

RECONSTRUCTION OF TOTAL MARINE FISHERIES CATCHES FOR THE REPUBLIC OF VANUATU, 1950-2010¹

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ABSTRACT

Vanuatu is an archipelago with one of the lowest per capita consumption rates of seafood among the South Pacific islands. Despite this fact, seafood is still an important contributor to the Ni-Vanuatu diet and economy. The reconstruction of total marine fisheries catch of Vanuatu showed that the reconstructed total catches of 886,700 t were 9.5% higher than the 810,021 t reported by the FAO on behalf of Vanuatu for the period 1950-2010. However, if only small-scale catches are considered (i.e., large-scale tuna and shark fisheries are excluded), it is estimated that reconstructed catches (164,100 t) are 64% higher than the 99,842 t reported catches assumed to represent the small-scale sector. The subsistence sector was found to be most important amongst small-scale fisheries with almost 84% of the small-scale catches. Exports were estimated to contribute 4.1% to the small-scale catch and tourist consumption 1.7%.

INTRODUCTION

The Republic of Vanuatu (referred to hereafter as Vanuatu) is an archipelagic country consisting of 83 islands (63 permanently inhabited) in the southwestern Pacific Ocean between 13°-21°S and 166°-171°E (Figure 1). Neighboring countries include New Caledonia to the southwest, Fiji to the east and Solomon Islands to the northwest. Vanuatu comprises a land area of over 12,000 km² (Anon. 2011), with an Exclusive Economic Zone (EEZ) of over 827,000 km², mostly located in the Food and Agriculture Organization (FAO) statistical area 71 (www.seaaroundus.org). The area of the EEZ includes the waters surrounding Matthew and Hunter islands. Vanuatu's claim to these islands and the water surrounding them is disputed by France (Amos 2007). We include the area here as it is the stated policy of the government of Vanuatu that their EEZ includes these waters.

During colonial times, this archipelagic country was called New Hebrides and was governed jointly by the United Kingdom and France through a British-French condominium (i.e., both nations have equal rights over the territory) since 1906. As a result of an independence effort in the 1970s, the country became the Republic of Vanuatu in 1980 (Amos 2007).

Vanuatu has limited inshore waters, with only narrow fringing reefs (Aylesworth and Campbell 2009). The reefs drop off rapidly and thus deep ocean waters lie close to the coast (David and Cillaurren 1988). The islands are located in the hurricane belt making travel between islands dangerous at times (van Pel 1956).

In the 1950s, the more urban business centers, such as Port Vila and Luganville, were already in short supply of fish (van Pel 1956). However, beef cattle were plentiful on the plantations and provided an alternative source of animal protein (van Pel 1956). There were many large commercial plantations which had a high demand for laborers, leaving no shortage of work for the Ni-Vanuatu (people of Vanuatu). Other, more dangerous ventures, such as fishing, which provided little more pay, did not offer much incentive (van Pel 1956). Personal gardens which provided fresh vegetables were also popular, and they also required time to maintain (van Pel 1956). Ni-Vanuatu who did fish in some capacity were most likely also taking part in farming or other work. Fishing was not realistically a full-time occupation. That being said, a 1983 survey of the small-scale fishing sector showed that

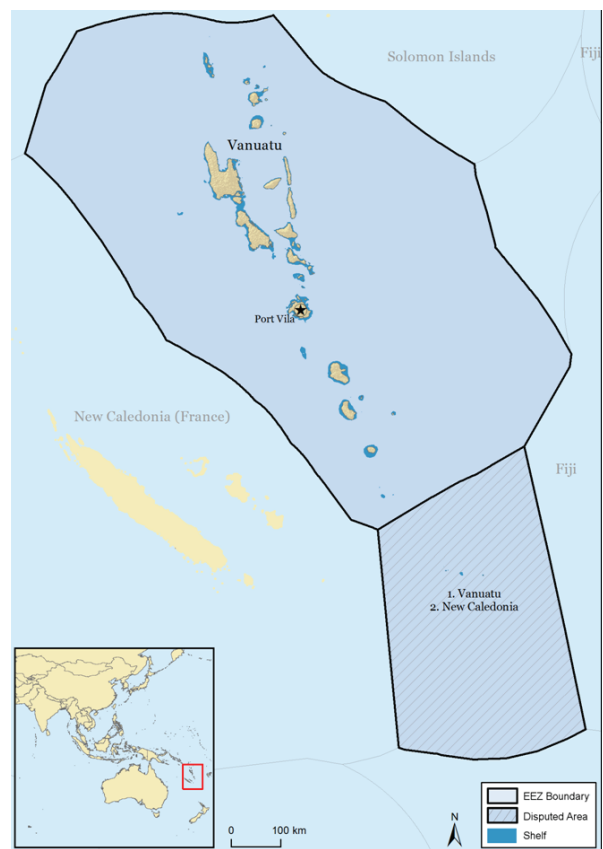


Figure 1. Vanuatu Exclusive Economic Zone (EEZ) and shelf waters to 200 m depth.

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fishing was more important to local economies than what was popularly believed (David and Cillaurren 1988). Another study carried out over the course of 1993-2001 on marine resource management in Vanuatu stated that within the 21 villages studied, 67% of the households participated in subsistence fishing and 23% sell some of their catch (Johannes and Hickey 2004). This study also illustrated the presence of customary marine tenure in Vanuatu, which means that “rights to the coastal waters contiguous to traditional land holdings usually extend to the clans, chiefs or villages that own the land” (Johannes and Hickey 2004, p. 17). These rights can be allocated amongst individual families within the clans and villages as well. Fishing is carried out with either the traditional outrigger canoe (majority) or outboard motorboats (David and Cillaurren 1988). Fishing with explosives has been a problem in the past and has caused damage to the reefs (van Pel 1956).

In 2009, the majority of the population was involved in the agriculture sector (ADB 2009). Subsistence fishing is second to agriculture in terms of a food source (Aylesworth and Campbell 2009). Vanuatu’s economy is dominated by agriculture and tourism. Copra is an important export item, as well as timber, beef, cocoa and kava (Friedman *et al.* 2008). Subsistence fisheries are important to local economies, both in terms of food security and income. Here, we reconstructed the total marine fisheries catches for Vanuatu using the approach outlined in (Zeller *et al.* 2007).

