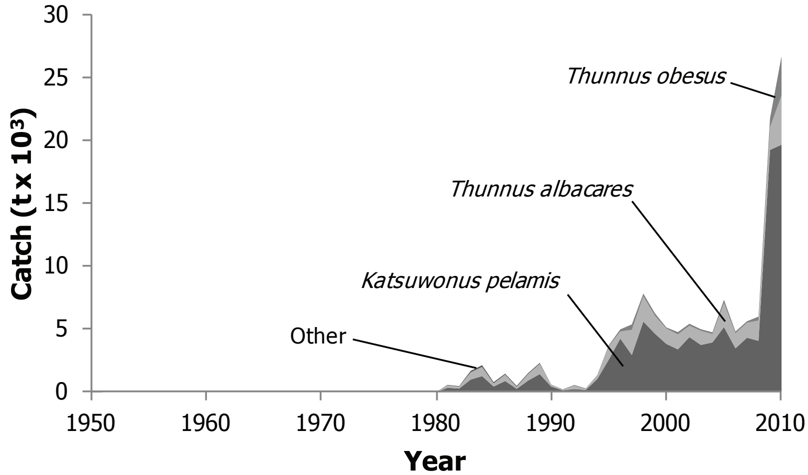

Figure 4. Total large-scale commercial reconstructed catches for Kiribati, 1950-2010, by species. 'Other' category constitutes *Thunnus alalunga* and Clupeidae catches.

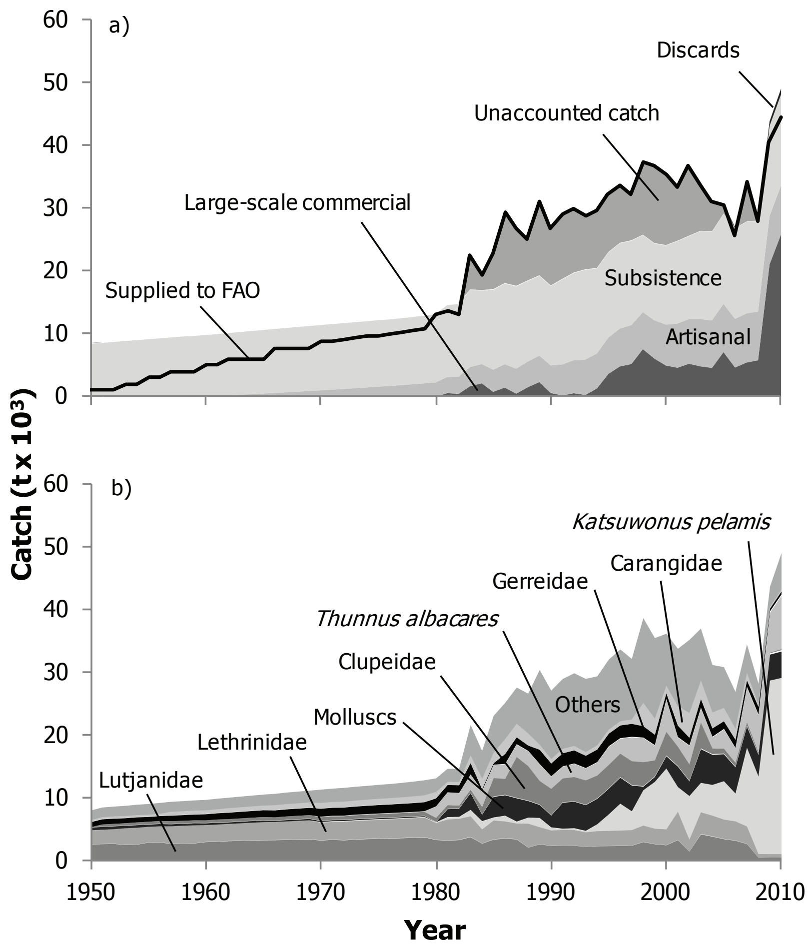

Figure 5. Reconstructed total catch of Kiribati, 1950-2010, a) by sector (FAO data overlaid as line graph) and b) by taxonomic composition. The 'other' category consists of 17 separate taxonomic categories. Please note that 'unaccounted catch' consists of catches from the FAO data which could not be accounted for in our reconstruction. Discards are shown separately but are only just visible at the end of the time period.

