RECONSTRUCTION OF FISHERIES CATCHES FOR TOKELAU (1950-2009)[1]

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ABSTRACT

Total marine fisheries catches were estimated for Tokelau between 1950 and 2009. As there are no commercial fisheries in Tokelau, our estimate represents subsistence fisheries only. Subsistence catches were estimated using *per capita* consumption rates. These rates were either found in independent fisheries studies or estimated from dietary assessments. The subsistence catches total approximately 24,250 t over the 1950-2009 time period (399 t·year^{-1} in the 2000s), which is almost 4.3 times larger than the FAO reported landings. This report highlights the importance of accurate fisheries catch reporting, as it is required for proper fisheries management and, for small island countries such as Tokelau, it is essential for maintaining food security.

INTRODUCTION

Tokelau, a territory of New Zealand, is comprised of three atolls: Fakaofo, Nukunonu, and Atafu. They are located approximately 300 miles north of Western Samoa at 8°-10° S and 171°-173° W (Figure 1). The land area is only 12.2 km^2, with an Exclusive Economic Zone (EEZ) of 319,031 km^2 (www.seaaroundus.org). The atolls are situated with Atafu in the northwest, Nukunonu in the middle, and Fakaofo in the southeast. Although each atoll consists of many small islands and islets, the majority of the population for each atoll is confined to one main island or islet (van Pel, 1958). The atolls are all closed, leaving no deep water passes for ships to enter the lagoons (van Pel, 1958). Atafu is the smallest atoll, both in land area (2.5 km^2) and lagoon size (19 km^2). Nukunonu is the largest with about 5.5 km^2 of land area and 109 km^2 for lagoon coverage. Fakaofo falls in the middle with 3 km^2 of land area, 59 km^2 of lagoon coverage (Ono and Addison, 2009).

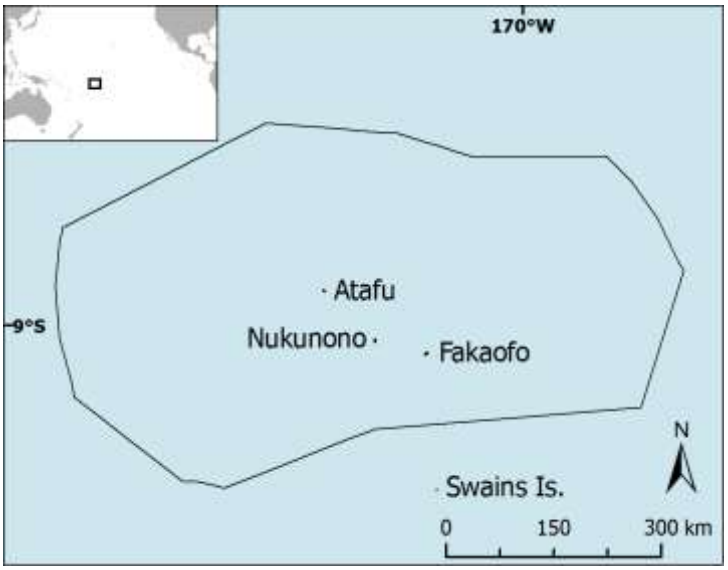

Figure 1. Map of Tokelau showing the three atolls, Atafu, Nukunono, and Fakaofo, and its EEZ, as well as Swains Island, a previous fourth atoll known as Olohega.

The Tokelau chain does, geographically, also consist of a fourth atoll, now known as Swains Island (Clanton, 2008). It is located 100 miles south of Fakaofo (Bertram and Watters, 1984) (Figure 1). The island was originally settled in 1400 by the Tokelauans and was given the name Olohega (Bertram and Watters, 1984). However, the atoll was officially annexed to the United States in 1925, and now forms part of American Samoa (Bertram and Watters, 1984; Clanton, 2008). Although there are many different

[1] Cite as: Zylich, K., Harper, S. and Zeller, D. (2011) Reconstruction of fisheries catches for Tokelau (1950-2009). pp. 107-117. *In*: Harper, S. and Zeller, D. (eds.) Fisheries catch reconstructions: Islands, Part II. Fisheries Centre Research Reports 19(4). Fisheries Centre, University of British Columbia [ISSN 1198-6727]

stories of what occurred with the early foreign explorers who came across Olohega, it is consistent that the eventual annexation to the United States occurred because of the Jennings family. In 1856, an Englishman reportedly sold his perceived "claim of ownership" to an American, Eli Hutchinson Jennings Sr. (Bertram and Watters, 1984; Clanton, 2008). Jennings and his wife ran a copra plantation using Tokelauan labour (Clanton, 2008). In 1917, Tokelauan workers submitted a claim to Western Samoa complaining about the working conditions on Olohega (Bertram and Watters, 1984). However, the matter was referred over to the United States as officials in Apia stated they had no authority over the Jennings family (Bertram and Watters, 1984). This led to questions of sovereignty of the island and seeing an opportunity to claim new land, the United States took possession. The island is still inhabited by a small Tokelauan population and many Tokelauans continue to consider it part of Tokelau, both historically and culturally (Bertram and Watters, 1984; Ono and Addison, 2009).