METHODS

The total marine fisheries catches of Vanuatu were estimated using population data, derived seafood consumption rates, and information from the grey literature. All sectors of Vanuatu’s marine fishery were estimated including subsistence, artisanal, recreational, tourist consumption, and exports. Industrial catches were also estimated, although these catches were deemed to be not truly domestic (i.e., dominated by foreign beneficial ownership).

Domestic seafood consumption

In order to calculate annual domestic seafood consumption by the Ni-Vanuatu, human population data were required for the entire time period. Data for the years 1960-2010 were acquired from the World Bank database.² Prior to 1960, data were obtained from the historical demography website Populstat (www.populstat.info). This gave a complete time series of population data for Vanuatu (Figure 2). Consumption rates were determined by using anchor points of small-scale annual catch and dividing by the population for that year to obtain a catch derived consumption rate. Gillett (2009) provided estimates for the 2007 coastal commercial (artisanal) and subsistence catches. Combining these and dividing by the population for that year (222,377) gave an approximate domestic *per capita* catch of 15 kg·person⁻¹·year⁻¹. This value is carried forward unaltered to 2010. A second anchor point was derived from a 1983 subsistence survey which also included what we would consider the artisanal sector (David and Cillaurren 1988, 1992). Within these reports, there are several different totals and subtotals of the small-scale catch and in some cases freshwater species are also included. Gillett (2009) also mentions this study and quotes that it gave an annual production by village fisheries from near-shore habitats as 2,849 t. As this value falls in the middle of the various quotes given by the two papers, we accept this value as an average estimate of the small-scale catch for 1983. Combined with the population, a consumption rate of 22.9 kg·person⁻¹·year⁻¹ is derived as the second anchor point. The *per capita* catch rate was interpolated between 1983 (22.9 kg) and 2007 (15 kg), and the rate of decrease was carried forward to 2010. For the early time period, an assumed *per capita* catch rate was derived from information regarding consumed imports. Information was available on fish imports for 1950-1955 (van Pel 1956) as well as 1984 (David and Cillaurren 1992). Taking the average of the *per capita* rate of imports for 1950-1955 and comparing it to the rate in 1984 showed that Ni-Vanuatu were consuming approximately 5 kg·person⁻¹·year⁻¹ more canned fish in 1984 than in the early 1950s. Therefore, we assumed that the *per capita* consumption rate of fresh seafood in 1950 was 5 kg greater than in 1984 to account for this missing component of their diet, giving an assumed 1950 rate of 27.5 kg·person⁻¹·year⁻¹. It should be noted that we did not convert the canned weight of the imports

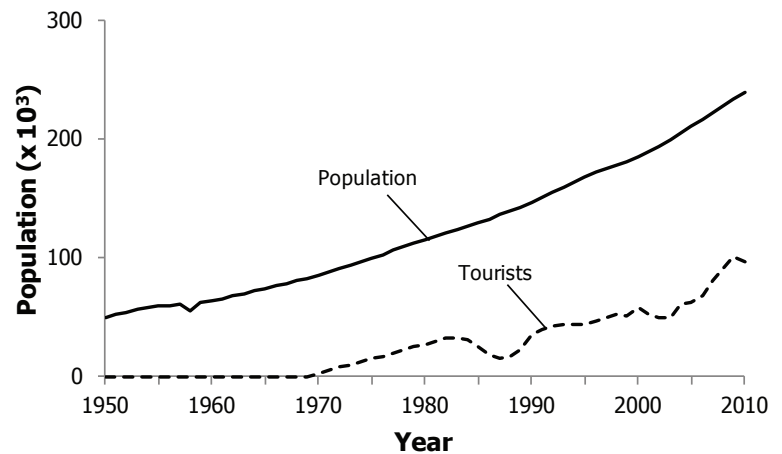


Figure 2. Total human population of Vanuatu and tourist population, 1950-2010.

Table 1. Aggregated taxonomic groupings split anchor points (%) for the artisanal and subsistence sectors.

| Taxonomic group | Artisanal | | | Subsistence | | |
|---------------------|-----------|------|------|-------------|------|------|
| | 1950-1970 | 1983 | 2010 | 1950-1970 | 1983 | 2010 |
| Deep-water fish | 0.0 | 21.3 | 26.8 | 0.0 | 23.9 | 9.1 |
| Shallow-water fish | 24.6 | 19.4 | 13.4 | 20.0 | 15.3 | 45.5 |
| Octopus | 2.3 | 1.8 | 1.8 | 3.9 | 2.9 | 9.1 |
| Lobsters | 55.2 | 43.4 | 26.8 | 16.8 | 12.8 | 4.5 |
| Marine shellfish | 11.8 | 9.3 | 4.4 | 53.0 | 40.3 | 27.3 |
| Tuna/tuna-like fish | 6.1 | 4.8 | 26.8 | 6.3 | 4.8 | 4.5 |

² <http://data.worldbank.org/country/vanuatu> [accessed September 25, 2012]

into the whole fish weight equivalent. However, this allowed us to be conservative in our estimate and so we accepted the values as they were. Interpolation was done between the 1950 rate (27.5 kg·person⁻¹·year⁻¹) and the 1983 anchor point (22.9 kg·person⁻¹·year⁻¹).

Reports indicated that in the 1950s, small-scale fishing activities were mainly geared toward meeting subsistence needs (van Pel 1956). As well, due to the high demand of laborers for agriculture on land, there was little incentive to take on the more dangerous work of fishing out at sea (van Pel 1956). It was therefore assumed that 95% of the catch for domestic consumption came from the subsistence sector and the other 5% was artisanal in 1950. The 2007 anchor point for the consumption rate was derived from Gillett's (2009) catch estimates, which were given separately for the subsistence and artisanal sectors. Therefore, the proportions of these estimates were used as a second anchor point with 85% subsistence catches and 15% artisanal catches. Proportions were interpolated between 1950 and 2007. The 2007 anchor points were carried forward unaltered to 2010.

