Reconstructing Catches for the Union of the Comoros: Uniting Historical Sources of Catch Data for Ngazidja, Ndzuwani and Mwali from 1950–2010*

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Abstract

Comorian fisheries consist of a small-scale boat fleet of *pirogues* and motor boats operated by men as well as shore-based fishing by women, both of which have few catch statistics. We compiled historical data on catch rates and the number of boats in the fleet from both grey literature and national statistics, and used these to reconstruct a time series of boat-based catch from 1950–2010. We also estimate catch by women fishers by extrapolating per-capita catch rates from a recently published study on the island of Ngazidja. Catches increased slowly from 1,000 t in 1950 to around 5,000 t in 1980, after which catches increased rapidly due to the increasing number of motorized vessels and the use of FADs offshore. The size of the fleet has grown rapidly since the 1990s and catch estimates are highest from 2005–2010 at around 19,000 t·year^{-1}. Overall, the reconstructed catches are 1.3 times the figures reported to and by the FAO for the Indian Ocean. Total reconstructed catches consist primarily of *Thunnus albacares* (yellowfin tuna), *Katsuwonus pelamis* (skipjack tuna), *Sardinella* spp. (sardinellas) and Engraulidae (anchovies).

Introduction

The Union of the Comoros (referred throughout as 'the Comoros') is an archipelago in the northern Mozambique channel of the Western Indian Ocean that is composed of three islands: Ngazidja (or Grande Comore), Ndzuwani (or Anjouan) and Mwali (or Mohéli; Figure 1). Fisheries in the Comoros consist of a small-scale *pirogues* and fibreglass motor boat (locally known as *barques* or *vedettes*) fleet as well as shore-based subsistence fishing by women. Until the 1980s the boat fleet was almost exclusively non-motorized *pirogues* using mostly handlines (de San 1983). Catches by this fleet increased in the 1980s, due to the importation of fibreglass motorboats and the use of anchored Fish Aggregating Devices (a-FADs) for fishing further offshore (Cayré 1991; Anon. 2013). The high season fishing months have historically occurred between November and February when tunas migrate around the islands; catches in other months are generally lower (Van Nierop 1985; James 1988).

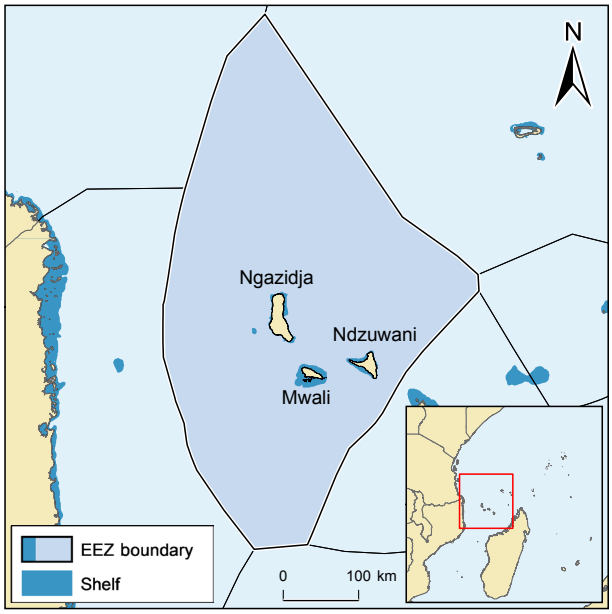

Figure 1. Map of the Comoros showing the islands of Ngazidja (Grande Comore), Ndzuwani (Anjouan) and Mwali (Mohéli), the extent of the Exclusive Economic Zone (EEZ), as well as the continental shelf (darker blue).

The fishing conditions on the three islands vary. Ngazidja is surrounded by a narrow coral reef extending about 500 m from shore (Fourmanoir 1954). The reef is generally not very deep, nor is it followed by a large shelf with productive fishing areas for reef species. Fishing here has historically targeted large pelagic species (e.g., sharks,[1] tuna, billfish and dolphinfish) in areas about 5–15 km offshore (Fourmanoir 1954). The fishing conditions off Ndzuwani are comparable to Ngazidja, except the productivity of the coral reefs is higher (Fourmanoir 1954). Fishermen from Ndzuwani and Ngazidja frequently fish the waters near Mwali, perhaps even more heavily than local residents (James 1988). Ndzuwani fishers also regularly fish in Mayotte's waters (Maggiorani *et al.* 1993; Doherty *et al.* this volume).

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[1] Historically there was a targeted fishery for sharks (Fourmanoir 1954), but fishing effort now targets more tuna and it does not appear that there is a fishery targeting sharks specifically. When caught, sharks are finned for the Chinese market and the meat is consumed locally (Kiszka *et al.* 2008).

Mwali is the least densely populated island, and its continental shelf extends about 10 km from the coast and harbours much more productive reef fisheries (Fourmanoir 1954). Thus, fisheries in Mwali have historically targeted more reef species (e.g., snappers, groupers and emperors). A marine park was established around the southern half of the island in 2001, extending from the high tide mark to 100 m depth and covering over 400 km² (Granek and Brown 2005).

Fishing in the Comoros is mostly day trips, as no vessels have refrigerating units (de San 1983; James 1988) and crews are small, usually 1–2 people per boat (WIOMSA 2011). The average crew and boat sizes are larger in Ngazidja, as these vessels often fish further offshore (WIOMSA 2011). Catches are usually landed on shore and sold on the same day (Anon. 2013). There are no restrictions on the amount of fish that may be landed, but fishers rarely catch more than they can consume or sell in one day (Hauzer *et al.* 2013a).

A survey conducted by the *Direction Nationale des Ressources Halieutiques* (National Fisheries Department) in 1994 provided the only comprehensive assessment of catch by the small-scale boat fleet, and Hauzer *et al.* (2013a) provided the only catch estimates for women fishers. Fishers reported declines in catch abundances, mean size and changes in species composition over the last two decades (Hauzer *et al.* 2013b), but there was a lack of official catch statistics to verify these trends. Other studies during the 1950–2010 period provided estimates of catch rates and the number of boats in the fleets, and were used to reconstruct a time-series of boat-based catch. The size of the fleet has grown rapidly since the 1990s, but data collection and catch statistics has remained limited.

