Reconstruction of marine fisheries catches for Morocoo (north, central and south), 1950-2010[1]

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Abstract

Fisheries catches in the Moroccan Exclusive Economic Zone (EEZ), including the Atlantic and Mediterranean areas, were reconstructed to include commercial small-scale, commercial large-scale, illegal and unregulated fisheries, non-commercial recreational and subsistence fisheries, and foreign catches in both EEZ areas. Estimated domestic catches suggest that Moroccan data supplied to FAO are less reliable than they should be, with over 41.5% of catches being unreported. This study also shows that 25.4 million tonnes of catches were taken from the southern EEZ area, which contributed to 52% of the Moroccan catch estimated at 48.4 million tonnes. This illustrates not only that Morocco needs to improve its fisheries monitoring system to include small-scale fishing and unregulated fishing, but also questions the impacts of the fishing access agreements signed by Morocco on the local economy and fisheries sustainability, particularly in the southern area where most foreign catches are taken.

Introduction

Morocco is located in North Africa, west of Algeria and shares the Alboran Sea with Spain in the North. On the West African coast, Morocco, including the former Spanish Sahara, ranges from Tangier (36° N) to Lagouira (20° N) on Cape Blanc, which is one of the richest fishing areas in the world due to the sustained east central Atlantic upwelling (Porter 1997; Anon. 2005a). Morocco proclaimed its EEZ in 1981 (Anon. 2007). Morocco maintains the southern area under its administration since 1976, after the Spanish Sahara territory became independent from Spain (Rojo-Diaz and Pitcher 2005). In this study, we do not take position on the legality of Moroccan fisheries in Saharan waters, which is a matter of the International Court of Justice 1975 ordinance on the right for self-determination (Barreira *et al.* 1998). Rather, we will attempt to first estimate total catches as defined above, and allocate these catches to the three areas defined above (northen Mediterranean, Atlantic central Moroccan and Atlantic southern areas) per fishing sector. Thus, this paper presents a reconstruction of the total removals from both the northern and central coasts of Morocco (Figure 1), along with the southern areas (Figure 2), from 1950 to 2010. It provides an update to the report by Baddyr and Guénette (2001), including small-scale fisheries catches and unreported catches of industrial fisheries. It also accounts for subsistence, recreational and unreported artisanal catches, as well as discards, including catches from the waters off the Mediterranean coast of Morocco.

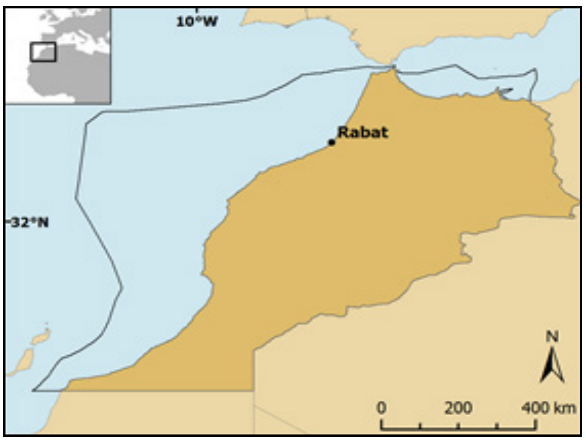

Figure 1. Map of Morocco showing the Mediterranean northern and the Atlantic central coasts.

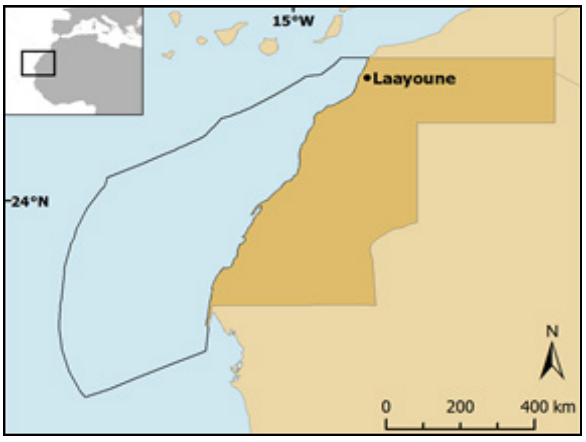

Figure 2. Map of the southern areas of Morocco.