Species breakdown

In order to determine the species breakdown of the small-scale sectors, a survey from 1983 (David and Cillaurren 1988) was used to split the catch of both the subsistence and artisanal sectors into larger species groupings. Each sector was initially divided into catches of tuna/tuna-like fish, deep-water fish, shallow-water fish, octopus, lobsters, and marine shellfish (Table 1). The 1983 survey also included a listing for freshwater prawns and these catches were excluded from the calculation as this reconstruction focuses only on marine catches. The survey did not include a tuna/tuna-like fish category; however due to information supplied by a Vanuatu fishery resource profile (Amos 2007), it was known that tuna are caught by the small-scale fleet and thus an assumption was made to include this category in the breakdown. Re-normalized percentages from the 1983 survey (David and Cillaurren 1988) with the tuna category included were used as the first anchor points of the breakdown. As it was known that the deep-water fishery began in the early 1970s (Amos 2007), from 1950-1970 deep-water fish catches were set to zero with the percentages from 1983 of all other categories re-normalized to 100%.

Linear interpolation was done between the 1970 and 1983 values. Given information regarding the current fishing status of the different groups (Amos 2007), assumptions were made to create a percentage breakdown for 2010. Linear interpolation was utilized between the 1983 and 2010 values for each group. Each of these larger taxonomic groups was broken down further with the same breakdown being used for both the artisanal and subsistence sectors (see Tables 2-6). The breakdown for the deep-water fish was based on a three year average of the composition of species recorded as landings at the Fisheries Extension Centres from 1990-1992 (Amos 2007; Table 2). Information regarding the composition of the shallow-water fish catch was obtained from a SPC report (Pratchett *et al.* 2011). The percentage breakdown was given by family. In some cases families were disaggregated into known species (Amos 2007) and the 'others' category was further broken down into three additional families which are known to occur in Vanuatu waters and a miscellaneous marine fish category. These values were used as anchor points in 2010. Based on general knowledge of the species present (Amos 2007), assumptions were made as to how the composition might have differed in 1950. Linear interpolation was done between the estimated anchor points in 1950 and the percentages in 2010 (Table 3). Very little information on octopus catches in Vanuatu was available. All octopus catches were simply labeled as *Octopus* spp. Lobsters were disaggregated into four species, based on information from Amos (2007), whose proportions remained constant over the entire time period (Table 4). The marine shellfish category was also further broken down using information from Pratchett *et al.* (2011). A species composition for invertebrate catches in Vanuatu was available. Sea cucumbers and trochus were excluded from the composition as these are estimated separately in the reconstruction as export items. Octopus, spiny lobsters, and crustaceans were also excluded as these have been calculated separately as well. The relative proportions of giant clams, gastropods, and bivalves were then used to inform an assumed species breakdown of the marine shellfish

Table 2. Taxonomic breakdown of the deep-water fish category of both the artisanal and subsistence sectors, 1950-2010.

| Species | Percentage |
|------------------------------------|------------|
| <i>Etelis carbunculus</i> | 15.8 |
| <i>Etelis coruscans</i> | 17.3 |
| <i>Etelis radiosus</i> | 2.7 |
| <i>Pristipomoides multidentis</i> | 5.1 |
| <i>Pristipomoides flavipinnis</i> | 2.0 |
| <i>Pristipomoides filamentosus</i> | 30.6 |
| <i>Lutjanus malabaricus</i> | 13.4 |
| <i>Aphareus rutilans</i> | 1.2 |
| <i>Epinephelus magniscuttis</i> | 3.8 |
| <i>Epinephelus morrhua</i> | 1.9 |
| <i>Epinephelus septemfasciatus</i> | 1.9 |
| <i>Seriola rivoliana</i> | 4.3 |

Table 3. Taxonomic breakdown of the shallow-water fish category of both the artisanal and subsistence sectors. Linear interpolation done between anchor points.

| Taxon name | 1950 (%) | 2010 (%) |
|----------------------------|----------|----------|
| Acanthuridae | 3.0 | 3.0 |
| <i>Naso lituratus</i> | 2.5 | 3.0 |
| <i>Acanthurus lineatus</i> | 2.5 | 3.0 |
| Kyphosidae | 3.0 | 4.4 |
| Serranidae | 6.0 | 0.7 |
| <i>Epinephelus merra</i> | 3.0 | 0.3 |
| <i>Variola louti</i> | 3.0 | 0.3 |
| Scaridae | 4.0 | 12.1 |
| Labridae | 2.0 | 0.0 |
| <i>Cheilinus undulatus</i> | 1.0 | 0.0 |
| Haemulidae | 5.0 | 6.0 |
| Lethrinidae | 6.0 | 8.8 |
| <i>Lethrinus harak</i> | 3.0 | 4.5 |
| <i>Lethrinus miniatus</i> | 3.0 | 4.5 |
| Lutjanidae | 6.0 | 0.5 |
| <i>Lutjanus fulvus</i> | 3.0 | 0.2 |
| <i>Lutjanus gibbus</i> | 3.0 | 0.2 |
| Siganidae | 8.0 | 13.3 |
| Carangidae | 8.0 | 10.0 |
| Mugilidae | 5.0 | 6.0 |
| Holocentridae | 1.0 | 1.2 |
| Mullidae | 8.0 | 7.6 |
| Balistidae | 3.0 | 4.5 |
| Miscellaneous marine fish | 8.0 | 5.9 |

Table 4. Taxonomic breakdown of the lobster category of both the artisanal and subsistence sectors, 1950-2010.

| Species | Percentage |
|-------------------------------|------------|
| <i>Panulirus penicillatus</i> | 60 |
| <i>Panulirus versicolor</i> | 15 |
| <i>Panulirus longipes</i> | 15 |
| <i>Parribacus caledonicus</i> | 10 |

category for 1950 and 2010 (Table 5). Linear interpolation was done between these two points. Finally, the tuna/tuna-like category was further disaggregated based on the relative proportions of the tuna and tuna-like species present in an account of artisanal production in 2004 (Amos 2007; Table 6).

It should be noted that upon comparison of the reconstructed catch with the FAO data, it was found that within the reconstruction the estimated amount of crustaceans was less than that reported by the FAO in two years (1984 and 1985). It is possible that our reconstruction underestimates the catch of crustaceans in these years. However, as these two years correspond to a spike in crustacean catches, we accepted our reconstructed values.

