Reconstruction of marine fisheries catches for the Republic of Cape Verde, 1950-2010[1]

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Abstract

Total marine fisheries catches were estimated for the islands of Cape Verde from 1950 to 2010. Fisheries catch data were very limited before 1981, when the first fisheries landing surveys started. Catches reported by the Cape Verdean National Institute of Fisheries Development to FAO represent only domestic commercial catches by national fleets. Inconsistencies were found in the data supplied to FAO and were adjusted using various governmental and non-governmental sources. Total marine fisheries catches for 1950-2010 were estimated at over 758,500 t, including subsistence catches (131,600 t), recreational catches (7,700 t), baitfish catches (177,000 t). Total reconstructed catches of over 758,500 t were 1.7 times the landings of 442,318 t reported by Cape Verde to FAO.

Introduction

The Republic of Cape Verde, a former Portuguese colony which gained independence in 1975, is comprised of 10 major islands and numerous islets of volcanic origin. Situated off West Africa between latitude 15.8°N and longitude 23.8°W, it covers a land area of approximately 4,000 km² with an Exclusive Economic Zone (EEZ) of around 790,000 km² (Figure 1, www.seaaroundus.org). Nine of these islands are inhabited with a total human population of 491,875 (INE 2010). The uninhabited islands are often used by fishers for overnight encampments (Meintel 1984; Silva 2009).

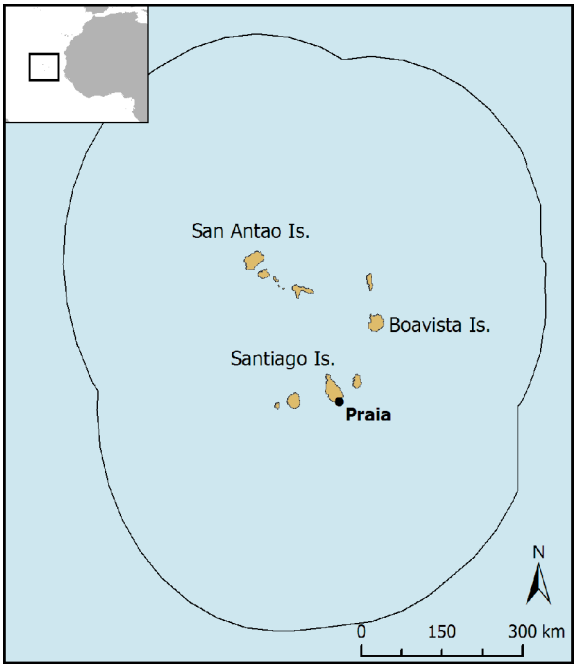

Figure 1. The Cape Verde islands and their Exclusive Economic Zone.

Darwin's visit to Cape Verde aboard the *M.H.S. Beagle* in 1832 highlighted these islands' marine life (Almeida 1997; Pauly 2004; Stobberup 2005). However, fisheries research and monitoring were neglected until recently (MAAP 2004). It was only in 1981 that a national fisheries agency started to collect catch and effort data (Monteiro 2002; Stobberup and Erzini 2006). Today, the National Institute of Fisheries Development (INDP) is responsible for the collection of fisheries statistics.

Domestic fisheries in Cape Verde are classified into three sectors: artisanal (small-scale), semi-industrial and industrial (INDP 2008, 2009; MegaPesca 2010). Small-scale fisheries represent an important source of employment (Baptista *et al.* 2006) and supply of animal protein for the local population (Tvedten and Hersoug

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1992). The small-scale fleet comprises boats ranging from 3 to 8 meters, which use hand-lines for large pelagic and demersal species, and purse seine, beach seine (*arrasto de praia*), gill net and dynamite for small pelagic species. The latter are used as baitfish or for direct human consumption (MegaPesca 2004). Scuba diving is practiced to catch coastal lobsters, mollusks and demersal fish species (MAAP 2004). Florida fighting conch (*Strombus alatus*) is widely exploited for tourist and domestic consumption (SEPA 1999). Both activities, scuba diving and catching conch, are considered small-scale fisheries.

The domestic semi-industrial and industrial fleets, here called "large-scale", operate boats from 8 to 20 meters and 20 to 28 meters, respectively (Fonseca 2000; MegaPesca 2004, 2010). These fleets target mainly large pelagic and demersal fishes using hand-line and pole and line, small pelagic species with purse-seine, and lobsters using traps (MAAP 2004). Prior to 1991, tuna landings represent about 80% of the total large-scale catch. In 1992, when new purse seine vessels targeting small pelagic species were introduced to this fishery sector, tuna landings started to decrease, and eventually tuna in total large-scale landings decreased to about 40% by 1998 (Fonseca 2000).

Recreational fisheries, which started, along with tourism in 1939 (Fialho 2011; CVRS 2012), are encouraged by the government and have developed alongside the tourism industry (Cabral 2005; MegaPesca 2010; ESR 2011). However, recreational catch data in Cape Verde, as in many other countries (e.g., Zeller *et al.* 2008), is scarce as the fisheries lacks monitoring.

Despite substantial investments in Cape Verdean fisheries, many coastal fishing communities suffer high rates of poverty (Baptista *et al.* 2009). These populations are heavily dependent on foreign aid, which covers about 40% of food imports (MegaPesca 2010). Furthermore, rising temperatures, decreasing rainfall and cyclical droughts related to climate change in the Sahel have further exposed rural populations to food security issues due to declining agricultural production (Kandji *et al.* 2006; Badjeck *et al.* 2011). Subsequently, populations tend to respond to climate change effects on agriculture by increasing fishing effort, thus placing increased pressure on coastal fisheries resources (MAAP 2004).

Extractions of marine fisheries resources are often underestimated in official statistics (Zeller *et al.* 2007). Landings data presented by FAO on behalf of countries cover mainly commercial fisheries (Garibaldi 2012), and Cape Verde is no exception (MAAP 2004). Cape Verdean fisheries play an important role in national food security and the local economy (Baptista and Santos 2008; ESR 2011). Hence, the aim of this study is to provide a comprehensive estimate of total domestic marine fisheries catches from Cape Verde, including reported landings and unreported catches (i.e. subsistence catches, discards, and recreational catches) from 1950 to 2010.