The purpose of this report was to estimate the total marine fisheries catches for the Comoros from 1950 to 2010, using FAO data as the baseline. Reconstructed estimates were compared with FAO landings in an attempt to identify unreported sources of catch and increase transparency in Comorian catch statistics.

The Comoros' Fisheries and Reconstruction Methods

Boat-based catch

We compiled catch and effort data from grey literature and unpublished datasets for select years with available data from 1950–2010. These data were treated as anchor points and linear interpolation of catch rates, and the number of fishing boats were used to estimate gaps in the data between anchor points.

Boat time-series

Table 1 summarizes the boat counts that were available for the small-scale fishing fleets since 1950. In the early 1950s, Fourmanoir (1954) estimated that there were 130 *pirogues* in the southern villages of Ngazidja. Moal (1962) counted 213 boats in these same villages, representing a ratio of 0.61:1 for boats in 1954 compared to those in 1962. We assumed that the same increase occurred proportionally on other areas of Ngazidja, Ndzuwani and Mwali and applied this ratio to boat counts by Moal (1962) to estimate boat numbers in 1954. There was a large discrepancy in the number of boats recorded in the 1993 and 1994 national survey data. Since we found no explanation to justify this, we used the average number of boats from 1993–1994.

Table 1. Anchor points for the number of boats in the Comoros for various years between 1950–2011.

Year	*Pirogues*						Motor boats[b]			Sources
	Non-motorized			Motorized[a]						
	Ngazidja	Ndzuwani	Mwali	Ngazidja	Ndzuwani	Mwali	Ngazidja	Ndzuwani	Mwali	
1954	566	123	36	-	-	-	-	-	-	Fourmanoir (1954)[c]
1962	928	201[d]	59	-	-	-	-	-	-	Moal (1962)
1979	1,455	970	194	45	30	6	-	-	-	Faharoudine (1979)
1983	-	-	-	-	-	-	15[e]	25	10[e]	Van Nierop (1985)
1987	1,500	1,200	300	-	-	-	11	18	6	James (1988)
1993	2,012	1,391	242	107	120	79	250	92	69	Unpub. data, 1994 survey, *Direction National des Ressources Halieutiques*
1994	1,748	1,505	247	87	80	54	109	77	39	
2011	1,888	1,864	227	23	25	209	802	708	18	Unpub. data, 2011 boat census, *Direction National des Ressources Halieutiques*[f]

[a] Includes Fedawa I.
[b] Includes *barques*, *vedettes*, Fedawa II, Yamaha G18, and Japawa). Classification of boat categories are based on boat size, capacity, and horse power (Lablache-Carrara and Laloë 1993; Aboulhalik 1998).
[c] Multiplied 1962 boat numbers by 0.61.
[d] Missing boat data for 3 communities (Vouani, Pomoni and Moya) was estimated using the median value from other communities in Ndzuwani.
[e] Estimated the distribution of vedettes in 1983 for Ngazidja and Mwali. There were originally 50 *vedettes* supplied (James 1988), 25 of which were originally on Ndzuwani (Van Nierop 1985).
[f] Obtained through SWIOFP database (http://41.206.61.142:8080/statbase_3).

The boat anchor points in Table 1 were converted to a boat per-capita[2] rate for each boat type and linear interpolation was used to estimate boats per-capita for years without boat data. This provided a boat per capita time-series from

[2] Population statistics for 1960–2012 were available from the World Bank database (http://databank.worldbank.org, Accessed: 06/06/2013) and for 1950 and 1955 from the United Nations database (http://data.un.org, Accessed: 06/06/2013). Missing years in the 1950s were linearly interpolated.

1950–2010 that was used to estimate a boat time-series by multiplying per capita boat rates by annual populations on each island (Figure 2).

Catch rates time series

Where available, estimates of annual catch were divided by total boats on the island to estimate an annual catch rate. Otherwise, daily catch rates were multiplied by the number of trips per year to estimate the annual catch for different boat types (Table 2).

Early observations of small-scale fisheries in the Comoros archipelago were well-documented by Fourmanoir (1954). These included catch rates of 50 kg·trip^{-1} for *pirogues* fishing twice per week on the southern offshore banks of Mwali, and an average annual catch rate of 5.2 t·*pirogue*$^{-1}$. *Pirogues* fishing every day on the interior reef had an average catch rate of 10 kg·trip^{-1} and an annual catch rate of 2.6 t·*pirogue*$^{-1}$, assuming trips occurred 5 times per week (Table 2).

During this time, a normal week of pelagic fishing by 70 *pirogues* off Ngazidja landed: 1,500 kg of sharks (*Isurus glaucus* and *Carcharinus longimanus*), ten yellowfin tuna (*Thunnus albacares*) with an average weight of 20 kg, two dolphinfish (*Coryphaena hippurus*) with an average weight of nine kilos, and four Indo-Pacific sailfish (*Istiophorus platypterus*). Average lengths of landed sailfish on Ngazidja were 2.9 m (Fourmanoir 1954), and we estimate their average weight as 50 kg per fish using length-weight relationships from FishBase (www.fishbase.org). This yielded a total of 1,918 kg of pelagic fish by 70 boats in one week, or an average weekly catch of 27.4 kg per *pirogue*. Based on the overall catch composition in the 1994 survey data (unpub. data, *Direction Nationale des Ressources Halieutiques*), we assumed an additional 20% of annual catches were composed of yellowtail barracuda (*Sphyraena flavicauda*), oilfish (*Ruvettues pretiosus*), small pelagics and other reef fish (e.g., Lethrinidae and Carangidae), also documented in catches by Fourmanoir (1954).