Recreational

Vanuatu is a well known game fishing location and hosts numerous game fishing tournaments, including the Vanuatu Marlin Classic and the Blue Marlin World Cup (Gentner 2009). Recreational fishing is not only limited to tournaments though. Hotels and resorts also hire boats to take guests out fishing and charter boats are available for hire to take tourists out on the water. Data on total number of boats used for recreational purposes was inconsistent across sources. Also, catch rates for smaller boats operating out of resorts were not available. However, it is known that when charter boats take people out for fishing, the boat retains all fish caught and then sells these to hotels, resorts, or restaurants, thus partially supplying fish for the tourist consumption demand. A catch rate of 48–64 t caught annually by the charter fleet was given for 2008 (Gay 2008). Taking the average gives an anchor point of 56 t in 2008. Chapman (2004) stated that charter fishing vessels began operating out of Port Vila in the late 1980s. We assumed that the very first charter fishing vessels began operating in 1980 and set the catch to zero t in 1979. Interpolation was done between the zero anchor point and the point of 56 t in 2008. The rate of increase in catch was carried forward to 2010.

No detailed information regarding species composition of recreational catches was readily available. However, it is known that recreational catches mainly consist of billfishes and tuna-like fishes. Thus an assumed composition of 90% family Istiophoridae and 10% family Scombridae was applied.

Tourist seafood consumption

Tourism is an important part of the Vanuatu economy (Gentner 2009). As an island nation, part of the attraction is the promise of fresh local seafood. In order to calculate the contribution of tourist consumption to the marine fisheries take of Vanuatu, we combined tourist stop-over numbers with tourist seafood consumption rates. The numbers of tourists visiting Vanuatu were available for the periods of 1982–1992³ and 1995–2010.⁴ Interpolation was done between the data points in 1992 and 1995. No information regarding when tourism began in Vanuatu was readily available, but it was known that tourist arrivals reached a peak in 1982/83. Therefore, we made an assumption that the tourist sector built up from a starting point in 1970. Interpolation was done between zero in 1969 and the first anchor point of 32,180 tourist in 1982. The decrease in tourist population from 1984–1987 was due to the disruption of air services, multiple cyclones hitting the islands, and fear of political instability (Figure 2).² Tourism had recovered by 1989 and continued to increase from there. The average length of stay of a tourist in 1992 was said to be 9 days, but on average through the years the majority of tourists stay one week or less.⁵ Therefore, to be conservative, we set the length of stay of a tourist at 7 days for the whole time period. Information regarding consumption amount and frequency was not readily available for the tourist population of Vanuatu. As a proxy, we used information on tourist consumption in the Caribbean. Adams (1992) estimated 250 grams per serving consumed by tourists in several Caribbean Islands. Combined with an assumed 1 serving per day and a stay of 7 days, this gives an estimated 1.75 kg-tourist⁻¹.year⁻¹. This derived consumption rate combined with the time series of tourist numbers gives the total catch supplying tourist demand.

Due to the fact that charter vessels sell their catch to the restaurants and hotels, the recreational catch counts towards the tourist seafood consumption supply. The total calculated tourist seafood consumption minus the recreational catch equals the remaining tourist demand which is supplied by artisanal catches. Therefore, catches supplying tourist consumption appear in both the recreational and artisanal sector. Information regarding the species composition of catches supplying the tourist demand from the artisanal sector was not available. Therefore, an assumed composition of 10% lobster, 50% serranids, 20% lutjanids and 20% lehrinids was applied. Billfishes and tuna-like fishes are already accounted for in the recreational catch which also supplies the tourist demand.

Table 5. Taxonomic breakdown of the tuna/tuna-like category of both the artisanal and subsistence sectors, 1950–2010.

| Common name | Scientific name | Percentage |
|----------------|-------------------------------|------------|
| Yellowfin tuna | <i>Thunnus albacares</i> | 44.0 |
| Skipjack tuna | <i>Katsuwonus pelamis</i> | 42.0 |
| Wahoo | <i>Acanthocybium solandri</i> | 8.0 |
| Dogtooth tuna | <i>Gymnosarda unicolor</i> | 2.5 |
| Rainbow runner | <i>Elagatis bipinnulata</i> | 1.5 |
| Marlin | Istiophoridae | 1.0 |
| Mahi mahi | <i>Coryphaena hippurus</i> | 1.0 |

Table 6. Taxonomic breakdown of the marine shellfish category of both the artisanal and subsistence sectors. Linear interpolation used between anchor points.

| Taxon group | 1950 (%) | 2010 (%) |
|-------------------------------------|----------|----------|
| Giant clams (<i>Tridacna</i> spp.) | 20 | 10 |
| Gastropods (Gastropoda) | 40 | 60 |
| Other bivalves (Bivalvia) | 40 | 30 |

³ http://www.unescap.org/ttdw/Publications/TPTS_pubs/Pub_1427/Pub_1427_ch3.pdf [accessed September 25, 2012]

⁴ <http://data.worldbank.org/country/vanuatu> [accessed September 25, 2012]

⁵ http://www.unescap.org/ttdw/Publications/TPTS_pubs/Pub_1427/Pub_1427_ch4.pdf [accessed September 25, 2012]

Exports

The export fisheries for trochus and sea cucumber are also considered part of the artisanal sector. These exports combined with the artisanal portions of both the domestically consumed catch and the tourist consumed catch, will equate to the total artisanal catch. Shark fin exports are considered industrial.

Trochus

Trochus shell is an important export of Vanuatu. Due to the fact that the main purpose of collecting trochus shells is to export the shells, and that consumption of the meat is a secondary utilization (van Pel 1956), this fishery is calculated separately of domestic consumption and is considered all artisanal. Trochus is reported in the FAO data starting in 1985. Reported values from the FAO were accepted for the years 1985-2010. Prior to that, export values of trochus were available for 1950-1958 (van Pel 1956; Devambeze 1959) and 1969-1982 (Bour and Grandperrin 1985). Reports indicated that the trochus fishery closed near the beginning of the year in 1958 and reopened in 1962 (Anon. 1997). Therefore, exports were set to zero from 1959-1961 and then the catch was interpolated from zero in 1961 to the next anchor point of 2 t in 1969. Interpolation was also performed from 50 t in 1982 to 75 t in 1985.

Sea cucumber

Sea cucumber is exported as *bêche-de-mer*, a popular food item in Asian markets. Sea cucumbers did not appear in the FAO data until 1983. Although there is qualitative information to suggest that the sea cucumber fishery began earlier than this, additional estimates were not made. Given the unpredictable and boom and bust nature of such a fishery, we accept the FAO data as is in order to be conservative.