Methods

Reported landings data were acquired from the FAO FishStatJ database, along with various publications, including bulletins from the National Institute of Fisheries Development of Cape Verde (INDP) for the period from 1950 to 2010 (Stobberup 2005). Using all available sources, we derived estimates of (1) adjusted landings, (2) baitfish catch, (3) discards, (4) recreational catches, and (5) subsistence catches, using a catch reconstruction approach (Zeller *et al.* 2007; Zeller and Pauly 2007).

Adjusted and unreported landings

Differences between the data reported by FAO and those supplied by INDP were identified for some time-periods, mainly 1950-1985 and 2004-2010. From 1986 to 2002, we kept the data supplied by INDP as the reported baseline, since they were consistent with FAO (Figure 2). We used landings data presented by Watanabe (1981, in Stobberup 2005) from 1956 to 1980 as a more reliable estimate, based on a compilation from various sources, and replaced the data reported to FAO for this period. To estimate landings from 1950 to 1956, we carried the 1956-1960 trend backwards and completed the time series. From 1981 to 1985, landings data from Stobberup (2005) were used, as the data supplied to FAO contained extrapolations errors, which were later identified by the INDP (Figure 2). From 2004 to 2010, FAO landings were greater than reported landings by INDP, due to the inclusion of catches by re-flagged foreign vessels targeting large pelagic species in the FAO data (Carlos Alberto Monteiro, pers. obs. INDP). These reflagged catches were identified as such, and

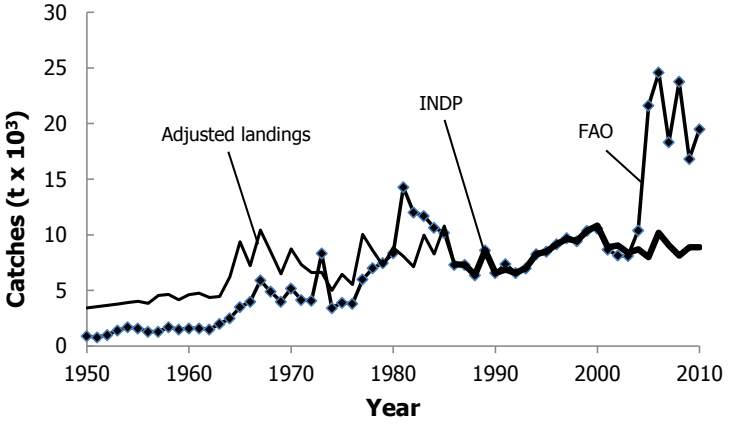

Figure 2. Adjusted landings from 1950 to 1985 (non-marked thin line without dots) and official INDP reported landings from 1986 to 2009 (thick line without dots). Lines without dots were used as domestic base line used in the resconstruction process, line with dots: data reported by FAO.

treated as non-EEZ reported landings. These adjusted for 1950-2010 were used as the baseline to estimate unreported domestic catch components (adjusting landings revealed that part of these were unreported between 1950 and 1980). Landings were separated into two sectors based on INDP (1998; 2008; 2009): the artisanal sector operated by boats between 3 and 8 meters, and the large-scale (also-called semi-industrial) sector operated by boats of over 8 meters long.

Table 1: Cape Verdean fleets and trips reported by INDP and its respective quantity of bait fish used per trip.

Fleet	Year	Boats	Effort (trips·boat^{-1}·year^{-1})	Catches (t)	Source	Bait·boat^{-1}·trip^{-1} (kg)	Source
Small-scale fleet	2009	136	135	4,552	INDP 2009	5	Silva (2009)
Large-scale fleet	2009	89	69	4,328	INDP 2009	380	MAAP (2003)

Baitfish catches

Baitfish is important for both small-scale and large-scale fisheries in Cape Verde (MegaPesca 2004). The small-scale fishery uses about 5 kg·boat^{-1}·trip^{-1} of live bait (Table 1) to catch large pelagic and demersal species (SEP 1985; Silva 2009). Similarly, the large-scale fleet, which also targets large pelagic and demersal species, and lobsters (MegaPesca 2010), uses around 380 kg·boat^{-1}·trip^{-1} of bait fish (Table 1), where 50% are eventually discarded (MAAP 2004).

The number of boats and the corresponding number of trips were obtained from INDP (2009) for 2009 (Table 1), then multiplied by 5 kg·boat^{-1}·trip^{-1} for small-scale boats and 380 kg·boat^{-1}·trip^{-1} for large-scale boats, resulting in a baitfish catch rate of 700 t·year^{-1} for small-scale boats and 2,333 t·year^{-1} for large-scale boats. Thereafter, we used landings by INDP (2009) to estimate the ratio 'bait fish/landings of targeted species', where 700 t·year^{-1} of bait fish were used to catch 4,552 t·year^{-1} of fish by the small-scale fleet, and 2,333 t·year^{-1} of bait fish were used to catch 4,328 t·year^{-1} by the large-scale fleet, i.e., 15% and 54%, respectively in 2009. We assumed constant rates from 1950 to 2010 and applied these rates over the adjusted landings to estimate total small pelagic baitfish catches from 1950 to 2010.

Dynamite use in bait fisheries

Fishers have been using dynamite to catch baitfish in Cape Verde since the 1950s, (MAAP 2004). This practice is illegal, but is still widely used. We treat these baitfish catches as unreported catch, since it is not regulated or monitored (Medina *et al.* 2002). Dynamite fishing is particularly damaging as it generates high rates of underwater mortality (Vakily 1993). In 1985, a development programme encouraged the use of purse seines in the artisanal small-scale fishery, as an alternative to the use of explosives (MAAP 2004; Silva 2009). Since then, purse seine fishing has increased and slowly replaced dynamite fishing (MAAP 2004). Therefore, we assumed that from 1950 to 1985, the amount of baitfish caught by dynamite fishing was the equivalent of 50% of the total baitfish estimated, and decreased this percentage to 10% by 2010, as the use of dynamite decreased (MAAP 2004).