21,800 t and 26,700 t in 2009 and 2010, respectively (Figure 4). This reconstructed catch is only 3.1% higher than the reported large-scale commercial catch, with the only unreported component being discards. The dominant species of the large-scale commercial catch was skipjack tuna (*Katsuwonus pelamis*) with 74.2% of the catch. The majority of the skipjack tuna comes from the joint venture purse seine fleet (91.6%). Yellowfin tuna (*Thunnus albacares*) constitutes a further 20.7% of the catch and bigeye tuna (*Thunnus obesus*) only comprises 4.4% of the catch. Other species, including albacore (*Thunnus alalunga*) and baitfish (Clupeidae) make up 1% of the total large-scale commercial catch (Figure 4). Adjustment of the spatial distribution of catches resulted in an estimated 84% of catches being caught in FAO area 71 and the remaining 16% in area 77. However, since fleets started fishing in area 77 in 2009, 47% of the catch from 2009 and 2010 has been from area 77. It was also estimated that 75% of large-scale commercial catches were taken from outside of Kiribati's EEZ. Almost all of the catches in the 1980s and early 1990s were caught inside the EEZ, after which there was a shift to fishing outside the EEZ; from 1994-2010 83% of large-scale commercial catches were estimated to be taken outside the EEZ. Although catches from outside the EEZ were allocated to the high seas or another country's EEZ when information was available, not all catches could be allocated this way, and therefore results cannot be given in more specific detail. In 2001, there was 100 t of foreign fishing estimated inside the Phoenix Islands' waters. This catch of shark was very damaging to the ecosystem. There is additional foreign fishing occurring in Kiribati waters that was not estimated at this time.

Small-scale sectors

The reconstructed total small-scale catch (artisanal, subsistence, and unaccounted catch combined) of Kiribati was estimated to be approximately 15% higher than the small-scale catches reported by the FAO on behalf of Kiribati. Small-scale catches (including unaccounted catch) increased gradually at the beginning of the time period, from an average of 9,100 t·year^{-1} in the 1950s to 12,200 t·year^{-1} in the 1970s (Figure 5a). Then, in the early 1980s, catches increased by approximately 58% between 1980 and 1983. Catches peaked in 2002 at almost 31,500 t, and then proceeded to decrease by 41% between 2000 and 2008, when catches then stabilized. Subsistence catches were estimated to contribute 64% of the small-scale sector catch. Another 18% was estimated to be from the artisanal sector and the last 18% is unaccounted catch which is possibly from a flag of convenience vessel (Figure 5a). Small-scale exports were estimated to contribute 33% to the artisanal catch and 5.8% to the total small-scale catch. Total catches in the early time period were greatly under-reported. For 1950-1979, it was estimated that 42% of catches went unreported, compared to only 1.4% unreported catches in the time period of 1980-2010.

If only the artisanal and subsistence catches are considered, the reconstruction is 20% higher than the adjusted FAO landings (i.e., removing the unaccounted catch). Subsistence catches are estimated to contribute 78.5% and artisanal catches 21.5%. Subsistence catches increased steadily from 8,400 t in 1950 to almost 14,600 t in 2010. Artisanal catches exhibited a much more rapid increase from 50 t·year^{-1} in the 1950s (Phoenix exports), to 500 t·year^{-1}, 1,500 t·year^{-1}, 3,300 t·year^{-1} and 5,600 t·year^{-1}, in the 1960s, 1970s, 1980s and 1990s, respectively, peaking at 7,850 t in 2010. Artisanal exports were more variable. The general trend shows 50 t·year^{-1} in the 1950s, dropping to 25 t in 1959, followed by a period of zero exports until 1979. Exports then increased from 3 t in 1979 to a peak of almost 3,700 t in 1993. Exports decreased to just under 1,000 t in 1999 before increasing again to an average of 3,000 t·year^{-1} from 2003-2007. Exports then declined again to just over 2,000 t in 2010.

The subsistence catch was dominated by Lutjanidae with almost 20% of the catch. Other major contributing groups include Lethrinidae (17.3%), Gerridae (7.5%), Clupeidae (7.4%), yellowfin tuna (*Thunnus albacares*; 7.2%), Carangidae (7.1%) and molluscs (6.5%). The artisanal catch had a similar composition in terms of species but much different proportions. Molluscs (29.2%), Lutjanidae (9.1%), Lethrinidae (8.3%), yellowfin tuna (7.1%), *Katsuwonus pelamis* (skipjack tuna; 7.0%), and sharks etc. (5.3%) constituted the major taxonomic groups. The overall species composition of the small-scale sector (including the unknown component) was Lutjanidae (16.5%), Lethrinidae (15.0%), molluscs (9.3%), Clupeidae (8.5%), Gerreidae (6.9%) and Carangidae (6.9%; Figure 5b).

Spatial allocation was mostly based on population distribution. As a result, 95% of the catches were estimated to be caught in FAO area 71, and only 5% in area 77. Within area 77, 93.4% of the small-scale catch is from the Line Islands group and only 6.6% is from the Phoenix Islands group. If we exclude the unaccounted catch, which was assigned to Area 71 based purely on the fact that that is where it was originally reported from, we see that 93.6% of the small-scale catch is Gilbert Islands catch, 6.0% is Line Islands and 0.4% is from the Phoenix Islands. Again, these proportions may not completely accurately reflect the distribution of catches, especially if artisanal catch is being transferred between Island groups, but it is more accurate than the FAO data which lists all of Kiribati's catch in area 71.