Large-scale commercial

Tuna fishery

Tuna and tuna-like catches within the FAO⁶ reported data are attributed to the large-scale commercial sector. This large-scale commercial sector is mostly made up of foreign vessels that are flagged as Vanuatu. Whether these vessels are joint ventures or flags of convenience is not quite clear. There are some specific records of joint ventures. Korean purse seiners which were managed under a joint venture were flagged as Vanuatu vessels, and began operating in the mid-1990s (Amos 2007). This is the time when purse seine catches first appear in the Western and Central Pacific Fisheries Commission (WCPFC) data for Vanuatu. There is also a record of Vanuatu-flagged vessels that are chartered to Papua New Guinea (PNG) companies and fish in PNG waters. It has been indicated that these catches have been attributed to both Vanuatu and PNG in terms of accounting. Regardless, the Government of Vanuatu's website clearly states that offshore commercial fishing is dominated by foreign vessels.⁷ Furthermore, it is stated that all tuna caught in local waters is delivered to American Samoa, Fiji, or Papua New Guinea.⁵ Even if a vessel is owned and operated by Ni-Vanuatu, the catch does not contribute to the Ni-Vanuatu domestic food supply. Therefore, large-scale commercial catches are analyzed separately from the small-scale sectors.

Upon comparison of FAO tuna and other large pelagic data (albacore, bigeye, skipjack, yellowfin, 'tuna-like fishes nei', black marlin, blue marlin, striped marlin, and swordfish), Forum Fisheries Agency (FFA) data, and WCPFC data, it was found that all sources matched. We therefore accepted the FAO tonnage as is. FFA and WCPFC data were used to give greater species, spatial and gear disaggregation to the FAO data. Proportions of tuna spatial disaggregation were also used to spatially assign associated by-catch.

Shark fins

Shark fins have also been an export item in Vanuatu, although exports in the recent time period have decreased substantially. Records of shark fin exports in dry weight were found for the years 1980-1986 and 2001-2004 (Amos 2007). An assumption was made that exports were zero in 1970 and linearly interpolated to the first anchor point of dry fin weight in 1980 of 10.7 t. Note that a complete time series of dry weight of fin exports was calculated first, and then converted into wet round weight. Interpolation was also done between the anchor point of 5 t in 1986 and 12 kg in 2001. The export quantity of 15 kg in 2004 was carried forward unaltered to 2010. The time series of dry fin weight exports was converted to wet fin weight using an average conversion factor of 43% (i.e., dry fins equate to 43% of the mass of wet fins) and then converted to wet round weight using an average conversion factor of wet fin weight equates to 3% of wet round weight (Biery 2012; Biery and Pauly 2012). It was assumed that the carcass weight (difference between wet fin weight and wet round weight) was completely discarded. Although it is known that the Ni-Vanuatu do consume shark meat, the majority of these sharks were caught by the South Pacific Fishing Company (Amos 2007) which is a large-scale commercial fleet as opposed to the small-scale commercial artisanal fleet which

⁶ FAO data was extracted using FishStatJ software (<http://www.fao.org/fishery/statistics/software/fishstatj/en>). When this study was first started, the global dataset on capture production was available from 1950 to 2010 (2010 version). This dataset has since been updated in March 2013; using the 2011 version. Although the catch of some tuna species has been updated since 1994 in the new FAO dataset (2011 version), this report uses the 2010 version. However, the database will be updated in the future to reflect the new dataset.

⁷ <http://www.governmentofvanuatu.gov.vu/index.php/government/agriculture> [accessed November 6, 2012]

would provide Ni-Vanuatu with shark meat for consumption. For the few years where tonnage of shark meat sold at the fish markets is available, the tonnage sold compared to the amount of carcass meat available from the finned sharks is insignificant. Although specific information regarding the taxonomic composition of the shark catches for the shark fin trade were not available, it was found that sharks of the family Carcharhinidae were fairly prominent in the waters of Vanuatu (Fourmanoir and Laboute 1976), and therefore an assumed composition of 70% Carcharhinidae and 30% Squalidae was used. Note that although there are more specific wet fin weight to wet round weight conversion factors for these two shark families (Biery 2012), the average conversion factor was used as it gave a more conservative estimate.

RESULTS AND DISCUSSION

The reconstructed total catch for Vanuatu was estimated to be 886,750 t over the 1950–2010 time period. This is 9.5% higher than the 810,021 t of landings reported by the FAO on behalf of Vanuatu (Figure 3). Of the total reconstructed catch, the industrial sector constitutes 81.5%, artisanal 2.9%, subsistence 15.5% and recreational 0.1%. The industrial sector increased from 200 t in 1950 to 2,100 t in 1984. After a slight decrease to the mid-1990s, catches increased rapidly to a peak of 46,000 t in 1999. Catches declined after that to a low of 12,000 t in 2001 before rising back up to another peak of almost 88,000 t in 2005. Catches followed a declining trend after that with only 39,500 t caught in 2010. Discards in the industrial shark fishery equated to almost 2% of the total industrial catch (12,000 t). Industrial catches may be taken from within Vanuatu's EEZ, within another countries' EEZ, or from the high seas. It was estimated that only 3.5% of the total industrial catch is taken from within Vanuatu's EEZ. In addition to the fact that the majority of industrial catches are taken from outside the EEZ, these industrial catches do not directly benefit the Ni-Vanuatu and their seafood consumption and the magnitude of these catches over-shadow the results of the small-scale sector.

Thus, if we look only at the small-scale catches, we see that reconstructed total catches are estimated at 164,100 t which is 64% higher than the catches reported to FAO (99,800 t) which are deemed to be the small-scale reported baseline (Figure 4a). Artisanal catches, on average, display an increasing trend. Catches increased from 119 t·year⁻¹ in 1950 to 175 t·year⁻¹ in 1957, then fell to 109 t·year⁻¹ in 1959. From 1959 onwards, artisanal catches generally increased with a slight dip in 1978–1979 where catches fell from 566 t·year⁻¹ to 347 t·year⁻¹. After 1980, catches increased to a peak of 752 t·year⁻¹ in 1998 then decreased slightly to 640 t·year⁻¹ by 2010 (Figure 4a). Artisanal catches were estimated to be 66% domestic consumption, 26% export, and 8% tourist consumption. The subsistence sector has experienced a steady growth, increasing from 1,280 t·year⁻¹ in 1950 to 2,890 t·year⁻¹ in 2010 (Figure 4a). Recreational catches began in 1980 and increased gradually from zero to 21 t·year⁻¹ in 1999. From 1999 to 2010 the rate of recreational catch increased and catch was estimated to be 64 t·year⁻¹ by 2010 (Figure 4a).