Discards

Cape Verdean fishery discards are generated by the baitfish fishery. However for the purposes of this study, the underwater mortality generated by explosives was not considered. Keeping baitfish alive onboard fishing vessels is an important issue in Cape Verde fisheries (SEP 1985). The issue here is lack of sufficient space to keep the baitfish alive. Hence, a large proportion of the live baitfish, i.e. 50%, dies onboard fishing vessels (MAAP 2004). Therefore, to estimate onboard discards generated by the baitfish fishery, we used a discard rate of 50% applied to the total reconstructed baitfish catch.

Recreational catches

Cape Verde does not supply any recreational catch data to FAO. Recreational fishing in Cape Verde, a member of the International Game Fish Association (IGFA 2012), started after the first airport opened in 1939 (Fialho 2011), and is practiced exclusively by tourists (MAAP 2004). The total number of tourists

Table 2: Recreational fishery estimates for Cape Verde.

Year	Number of Tourists	Number of tourists fishing	CPUE (t·tourist^{-1}·year^{-1})	Catches (t)
1939	0[a]	0	-	-
1988	14,000[b]	175	0.248	44
1990	23,000[b]	288	0.248	71
1995	58,000[b]	727	0.215	157
2000	145,076[c]	1,818	0.183	332
2001	162,000[c]	2,030	0.176	358
2002	152,000[c]	1,905	0.170	323
2003	178,790[c]	2,241	0.163	366
2004	184,738[c]	2,315	0.157	363
2005	233,548[c]	2,927	0.150	439
2006	280,582[c]	3,517	0.144	505
2007	312,880[c]	3,921	0.137	537
2008	333,354[c]	4,178	0.131	545
2009[d]	330,319[c]	4,140	0.124	513
2010	381,831[b]	4,786	0.124	593

[a]Assumed-value; [b]www.ine.cv [2012]; [c]Anon (2010); [d] For 2009, the catches were extracted from the web site [www.capeverdemarlin.com], Anon (2012).

was available for 1988, 1990, 1995, and from 2000 to 2010 (CCIT 2010) (Table 2). We interpolated linearly from zero tourists in 1939 to 14,000 tourists in 1988 and completed the time series by a series of linear interpolations between 1988 and 2000.

Table 3: Taxonomic composition of recreational catches.

Common name	Taxon name	%[a]
Marlins	*Makaira* spp.	70
Wahoo	*Acanthocybium solandri*	7
Yellowfin tuna	*Thunnus albacares*	10
Sailfish	*Istiophorus platypterus*	3
Gilthead seabream	*Sparus* spp.	3
Groupers	*Epinephelus* spp.	3
Others		3

a) Percentages from Anon (2012).

The number of recreational fishers (92 tourist·month^{-1}), the number of trips (4 trips·tourist^{-1}·year^{-1}), and catch per tourist (124 kg·tourist^{-1}·day^{-1} or 0.496 t·tourist^{-1}·year^{-1}), were available for 2009 from a company offering "fishing safaris" in Cape Verde (Anon. 2012). As these catches were likely highliner catches from the most successful fishers, presented for advertising and promotional purposes, we assumed the actual catch rate to be 25% of the reported catch, i.e., 0.124 t·tourist^{-1}·year^{-1}. Due to the high development of tourism in the archipelago (Cabral 2005), we conservatively assumed the number of companies offering fishing safaris was 1 per island (9 companies in total), with the same average number of tourists per company, i.e., 828 tourists·month^{-1}. Since the number of fishing tourists represents a monthly average over seven months, we conservatively assumed that the number of recreational fishers was five times as high as the previous estimate over a one year period. We estimated the percentage of recreational fishers (4,140) out of the total number of tourists (330,319), i.e., 1.3%, and applied this rate to the total number of tourists from 1950 to 2010 (excluding 2009) to derive a time series of recreational fishers (Table 2).

We assumed the annual catch per tourist from 1950 to 1990 was twice (0.248 t·tourist^{-1}·year^{-1}) the 2009 and 2010 catch rate (0.124 t·tourist^{-1}·year^{-1}, Table 2) because of the overexploitation of large pelagic species targeted by tourists in the archipelago and commercial fisheries (Monteiro 2002; Stobberup 2005). A linear interpolation was used between 1991 and 2009 to complete the time series. We then estimated the total annual catch by multiplying the total number of recreational fishers by the catch per tourist for each year (Table 2). Recreational catches were disaggregated using catch data by Anon. (2012, Table 3).

Subsistence catches

Cape Verdeans catch fish to meet their nutritional needs via subsistence fishing (WorldBank 2008; Baptista *et al.* 2009). These catches consist mainly of mackerel scad (*Decapterus macarellus*) and other small pelagic species, which are not reported, and thus not included in official catch figures (MAAP 2004). Subsistence fishers commonly use beach seine, purse seine, gillnet, hand line and dynamite (SEP 1985; MAAP 2004). Therefore, subsistence catches for Cape Verde were estimated as a proportion of reported catches from each fishing gear.

Beach seine catches were available from INDP bulletins from 1997 to 2001, and for 2008 and 2009 (INDP 1998, 2008, 2009). These included catches used for bait and for personal consumption. We divided these catches by total reported landings and estimated the proportion caught by beach seines between 1997 and 2001, and for 2008 and 2009, i.e., 2.1%, 3.6%, 5.4%, 4.7% and 4% respectively for the years between 1997 and 2001, and 13.6% and 15.9% for 2008 and 2009 respectively. After the independence of Cape Verde in 1975, the contribution of beach seines to total catches was lower because of the increasing use of purse-seine (MAAP 2004). Thus, we conservatively assumed beach seine catches accounted for 10% of the total catch between 1950 and 1974. Thereafter, we interpolated linearly from 10% in 1974 to 2.1% in 1997 and from 4% in 2001 to 13.6% in 2008 to complete the time series assuming the same rate for 2009 and 2010, and applied these rates to the total reported landings. We assumed the equivalent of 50% of estimated beach seine catches were used for personal consumption, i.e., subsistence, because of their low value (MAAP 2004), thus not reported nor used as bait fish.