Linear interpolation between catch rates was used to fill in gaps. We used the same rates for all three islands where island specific rates were not available. We had no catch rates beyond 1994; however, the majority of boat fishers interviewed by Hauzer *et al.* (2013a) reported declines in catch abundance and mean fish sizes over the last 20 years. This was not surprising given the large increase in motorized vessels in the small-scale fishing fleet during this time (Figure 2). We assumed catch rates declined by 50% between 1994 and 2010 (Figure 3).

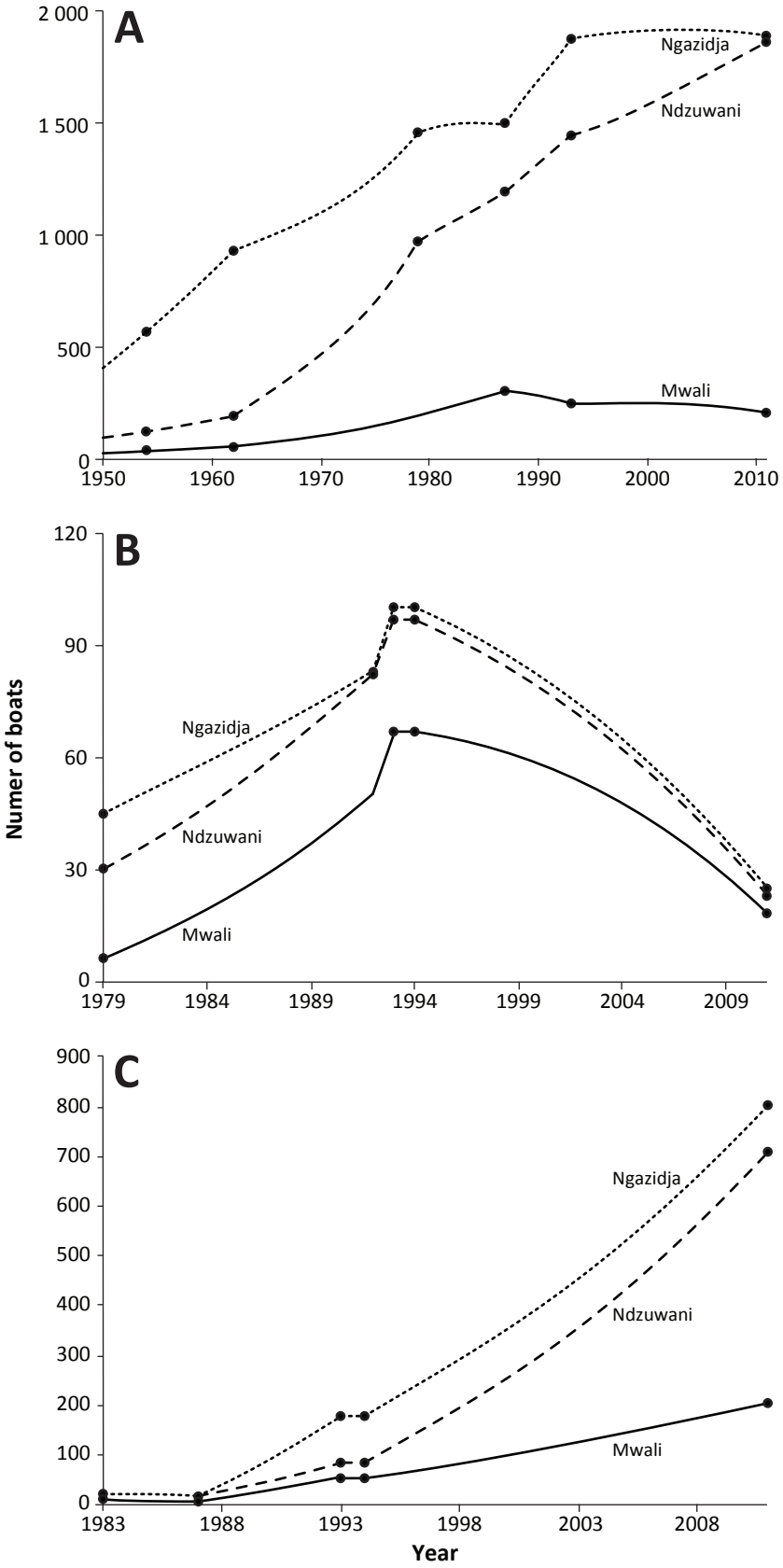

Figure 2. Estimated annual number of A) non-motorized *pirogues* from 1950–2010, B) motorized *pirogues* from 1979–2010, and C) motor boats from 1983–2010. Solid circles represent anchor points described in Table 1.

Table 2. Summary of annual catch rate estimates from 1954 to 1994.

Year	Boat type	Daily catch rate (kg·boat^{-1})	Trips per year	Annual catch rate (t·boat^{-1})[a]	Sources and comments
Ngazidja					
1954	Non-motorized *pirogue*	34.3[a]	-	1.8	Fourmanoir (1954)
1962		-	-	1.5	Moal (1962)
1978		-	-	1.4	de San (1983)
1994		-	-	1.7	Unpub. data, 1994 survey, *Direction Nationale des Ressource Halieutiques*
	Motorized *pirogue*	-	-	12.2	
	Motor boat	-		23.7	
Ndzuwani					
1962	Non-motorized *pirogue*	-	-	3.5	Moal (1962)
1979		-	-	1.4	de San (1983)
1983–1984		39.7 (high season), 21.8[b] (low season)	104.0	3.0	Van Nierop (1985), James (1988). Annual catch rate assumes 60% of trips occur in low season and 40% of trips occur in high season (Van Nierop 1985; James 1988)
	Motorized *pirogue*	69.0 (high season), 38.0[b] (low season)	104.0	5.2	
	Motor boat	252.4 (high season), 138.9[b] (low season)	122.0	22.6	
1986–1987	Non-motorized *pirogue*	20.0	104.0	2.1	James (1988)
	Motor boat	250.0	122.0	30.5	
1994	Non-motorized *pirogue*	-	-	1.4	Unpub. data, 1994 survey, *Direction Nationale des Ressources Halieutiques*
	Motorized *pirogue*	-	-	8.0	
	Motor boat	-	-	15.0	
Mwali					
1954	Non-motorized *pirogue*	50 (offshore) and 10 (inshore)	104 (offshore) and 260 (inshore)[c]	3.9	Fourmanoir (1954). Average of inshore and offshore rate
1962		-	-	5.1	Moal (1962)
1979		-	-	2.1	Faharoudine (1979), de San (1983)
1994		-	-	0.8	Unpub. data, 1994 survey, *Direction Nationale des Ressources Halieutiques*
	Motorized *pirogue*	-	-	4.7	
	Motor boat	-	-	9.8	

[a] Numbers reflect weekly catch rates observed in October; number of trips per week unknown.
[b] Low-season rate estimated as 55% of high season rate based on ratios from James (1988).
[c] Fourmanoir (1954) indicates these fishers fish every day; here we assume an average of 5 trips per week throughout the year (Van Nierop 1985).