The catch trend for the Gilbert Islands, again just looking at the artisanal and subsistence data (i.e. the data assigned to island groups), is the same as looking at the whole catch as it is dominant with almost 94% of the catch. The catch steadily increases from 7,800 t in 1950 to 20,300 t in 2010. The Line Islands show a slightly different trend, first increasing slowly from just over 300 t in 1950 to 670 t in 1985. Catches then increases more rapidly up to approximately 1,400 t in 1993. Catches then hovered around 1,400 t·year^{-1} from 1994-2000 before increasing again up to 2005, where catches then remained stable until 2010 with 2,100 t·year^{-1}. Catches in the Phoenix peaked in the early time period, in contrast to the other island groups. Catches peaked in 1955 at 370 t and declined to zero in 1964. Catches then increased again starting in 1983, up to a much smaller peak of almost 18 t in 1995. Catches then declined again to 5 t in 2010. In 2001, there was one incident of foreign fishing estimated in the Phoenix Islands of 100 t shark catch by a Samoan boat.

Reconstructed total catch

The reconstructed total catch of Kiribati for the time period 1950-2010 was approximately 14% higher than the catches reported by the FAO on behalf of Kiribati (Figure 5a). Catches increased steadily from 8,500 t in 1950 to 14,800 t in 1982. Catches increased sharply in 1983 to almost 22,500 t. Catches continued to increase to the first peak in 1998 with 37,500 t, before declining slightly to 27,000 t in 2006. Catches increased again to the second peak of 49,000 t in 2010. The peak in the last few years of the time period is driven by an increase in the large-scale commercial catches. The magnitude of the increase from the early 1980s to the early 2000s is amplified by the apparent unaccounted catch and this same sudden increase in 1983 is also seen in the FAO data. Of the total reconstructed catch, the large-scale commercial sector contributes 11.3%, the artisanal sector accounts for 15.6%, the subsistence sector equates to 57.0%, and the unaccounted catch makes up the last 16.1%. The species composition is dominated by Lutjanidae at 14.6% of the total catch. Lethrinidae (13.3%), *Katsuwonus pelamis* (12.4%), molluscs (8.3%), Clupeidae (7.6%), *Thunnus albacares* (7.6%), Carangidae (6.1%), and Gerreidae (6.1%) are also important contributors to the overall catch.

Discussion

The reconstructed total large-scale commercial catch of Kiribati was estimated to be 3.2% higher than the industrial catch reported to the FAO. This difference was due to unreported discards. The large-scale commercial catches of Kiribati experienced several abrupt increases in average yearly catch. The first increase in the mid-1990s was due to the start of the purse seine joint venture. The second increase, in 2009, was due to a massive re-flagging of foreign vessels (WCPFC 2011a). In the recent time period, there has been a shift of the industrial fisheries eastward, from operating solely in FAO area 71 to an increasing proportion of catches in area 77. This shift is partly influenced by the pattern of El Niño which influences the movement of skipjack tuna (WCPFC 2011a). Overall, it can be seen that the majority of the large-scale catch comes from re-flagged vessels or joint ventures which are mainly run by foreign countries with majority foreign beneficial ownership. Therefore, although these are Kiribati catches, they are not indicative of the marine fisheries catches of the I-Kiribati people. Also, given the fact that 75% of large-scale commercial catches were estimated to be taken from outside the Kiribati EEZ, this could indicate that large-scale fisheries do not have a great impact on small-scale fisheries resources. However, if large-scale fisheries are intercepting tuna stocks which would normally migrate through the EEZ to be available to the artisanal tuna fishers, then the increasing catches by Kiribati flagged large-scale vessels could begin to present a problem to the food security of the I-Kiribati. Furthermore, it is highly likely that foreign vessels have, and may continue to fish inside the EEZ of Kiribati, either under foreign access agreements, or illegally.

The reconstructed total small-scale catch (including unaccounted catches) of Kiribati was estimated to be 15% higher than the small-scale portion of the FAO data. The gradual increase of small-scale catches at the beginning of the time period was due to an increasing population. The early 1980s were a period of rapid increase which was most likely due to an increase in exports as well as an increase in the presence of overseas companies which most likely formed joint ventures with local businesses. Kiribati declared its EEZ in 1978 and became an independent nation in 1979. Therefore, it is reasonable to assume that in the following years, foreign fleets may have made the decision to try and coordinate joint ventures with the countries whose waters they previously used to fish unrestricted, in order to gain access to those resources once again. According to the data, the decline in recent years is due to a decline in inshore species. This is one possibility, and in all likelihood is occurring to some extent as it is known that specific inshore stocks are in decline. However, it is possible that the abruptness of the decline was due to reporting issues. Both of these factors are discussed in further detail below.

Kiribati has struggled with development of their offshore fisheries (Anon. 2003; Barclay and Cartwright 2007). Kiribati's isolation, lack of resources, and difficulties with transportation have stifled the development of domestic offshore fisheries. The most successful large-scale offshore fishery has been the purse seine fleet which is a joint venture with a Japanese company and re-flagged vessels. The vessels spends most of their time operating outside of the EEZ and often lands catch at other ports (Barclay and Cartwright 2007). This difficulty in developing an offshore fishery led to a shift towards operating in the inshore sector (Anon. 2003). Marine resources are a vital part of the country's economic development with many inshore species being important export items, such as sea cucumber, lobsters and molluscs. Although officials are aware that those resources are in decline, they continue to encourage both local and overseas companies to commercially exploit these resources (Anon. 2003).