Since fish caught by other, mainly offshore gears (e.g., gillnet, purse seine, hand line and dynamite), are of better quality and are more likely to be sold and used as baitfish (MAAP 2004), we assumed the equivalent of 25% of the reported landings by these gears to be

Table 4: Main fishing gears used by foreign fleets operating in Cape Verde and the development of licences drawn. Source: DGP, Cape Verde.

Gears by vessel	Flag	Licences drawn			
		2007	2008	2009	2010
Surface long line	Japan	18	18	16	8
Pole and line	Senegal	7	2	4	0
Total (non - EU)		**25**	**20**	**20**	**8**
Surface long line	EU	28	27	26	28
Pole and line		11	10	8	8
Purse seine		8	10	12	21
Total (EU)		**47**	**47**	**43**	**57**

Table 5: Development of declared foreign fleet catches by main species (Japan and US), within Cape Verdean EEZ. Only about 9.4% of the foreign fleets reported their catches (DGP in Fonsceca 2000). Source: (MAAP 2004).

Main species	1997	1998	1999	2000	2001	2002
Yellowfin tuna	63.0	44.3	54.8	31.5	35.9	124.8
Skypjack tuna	263.0	-	-	-	-	40.2
Bigeye tuna	-	32.0	211.7	279.1	148.1	144.8
Bill fish	21.4	-	7.0	23.7	5.0	3.2
Swordfish	146.0	159.6	54.7	52.9	11.1	72.4
Sharks	522.9	590.3	125.4	331.3	109.5	486.2
Others	101.3	293.4	51.6	205.2	58.7	170.8

unreported subsistence catch kept for personal consumption. We then applied this rate to the total landings (excluding estimated catches of beach seine) from 1950 to 2010.

Industrial foreign fleet catches

Foreign fishing vessels operating in the Cape Verde EEZ are mainly longliners and some purse seiners. According to Hallier and Vieira (1996 in Fonseca 2000), their annual average catches are around 4,000 t. Between 43 and 57 foreign vessels from Japan, Senegal and the EU have been fishing in Cape Verde from 2007 to 2010 (Table 4), under a range of different access arrangements and there is no record of landings from these vessels in Cape Verdean ports (MegaPesca 2010). Most recently, new agreements were made with China (Carlos Alberto Monteiro, pers. obs.). The inconsistencies found between the statistics presented by INDP and FAO for the period 2004-2010 are likely due to re-flagging of foreign vessels, considered as domestic catch by FAO. Only a few truly domestic Cape Verdean vessels have the capacity to operate in offshore waters within the Cape Verde EEZ. While FAO reports these catches as being caught by Cape Verde, based on data from ICCAT, no knowledge of these catches exist among Cape Verdean fisheries experts (Carlos Alberto Monteiro, pers. obs.), and hence these catches are likely exclusively for foreign beneficial ownership. However, because we were unable to identify the beneficial country of origin, these catches were treated here as Cape Verdean catches. This highlights a need for greater transparency of actual beneficial vessel ownership in order to improve fisheries accounting not just in Cape Verde, but everywhere.

The number of licenses given to foreign fleets from the Europe Union and Japan are registered by General Direction of Fisheries (DGP) of Cape Verde (Table 4). The main species targeted by those fleets are highly migratory species, e.g., bigeye tuna (*Thunnus obesus*), swordfish (*Xiphias gladius*), yellowfin tuna (*Thunnus albacares*) and sharks (as by-catch) (Table 5). Furthermore, all foreign fleets have to fill in logbooks and report to the port authorities fishing location, catch, entry and exit from Cape Verde jurisdiction as well as allow observers on board (MegaPesca 2004). However, only about 10% of the foreign fleets really declare their catches (DGP, in Fonsceca 2000).

Taxonomic composition

We derived a species composition of major taxonomic groups from INDP (1998, 2008, 2009) reports. We converted quantities by species to percentages for both small-scale (Table 6) and large-scale (Table 7) fleets. We applied the species breakdown for small pelagic and demersal species from 1950 to 1998 based on INDP (1998), and from 1999 to 2010 from INDP

Table 6: Taxonomic composition in (%) for main groups of small-scale reported landings derived from INDP (1998, 2008, 2009).

Period	Large pelagics	Small pelagics	Demersal	Others	Sharks	Lobsters	*Buzio cabra*[d]	Octopus[c]
1950-1986[a]	63	27	8	0.11	0.31	0.10	1.16	0.05
1987[a]	63	25	10	0.18	0.31	0.06	1.17	0.05
1988[a]	66	21	11	0.14	0.31	0.09	1.16	0.05
1989[a]	47	41	11	0.38	0.32	0.08	1.19	0.05
1990[a]	47	40	10	0.51	0.32	0.09	1.20	0.05
1991[a]	43	42	13	0.30	0.32	0.09	1.18	0.05
1992[a]	45	44	9	0.22	0.31	0.09	1.17	0.05
1993[a]	45	45	8	0.42	0.32	0.09	1.19	0.05
1994[a]	44	45	9	0.17	0.31	0.08	1.17	0.05
1995[a]	45	41	12	0.42	0.32	0.09	1.19	0.05
1996[a]	44	41	13	0.35	0.32	0.09	1.18	0.05
1997[a]	44	37	17	0.72	0.32	0.09	1.21	0.05
1998[a]	35	52	12	0.57	0.15	0.13	0.00	0.00
1999[b]	38	40	20	0.60	0.15	0.11	1.23	0.06
2000[b]	34	41	22	0.69	0.14	0.09	1.24	0.06
2001[b]	44	32	22	0.45	0.17	0.11	1.21	0.05
2002[b]	47	31	20	0.47	0.19	0.11	1.21	0.05
2003[b]	46	31	20	0.52	0.21	0.10	1.21	0.05
2004[b]	33	40	24	0.42	0.21	0.10	1.21	0.05
2005[b]	30	44	23	0.64	0.24	0.10	1.22	0.06
2006[b]	41	32	25	1.23	0.28	0.10	1.25	0.06
2007[b]	34	34	29	1.75	0.29	0.11	1.27	0.06
2008[b]	33	34	29	1.77	0.34	0.10	1.27	0.06
2009-2010[c]	41	31	26	1.89	0.31	0.13	0.43	0.06

[a]INDP (1998); [b]INDP (2008); [c]INDP (2009); [d]*Strombus alatus*

Table 7: Taxonomic composition (in %) of main groups for large-scale reported landings derived from INDP bulletins (1998, 2008, 2009) and SEP (1985).