Shore-based fishing by women

Hauzer *et al.* (2013a) provided the only estimates of catch by women fishers in the Comoros. Based on data collected from interviews in 2009–2010, the annual catch by women was estimated for three communities on Ngazidja (Table 3). Each community had 80 women fishers and catch estimates for each village ranged from 40–99 tonnes due to the differences in catch rates and the number of full-time fishers. There are another seven communities on the island consisting of women fishers, one of which contains only ten fishers (Hauzer *et al.* 2013a). We estimated that the other six villages also contained approximately ten women fishers, based on the second author's personal experience. Extrapolated to the entire island of Ngazidja, this yielded an estimate of 255 tonnes for 2010. We converted these 255 tonnes to a shore-based catch per-capita and assumed the same per-capita catch rate for the islands of Mwali and Ndzuwani in 2010.

Table 3. 2010 annual catch estimates for full-time and part-time women fishers on Ngazidja (derived from Hauzer *et al.* 2013a).

Community	Annual catch (t)	Average catch per year		Number of fishers		% full time
		Full time	Part time	Full time	Part time	
Chindini	40.2	0.9	0.4	10	70	0.13
Hantsindzi	59.7	0.9	0.5	50	30	0.63
Mitsamiouli	98.8	1.4	0.7	60	20	0.75
Seven other villages	8.1	1.1[a]	0.5[a]	5	5	0.50[a]

[a] Estimated as average value from the three communities above.

All women fishers interviewed by Hauzer *et al.* (2013a) reported declines in catch abundance in the last ten years. We therefore assumed a higher shore-based catch per-capita in 2000, increasing the 2010 per-capita rate by 25%. We used linear interpolation to derive per-capita catch rates from 2001–2009 and maintained the 2000 rate from 1950–1999.

Taxonomic and sectoral breakdown

We maintained the same annual taxonomic compositions for the boat-based reconstructed catch as what was reported to the FAO for the 1970–2010 period. Data reported to the FAO from 1950–1969 had poor taxonomic detail, with 20–70% of the catch reported as 'marine fishes nei' (i.e., unidentified marine fish). To improve the taxonomic breakdown prior to 1970, we reallocated catches of unidentified fish to other taxonomic groups based on the catch composition in the early 1970s, using the average 1971–1973 breakdown from FAO. The assumption here was that new taxa reported in 1971–1973 FAO landings (e.g., Carangidae, Engraulidae, Istiophoridae and Scombriae) were reflective of improved taxonomic reporting rather than new fish species targeted by fisheries. This retained 7%

of annual catches as 'unidentified marine fish' and reassigned the remainder as anchovies, bigeye tuna, Carangidae, Indian mackerel, Indo-Pacific sailfish, kawakawa, skipjack tuna, swordfish and yellowfin tuna.

The *Sea Around Us* uses the following fishing sectors in its global catch database: 'industrial' (i.e., large-scale commercial), 'artisanal' (i.e., small-scale commercial), 'subsistence' (i.e., small-scale non-commercial with primary purpose being self- or family-consumption), and 'recreational' (i.e., small-scale non-commercial with the primary purpose being pleasure). For the purposes of the *Sea Around Us* database, the small-scale shore fishing and boat-based catches were divided into artisanal and subsistence components. Species of higher value, such as tunas (*Thunnus* spp. and *Euthynnus* spp.), billfishes (Istiophoridae) and lobsters, were assumed to be primarily sold commercially and thus 80% of this catch was allocated to the 'artisanal' sector. Fish species sold at lower prices, such as small pelagics (Clupeiformes), and marine molluscs, were assumed to be primarily used for take-home consumption and 80% of these catches were allocated as 'subsistence'. For other species where the distinction was not obvious, such as jacks (Carangidae), mackerels (*Auxis* spp., *Rastrelliger* spp., *Scomberomorus* spp.), and other unidentified marine fish, we used an even split, allocating 50% to each small-scale sector. All shore-based catch was allocated as subsistence.

Flags of Convenience

FAO landing data (FishStat 2014) also included catches from the Central Eastern Atlantic (FAO Area 34) from 2007–2012. These landings were composed mostly of pelagic species (primarily Clupeidae, Engraulidae, and Carangidae) as well as a small amount (2%) of demersals. However, as there were no records of any distant water Comorian fishing fleets, these catches were not considered domestic.

Rather, we suspected that these catches were from industrial fishing vessels fishing the high seas using the Comoros as a flag of convenience. As a matter of fact, the Comoros has been previously identified as a potential flag of convenience state for high seas fishing (Gianni and Simpson 2005; Anon. 2013). The FAO fishing vessels finder database (www.fao.org/figis/vrmf/finder; Accessed: June 26, 2014) listed six foreign vessels (Table 4) that have been registered with the Comoros flag between 2004 and 2012. Given the absence of any other information we assumed that these countries were responsible for the FAO reported landings in the Atlantic. We allocated 89% of the pelagic catch to Lithuania