With evermore fishing in the inshore sector being encouraged, it is not surprising that most of the heavily exploited inshore stocks have been reported to be in decline. Molluscs (both the ark shell and giant clams) have been reported to be greatly under pressure, and in some areas (South Tarawa most notably) the fisheries may even have collapsed (Thomas 2003a; Preston 2008; Sullivan and Ram-Bidesi 2008). Bonefish stocks are also in sharp decline. This is not only due to overfishing but also due to their spawning runs being disrupted by the construction of causeways (Johannes and Yeeting 2000; Sullivan and Ram-Bidesi 2008). As the subsistence and artisanal fishers overexploit bonefish stocks on Kiritimati, it leaves little to attract tourism, which is one of the only sources of revenue for the island (Anon. 2003). Kiribati's fisheries division did implement restrictions on bonefish capture in early 2008 (Gillett 2011a); however, information on the current status of the stocks could not be found. Comparison of areas targeted by the live reef food fish trade and non-target areas confirms that the fishery has had a negative impact on fish stocks, despite the fact that operations occurred over a short time period (Anon. 2003). The ornamental fish trade is also thought to have led to the decline of some reef fish stocks (Preston 2008).

Another issue that came to light during the reconstruction was the fact that Kiribati's marine fisheries catches seem abnormally high in the latter half of the time series. Even given the high consumption rate of the I-Kiribati, it still seems as though all of the reported catches cannot be accounted for. This also means that all of the catches which we can account for are deemed as reported. This is a noteworthy finding, given the fact that subsistence catches in the South Pacific are known to be under-reported due to a lack of resources available to monitor the sector (Dalzell *et al.* 1996). According to a Kiribati fisheries division report (Anon. 2003), data are in fact collected from subsistence fishers. However, it is interesting that although we accepted the reported small-scale tuna catch as it was recorded, we know that taxonomically some of the catch seems to be missing; although, due to this 100% reporting record for an approximately 20 year period, the tonnage of the tuna appears to be included. We know specifically that in the last few years (2007-2010), the total amount of small-scale tuna catch was reported taxonomically and interestingly, at the same time that complete tuna catches became incorporated into the data, the amount of reported reef fish and invertebrates plummeted (with this also occurring in the year 2000). It seems unusual that within a year there would be such a dramatic change in actual catches and diet. Therefore, this does support the possibility that the total actual tonnage of tuna was reported in the data, but was taxonomically incorrectly reported as something else.

Regardless of the taxonomic issues in reporting, there is also an issue with accounting for the tonnage of the catch. As stated earlier, some of the catches within the FAO data may be attributable to flag of convenience vessels. If there has been encouragement to exploit the inshore resources, it is possible that foreign re-flagged vessels are collecting inshore species. Another possibility is that re-flagged vessels are fishing tuna and are misreporting it taxonomically. The final possible explanation is that large amounts of reef fish caught by Kiribati flagged vessels are being processed into fishmeal. This, in fact, seems like the most satisfactory explanation. However, there is little evidence to support it. In an FAO country profile of Kiribati (Gillett 2011a) there is a single mention within a table that a large amount of fish is being used for "animal feed and other purposes" as opposed to a smaller amount "for direct human consumption." However, within the report there is no explanation or further mention of this and no reference as to where this number came from. Also, within the same report are estimated values of coastal commercial and coastal subsistence catches which have been taken from Gillett (2009). The total production within this table is the same as the first and the subsistence catch is roughly equal to the amount supposedly used for animal feed. Gillett (2009) defines coastal subsistence catches as those retained by the fisher for either their or another community members consumption. Thus under that definition, the large amount of fish meal would not be included in those numbers. These two values are contradictory. After an extensive literature search, no other information regarding fishmeal production or catches for fishmeal production by Kiribati could be found. Therefore, whether it is a matter of taxonomic misreporting, over-reporting, or reporting by flag of convenience vessels, there is a definite lack of transparency in Kiribati's marine fisheries data. Due to the multitude of issues that are present throughout the time span, it is extremely difficult to assess exactly what is occurring in Kiribati's waters.

It should also be recognized that due to the widespread and scattered nature of Kiribati's islands, assessing and reporting total catches is a challenge. However, due to a lack of comprehensive data on separate islands, it was necessary to analyze Kiribati's marine fisheries catches as a whole. Also, although it was estimated that only a small portion of the small-scale catches are taken from the waters of FAO area 77, this estimate was based on the assumption that catches were proportional to population distribution. This may not be the best indication of catch. It is known that some of the outer islands (include Kiritimati, which is located in area 77) export catches to Tarawa (area 71), in order to supply the high demand by the more densely packed population (Awira *et al.* 2008). However, this information could not be used directly to make an assumption of the spatial distribution of catches, as the study consisted of very small sample sizes that could not be extrapolated to the whole population. Thus island group specific separation of national catch data would be a useful step forward.