Period	Large pelagics	Small pelagics	Demersals	Others	Lobsters	Sharks
1950-1985[a]	83	10	4.97	0.02	1.41	0.03
1986[a]	84	10	4.68	0.00	1.36	0.01
1987[a]	86	13	0.14	0.01	1.42	0.02
1988[a]	91	7	0.95	0.00	1.56	0.01
1989[a]	80	11	7.85	0.01	1.12	0.02
1990[a]	84	10	4.76	0.01	1.38	0.02
1991[a]	82	15	1.04	0.01	1.86	0.02
1992[a]	84	12	0.21	0.01	2.83	0.02
1993[a]	43	52	0.23	0.01	4.66	0.02
1994[a]	40	56	0.95	0.06	3.49	0.02
1995[a]	33	63	1.82	0.01	2.36	0.01
1996[a]	44	51	2.81	0.01	1.54	0.01
1997[a]	40	54	4.98	0.06	0.70	0.01
1998[a]	27	70	2.58	0.03	0.55	0.01
1999[b]	29	67	3.30	0.08	0.66	0.01
2000[b]	49	46	4.07	0.10	0.82	0.04
2001[b]	47	50	2.70	0.06	0.78	0.04
2002[b]	41	55	2.81	0.15	0.83	0.04
2003[b]	30	67	1.72	0.01	0.66	0.04
2004[b]	32	66	1.46	0.10	0.56	0.04
2005[b]	38	59	2.57	0.01	0.78	0.04
2006[b]	22	74	3.76	0.03	0.41	0.04
2007[b]	26	70	4.12	0.47	0.20	0.04
2008[b]	19	78	2.93	0.22	0.20	0.04
2009-2010[c]	20	76	3.06	0.02	0.21	0.04

[a]INDP (1998); [b]INDP (2008); [c]INDP (2009).

(2008, 2009). The taxonomic breakdown for tuna from 1950 to 1983 was derived from SEP (1985). For 1984-1998, we used the percentages from INDP (1998), and for 1999-2010 we used the percentages found in INDP (2008, 2009). We disaggregated baitfish catches using the same species composition as that of the small pelagic fishery, and for subsistence catches we used the same species composition as that of small pelagic and demersal fisheries.

Results

Baitfish catches

Our total reconstructed baitfish catches (utilized in the fishery, i.e., not discarded) for Cape Verde from 1950 to 2010 were estimated to be around 88,450 t (Figure 3). Between 1950 and 1965, catches remained at around 900 t·year^{-1}. Between 1966 and 2010, baitfish catches varied with large catches in 1985 (2,600 t) and 2006 (2,200 t) and lower catches in 1976 (1,100 t) and 1990 (1,200 t). Baitfish caught using dynamite, and utilized in the fishery, were estimated at 15,500 t from 1950 to 1985 and 9,100 t between 1986 and 2010. Baitfish catches were dominated by mackerel scad with 48,800 t, blackspot picarel (*Spicara melanurus*) with 19,900 t and bigeye scad (*Selar crumenophthalmus*) with 11,200 t, over the 1950-2010 time period.

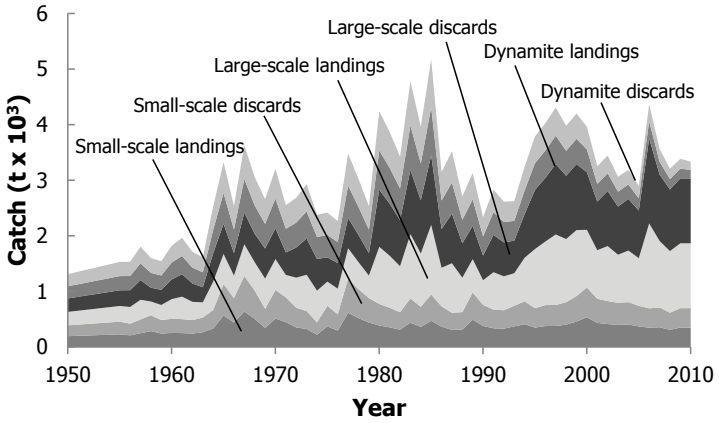

Figure 3. Small and large-scale baitfish catches (i.e., live baitfish used in the fishery) and the corresponding baitfish discards generated by sector.

Discards

Discards generated by baitfish catches totaled around 88,450 t between 1950 and 2010, and included mainly small pelagics (Figure 3). Baitfish discards increased from 655 t·year^{-1} in 1950 to 1,700 t·year^{-1} in 2010, with peaks of 1,800 t in 1967, 2,600 t in 1985, and around 2,200 t in 2006. Small pelagic species, such as mackerel scad represented over 50% (48,800 t) of the discards from 1950 to 2010.

Recreational catches

The total recreational catch was estimated at approximately 7,700 t over the period 1950-2010, which included 5,400 t of marlin (*Makaira* spp.), 540 t of wahoo (*Acanthocybium solandri*), 770 t of yellowfin tuna (*Thunnus albacares*), and just under 1,000 t of other pelagic species including sailfish (*Istiophorus platypterus*) and demersal species such as gilthead seabream (*Sparus aurata*) and groupers (*Epinephelus* spp.).