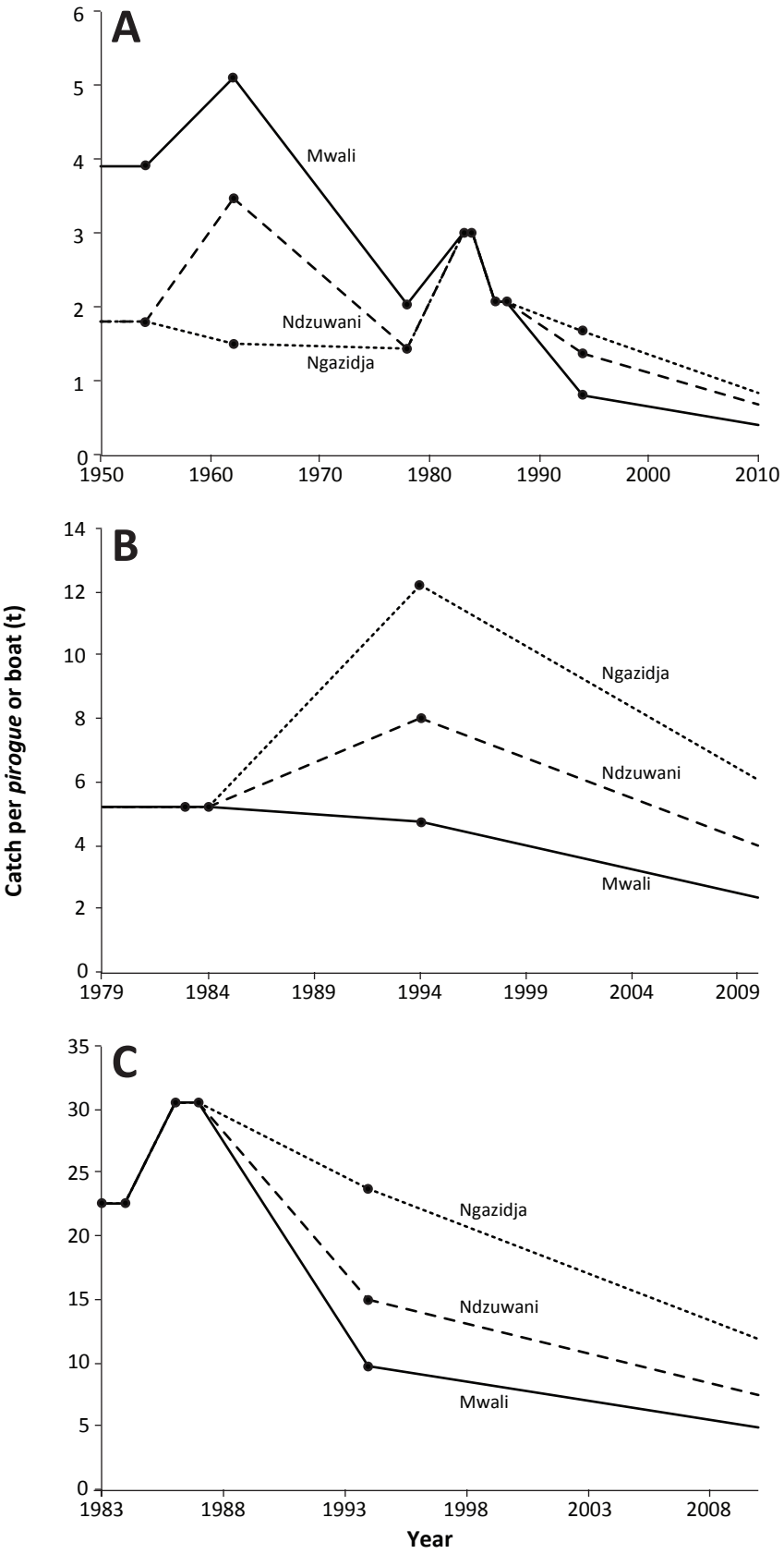

Figure 3. Estimated annual catch rates (t·boat-1) for A) non-motorized pirogues from 1950–2010, B) motorized pirogues from 1979–2010, and C) motor boats from 1983–2010. Solid circles represent anchor points described in Table 2.

and 11% to Netherlands based on the proportion of total tonnage by vessels from these countries using midwater otter trawls. Demersal catches were reallocated to France, the only country with vessels using bottom trawls.

Table 4. Fishing vessels registered with the Comoros flag in the FAO fishing vessel finder database.

Country	Boat name	Period	Gear	Length (m)	Gross tonnage
Lithuania	ARAS-1	2009, 2012	Midwater otter trawl	104	4,378
	IRVINGA	2011–2013		105	4,407
	BALANDIS	2011, 2012		109	5,953
	KOVAS			118	5,979
The Netherlands	OCEAAN VII	2012		90	2,624
France	LA MADONE 2	2004	Bottom trawl and dredging	11	16

Although we could not confirm that France, Lithuania and Netherlands were responsible for these catches, we are confident that these catches were not from the Comoros fishing fleets and our reallocation is, therefore, more informative than what is currently in the FAO database.

Foreign fisheries

Industrial longliners from Japan have fished in Comorian waters since at least the late 1950s (Moal 1962). Although there were no formal agreements at this time, Japan has contributed funds and equipment (e.g., fiberglass vessels, fishing nets) to develop the Comoros' fisheries over the years (de San 1983; James 1988; Lablache-Carrara and Laloë 1993). Formal agreements with the European Union have been signed in recent years, which allowed up to 45 tuna seiners and 25 longliners from France, Spain, Italy and Portugal to fish for tuna in the Comoros EEZ (Anon. 2013; Eckstein 2014).

Results

Overall, the total reconstructed catches from 1950–2010 were nearly 516,000 t, 96% of which were from the small-scale boat fleet, and 4% of which were from shore-based fishing by women (Figure 4A). Catches increased slowly from 1,000 t in 1950 to around 5,000 t in 1980, after which catch volumes increased rapidly due to the increasing number of motorized vessels and the use of offshore a-FADs. The size of the fleet has grown rapidly since the 1990s and despite decreasing catch rates, catch estimates were the highest from 2005–2010 at around 19,000 t·year^{-1}. Overall, the reconstructed catches were 1.3 times the landings reported to FAO in the Indian Ocean. Total reconstructed catches consisted primarily of yellowfin tuna, skipjack tuna, sardinellas, and anchovies (Figure 4B). The sectoral assignments suggested that 'artisanal' and 'subsistence' catches accounted for 61% and 39% of total reconstructed catches from 1950–2010, respectively (Figure 4A).