We have made the best possible estimates of total catches with the available information. Further research is required to assess the state of Kiribati's fisheries. Kiribati's isolation, which leads to high transport costs and thus high import costs, leads the population to rely on local resources. A lack of fertile soils means that the only local resource to satisfy their dietary protein needs is their marine resources. With a high *per capita* seafood consumption rate it is essential that measures be taken to ensure that the marine resources are sustainably caught, and this applies especially to inshore pelagic and non-pelagic resources that are of fundamental food security importance to the I-Kiribati. This also means that much better transparency is required in the officially reported data.

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References

ADB (2002) Monetization in an atoll society: managing economic and social change in Kiribati. Asian Development Bank (ADB), Manila, Philippines. 278 p.

Anderson A, Wallin P, Marinsson-Wallin H, Fankhauser B and Hope G (2000) Towards a first prehistory of Kiritimati (Christmas) Island, Republic of Kiribati. Journal of the Polynesian Society 109(3): 273-293.

Anon. (2003) Annual report: Kiribati. Department of Fisheries. 56 p.

Anon. (2006) Kiribati designates large MPA, to be funded by endowment. MPA News 7(9): 1-2.

Awira R (2006) The live reef food fish and ornamental fish trades in Kiribati. pp. 31-44 *In* Johnston B and Yeeting B (eds.), Economics and marketing of the live reef fish trade in Asia-Pacific. Australian Centre for International Agricultural Research, Canberra, Australia.

Awira R, Friedman K, Sauni S, Kronen M, Pinca S, Chapman L and Magron F (2008) Kiribati country report: Profiles and results from survey work at Abaiang, Abemama, Kuria, and Kirimati. Secretariat of the Pacific Community (SPC), Noumea, New Caledonia. 343 p.

Baaro B (1993) Chapter 12: Economic overview. pp. 161-167 *In* Van Trease H (ed.), Atoll politics: the Republic of Kiribati. Institute of Pacific Studies, University of the South Pacific, Suva, Fiji.

Barclay K and Cartwright I (2007) Kiribati. pp. 117-147 *In* Capturing wealth from tuna: case studies from the Pacific. Asia Pacific Press, Canberra, Australia.

Bertram IG and Watters RF (1984) New Zealand and its small island neighbours: A review of New Zealand policy toward the Cook Islands, Niue, Tokelau, Kiribati and Tuvalu. Institute of Policy Studies, Wellington, New Zealand. 574 p.

Biery L and Pauly D (2012) A global review of species-specific shark-fin-to-body-mass ratios and relevant legislation. Journal of Fish Biology 80(5): 1643-1677.

Dalzell P, Adams TJH and Polunin NVC (1996) Coastal fisheries in the Pacific Islands. pp. 395-531 *In* Ansell AD, Gibson RN and Barnes M (eds.). Oceanography and marine biology: an annual review 34. UCL Press, London, U.K.

De Santo EM (2012) From paper parks to private conservation: the role of NGOs in adapting marine protected area strategies to climate change. Journal of International Wildlife Law & Policy 15(1): 25-40.

Garibaldi L (2012) The FAO global capture production database: a six-decade effort to catch the trend. Marine Policy 36: 760-768.

Gillett R (2002) Pacific island fisheries: regional and country information. FAO Regional Office for Asia and the Pacific, Bangkok, Thailand. 168 p.

Gillett R (2009) Fisheries in the economies of the Pacific island countries and territories. Asian Development Bank (ADB), Mandaluyong City, Philippines. 521 p.

Gillett R (2011a) Fisheries of the Pacific Islands: Regional and national information. Food and Agriculture Organization of the United Nations (FAO), Bangkok, Thailand. 279 p.

Gillett R (2011b) Issues in small-scale tuna fisheries in FFA member countries. Forum Fisheries Agency, Honiara (Solomon Islands). 13 p.

Gillett R and Lightfoot C (2001) The contributions of fisheries to the economies of the Pacific Island countries. Asian Development Bank (ADB), Manila, Philippines. 218 p.

Hannesson R (2008) The exclusive economic zone and economic development in the Pacific island countries. Marine Policy 32: 886-897.

Harper S, Zeller D, Hauzer M, Pauly D and Sumaila UR (2013) Women and fisheries: contribution to food security and local economies. Marine Policy 39: 56-63.

Johannes RE and Yeeting B (2000) I-Kiribati knowledge and management of Tarawa's lagoon resources. Atoll Research Bulletin 489: 1-25.

Jones P, Shepherd L, Gibson H, Ryan H and Gilbert K (2006) Kiribati: Preparing the outer island growth centers. Asian Development Bank (ADB), Melbourne, Australia. 190 p.

Lawson TA (1997) Estimation of bycatch in central and western pacific tuna fisheries: preliminary results. South Pacific Commission (SPC), Noumea, New Caledonia. 29 p.