Subsistence catches

Subsistence catches totaled 132,000 t for the period between 1950 and 2010, of which 17,600 t (13%) were taken by beach seine, and 12,300 t (9%) by dynamite. Subsistence catches by other gears (purse seine, gillnet and hand line) were estimated at approximately 101,800 t (77%) (Figure 4). Mackerel scad represented 41% of the subsistence catches with over 54,600 t.

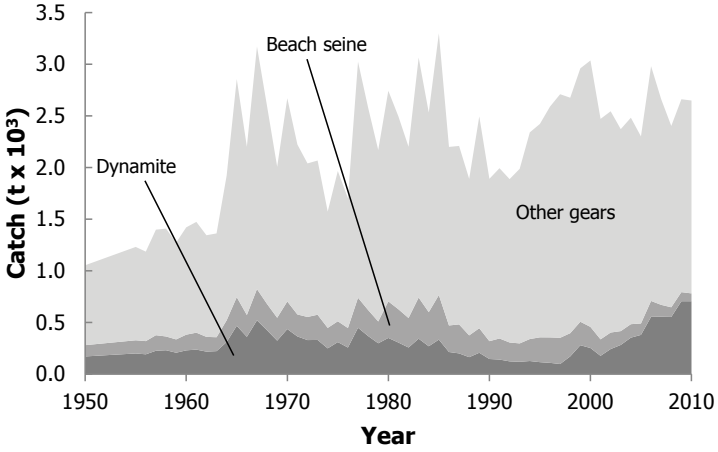

Figure 4. Subsistence catches by different gears; beach seine, dynamite and other gears (purse seine, gillnet and hand line) from Cape Verde waters, 1950-2010.

Industrial foreign fleet catches

For the period from 2004 to 2010, the data reported to FAO was higher than the data shown in INDP reports for the same period (Figure 2). These catches were higher due to the inclusion of re-flagged foreign fleet catches (Carlos Alberto Monteiro, pers. obs. INDP). From 2004 to 2010, INDP reported 17,800 tonnes of large pelagic "*Tunídeos"*, yellowfin tuna, common dolphinfish (*Coryphaena hippurus*), frigate tuna (*Auxis thazard*), little tunny

(*Euthynnus alletteratus*) and wahoo, for the same period, data supplied to FAO were 93,600 t, which represented an addition of 75,700 t in this category. While these catches are technically foreign, the unknown origin of these fleets required that they continue to be considered domestic landings.

Total reconstructed catches

Total reported catches for Cape Verde were estimated to be approximately 287,200 t between 1950 to 2010 for the small-scale fishery and 155,000 t for the large-scale fishery (Figure 5a). The overall reconstruction includes adjusted landings, bait fish catches (utilized and discarded), recreational catches and subsistence catches, for a total reconstructed catches of 758,500 t from 1950 to 2010 (Figure 5a). Yellowfin tuna is the most abundant large pelagic species, representing 16% of the total reconstructed catch (Figure 6b) and the most abundant small pelagic species was mackerel scad, representing 32% of the total reconstructed catch. From 1950 to 1963, total reconstructed catches remained relatively constant at around 7,000 t·year^{-1}, and then increased to 16,600 t·year^{-1} in 1977. Catches reached a peak of 19,300 t·year^{-1} in 1985, and then decreased to 10,900 t·year^{-1} in 1992, increasing again to 18,100 t·year^{-1} in 2006. The unreported component showed a decreasing trend, in 1950 reconstructed catches were over 6 times the landings data supplied to FAO and in 2010 the under-reporting tendency was reversed, when the data reported by FAO were 26% higher. However, in recent years FAO data included essentially non-domestic catches of large pelagic species by foreign fleets, if these were excluded in 2010, reconstructed catches would be about 1.7 times the data provided by Cape Verde to FAO.

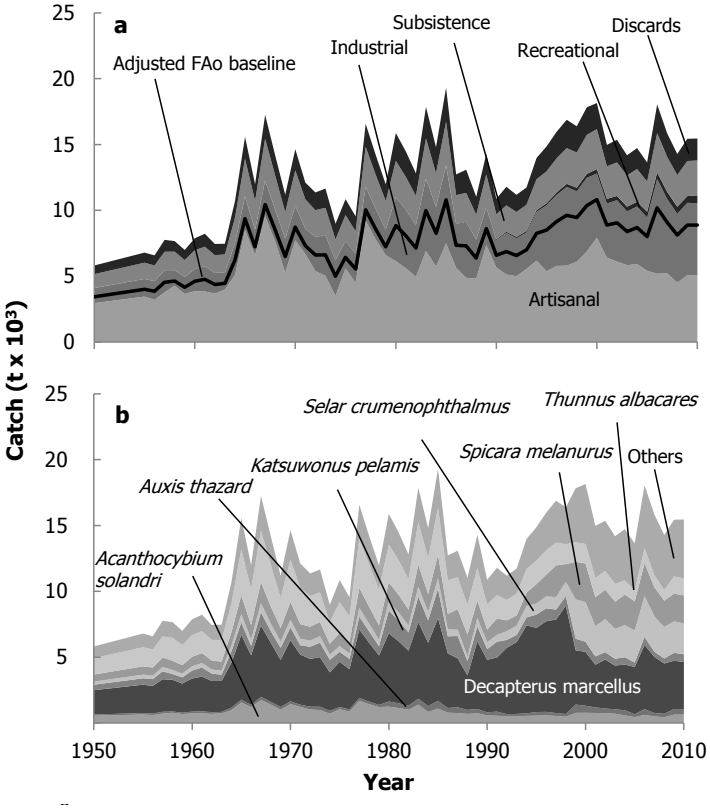

Figure 5. Overall catch reconstruction compared to data supplied to FAO (a) and and its taxonomic breackdown by major taxa (b) from 1950 to 2010. Others inlude large pelagics (7 taxa), small pelagics (10 taxa), demersal (26 taxa), lobsters (4 taxa), sharks, molluscs (*Strombus alatus* and *Octopus* spp.).