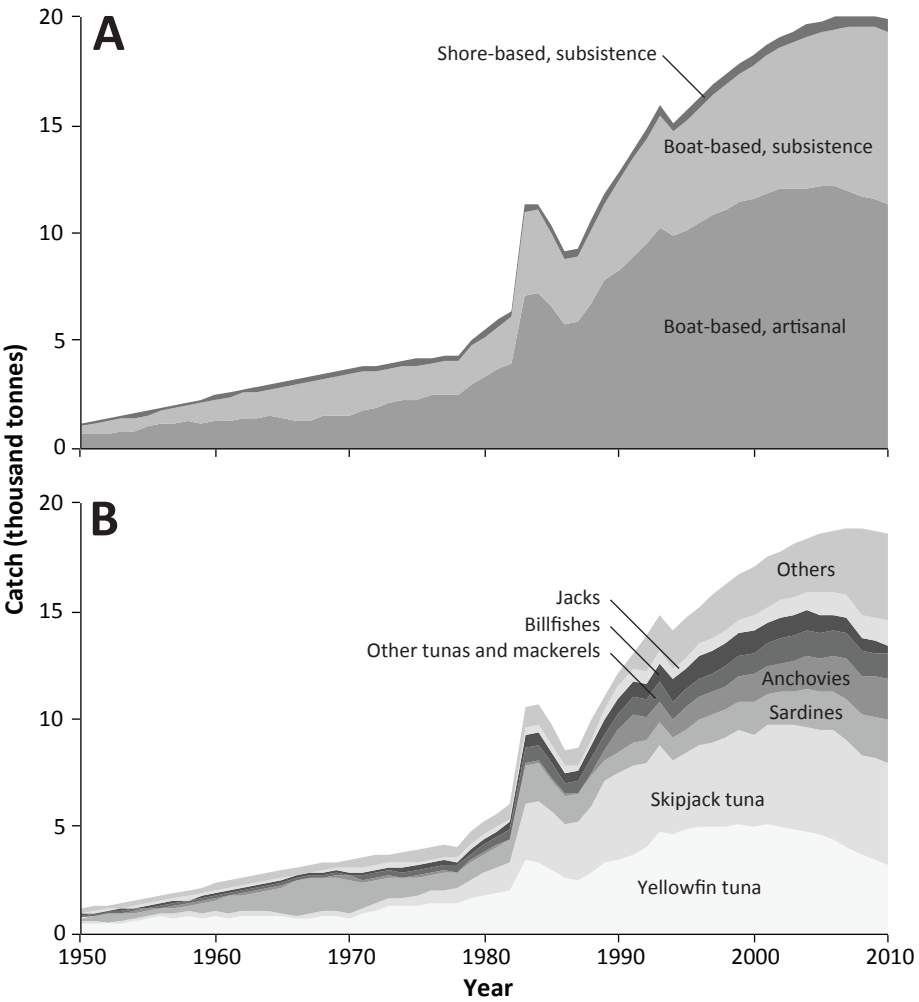

Figure 4. Reconstructed catches by A) sector and B) major taxa. 'Others' includes lobsters, molluscs, sharks, rays and other unidentified marine fish. See details in Appendix Table A1 and Appendix Table A2.

Discussion

The overall discrepancy between the reconstructed domestic catches and the data reported to FAO was mainly due to an increase in catch since 1995, which contributed 54% of the total reconstructed catch (and were 95,000 t higher than what was reported to FAO). In estimating catches for these years, we assumed a 50% decline in catch rates since the 1994 survey by the *Direction Nationale des Ressources Halieutiques*,which is the only comprehensive assessment of small-scale fisheries in the Comoros.

The 2012 dataset produced by FAO (2012; i.e., the dataset used here) showed that catches have steadily decreased from 1994 to around 11,000 t·year^{-1} from 2001–2010. This was in stark contrast to the 2010 dataset (FAO 2012), where catches increased from 1994 to 20,500 t·year^{-1} in 2008–2010. As we found no catch statistics for this period, the reasons for this change in the FAO data remains unknown. What we do know is that the number of motor boats in the Comoros increased from around 300 in 1994 to about 1,700 in 2011 (Figure 2). Catches in the 2012 FAO data declined by 23% over this same period and, if accurate, would correspond to about a 70% decline in annual catch per boat since 1994 (Figure 5).

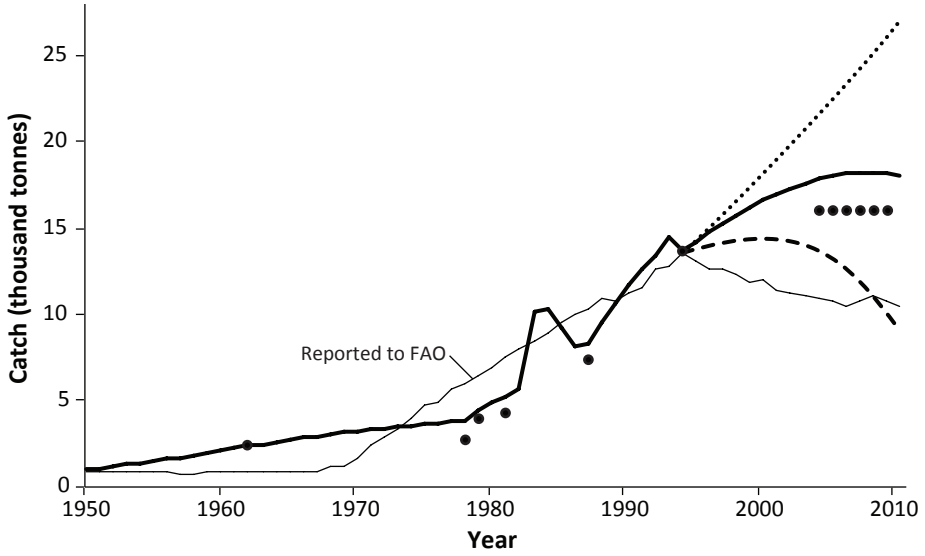

Figure 5. Reconstructed boat-based catch compared to other sources of catch data. Solid circles represent estimates observed in the grey literature (Moal 1962; de San 1983; Van Nierop 1985; James 1988; Amoriggi 2010) and the 1994 survey by the *Direction National des Ressources Halieutiques*. Dashed (75% decline) and dotted (25% decline) lines show sensitivity analysis for different assumptions about the decline in catch rates between 1994–2010.