Tokelau was under British colonial rule (starting in 1889) and was incorporated with the Gilbert and Ellice Islands Colony in 1916 (Bertram and Watters, 1984). The current three atolls of Tokelau were brought under New Zealand administration in 1926. However, it was not until the Tokelau Act of 1948 that New Zealand took formal control over the atolls (Adams *et al.*, 1995; Townend, 2007). Although New Zealand has been pushing for Tokelau to become an independent self-governing country, Tokelau has resisted at every step. In 1974, the New Zealand Ministry of Foreign Affairs was said to begin the "process of administrative decolonization", even though it was known that Tokelau had firmly rejected the idea of self-government (Bertram and Watters, 1984). Since then, Tokelau voted in two referenda, first in 2006 and again in 2007, to determine whether or not they wish to become a self-governing nation. In both referenda they fell short of a two-thirds majority vote needed to change their political status (Hoëm, 2009).

Despite the Tokelauans best efforts to resist the new social and economic structure that the New Zealand government was trying to implement, there have been some radical changes to their way of life. Although tradition is still observed on the surface, the same sense of community and cooperation is not there (Hooper, 1985). This disruption is the result of New Zealand's attempts to introduce new programs and social order, which are counter to the Tokelauans expressed feelings (Bertram and Watters, 1984). A major change which had wide-spread effects was the introduction of the New Zealand public service lines in 1976, which were staffed by Tokelauans (Bertram and Watters, 1984; Hooper, 1985). This took a lot of able-bodied men out of the village labour force. Before this happened, the activities of these men were coordinated by the village council. Now that they are being employed by an outside entity there is less cohesiveness between the village and council (Hooper, 1985). Although this change led to less fisher-hours per week, the new influx of cash allowed more modern fishing gear to be purchased. New aluminum dinghies (12-14 feet long with 15 to 25 horsepower outboard engines) have mostly replaced the traditional canoes used (some canoes with outboard motors are in use) (Hooper, 1985). These allow for more efficient fishing as it takes less time to manoeuvre the area and less human effort (Hooper, 1985).

As a fairly isolated community, Tokelau has been and continues to be very dependent on subsistence fishing activities. Almost everyone participates in some type of fishing activity (Chapman *et al.*, 2005). Even though ship transport has increased significantly over the years, there is still heavy reliance on locally caught fish in the diet. On Atafu, the people not only engage in subsistence fishing, but also root-crop cultivation and fruit-tree harvesting (Ono and Addison, 2009). Previously, copra was a major commercial crop exported from the atolls and, at times, brought in decent revenues (Bertram and Watters, 1984), but not anymore (Ono and Addison, 2009). Tokelau is heavily subsidized by the New Zealand government, and beginning in 1976, many Tokelauans went to work in the public service lines with wages being paid by New Zealand (Hooper, 1985; Passfield, 1998). Tokelau does bring in a small amount of profit from the sale of handicrafts such as hats, bags, and wood carvings (Passfield, 1998; Ono and Addison, 2009).

Although fishing is extremely important to Tokelauans, catch amounts are not recorded or monitored. The FAO FishStat database, which provides time series data on marine fisheries landings from 1950 to present, is based predominantly on the national statistical data supplied by its member countries. Therefore, the quality of these data depends on the accuracy of the country's collection methods.

The objective of this study is to provide a complete time series estimate of the total marine fisheries catch of Tokelau from 1950-2009. Although there have been several studies in the past which have estimated Tokelau's fisheries catch for specific years, there has not been a comprehensive review of the trend over time.

MATERIALS AND METHODS

Estimates were only made for subsistence catches, as there are no fishing practices in Tokelau which would qualify as commercial fishing. These estimates were based on reports from several different researchers. These reports consisted of a mixture of catch and consumption data, as well as information about eating and fishing habits, which were used to make assumptions when there were no data available. Available catch data were used, along with human population data, to estimate *per capita* consumption rates. Interpolations between data anchor points were used to estimate the catch rates for the entire study period (1950-2009). A taxonomic breakdown was then applied, which included categories by species and family.

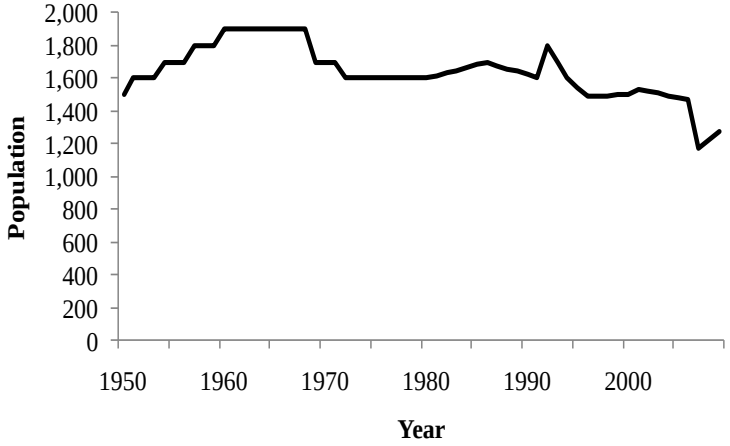

Figure 2. Estimated population of Tokelau, 1950-2009.