Skipjack tuna (*Katsuwonus pelamis*) contributed to the majority of the industrial catch, representing 68% of the catch from 1950–2010. This was followed by albacore tuna (*Thunnus alalunga*) and yellowfin tuna (*Thunnus albacares*) which account for approximately

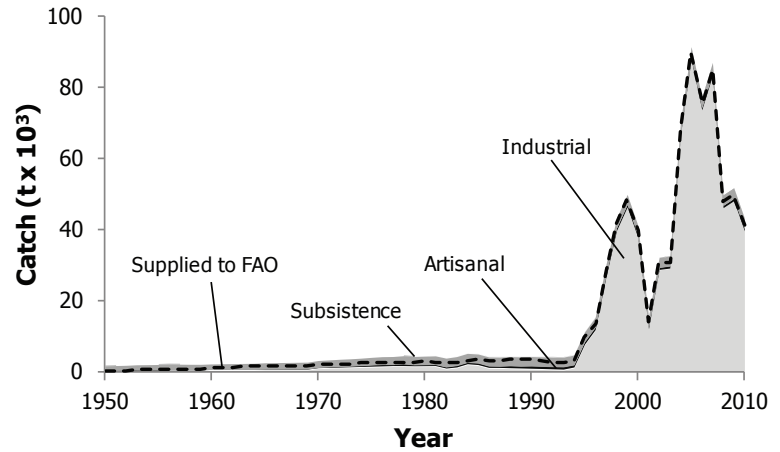


Figure 3. Reconstructed total catches of Vanuatu, 1950–2010, by fisheries sector with data supplied to FAO overlaid as line graph. Note that the recreational sector is too small to be visible on the graph.

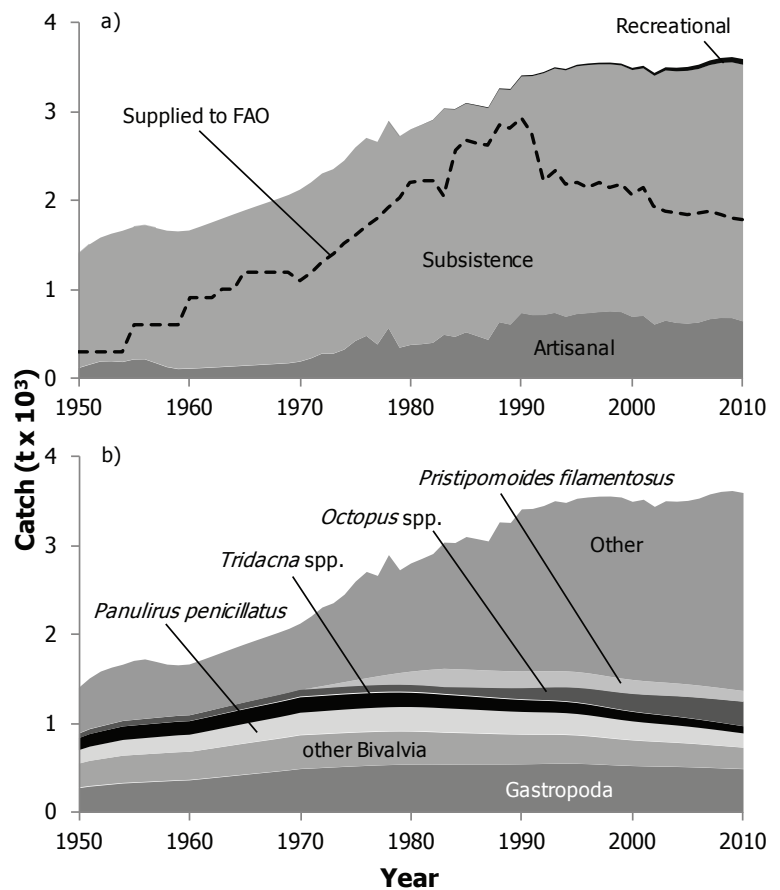


Figure 4. Reconstructed total small-scale catches of Vanuatu, 1950–2010, by a) fisheries sector with adjusted FAO data overlaid as line graph; and b) major taxonomic groups. 'Other' represents 49 additional taxonomic categories.

14% and 12%, respectively. Small-scale catches were dominated by invertebrates, including gastropods (17.6%), pronghorn spiny lobster (*Panulirus penicillatus*; 8.4%), giant clams (*Tridacna* spp.; 5.2%), octopus (4.4%) and other bivalves (12.3%; Figure 4b). The most important fish taxa was crimson jobfish (*Pristipomoides filamentosus*; 3.6%). Trochus was the dominant species caught within the artisanal sector, followed by the pronghorn spiny lobster (*Panulirus penicillatus*), representing 17% and 16% of the total artisanal catches, respectively. Subsistence catches for the period 1950 to 2010 were composed mainly of gastropods (20%), followed by other bivalves (i.e., excluding *Tridacna* spp.; 14%). For the same period, the recreational catch was assumed to be 90% Istiophoridae and 10% Scombridae.

Vanuatu has one of the lowest seafood consumption rates in the South Pacific. This is due to the fact that unlike most other Pacific islands, Vanuatu has an agricultural sector. Not only do most Ni-Vanuatu maintain personal garden crops but Vanuatu also exports beef with approximately 30% being canned for local consumption.⁸ As Ni-Vanuatu have a second source of local animal protein, they are not as reliant on seafood as some of the other Pacific island countries. Although the Ni-Vanuatu are not as reliant on seafood as other Pacific island countries, this does not mean that the marine resources are not valued. Studies showed that seafood was more important to the Ni-Vanuatu diet than was originally believed. Also, although the large-scale fisheries do not directly contribute to domestic food security, the revenue from joint ventures, as well as some access agreements for foreign vessels, are important to the economy of Vanuatu. Although not addressed in this report, it should be mentioned that as Vanuatu is engaged in multiple joint venture agreements and is fishing in other countries' EEZs, it has been reported that these industrial catches may be double counted. Catches by Vanuatu flagged purse seiners fishing in Papua New Guinea waters which are chartered to Papua New Guinea companies have been cited as also being reported by Papua New Guinea (Gillett 2011). As these catches are taken by Vanuatu flagged vessels, we consider them Vanuatu catch and therefore they are included here. However, it is apparently common practice by Pacific island countries for catches by chartered vessels in the waters of the host country to be attributed to the host country and therefore Papua New Guinea also reports these catches. This is just another instance where better communication and cooperation between countries when it comes to international fisheries issues is greatly needed.