Interviews with fishermen confirmed that there has been a decrease in mean fish sizes and perceived catch abundance over the last 20 years (Hauzer *et al.* 2013b), but by how much we do not know. In these interviews 62% of motorized boat fishers and 55% of *pirogue* fishers reported declines in fish sizes. Similarly, 50% of motorized boat fishers and 75% of *pirogue* fishers reported declines in catch abundance. Given that this perception was not consistent among fishers, Hauzer *et al.* (2013b) suspected that the declines in catch were not drastic. Furthermore, catch figures remained reasonably high in recent years, averaging 22 kg·day^{-1} for *pirogues* and 110 kg·day^{-1} for motor boats (Hauzer *et al.* 2013b). Thus, we think that our assumption of a 50% decline may well be conservative, and catches over this period may actually be higher. Not surprisingly, sensitivity analysis of this assumption shows that catches in the last 15 years would vary considerably depending on the decline in catch rates assumed; thus this is a major source of uncertainty in our estimates (Figure 5). We were not able to provide estimates of uncertainty for the reconstructed totals, as error estimates are unavailable for catch statistics used, including those reported by the FAO.

For most of the 1950–1994 period, we found the 2012 FAO dataset to be a reasonable estimate of boat-based catches. The reconstructed estimates here provide an alternative, but show a similar trend to FAO data. The reconstructed catches yielded per-capita consumption rates of 6–15 kg·person^{-1}·year^{-1} from 1950–1979. These are low for an island country with few other protein sources. However, it is known that throughout the 1950s-1970s, fishing did not satisfy local consumption requirements and large amounts of salted fish were imported from Madagascar and Zanzibar (Fourmanoir 1954; Moal 1962; Faharoudine 1979; Meyer *et al.* 2006).

Further studies are necessary to improve confidence in our results, notably with regards to the shore-based activities conducted by women fishers. In this study we extrapolated estimates by Hauzer *et al.* (2013b) for the island of Ngazidja to estimate catches for all of the Comoros and using population data estimated historical catches by this sector. This information provides a preliminary estimate of the scale of these catches, which could be improved through specific studies on the islands of Mwali and Ndzuwani. The importance of such activities for food security and livelihoods is increasingly recognized (Harper *et al.* 2013; Anon. 2014; Kleiber *et al.* 2014). Thus, further research is required to better understand the species most affected by these fisheries and well as their social and economical impact.

We found few data on the species composition of catches in the Comoros and much of the data reported to FAO from 1950–1969 was recorded as unidentified marine fish. We attempted to improve the taxonomic detail of these catches, by disaggregating them based on more detailed information in FAO data in the early 1970s. Information on major species caught by fisheries in 1950s (Fourmanoir 1954) and the 1994 national statistics could be used in future efforts to improve Comorian catch statistics and may provide valuable information of changes in species composition over time. For example, approximately 80% of catches on Ngazidja observed by Fourmanoir (1954) over a one-week period were composed of sharks, whereas they accounted for less than 1% of annual catches on Ngazidja in 1994 and fishermen reported that sharks are now rarely seen in catches (M. Hauzer, unpub. data). It is clear that tunas are now the main target species for offshore pelagic fisheries, but sharks likely accounted for a much larger proportion of catches in earlier years and this is not reflected in our estimates. Groupers (*Plectropomus pessuliferus*,[3] *Epinephelus merra*, *Variola louti*), snappers (*Lutjanus argentimaculatus*, *Aprion virescens*) and emperors (*Lethrinus nebulosus, L. olivaceus*[4]) were commonly caught in Mwali reef fisheries in the 1950s (Fourmanoir 1954), but we found no species specific catch statistics for reef fisheries in recent years to compare these with. Interviews with fishermen suggested that some species that were once common are now rarely seen,

[3] *Plectropomus maculatus* listed in Fourmanoir (1954) is a likely misidentification (Froese and Pauly 2014).
[4] *Lethrinus miniatus* listed in Fourmanoir (1954) is a likely misidentification (Froese and Pauly 2014).

while other species have completely disappeared from catches (M. Hauzer, unpub. data). The lack of detailed catch statistics for the Comoros makes it difficult to assess the magnitude of such changes, their causes and their impacts on fisheries and marine ecosystems

It is critical for fisheries management that the Comoros dedicates more resources to accurately recording fisheries statistics (Pauly *et al.* 2013). Other than the 1994 national statistics and a few recently published studies (e.g., Hauzer *et al.* 2013a,b), data that exist are mostly from grey literature and often based on brief observations of the fishery in select regions. It is unlikely that we will ever know the 'true' historic catches of small-scale fisheries in the Comoros, but we hope this work may serve as a starting point to account for unreported catch statistics, improve transparency in fisheries data, and provide a resource of historical information for Comorian fisheries. If there are additional data that were unavailable to us, we hope they may be used to improve this work and we welcome contributions from other researchers to improve this database, which will be made available *via* the *Sea Around Us* website.

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Appendix Table A1. Total reconstructed catch compared to official data reported to FAO.