Human population data

Our estimates for total catch amounts were computed from *per capita* consumption rates combined with human population data. Population data were obtained from the population statistics historical demography website (www.populstat.info [accessed July 8, 2011]). For most years after 1978, no population data were available. This can be attributed to the fact that in 1975 the New Zealand Ministry of Foreign Affairs assumed control of the islands and shortly after that they reverted from annual population censuses to having one estimate every five years (Bertram and Watters, 1984). Data for the years 1991, 1996, and 2001 were obtained from official Tokelau census data[2] as well as the year 2006 (Anon., 2006). The population for 2007 was obtained from Gillett (2009) as this also provided a critical anchor point for seafood consumption for the same year. Data for 2008 and 2009 were linearly interpolated between the 2007 population and a 2011 estimate from the World Factbook[3]. For the remaining years when no data were available, a linear interpolation between years of known population was performed to give a complete time series of population data from 1950-2009 (Figure 2).

Subsistence fisheries

Several reports indicate the absence of commercial fisheries operating in Tokelau (Dalzell *et al.*, 1996; Passfield, 1998). All fishing activities are therefore deemed to be subsistence. Subsistence fishing in Tokelau includes fishing for personal consumption, as gifts to send overseas, and for trade within the community.

Table 1. *Per capita* consumption rates used to estimate total demand.

Years	Consumption Rate (kg/person/year)	Source
1950	255	Assumption-based[a]
1951-2006	-	Linear interpolation
2007	214	Gillett (2009)
2008	214	Carried forward
2009	214	Carried forward

[a]2007 estimate adjusted for increased domestically sourced fresh fish in 1950.

Gillett (2009) estimated the 2007 total catch for Tokelau to be 375 tonnes. This estimate was obtained by analyzing estimates from several independent studies completed between 1977 and 1998, with adjustments for changes in transportation availability and population (Gillett, 2009). This estimate accounts for increased transport between Tokelau and Apia, Samoa, and thus includes 125 tonnes of export (Gillett, 2009). Using these figures and the current population, Gillett (2009) estimated a consumption rate of 214 kg·person^{-1}·year^{-1}, which was used as the 2007, 2008, and 2009 anchor point (Table 1).

[2] http://www.spc.int/prism/country/tk/stats/Social/Population/age_sex_.htm [accessed June 8, 2011]
[3] https://www.cia.gov/library/publications/the-world-factbook/geos/tl.html [accessed June 8, 2011]

For the early time period (1950-1980s), the only contact that Tokelau had with the outside world was from a trading ship, which three or four times a year brought basic items such as flour, sugar, rice, kerosene, and tobacco to the atolls (van Pel, 1958). It was therefore assumed that they were not, at that time, receiving the canned meats and fish that were available later in the time period (Passfield, 1998). Given the percentages of total animal protein obtained from canned meats and fish in 1998 (Passfield, 1998), it was assumed that this amount of animal protein was supplied in the early period by fresh seafood. In this computation we assumed that the densities of all protein products were the same. The result of this assumption was a consumption rate in 1950 that was 41 kilograms higher than in 2007, (i.e., 255 $kg \cdot person^{-1} \cdot year^{-1}$) (Table 1). We then linearly interpolated between the 1950 assumed and the 2007 reported consumption rates. Using these consumption rates along with the population data, the total demand for fresh fish was calculated for the 1950-2009 time period.

Exports

In order to calculate total subsistence catch, 'exports' needed to be added to what was being locally eaten by the Tokelauans. Although there are no formal exports, the people of Tokelau do send frozen and dried fish to friends and family in Samoa as gifts (Hooper, 1985; Passfield, 1998; Gillett, 2009). Passfield (1998) calculated exports for Fakaofo, and when extrapolated to all of Tokelau, they were estimated to be 15.4 tonnes per year. It is also known that it was around 1980 when the Tokelauans began sending frozen clams to Western Samoa a few times a year (Hooper, 1985). Therefore, the exports were set to zero from 1950 to 1979, and then linearly interpolated between zero tonnes in 1979 and 15.4 t in 1998. We interpolated again between the 1998 point and Gillett's (2009) point of 125 t for 2007-2009. Adding these values to the dietary demand for each year gives the estimate for annual subsistence catches, 1950-2009.

Catch composition

The Food and Agriculture Organization of the United Nations (FAO) reports the fish catch for Tokelau under two categories: 'tuna-like fishes not elsewhere included' (nei) and 'marine fishes nei'. Also according to the FAO data, up until 1990 there were no tuna-like fish caught (except for one year of non-zero catch data in 1956). However, it is known that tuna-fishing has historically been a very important practice to the Tokelauans (Gillett and Toloa, 1987; Ono and Addison, 2009). In order to show a more complete picture of the catch composition, information was combined from several different sources. Gillett and Toloa (1987) gave us a basic composition by not only recording the species but also the percentage breakdown of the tuna and tuna-like fish. They also recorded the species information for the other pelagic fish, but only provided an overall percentage. Based on the household survey of Passfield (1998) and the observations of van Pel (1958), we broke down the inshore fish category into species and assigned percentages to both those and the species within the other pelagic category. Although marlins (*Makaira* spp.) have been known to be landed by Tokelauan fishers, they have not been included as a distinct taxon within the catch

Table 2. Estimated catch composition for the subsistence fisheries of Tokelau. Prior to 1986, adjustments were made to account for the complete absence of *Katsuwonus pelamis* until 1980. Percentages were linearly interpolated between 1980 and 1986. (See 'catch composition' in text).