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⁸http://www.unescap.org/ttdw/Publications/TPTS_pubs/Pub_1427/Pub_1427_ch2.pdf [accessed September 25, 2012]

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

| Year | FAO landings | Reconstructed total catch | Industrial | Artisanal | Subsistence | Recreational | Discards ¹ |
|------|--------------|---------------------------|------------|-----------|-------------|--------------|-----------------------|
| 1950 | 500 | 1,600 | 200 | 119 | 1,280 | - | - |
| 1951 | 500 | 1,710 | 200 | 157 | 1,350 | - | - |
| 1952 | 500 | 1,780 | 200 | 193 | 1,390 | - | - |
| 1953 | 600 | 1,930 | 300 | 195 | 1,430 | - | - |
| 1954 | 600 | 1,960 | 300 | 187 | 1,470 | - | - |
| 1955 | 900 | 2,000 | 300 | 215 | 1,490 | - | - |
| 1956 | 1,000 | 2,120 | 400 | 217 | 1,500 | - | - |
| 1957 | 1,000 | 2,090 | 400 | 175 | 1,520 | - | - |
| 1958 | 1,000 | 2,060 | 400 | 131 | 1,530 | - | - |
| 1959 | 1,000 | 2,050 | 400 | 109 | 1,550 | - | - |
| 1960 | 1,400 | 2,160 | 500 | 112 | 1,550 | - | - |
| 1961 | 1,400 | 2,210 | 500 | 118 | 1,590 | - | - |
| 1962 | 1,400 | 2,250 | 500 | 125 | 1,630 | - | - |
| 1963 | 1,500 | 2,300 | 500 | 131 | 1,670 | - | - |
| 1964 | 1,500 | 2,340 | 500 | 138 | 1,710 | - | - |
| 1965 | 1,800 | 2,490 | 600 | 145 | 1,740 | - | - |
| 1966 | 1,800 | 2,530 | 600 | 152 | 1,780 | - | - |
| 1967 | 1,800 | 2,580 | 600 | 159 | 1,820 | - | - |
| 1968 | 1,800 | 2,620 | 600 | 166 | 1,850 | - | - |
| 1969 | 1,800 | 2,660 | 600 | 174 | 1,890 | - | - |
| 1970 | 2,100 | 3,120 | 1,000 | 191 | 1,930 | - | - |
| 1971 | 2,200 | 3,290 | 1,002 | 228 | 1,980 | - | 80 |
| 1972 | 2,300 | 3,470 | 1,005 | 281 | 2,020 | - | 161 |
| 1973 | 2,400 | 3,600 | 1,007 | 279 | 2,070 | - | 241 |
| 1974 | 2,510 | 3,780 | 1,010 | 325 | 2,120 | - | 322 |
| 1975 | 2,610 | 4,010 | 1,012 | 421 | 2,180 | - | 402 |
| 1976 | 2,710 | 4,200 | 1,015 | 479 | 2,230 | - | 483 |
| 1977 | 2,816 | 4,250 | 1,023 | 382 | 2,280 | - | 563 |
| 1978 | 2,825 | 4,470 | 935 | 566 | 2,330 | - | 644 |
| 1979 | 2,819 | 4,260 | 811 | 347 | 2,380 | - | 724 |
| 1980 | 2,937 | 4,360 | 752 | 378 | 2,420 | 1 | 805 |
| 1981 | 2,715 | 4,440 | 533 | 386 | 2,460 | 2 | 1,053 |
| 1982 | 2,715 | 3,800 | 512 | 400 | 2,500 | 3 | 376 |
| 1983 | 2,542 | 4,230 | 521 | 490 | 2,540 | 4 | 677 |
| 1984 | 2,956 | 5,140 | 451 | 468 | 2,560 | 5 | 1,654 |
| 1985 | 3,686 | 4,960 | 1,038 | 518 | 2,570 | 6 | 827 |
| 1986 | 3,328 | 4,150 | 703 | 477 | 2,590 | 7 | 376 |
| 1987 | 3,328 | 4,120 | 716 | 435 | 2,610 | 8 | 351 |
| 1988 | 3,506 | 4,250 | 660 | 631 | 2,620 | 9 | 326 |
| 1989 | 3,410 | 4,170 | 609 | 605 | 2,640 | 11 | 301 |
| 1990 | 3,470 | 4,240 | 559 | 733 | 2,670 | 12 | 276 |
| 1991 | 3,260 | 4,170 | 508 | 710 | 2,690 | 13 | 251 |
| 1992 | 2,655 | 4,120 | 447 | 712 | 2,720 | 14 | 226 |
| 1993 | 2,710 | 4,090 | 386 | 735 | 2,750 | 15 | 201 |
| 1994 | 3,187 | 4,660 | 1,006 | 692 | 2,780 | 16 | 176 |
| 1995 | 9,687 | 11,170 | 7,492 | 723 | 2,790 | 17 | 151 |
| 1996 | 13,748 | 15,270 | 11,602 | 733 | 2,790 | 18 | 126 |
| 1997 | 28,462 | 29,920 | 26,265 | 745 | 2,790 | 19 | 101 |
| 1998 | 41,672 | 43,160 | 39,525 | 752 | 2,780 | 20 | 76 |
| 1999 | 48,366 | 49,770 | 46,178 | 745 | 2,780 | 21 | 51 |
| 2000 | 39,623 | 41,070 | 37,553 | 691 | 2,780 | 25 | 26 |
| 2001 | 14,055 | 15,440 | 11,919 | 703 | 2,790 | 29 | 1 |
| 2002 | 30,582 | 32,080 | 28,641 | 605 | 2,800 | 33 | 2 |
| 2003 | 30,871 | 32,520 | 28,987 | 648 | 2,820 | 37 | 36 |
| 2004 | 68,383 | 70,020 | 66,520 | 623 | 2,830 | 40 | 1 |
| 2005 | 89,628 | 91,290 | 87,779 | 616 | 2,850 | 44 | 1 |
| 2006 | 75,416 | 77,090 | 73,561 | 628 | 2,860 | 48 | 1 |
| 2007 | 85,137 | 86,840 | 83,262 | 665 | 2,860 | 52 | 1 |
| 2008 | 47,861 | 49,620 | 46,012 | 679 | 2,870 | 56 | 1 |
| 2009 | 49,784 | 51,600 | 47,978 | 677 | 2,880 | 60 | 1 |
| 2010 | 41,246 | 43,050 | 39,459 | 640 | 2,890 | 64 | 1 |

¹ Discards are from the industrial shark fishery.