Discussion

Total reconstructed catches for Cape Verde for the period 1950-2010 were estimated at approximately 758,500 t, nearly 1.7 times the total landings supplied by Cape Verde to FAO (448,200 t). Overall, unreported components were: 132,000 t (subsistence catches), 176,900 t (bait fish catches, including discards as bait fish) and 7,700 t (recreational catches). Adjusted landings, now acounting for the under-reporting prior to 1980, and over-reporting in the 2000s, based on reported INDP bulletins and other literature sources were 442,318 t.

The current fisheries data monitoring system only covers about 15% of landings sites in Cape Verde (INDP 1998, 2008, 2009), which suggests substantial under-reporting, as illustrated in this study. Research efforts have mainly focused on the study of fishing possibilities in the archipelago (Fonseca 2000; Stobberup 2005; Baptista *et al.* 2006; Baptista and Santos 2008), without emphasizing the importance of collecting consistent catch time series (Stobberup *et al.* 2005; Merino 2006). This report is the first attempt of accounting for all Cape Verdean fisheries removals.

Besides poor monitoring coverage and a lack of reliable data, environmental concerns about Cape Verdean marine resources and the sustainability of fisheries are increasing (FOPESCA 1997; SEPA 1999; Baptista 2005). Ecosystems are threatened by the use of destructive gears such as dynamite (MAAP 2004; Merino 2006) and the loss generated by these gears (discards as underwater mortality) could be as high as 265,000 t from 1950 to 2010, which is the equivalent to about 38% of total reconstructed catches. Although these numbers illustrate the destruction and waste caused by the use of dynamite, they were not included in the analysis of fisheries trends described in the present study.

The increasing trend in subsistence catches suggests a rising dependence on fish as source of food. This dependence is accentuated by climate change which has caused cyclical droughts since 1968 affecting agricultural production (Anon. 1999; NAPA 2007). Subsistence fisheries show high vulnerability to climate change in most West African

countries (Allison *et al.* 2009). Tourism development in the Cape Verde archipelago has resulted in increasing sport fishing (ICCAT 2009). Catches by tourists from 1950 to 1980 were relatively low, about 23 t·year^{-1}, due to the low number of tourists participating in recreational fishing. These catches increased to 325 t·year^{-1} from 1990 to 2010, due to the expansion of tourism (Cabral 2005). This trend shows that recent developments of tourism in the archipelago along with the complete absence of monitoring of recreational fisheries (MAAP 2004) has generated considerable unreported catches. Tourist catches represented about 7% of the Cape Verdean artisanal reconstructed domestic catch from 2000 to 2010, which suggests a strong interest in recreational fishing by tourists over the past decade.

Overall, this study shows that fisheries data in Cape Verde, as in many countries in the world, are a substantial under-estimate of total domestic fisheries removals. In this context, we present a more realistic estimate of total domestic catches for Cape Verde.

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Appendix Table A1: FAO reported landings of the Cape Verde Islands vs. large and small-scale adjusted landings (baitfish included), subsistence catches, discards and recreational catches.

Year	FAO	Small-scale	Large-scale	Subsistence	Discards	Recreational	Total reconstructed
1950	900	2,955	1,139	1,055	655	10	5,354
1951	800	3,054	1,177	1,090	677	11	5,522
1952	1,000	3,153	1,215	1,125	699	12	5,719
1953	1,400	3,252	1,253	1,161	721	12	5,935
1954	1,700	3,352	1,292	1,196	743	13	6,142
1955	1,600	3,451	1,330	1,232	765	14	6,309
1956	1,300	3,199	1,417	1,186	766	15	6,073
1957	1,300	3,776	1,667	1,399	903	16	7,158
1958	1,700	4,273	1,165	1,409	800	17	7,131
1959	1,500	3,650	1,284	1,273	772	18	6,482
1960	1,600	3,861	1,667	1,421	912	19	7,271
1961	1,600	3,843	1,904	1,474	983	20	7,569
1962	1,500	3,679	1,549	1,345	856	20	6,877
1963	2,000	3,989	1,284	1,363	807	21	6,925
1964	2,500	5,083	2,406	1,922	1,265	22	9,855
1965	3,500	8,487	2,553	2,856	1,662	23	14,472
1966	4,000	6,597	1,904	2,201	1,267	24	11,148
1967	5,900	9,559	2,686	3,171	1,814	25	16,046
1968	4,900	7,624	2,406	2,593	1,528	26	13,156
1969	4,000	5,268	2,553	2,007	1,330	27	10,297
1970	5,181	7,730	2,613	2,671	1,602	28	13,575
1971	4,153	6,682	1,904	2,223	1,276	28	11,262
1972	4,078	5,394	2,553	2,040	1,343	29	10,464
1973	8,333	5,027	3,070	2,068	1,463	30	10,682
1974	3,428	3,504	2,686	1,574	1,188	31	8,190
1975	3,900	5,595	2,052	1,966	1,209	32	10,049
1976	3,800	4,507	2,170	1,704	1,133	33	8,793
1977	6,000	9,208	2,568	3,024	1,741	34	15,420
1978	7,000	7,782	2,302	2,580	1,512	35	13,209
1979	7,476	6,597	1,904	2,169	1,267	36	11,136
1980	8,351	6,142	4,835	2,743	2,121	36	14,474
1981	14,272	5,600	4,408	2,494	1,934	37	13,197
1982	12,019	4,957	3,901	2,201	1,712	38	11,681
1983	11,697	6,919	5,447	3,064	2,390	39	16,286
1984	10,634	5,734	4,513	2,532	1,981	40	13,498
1985	10,190	7,490	5,896	3,298	2,587	41	17,615
1986	7,309	5,643	3,273	2,200	1,574	42	11,724
1987	7,309	4,874	4,199	2,209	1,760	43	11,982
1988	6,374	4,828	2,914	1,890	1,355	44	10,206
1989	8,601	7,357	2,822	2,495	1,566	58	13,374
1990	6,570	5,659	2,087	1,891	1,168	71	10,208
1991	7,369	5,126	3,166	1,994	1,417	91	11,002
1992	6,564	5,004	2,876	1,888	1,307	109	10,476
1993	6,995	5,556	2,756	1,988	1,312	126	11,052
1994	8,256	6,183	3,693	2,340	1,620	142	13,160
1995	8,495	5,377	5,012	2,422	1,894	157	13,934
1996	9,155	5,782	5,387	2,590	2,014	197	15,022
1997	9,705	5,805	5,976	2,710	2,154	235	15,852
1998	9,424	6,094	5,355	2,676	1,989	271	15,472
1999	10,360	6,881	5,590	2,960	2,100	303	16,909
2000	10,586	7,922	4,880	3,036	1,981	332	17,317
2001	8,676	6,402	4,115	2,471	1,627	358	14,317
2002	8,145	6,116	4,658	2,545	1,722	323	14,738
2003	8,103	5,837	4,079	2,372	1,531	366	13,654
2004	10,396	5,924	4,369	2,482	1,593	363	14,197
2005	21,617	5,413	4,037	2,301	1,449	439	13,190
2006	24,590	5,186	7,196	2,981	2,184	505	17,430
2007	18,328	5,220	5,637	2,662	1,783	537	15,355
2008	23,768	4,514	5,218	2,403	1,604	545	13,883
2009	16,828	5,078	5,495	2,661	1,692	513	15,070
2010	19,500	5,053	5,495	2,649	1,668	593	15,063