Taxa	Catch (%)	
	1950-1980	1986-2009
Acanthocybium solandri	6.02	5.06
Acanthuridae	3.65	3.65
Elagatis bipinnulata	1.50	1.50
Selar crumenophthalmus	7.30	7.30
other Carangidae	7.30	7.30
Carcharhinidae	1.00	1.00
Chaetodontidae	1.46	1.46
Coryphaena hippurus	1.50	1.50
Cypselurus spp.	18.25	18.25
Grammatorcynus bilineatus	0.13	0.11
Gymnosarda unicolor	1.05	0.88
Istiophorus platypterus	0.50	0.50
Katsuwonus pelamis	0.00	3.52
Labridae	1.46	1.46
Lethrinidae	1.46	1.46
Lutjanidae	2.19	2.19
Misc. invertebrates	3.65	3.65
Misc. marine crustaceans	1.46	1.46
Misc. marine fishes	3.65	3.65
Mugilidae	3.65	3.65
Octopus spp.	1.46	1.46
Panulirus spp.	1.46	1.46
Scaridae	10.95	10.95
Serranidae	2.19	2.19
Sphyraena barracuda	0.50	0.50
Thunnus albacares	7.40	6.215
Thunnus obesus	7.40	6.215
Tridacna spp.	1.46	1.46

composition. Gillett (1985) reports Tokelauan fishers occasionally catch billfish, with sailfish (*Istiophorus platypterus*) being caught most commonly, while marlins are landed far less frequently than they used to be. Table (2) shows the complete breakdown of the subsistence catch for 1986 and onwards. Prior to 1986, the percentages of the various tuna species were adjusted to account for skipjack tuna (*Katsuwonus pelamis*) being absent from the waters of Tokelau from 1950-1980 (Table 2).

Skipjack tuna is subject to large fluctuations in abundance. For example, the Skipjack Survey and Assessment Programme which completed its surveys for Tokelau waters in 1978, spotted 71 schools in just 35 hours (Anon., 1983). By contrast, the United States Bureau of Commercial Fisheries spent approximately 47 hours of a research cruise looking for schools of skipjack in the waters of Tokelau and spotted none (Anon., 1983). A native Tokelauan communicated to the researchers of the Skipjack Survey that in a span of ten years they will probably see one or two extremely abundant years (Anon., 1983). Hooper (1985) described a span of 15-20 years with no skipjack sightings. This covers the period of 1950-1970. In 1971, skipjack tuna reappeared but only for a span of about a week, after which they disappeared again (Hooper, 1985). In 1986, skipjack was recorded as part of the catch during a 12 week study (Gillett and Toloa, 1987). Taking into account all of this information, these fluctuations were adjusted for by assigning zero percent of the tuna catch to skipjack from 1950-1980. We renormalized the percentages for the other tuna species for this time period (Table 2). Skipjack tuna percentages were then linearly interpolated from zero in 1980 to 3.52% in 1986. The values for the other tuna species were also adjusted, as the percentage of skipjack increased.

Baitfish

Fisheries of Tokelau use handline and noose fishing techniques which require the use of baitfish. Baitfish fisheries in other parts of the South Pacific operate in parallel to the tuna pole-and-line fishery, often using the same vessels (Gillett, 2011). The baitfish required to catch a given amount of tuna varies depending on the type of bait species used, fishing method applied, and many other factors. Tokelau appears to be a unique case in all aspects of baitfish use. The method typically used in other countries does not apply for Tokelau due to topographical characteristics which prevent large vessels from entering the lagoon (Anon., 1983). Tokelauans use very traditional methods for tuna fishing which differ from the method that the tuna to baitfish ratio of 32:1 is based on (Gillett, 2011). Reports on Tokelauan use of baitfish suggest a range of species are used including flying fish (*Cypselurus* spp.), double-lined mackerel (*Grammatorcynus bilineatus*), garfish (*Hemiramphus* spp.), shortfin scad (*Decapterus macrosoma*), bigeye scad (*Selar crumenophthalmus*), and squirrelfish (Holocentridae) (Gillett, 1985). This variation in baitfish use may reflect the seasonal availability of certain species. Given these differences in baitfish use, we assume that the traditional methods used by the Tokelauans are more specific and efficient than the typical baitfish catch method for pole-and-line gear. Assuming that Tokelauan fishers use half as much baitfish as used for pole-and-line fishing, we modified Gillett's (2011) tuna to baitfish ratio to an adjusted 64:1. Tokelauans use baitfish to catch more than just tuna, therefore this ratio was applied to the following species which are all landed by the handline and noose methods: yellowfin tuna (*Thunnus albacares*), dogtooth tuna (*Gymnosarda unicolor*), wahoo (*Acanthocybium solandri*), rainbow runner (*Elagatis bipinnulata*), bigeye tuna (*Thunnus obesus*), indo-pacific sailfish (*Istiophorus platypterus*), sharks (Carcharhinidae), and barracuda (*Sphyraena barracuda*) (Gillett, 1985). Skipjack tuna was not included, as they are mainly caught with artificial lures (Gillett, 1985). Traditional methods made use of pearl-shell lures, however these have become rare and difficult to acquire (Hooper, 1985). Gillett (1985) found that Tokelauans are resourceful people and would even make use of a yellow, translucent handle of a screwdriver for a lure. Baitfish estimates for Tokelau were divided evenly between the six previously mentioned taxa of baitfish used. These estimates were not included in the subsistence catch composition and therefore the 3 taxa which are used solely for bait (*Hemiramphus* spp., *Decapterus macrosoma,* and Holocentridae) and not actually consumed in the diet are not listed in Table (2).