Appendix Table A2. Reconstructed total small-scale catch (in tonnes) by major taxonomic category for Vanuatu, 1950-2010. 'Others' contain 49 additional taxonomic categories.

| Year | Gastropoda | Misc. bivalvia | <i>Panulirus pencillatus</i> | <i>Tridacna</i> spp. | <i>Octopus</i> spp. | <i>Pristipomoides filamentosus</i> | Others |
|------|------------|----------------|------------------------------|----------------------|---------------------|------------------------------------|--------|
| 1950 | 274 | 274 | 151 | 137 | 51 | - | 510 |
| 1951 | 292 | 288 | 160 | 143 | 54 | - | 568 |
| 1952 | 304 | 296 | 166 | 147 | 56 | - | 615 |
| 1953 | 315 | 304 | 172 | 150 | 58 | - | 629 |
| 1954 | 327 | 311 | 178 | 153 | 59 | - | 632 |
| 1955 | 333 | 313 | 181 | 153 | 60 | - | 663 |
| 1956 | 339 | 315 | 184 | 153 | 61 | - | 668 |
| 1957 | 345 | 317 | 186 | 154 | 61 | - | 629 |
| 1958 | 351 | 319 | 189 | 154 | 62 | - | 587 |
| 1959 | 358 | 320 | 192 | 154 | 63 | - | 568 |
| 1960 | 362 | 320 | 194 | 153 | 63 | - | 572 |
| 1961 | 374 | 327 | 199 | 155 | 64 | - | 587 |
| 1962 | 386 | 333 | 205 | 158 | 66 | - | 604 |
| 1963 | 398 | 340 | 211 | 160 | 68 | - | 620 |
| 1964 | 411 | 347 | 218 | 163 | 70 | - | 637 |
| 1965 | 424 | 353 | 224 | 165 | 71 | - | 654 |
| 1966 | 436 | 359 | 230 | 167 | 73 | - | 669 |
| 1967 | 448 | 365 | 235 | 168 | 74 | - | 685 |
| 1968 | 460 | 370 | 241 | 170 | 76 | - | 701 |
| 1969 | 474 | 376 | 248 | 172 | 77 | - | 718 |
| 1970 | 488 | 383 | 254 | 174 | 79 | - | 745 |
| 1971 | 493 | 383 | 257 | 173 | 80 | 12 | 806 |
| 1972 | 500 | 383 | 260 | 172 | 80 | 25 | 885 |
| 1973 | 506 | 384 | 262 | 172 | 81 | 38 | 911 |
| 1974 | 512 | 384 | 265 | 171 | 81 | 52 | 985 |
| 1975 | 518 | 384 | 268 | 170 | 82 | 67 | 1,110 |
| 1976 | 523 | 383 | 270 | 168 | 82 | 82 | 1,197 |
| 1977 | 528 | 382 | 272 | 167 | 82 | 98 | 1,131 |
| 1978 | 532 | 381 | 274 | 165 | 82 | 115 | 1,345 |
| 1979 | 535 | 379 | 275 | 163 | 82 | 133 | 1,156 |
| 1980 | 537 | 376 | 276 | 161 | 82 | 150 | 1,218 |
| 1981 | 538 | 372 | 276 | 159 | 82 | 168 | 1,257 |
| 1982 | 538 | 368 | 276 | 156 | 81 | 187 | 1,301 |
| 1983 | 537 | 363 | 275 | 153 | 81 | 206 | 1,421 |
| 1984 | 538 | 360 | 272 | 150 | 87 | 204 | 1,420 |
| 1985 | 538 | 356 | 270 | 148 | 94 | 201 | 1,493 |
| 1986 | 538 | 352 | 267 | 145 | 100 | 199 | 1,473 |
| 1987 | 539 | 348 | 264 | 142 | 107 | 196 | 1,453 |
| 1988 | 539 | 344 | 261 | 140 | 114 | 194 | 1,672 |
| 1989 | 539 | 341 | 258 | 137 | 121 | 191 | 1,670 |
| 1990 | 540 | 338 | 256 | 135 | 128 | 189 | 1,824 |
| 1991 | 542 | 335 | 253 | 133 | 135 | 187 | 1,829 |
| 1992 | 545 | 333 | 251 | 131 | 143 | 185 | 1,860 |
| 1993 | 547 | 330 | 249 | 129 | 151 | 183 | 1,913 |
| 1994 | 547 | 327 | 246 | 127 | 159 | 181 | 1,897 |
| 1995 | 546 | 323 | 242 | 124 | 166 | 178 | 1,952 |
| 1996 | 542 | 317 | 237 | 121 | 173 | 174 | 1,980 |
| 1997 | 537 | 310 | 231 | 117 | 179 | 170 | 2,008 |
| 1998 | 531 | 304 | 225 | 114 | 185 | 166 | 2,030 |
| 1999 | 526 | 297 | 220 | 110 | 191 | 161 | 2,039 |
| 2000 | 521 | 291 | 214 | 107 | 197 | 158 | 2,006 |
| 2001 | 518 | 286 | 210 | 104 | 205 | 154 | 2,042 |
| 2002 | 516 | 282 | 205 | 102 | 212 | 151 | 1,971 |
| 2003 | 513 | 278 | 201 | 99 | 220 | 148 | 2,043 |
| 2004 | 511 | 273 | 196 | 97 | 228 | 145 | 2,047 |
| 2005 | 508 | 269 | 191 | 94 | 235 | 142 | 2,067 |
| 2006 | 504 | 264 | 186 | 92 | 243 | 138 | 2,105 |
| 2007 | 500 | 258 | 181 | 89 | 250 | 134 | 2,167 |
| 2008 | 496 | 253 | 174 | 86 | 257 | 130 | 2,210 |
| 2009 | 491 | 248 | 167 | 84 | 264 | 126 | 2,236 |
| 2010 | 487 | 243 | 161 | 81 | 272 | 122 | 2,229 |