MacDonald B (2001) Cinderellas of the empire: towards a history of Kiribati and Tuvalu. Institute of Pacific Studies, University of the South Pacific, Suva (Fiji). 335 p.

Niesten E and Gjertsen H (2010) Economic incentives for marine conservation. Science and Knowledge Division, Conservation International, Arlington, Virginia. 40 p.

Pala C (2013a) Fishing undercuts Kiribati President's marine protection claims. Inter Press Service News Agency, edition of June 19, 2013. Available at: http://www.ipsnews.net/2013/06/fishing-undercuts-kiribati-presidents-marine-protection-claims/ [Accessed: August 2013].

Pala C (2013b) History through a watery lens. pp. 15-23 In Stone GS and Obura D (eds.), Underwater Eden: saving the last coral wilderness on Earth. The University of Chicago Press, Chicago.

Pauly D (1997) Small-scale fisheries in the tropics: marginality, marginalization, and some implications for fisheries management. pp. 40-49 *In* Pikitch EK, Huppert DD and Sissenwine MP (eds.), Global trends: fisheries management. American Fisheries Society Symposium 20, Bethesda (USA).

Pratchett MS, Munday PL, Graham NAJ, Kronen M, Pinca S, Friedman K, Brewer TD, Bell JD, Wilson SK, Cinner JE, Kinch JP, Lawton RJ, Williams AJ, Chapman L, Magron F and Webb A (2011) Vulnerability of coastal fisheries in the tropical Pacific to climate change. pp. 493-576 *In* Bell JD, Johnson JE and Hobday AJ (eds.), Vulnerability of tropical Pacific fisheries and aquaculture to climate change. Secretariat of the Pacific Community, Noumea (New Caledonia).

Preston GL (2008) Coastal fisheries development and management. Working Paper 3, Institutional Strengthening Scoping Study Report, South Pacific Forum Fisheries Agency (SPFFA), Honiara, Solomon Islands. 33 p.

Rawlinson NJF, Milton DA and Blaber SJM (1992) Tuna baitfish and the pole-and-line industry in Kiribati. Australian Centre for International Agricultural Research, Canberra, Australia. 90 p.

Schoeffel P (1985) Women in the fisheries of the South Pacific. pp. 156-175 *In* Women in development in the South Pacific: Barriers and opportunities. Development Studies Centre, The Australian National University, Canberra, Australia.

Sommerville W and Pendle D (1999) Live reef fish operations in Kiribati. SPC Live Reef Fish Information Bulletin 5: 16-18.

SPC (1977) Country statement–Gilbert Islands. South Pacific Commission (SPC), Noumea, New Caledonia. 3 p.

SPC (1979) Country statement–Republic of Kiribati. South Pacific Commission (SPC), Noumea, New Caledonia. 8 p.

SPC (1995) Kiribati–country statement. South Pacific Commission (SPC), Noumea, New Caledonia. 8 p.

SPC (2007) Kiribati 2005 census: volume 2. SPC's Statistics and Demography Programme and Kiribati Statistics Office, Noumea (New Caledonia). 158 p.

Stone GS (2013) In search of paradise. pp. 1-14 *In* Stone GS and Obura D (eds.), Underwater Eden: saving the last coral wilderness on Earth. The University of Chicago Press, Chicago.

Sullivan N and Ram-Bidesi V (2008) Gender issues in tuna fisheries: Case studies in Papua New Guinea, Fiji and Kiribati. Forum Fisheries Agency and Pacific Islands Forum Secretariat, Honiara, Solomon Islands. 59 p.

Taumaia P and Gentle M (1983) Report on the Deep Sea Fisheries Development Project's visit to the Republic of Kiribati (23 April–18 November 1980). South Pacific Commission (SPC), Noumea, New Caledonia. 27 p.

Teiwaki R (1988) Management of marine resources in Kiribati. Institute of Pacific Studies, University of the South Pacific, Suva, Fiji. 239 p.

Tekanene M (2006) The women fish traders of Tarawa, Kiribati. pp. 115-120 *In* Choo PS, Hall SJ and Williams MJ (eds.), Global symposium on gender and fisheries. WorldFish Center, Penang, Malaysia.

Thomas FR (2003a) Fisheries development in Kiribati: sustainability issues in a "MIRAB" economy. Pacific Studies 26(1): 1-23.

Thomas FR (2003b) Kiribati: "Some aspects of human ecology", forty years later. Atoll Research Bulletin 501: 1-40.

Tumoa R (2006) National fisheries report: Kiribati–part 1. Western and Central Pacific Fisheries Commission (WCPFC), Manila, Philippines. 12 p.

Turbott IG (1949) Diets, Gilbert and Ellice Islands colony. The Journal of the Polynesian Society 58(1): 36-46.

UN (2008) Ex-ante impact assessment of likely consequences of graduation of the Republic of Kiribati from the least developed country category. United Nations, Department of Economic and Social Affairs, Secretariat of the Committed for Development Policy, New York. 38 p.