RESULTS

The reconstructed total catch for the period 1950-2009 was estimated at 24,255 t. This equates to approximately 4.3 times the total landings reported by the FAO on behalf of Tokelau for the same time period (Figure 3). Average annual catches peaked in the 1960s at approximately 460 t·year^{-1}, with a low of 368 t·year^{-1} in the 1990s. Catches in the recent period (2000s) are estimated to be 399 t·year^{-1}. Exports

totalled 1,091 t over the study period, representing 4.5% of the total catch. However, these were not commercial exports, but rather gifts mainly sent to Samoa.

The total reconstructed catch was dominated by flying fish (*Cypselurus* spp.) with an estimated 4,425 t over the time period, representing approximately 18% of the total catch (Figure 4). Families Scaridae and Carangidae, as well as the species *Selar crumenophthalmus* (bigeye scad), *Thunnus albacares* (yellowfin tuna), *Thunnus obesus* (bigeye tuna), and *Acanthocybium solandri* (wahoo) also made up large portions of the catch, with approximately 44 t·year^{-1}, 29 t·year^{-1}, 30 t·year^{-1}, 28 t·year^{-1}, 28 t·year^{-1}, and 23 t·year^{-1}, respectively. The category 'other taxa' includes the remaining 21 taxonomic groups of the subsistence catch (as per Table 2), as well as the other three baitfish taxa, as they represented smaller portions of the total catch. Together, they represent roughly 37% of the total catch. Baitfish alone represented only 0.4% of the total catch, with approximately 90 t being used over the entire time period.

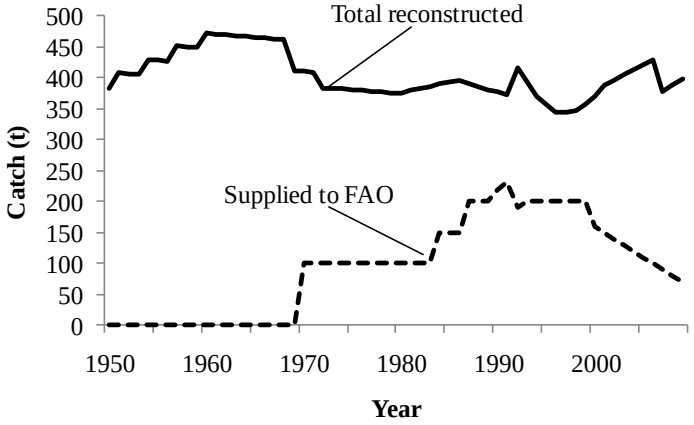

Figure 3. Total reconstructed fisheries catches for Tokelau compared to data supplied to FAO, 1950-2009.

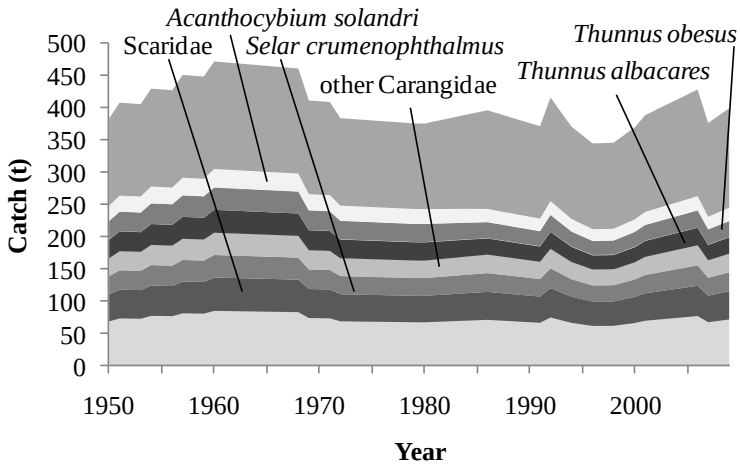

Figure 4. Taxonomic breakdown of total reconstructed catch for Tokelau. The grouping 'other taxa' represents 24 taxa (as listed in Table 2, plus 3 additional baitfish taxa).