Year	Reconstructed				Reported to FAO
	Shore-based	Boat-based		Total	
		Artisanal	Subsistence		
1950	142	653	347	1,142	835
1951	145	659	431	1,235	935
1952	148	634	549	1,331	918
1953	152	739	542	1,433	818
1954	155	796	584	1,535	818
1955	158	975	518	1,651	835
1956	161	1,052	559	1,772	835
1957	164	1,091	643	1,898	717
1958	167	1,166	688	2,021	717
1959	170	1,143	839	2,152	817
1960	173	1,221	896	2,290	817
1961	176	1,171	1,087	2,434	817
1962	179	1,285	1,115	2,579	917
1963	182	1,344	1,165	2,691	917
1964	185	1,403	1,217	2,805	917
1965	189	1,318	1,407	2,914	917
1966	193	1,212	1,617	3,022	875
1967	197	1,258	1,678	3,133	875
1968	202	1,425	1,619	3,246	1,235
1969	206	1,470	1,671	3,347	1,235
1970	211	1,420	1,815	3,446	1,662
1971	215	1,647	1,672	3,534	2,470
1972	220	1,832	1,564	3,616	2,879
1973	225	1,985	1,486	3,696	3,287
1974	230	2,074	1,472	3,776	4,047
1975	237	2,115	1,517	3,869	4,756
1976	245	2,315	1,412	3,972	4,864
1977	255	2,357	1,470	4,082	5,621
1978	265	2,378	1,408	4,051	6,027
1979	275	2,821	1,610	4,706	6,486
1980	285	3,131	1,732	5,148	6,952
1981	295	3,428	1,863	5,586	7,460
1982	304	3,711	1,990	6,005	7,975
1983	312	6,684	3,540	10,536	8,494
1984	321	6,774	3,543	10,638	9,000
1985	330	6,136	3,175	9,641	9,516
1986	339	5,444	2,773	8,556	9,971
1987	348	5,543	2,757	8,648	10,379
1988	357	6,349	3,151	9,857	10,914
1989	366	7,345	3,282	10,993	10,752
1990	375	7,804	3,855	12,034	11,252
1991	385	8,321	4,291	12,997	11,552
1992	394	8,853	4,597	13,844	12,591
1993	403	9,624	4,807	14,834	12,758
1994	413	9,191	4,510	14,114	13,537
1995	423	9,484	4,756	14,663	13,109
1996	434	9,838	4,934	15,206	12,696
1997	445	10,110	5,170	15,725	12,576
1998	456	10,368	5,358	16,182	12,317
1999	468	10,701	5,475	16,644	11,818
2000	480	10,770	5,826	17,076	12,003
2001	482	11,077	5,895	17,454	11,425
2002	485	11,246	6,069	17,800	11,178
2003	487	11,314	6,289	18,090	11,053
2004	489	11,263	6,587	18,339	10,987
2005	491	11,383	6,661	18,535	10,738
2006	492	11,393	6,784	18,669	10,464
2007	494	11,102	7,156	18,752	10,724
2008	495	10,921	7,352	18,768	11,093
2009	496	10,803	7,414	18,713	10,825
2010	496	10,621	7,449	18,566	10,540

Appendix Table A2. Total reconstructed catch by taxa.

Year	Yellowfin tuna	Skipjack tuna	Sardines	Anchovies	Jacks	Others
1950	477	99	120	44	69	334
1951	463	98	233	43	67	332
1952	396	95	386	47	74	333
1953	479	117	313	58	90	376
1954	516	126	337	62	96	397
1955	701	159	179	66	102	445
1956	754	173	193	71	110	470
1957	735	186	242	89	138	508
1958	783	201	258	95	148	535
1959	735	189	485	89	139	515
1960	782	204	518	95	148	542
1961	714	183	829	81	126	500
1962	788	209	785	96	150	552
1963	821	221	821	101	157	572
1964	857	231	857	105	163	592
1965	759	206	1,188	87	136	538
1966	673	175	1,616	48	74	436
1967	695	185	1,677	49	77	450
1968	822	225	1,479	73	113	535
1969	845	235	1,526	75	116	550
1970	732	202	1,557	195	195	565
1971	865	249	1,209	134	269	808
1972	1,072	319	1,062	118	236	809
1973	1,235	379	950	106	211	815
1974	1,249	397	876	88	219	947
1975	1,269	432	916	76	191	984
1976	1,423	552	766	77	192	963
1977	1,386	607	817	68	170	1,033
1978	1,383	675	754	63	157	1,019
1979	1,607	870	840	68	178	1,142
1980	1,742	1,039	881	70	189	1,227
1981	1,855	1,213	936	71	199	1,312
1982	1,950	1,392	987	79	207	1,391
1983	3,404	2,643	1,733	144	361	2,250
1984	3,345	2,816	1,720	138	355	2,265
1985	2,932	2,668	1,526	117	313	2,084
1986	2,525	2,479	1,327	99	264	1,862
1987	2,498	2,638	1,288	96	256	1,873
1988	2,760	3,134	1,471	113	287	2,092
1989	3,283	3,756	988	494	494	1,978
1990	3,441	3,938	1,036	1,036	518	2,065
1991	3,626	4,149	1,092	1,310	546	2,274
1992	4,000	3,906	1,068	1,068	534	3,268
1993	4,712	3,972	1,131	984	566	3,470
1994	4,643	3,408	1,012	881	506	3,664
1995	4,799	3,615	1,086	978	543	3,642
1996	4,941	3,828	1,163	1,047	570	3,656
1997	4,954	3,951	1,215	1,093	571	3,941
1998	4,987	4,103	1,277	1,149	600	4,066
1999	5,112	4,347	1,300	1,163	616	4,105
2000	4,928	4,339	1,452	1,313	691	4,353
2001	5,040	4,605	1,486	1,263	743	4,318
2002	4,993	4,743	1,549	1,317	775	4,424
2003	4,861	4,816	1,593	1,433	796	4,591
2004	4,682	4,850	1,868	1,543	812	4,583
2005	4,554	4,954	1,680	1,596	1,008	4,742
2006	4,410	5,053	1,737	1,650	1,042	4,776
2007	4,033	4,890	1,958	1,873	1,107	4,891
2008	3,621	4,667	1,894	1,812	1,071	5,704
2009	3,413	4,705	1,935	1,851	1,094	5,714
2010	3,185	4,728	1,972	1,886	1,114	5,680