WCPFC (2011a) Annual report to the commission–Part 1: information on fisheries, research, and statistics–Kiribati. Western Central Pacific Fisheries Commission (WCPFC), Pohnpei, Federated States of Micronesia. 19 p.

WCPFC (2011b) WCPFC tuna fishery yearbook 2010. Western and Central Pacific Fisheries Commission (WCPFC), Noumea, New Caledonia. 121 p.

Williams P (2011) Issues with Chinese flongline fleet data submitted to the WCPFC. Westerna and Central Pacific Fisheries Commision, Pohnpei (Federated States of Micronesia). 10 p.

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

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

Year	FAO landings[a]	Reconstructed total catch	Large-scale commercial	Artisanal	Subsistence	Unaccounted catch	Discards
1950	1,000	8,500	-	50	8,410	-	-
1951	1,000	8,600	-	50	8,560	-	-
1952	1,000	8,800	-	50	8,710	-	-
1953	2,000	8,900	-	50	8,850	-	-
1954	2,000	9,000	-	50	9,000	-	-
1955	3,000	9,200	-	50	9,140	-	-
1956	3,000	9,300	-	50	9,290	-	-
1957	4,000	9,500	-	50	9,430	-	-
1958	4,000	9,600	-	50	9,570	-	-
1959	4,000	9,700	-	25	9,710	-	-
1960	5,000	9,900	-	82	9,770	-	-
1961	5,000	10,000	-	167	9,850	-	-
1962	6,000	10,200	-	254	9,920	-	-
1963	6,000	10,300	-	345	10,000	-	-
1964	6,000	10,500	-	438	10,070	-	-
1965	6,000	10,700	-	533	10,140	-	-
1966	7,500	10,800	-	632	10,200	-	-
1967	7,500	11,000	-	733	10,260	-	-
1968	7,500	11,100	-	836	10,310	-	-
1969	7,500	11,300	-	942	10,360	-	-
1970	8,801	11,500	-	1,050	10,400	-	-
1971	8,901	11,600	-	1,161	10,450	-	-
1972	9,101	11,800	-	1,274	10,490	-	-
1973	9,201	11,900	-	1,390	10,520	-	-
1974	9,475	12,100	-	1,508	10,560	-	-
1975	9,650	12,200	-	1,630	10,600	-	-
1976	9,824	12,400	-	1,751	10,610	-	-
1977	10,053	12,500	-	1,880	10,650	-	-
1978	10,606	12,700	-	2,017	10,720	-	-
1979	10,838	13,000	-	2,160	10,800	-	-
1980	12,929	13,200	-	2,309	10,890	-	-
1981	13,502	14,600	590	2,575	11,470	-	-
1982	13,009	14,800	490	2,744	11,570	-	-
1983	22,485	22,500	1,700	3,066	12,270	5,450	-
1984	19,380	19,400	2,160	3,081	11,710	2,440	-
1985	22,844	22,800	800	3,524	12,740	5,780	-
1986	29,271	29,300	1,480	3,729	12,850	11,220	-
1987	27,137	26,700	510	3,990	13,110	9,110	-
1988	25,002	25,000	1,530	4,094	12,850	6,530	-
1989	30,983	31,000	2,340	4,235	12,710	11,700	-
1990	26,852	26,900	610	4,404	12,640	9,190	-
1991	29,170	29,200	240	4,929	13,560	10,450	-
1992	30,023	30,000	580	5,268	13,890	10,290	-
1993	28,884	28,900	310	5,650	14,290	8,640	-
1994	29,569	29,600	1,330	5,579	13,550	9,110	39
1995	32,120	32,200	3,640	5,809	13,550	9,120	105
1996	33,687	33,900	4,840	6,056	13,580	9,210	169
1997	32,138	32,300	5,210	6,227	13,440	7,260	182
1998	37,284	37,500	7,580	5,913	12,280	11,510	265
1999	36,365	36,900	6,080	6,119	12,240	12,210	213
2000	35,446	35,600	4,980	6,541	12,600	11,330	174
2001	33,280	33,400	4,620	7,066	13,120	8,470	162
2002	36,694	36,900	5,260	7,121	13,220	11,080	184
2003	33,712	33,900	4,840	7,546	14,010	7,310	169
2004	31,062	31,200	4,600	7,595	14,110	4,760	161
2005	30,562	30,800	7,110	7,707	14,310	1,430	249
2006	25,661	27,000	4,660	7,757	14,410	-	163
2007	34,170	34,400	5,450	7,848	14,580	6,290	191
2008	28,000	28,200	5,810	7,782	14,450	-	204
2009	40,623	43,900	21,050	7,743	14,380	-	731
2010	44,599	49,200	25,830	7,849	14,580	-	904

[a]This represents the adjusted FAO time series.

Appendix Table A2. Reconstructed total catch (in tonnes) by major taxa for Kiribati, 1950-2010. 'Others' contains 17 additional taxonomic categories.