DISCUSSION

The total reconstructed catch for Tokelau during the time period 1950-2009 was over four times larger than the total catch reported by the FAO on behalf of Tokelau. The main reason for this difference is that there is no system in place for monitoring fisheries catches in Tokelau (Anon., 1983). According to Bertram and Watters (1984), the reports of the New Zealand Ministry of Foreign Affairs, which took over control of the islands in 1974-1975, show the lack of interest the Ministry had in the territory. Large discrepancies exist between the reported and reconstructed tuna catches. The FAO data suggest that there were zero tuna or tuna-like fish caught from 1950-1989, whereas the total tuna and tuna-like fish estimated from the reconstruction for the years of 1950-1989 represented 68% of the estimated tuna and tuna-like catch for the entire 1950-2009 study period. Also, the data supplied to FAO only represent two categories: 'tuna-like fish nei' and 'marine fish nei'. In contrast, our reconstruction accounts for 31 taxa. Furthermore, while there are no invertebrate species taken into account in the FAO data, our reconstructed estimate suggests that invertebrates represent 9.5% of the total reconstructed catch.

Since all of Tokelau's catches are subsistence and our estimates are based on consumption rates, annual catch rates are subject to fluctuations which correspond to fluctuations in the population. There is a general trend of population decline from its peak in the 1960s until present. Countering the effect of this decline is the increased transport between Tokelau and Samoa which has led to an increase in informal exports. In 1980, Tokelauans began sending frozen seafood by ship to friends and family as gifts. The decrease in dietary demand, in combination with increasing amounts being sent overseas, has resulted in a relatively constant overall trend in catches.

Fishing is an activity that almost everyone in Tokelau takes part in. Fishing occurs off-shore, on the outer reef, and in the lagoons (van Pel, 1958). Typically, it is the men who fish on the outer reef, with women and children taking part in gathering and fishing in the lagoon and on the reef (Chapman, 1987; Ono and Addison, 2009). Chapman *et al.* (2005) surveyed the atolls to obtain an estimate of the gender distribution for various fishing activities, the percentage of time using different fishing techniques, and the percentage of people on the island who take part in fishing. Of the 75% of households interviewed, 99% take part in fishing activities. An average of 12% of the fishing effort was performed by women, with most of this effort focused on reef gleaning and diving for clams. Women also participated, albeit to a lesser extent, in gillnetting and reef fishing (Chapman *et al.*, 2005). Passfield (1998) found that each household spent approximately 14 person hours per week fishing.

Although the Tokelauans have incorporated newer, modern fishing gear into their practices, there are some areas where tradition still dominates. The handmade wooden canoes are still required for handling yellowfin, skipjack, marlin, or large sharks, as well as for a traditional Tokelauan method of noosing *pāla* (*Acanthocybium solandri*) (Hooper, 1985). Many traditional fishing methods such as *lama hahave* (fishing with a scoop net and torch) and *takiulu* (luring fish into a prepared noose) are still used. Tokelauans also still use the *inati* system to distribute large catches (particularly of skipjack tuna) or catches of sacred 'fish' (turtles, marlin, and sailfish), so that everyone receives an equal share (Hooper, 1985; Ono and Addison, 2009). Use of spears and spear-guns are not a favoured form of fishing, as it is believed that they result in fish being afraid whenever people enter the water (Hooper, 1985). However, spear-guns have become more widely used in recent years (Ono and Addison, 2009). The main methods of fishing are trolling, reef gleaning, reef fishing, mid-water fishing, gillnetting, diving, bottom fishing, and bait fishing (Chapman *et al.*, 2005). Today, as well as in the past, trolling for *Katsuwonus pelamis* (skipjack tuna) and *Thunnus albacares* (yellowfin tuna) is the most important type of fishing to the Tokelauan people (Ono and Addison, 2009).

There are no commercial fisheries in Tokelau. Although it is known that a portion of the catch is used for internal island trade or shipped to friends and family as gifts, these activities are not a commercial cash enterprise. The act of selling fish is viewed as offensive by the Tokelauan people (Hooper, 1985). Traditional systems make it almost impossible to sell fish, regardless of what the individual's views are. The people of Tokelau operate under the *inati* system, which essentially requires fishers to share large catches with the entire community. This takes away the motivation and possibility of catching fish to be sold for personal financial gain (Passfield, 1998). Even if Tokelau abandoned these traditional systems, they do not have the resources to maintain a commercial fleet of their own. There are no ports for larger commercial vessels to dock and land large quantities of catch. The *MV Tokelau*, which transports goods and people to and from Tokelau, must anchor offshore and have its passengers and cargo transported to land by a low aluminum barge with an outboard motor (Townend, 2009). The atolls are closed and only have about 15 natural depressions and a few blasted channels which small vessels can pass through into the lagoon (Gillett and Toloa, 1987). Therefore, given the topography of the atolls, it would not be easy to maintain a commercial fleet for Tokelau. In 1980, the United Nations Development Programme (UNDP) attempted to develop the Tokelauan fishing industry by giving each atoll a 29-foot catamaran which would be used to start a small artisanal fishery or to simply help increase their current subsistence efforts (Hooper, 1985). However, use of the catamarans required a large amount of village cooperation and this was difficult to organize with a large proportion of the population working in the public service sector (Hooper, 1985). The catamarans also have high operating costs (e.g., fuel and maintenance) which would require fish to be sold to recoup costs, which is something the Tokelauans frown upon (Hooper, 1985). Thus, the catamarans ended up being used for shipping people and goods across the lagoon (Hooper, 1985). Another reason that commercial fishing would not be profitable in Tokelau is that fishing beyond the subsistence level would possibly put too much pressure on the already limited fish stocks which would likely be detrimental to resource levels (van Pel, 1958; Passfield, 1998).