Appendix Table A2: Taxonomic composition of the reconstructed catch of the Cape Verde Islands.

Year	*Thunnus albacares*	*Katsuwonus pelamis*	*Acanthocybium solandri*	*Auxis thazard thazard*	*Decapterus macarellus*	*Selar crumenophthalmus*	*Spicara melanurus*	Others
1950	1,242	414	551	95	1,845	238	536	891
1951	1,284	428	570	98	1,907	246	554	921
1952	1,326	442	589	101	1,969	254	572	951
1953	1,368	456	607	104	2,031	262	590	981
1954	1,410	470	626	108	2,093	270	609	1,011
1955	1,452	484	644	111	2,156	278	627	1,040
1956	1,367	513	605	117	2,099	271	608	1,004
1957	1,613	604	714	138	2,476	320	717	1,179
1958	1,743	433	780	100	2,406	310	704	1,189
1959	1,521	470	677	108	2,213	285	644	1,078
1960	1,645	605	728	138	2,511	324	728	1,200
1961	1,666	687	735	157	2,634	340	761	1,244
1962	1,563	562	693	128	2,370	306	688	1,139
1963	1,649	472	736	108	2,353	303	686	1,155
1964	2,192	871	967	198	3,424	442	990	1,614
1965	3,493	946	1,559	217	4,915	633	1,434	2,383
1966	2,705	707	1,209	162	3,775	486	1,103	1,846
1967	3,913	1,001	1,749	229	5,433	699	1,587	2,644
1968	3,150	889	1,405	204	4,477	577	1,305	2,169
1969	2,279	923	1,005	210	3,582	462	1,035	1,687
1970	3,215	962	1,432	220	4,635	597	1,349	2,235
1971	2,737	708	1,224	162	3,810	491	1,113	1,868
1972	2,327	924	1,027	211	3,634	469	1,051	1,717
1973	2,248	1,101	984	250	3,766	486	1,083	1,740
1974	1,629	957	707	217	2,924	378	836	1,335
1975	2,344	751	1,043	172	3,439	443	1,000	1,663
1976	1,947	784	860	179	3,051	394	882	1,450
1977	3,767	957	1,685	219	5,210	671	1,522	2,545
1978	3,198	854	1,429	196	4,471	576	1,305	2,182
1979	2,705	707	1,210	162	3,760	484	1,098	1,847
1980	2,873	1,723	1,244	391	5,178	669	1,479	2,321
1981	2,620	1,571	1,134	356	4,717	609	1,347	2,119
1982	2,318	1,390	1,004	315	4,171	539	1,191	1,881
1983	3,238	1,942	1,402	440	5,821	752	1,662	2,603
1984	2,718	1,700	839	449	4,812	622	1,374	2,286
1985	3,551	2,222	1,096	587	6,284	812	1,794	2,967
1986	2,561	1,298	781	360	4,148	536	1,161	1,888
1987	2,426	1,696	756	439	3,715	480	1,560	2,014
1988	2,269	1,087	690	305	2,619	339	1,673	2,047
1989	2,451	1,110	744	316	5,150	663	1,320	2,543
1990	1,895	813	576	235	3,993	515	961	1,889
1991	1,774	1,195	556	311	4,108	531	1,240	2,079
1992	1,541	592	489	177	5,054	662	826	1,843
1993	1,656	538	502	190	5,462	715	765	1,911
1994	1,797	600	545	187	6,684	879	1,006	2,282
1995	1,790	1,013	559	273	6,391	843	1,466	2,527
1996	1,854	980	578	269	6,882	909	1,652	2,846
1997	1,733	754	539	217	7,107	950	2,399	3,181
1998	1,514	722	477	203	8,232	1,088	1,350	2,799
1999	1,478	878	770	632	4,120	2,986	2,858	4,111
2000	1,481	765	773	539	4,094	3,007	2,938	4,555
2001	1,457	629	762	422	3,244	2,303	2,193	3,962
2002	1,418	558	740	363	3,720	2,512	2,238	3,815
2003	1,343	517	705	334	3,325	2,270	2,066	3,624
2004	1,082	557	573	392	3,474	2,434	2,324	3,893
2005	825	334	448	220	3,589	2,432	2,216	3,575
2006	1,153	612	619	434	4,879	3,085	2,513	4,757
2007	908	391	497	262	4,267	2,682	2,214	4,617
2008	799	374	443	257	3,821	2,404	1,994	4,191
2009	1,300	604	635	428	3,664	2,388	2,107	4,312
2010	1,290	588	636	414	3,581	2,346	2,134	4,469