Year	Lutjanidae	Lethrinidae	*Katsuwonus pelamis*	Molluscs	Clupeidae	*Thunnus albacares*	Gerreidae	Carangidae	Others
1950	2,700	2,210	-	430	345	-	796	463	1,520
1951	2,740	2,250	-	439	351	-	811	471	1,540
1952	2,780	2,300	-	447	356	-	827	480	1,570
1953	2,610	2,620	-	398	393	-	783	478	1,630
1954	2,650	2,660	-	406	398	-	798	486	1,650
1955	2,970	2,480	-	357	435	-	754	485	1,710
1956	3,020	2,520	-	365	440	-	769	493	1,730
1957	2,770	2,780	-	315	408	-	882	744	1,590
1958	2,810	2,820	-	324	413	-	896	752	1,610
1959	2,850	2,850	-	332	419	-	911	760	1,620
1960	3,060	2,670	-	282	455	-	967	758	1,660
1961	3,110	2,710	-	291	461	-	983	767	1,690
1962	3,210	2,710	-	243	471	-	1,024	848	1,670
1963	3,260	2,760	-	252	477	-	1,041	858	1,700
1964	3,310	2,810	-	262	483	-	1,057	867	1,720
1965	3,350	2,850	-	271	489	-	1,074	876	1,750
1966	3,370	2,860	-	193	535	-	1,098	965	1,810
1967	3,410	2,910	-	203	541	-	1,114	974	1,840
1968	3,460	2,950	-	212	546	-	1,130	983	1,860
1969	3,500	3,000	-	221	552	-	1,146	992	1,890
1970	3,320	2,810	100	154	550	100	1,255	1,055	2,110
1971	3,430	2,820	100	157	553	100	1,261	1,059	2,120
1972	3,350	2,940	100	155	578	100	1,274	1,074	2,200
1973	3,460	2,950	100	157	580	100	1,279	1,077	2,210
1974	3,540	2,960	100	150	589	100	1,311	1,120	2,190
1975	3,590	3,000	100	150	598	100	1,330	1,137	2,220
1976	3,630	3,030	100	147	605	100	1,345	1,153	2,250
1977	3,680	3,060	100	143	615	100	1,364	1,174	2,290
1978	3,750	3,090	100	123	630	100	1,394	1,213	2,340
1979	3,810	3,140	100	121	641	100	1,419	1,240	2,400
1980	3,400	2,700	100	13	591	1,810	1,259	1,162	2,170
1981	3,310	3,360	360	1,254	449	2,020	1,156	654	2,080
1982	3,390	3,380	290	1,300	486	1,980	1,222	661	2,100
1983	3,860	3,320	1,000	2,664	1,195	2,400	1,809	1,374	4,870
1984	2,820	2,280	1,280	1,018	2,953	2,560	220	1,838	4,410
1985	3,470	3,040	450	3,286	2,572	2,080	230	1,833	5,890
1986	3,620	2,730	890	3,255	6,554	2,340	1,580	2,548	5,760
1987	3,490	2,530	270	3,714	5,539	1,970	1,107	2,323	5,770
1988	2,190	3,820	930	2,649	3,789	2,360	848	2,099	6,330
1989	2,710	2,730	1,440	2,071	4,229	2,660	2,258	972	11,920
1990	2,450	2,470	450	1,880	3,826	1,960	2,040	874	10,910
1991	2,490	2,510	160	4,144	3,896	1,880	2,076	886	11,130
1992	2,490	2,500	250	4,230	3,909	2,120	2,080	862	11,590
1993	2,310	2,320	180	4,100	3,676	1,920	1,948	765	11,660
1994	2,410	2,410	1,050	4,060	3,760	2,090	2,000	832	11,000
1995	2,430	2,430	2,590	4,100	3,790	2,900	2,010	833	11,140
1996	2,450	2,460	4,250	4,150	3,834	2,390	2,033	835	11,450
1997	2,490	2,490	2,950	4,120	3,861	3,820	2,073	877	9,630
1998	3,070	2,640	5,600	571	2,605	3,850	1,828	3,882	13,510
1999	2,720	2,480	7,440	776	3,839	2,370	1,651	2,725	12,850
2000	2,560	2,540	9,680	1,947	3,139	5,140	936	1,389	8,280
2001	3,380	4,500	3,930	3,260	2,662	1,450	1,824	3,254	9,170
2002	1,550	1,950	6,890	2,337	4,211	2,970	1,222	4,104	11,650
2003	4,300	3,500	4,690	5,378	954	2,260	1,401	3,126	8,280
2004	3,940	3,330	4,890	4,800	846	1,800	1,340	2,714	7,560
2005	3,530	3,120	6,100	4,300	669	3,060	1,239	2,288	6,500
2006	3,290	3,070	4,420	4,186	610	2,320	1,290	1,935	5,870
2007	2,760	2,790	12,550	3,375	358	5,560	1,067	1,345	4,560
2008	580	630	12,310	3,415	265	5,960	1,229	537	3,320
2009	600	580	27,660	4,145	349	6,400	542	431	3,200
2010	630	560	28,070	4,215	312	8,510	601	437	5,830