Overall it appears that there is little threat of overfishing in Tokelau. This can be attributed to the Tokelauans methods and views toward fishing. The Tokelauans are very aware of what is available in their waters and thus know what they can and cannot take. As well, appropriate measures would be taken if any declines were in fact observed (Hooper, 1985). The Tokelauans rely heavily on the fish, and know if overfished they will not have anything to eat for the next week, month, or year. Giant clams on the other hand, may be in jeopardy. According to an early report by van Pel (1958), *Tridacna gigas* were relatively abundant in the early period, whereas later on there is no mention of them. However, later reports mention two other clam species: *Tridacna squamosa* and *Tridacna maxima* (Passfield, 1998). According

to Hooper (1985), giant clams were regarded as an emergency resource that were only harvested when severe weather conditions prevented the catch of other fish. However, around 1980, the Tokelauans made use of the commercial freezers given to them by the UNDP and would load them up with frozen giant clams to be sent to friends and family in Western Samoa as gifts (Hooper, 1985). This occurred only a few times a year based on the shipping schedule (Hooper, 1985). Although this may have put pressure on stocks, it seems that the Tokelauans only had to change their technique and dive a little deeper if they wished to continue harvesting (Hooper, 1985). In a more recent study, there is mention of frequent harvesting of *T. squamosa* and *T. maxima*. However, it also stated that on Atafu there have been strict limitations put in place on the harvesting of these clams (Ono and Addison, 2009). Therefore, it seems that concern over these stocks has resulted in measures being put in place to prevent overharvesting.

Although there have not been many studies conducted on the fishing activities of Tokelau, it can be seen from the data that has been collected that even something as simple as a household survey once every five years could provide important information (Zeller *et al.*, 2006; Gillett, 2009). Although creel surveys (i.e., interviews with fishers and surveillance of their catch) are too costly for small countries to complete every year, a survey completed once every five years would provide important data which could be interpolated between collection years (Zeller *et al.*, 2007). If data were collected on the eating habits of Tokelauans, how much they export and import, how much of their seafood consumption is fresh, what types of fish they are catching, or what kind of gear they are using, this could be used to derive more comprehensive estimates of their annual catches (Zeller *et al.*, 2007). Regional (e.g., SPC) and international agencies (e.g., FAO) should consider facilitating and establishing such data collection and utilization approaches, and the required technical and financial resources. For a small island country such as Tokelau, where people rely on the ocean for their sustenance, monitoring of fisheries removals is fundamental to maintaining national food security.

ACKNOWLEDGMENTS

We acknowledge the support of the *Sea Around Us* Project, a scientific collaboration between the University of British Columbia and the Pew Environment Group.

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Appendix Table A1: FAO landings vs. total reconstructed catch (in tonnes) for Tokelau, 1950-2009.

Year	FAO landings	Reconstructed catch
1950	0.25	384.0
1951	0.25	408.5
1952	0.25	407.3
1953	0.25	406.1
1954	0.25	430.3
1955	0.25	429.1
1956	0.50	427.8
1957	0.25	451.7
1958	0.25	450.4
1959	0.25	449.1
1960	0.25	472.7
1961	0.25	471.3
1962	0.25	470.0
1963	0.25	468.6
1964	0.25	467.2
1965	0.25	465.8
1966	0.25	464.5
1967	0.25	463.1
1968	0.25	461.7
1969	0.25	411.9
1970	100.00	410.7
1971	100.00	409.4
1972	100.00	384.2
1973	100.00	383.0
1974	100.00	381.9
1975	100.00	380.7
1976	100.00	379.6
1977	100.00	378.4
1978	100.00	377.3
1979	100.00	376.1
1980	100.00	375.8
1981	100.00	379.3
1982	100.00	382.7
1983	100.00	386.2
1984	150.00	389.8
1985	150.00	393.1
1986	150.00	396.5
1987	200.00	391.5
1988	200.00	386.5
1989	200.00	381.6
1990	220.00	376.7
1991	231.00	371.8
1992	191.00	416.5
1993	200.00	393.6
1994	200.00	370.8
1995	200.00	358.0
1996	200.00	345.0
1997	200.00	345.3
1998	200.00	346.0
1999	200.00	357.8
2000	160.00	369.6
2001	150.00	388.8
2002	140.00	396.9
2003	130.00	405.0
2004	120.00	412.8
2005	110.00	420.9
2006	100.00	429.0
2007	90.00	376.7
2008	80.00	388.3
2009	70.00	399.6

Appendix Table A2: Total reconstructed catch (in tonnes) for Tokelau (1950-2009) by major taxa. Others grouping includes 24 taxa.

Year	*Cypselurus* spp.	Scaridae	*Selar crumenophthalmus*	Other Carangidae	*Thunnus albacares*	*Thunnus obesus*	*Acanthocybium solandri*	Others
1950	70.1	41.9	28.2	27.9	28.3	28.3	23.0	136.3
1951	74.5	44.5	30.0	29.7	30.1	30.1	24.5	145.0
1952	74.3	44.4	29.9	29.6	30.0	30.0	24.4	144.6
1953	74.1	44.3	29.8	29.5	29.9	29.9	24.4	144.2
1954	78.5	46.9	31.6	31.3	31.7	31.7	25.8	152.8
1955	78.3	46.8	31.5	31.2	31.6	31.6	25.7	152.3
1956	78.1	46.7	31.4	31.1	31.5	31.5	25.7	151.9
1957	82.4	49.3	33.1	32.8	33.3	33.3	27.1	160.4
1958	82.2	49.1	33.0	32.8	33.2	33.2	27.0	159.9
1959	81.9	49.0	33.0	32.7	33.1	33.1	26.9	159.4
1960	86.2	51.6	34.7	34.4	34.8	34.8	28.4	167.8
1961	86.0	51.4	34.6	34.3	34.7	34.7	28.3	167.3
1962	85.7	51.3	34.5	34.2	34.6	34.6	28.2	166.8
1963	85.5	51.1	34.4	34.1	34.5	34.5	28.1	166.4
1964	85.2	51.0	34.3	34.0	34.4	34.4	28.0	165.9
1965	85.0	50.8	34.2	33.9	34.3	34.3	28.0	165.4
1966	84.7	50.7	34.1	33.8	34.2	34.2	27.9	164.9
1967	84.5	50.5	34.0	33.7	34.1	34.1	27.8	164.4
1968	84.2	50.4	33.9	33.6	34.0	34.0	27.7	163.9
1969	75.1	44.9	30.2	29.9	30.4	30.4	24.7	146.2
1970	74.9	44.8	30.1	29.9	30.3	30.3	24.6	145.8
1971	74.7	44.7	30.0	29.8	30.2	30.2	24.6	145.4
1972	70.1	41.9	28.2	27.9	28.3	28.3	23.1	136.4
1973	69.9	41.8	28.1	27.9	28.2	28.2	23.0	136.0
1974	69.7	41.7	28.0	27.8	28.1	28.1	22.9	135.6
1975	69.5	41.5	27.9	27.7	28.1	28.1	22.8	135.2
1976	69.2	41.4	27.8	27.6	28.0	28.0	22.8	134.8
1977	69.0	41.3	27.8	27.5	27.9	27.9	22.7	134.3
1978	68.8	41.1	27.7	27.4	27.8	27.8	22.6	133.9
1979	68.6	41.0	27.6	27.3	27.7	27.7	22.6	133.5
1980	68.6	41.0	27.6	27.3	27.7	27.7	22.5	133.4
1981	69.2	41.4	27.8	27.6	27.2	27.2	22.2	136.8
1982	69.8	41.7	28.1	27.8	26.7	26.7	21.7	140.1
1983	70.5	42.1	28.3	28.1	26.2	26.2	21.3	143.5
1984	71.1	42.5	28.6	28.4	25.7	25.7	20.9	147.0
1985	71.7	42.9	28.8	28.6	25.1	25.1	20.4	150.4
1986	72.3	43.3	29.1	28.8	24.6	24.6	20.0	153.9
1987	71.4	42.7	28.7	28.5	24.3	24.3	19.7	151.9
1988	70.5	42.2	28.3	28.1	23.9	23.9	19.5	150.0
1989	69.6	41.6	28.0	27.8	23.6	23.6	19.2	148.1
1990	68.7	41.1	27.6	27.4	23.3	23.3	19.0	146.2
1991	67.8	40.6	27.3	27.0	23.0	23.0	18.7	144.3
1992	76.0	45.5	30.5	30.3	25.8	25.8	21.0	161.6
1993	71.8	42.9	28.9	28.6	24.4	24.4	19.8	152.7
1994	67.7	40.5	27.2	27.0	23.0	23.0	18.7	143.9
1995	65.3	39.1	26.2	26.0	22.2	22.2	18.1	138.9
1996	62.9	37.6	25.3	25.1	21.4	21.4	17.4	133.9
1997	63.0	37.7	25.3	25.1	21.4	21.4	17.4	134.0
1998	63.1	37.8	25.4	25.2	21.4	21.4	17.4	134.3
1999	65.3	39.0	26.2	26.0	22.2	22.2	18.0	138.8
2000	67.4	40.3	27.1	26.9	22.9	22.9	18.6	143.4
2001	70.9	42.4	28.5	28.3	24.1	24.1	19.6	150.9
2002	72.4	43.3	29.1	28.9	24.6	24.6	20.0	154.0
2003	73.9	44.2	29.7	29.5	25.1	25.1	20.4	157.1
2004	75.3	45.1	30.3	30.0	25.6	25.6	20.8	160.2
2005	76.8	45.9	30.9	30.6	26.1	26.1	21.2	163.3
2006	78.3	46.8	31.5	31.2	26.6	26.6	21.6	166.5
2007	68.7	41.1	27.6	27.4	23.3	23.3	19.0	146.2
2008	70.8	42.4	28.5	28.2	24.0	24.0	19.6	150.7
2009	72.9	43.6	29.3	29.1	24.8	24.8	20.2	155.1