The artisanal fishery is an informal sector in Morocco, and there is no data collection system (Malouli Idrissi *et al.* 2001; ArtFiMed 2009); it consists mostly of small wooden dories under six meters of length called *pateras,* targeting mainly small fish and other species. This category also includes hand collection of algae and mussels and shore-based fishing using lines (Baddyr and Guénette 2001). The large-scale fisheries include two types of activities: inshore or coastal fisheries initiated by Spanish and Portuguese fishers with 16 to 24 m wooden boats manufactured locally without catch preservation systems, and targeting pelagic species using purse seines, demersal species using long liners, bottom trawls and driftnets, and the off-shore industrial fishery

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which started in 1972 and has grown rapidly since then. It consists almost exclusively of large freezer trawlers fishing for several weeks at a time (Baddyr and Guénette 2001; Franquesa *et al.* 2001; Rojo-Diaz and Pitcher 2005; Tudela *et al.* 2005; Anon. 2007; FAO 2011). Fishing in Morocco has been a major activity since the 1930s, and the industry experienced tremendous growth during the 1980s (Rojo-Diaz and Pitcher 2005). However, heavy exploitation by both national and foreign vessels (Ariz 1985; Baddyr and Guénette 2001), a lack of monitoring and enforcement because of existing economic difficulties (Kaczynski 1989), and an emphasis on short-term profits from resource exploitation rather than long-term sustainable benefits (Kaczynski 1989) resulted in over-exploitation of important demersal stocks, shifting stocks (Balguerías *et al.* 2000; Baddyr and Guénette 2001; Pitcher *et al.* 2002; Anon. 2005a) and increasing illegal, unreported and unregulated fisheries (Anon. 2005c). Importantly, fisheries contribute to the livelihood of around 400 000 people in poor, rural areas, and represent 15% of the total Moroccan exports. Moreover, 20% of the Moroccan and former Spanish Saharan populations suffer from a lack of protein, and live under the poverty line (Anon. 2005a). For these reasons, it is important to analyze more complex trends of total fisheries catches and question the management strategy of Morocco.

Methods

Electronic time series of landings data were available from the Food and Agriculture Organization (FAO) from 1950 to 2010, and Moroccan National Fisheries Office reports (*Office national des pêches*, ONP) from 1999 to 2010. We also used data available from a previous reconstruction by Baddyr and Guénette (2001), which included the artisanal and the industrial fisheries effort and catches for Moroccan Atlantic and Western Sahara from 1950 to 1998. Reported landings are distinguished by species or higher taxonomic grouping and `miscellaneous groups´. Since the main goal of this study is to estimate the total catch per species or higher taxonomic group, we compared the FAO data to the above-cited national reports, and concluded that differences between the datasets from 1999 to 2010 were not significant. Thereafter, we aggregated catch data presented by area during the period from 2000 to 2010 (www.onp.co.ma [2011]), separated landings from northen, central and southern areas, and concluded that catches from southern areas represented around 56% of the total Moroccan landing data supplied to the FAO. We applied this rate to the data reported to the FAO from 1950 to 2010 to estimate reported catches by Morocco for the southern areas. We used the separated data for Morocco (Mediterranean northern and Atlantic central areas) and southern areas as a reported baseline, to which we added: (1) under-reported small-scale artisanal catches; (2) under-reported large-scale catches; (3) illegal catches; (4) discards; (5) subsistence catches and (6) recreational catches.

Table 1. Anchor points for small-scale fishing effort (number of boats) and the corresponding CPUE (t·boat-1·year^{-1}) for Morocco.

Year	Effort	Source	CPUE	Source	Catch (t)	Source
Atlantic central and southern areas						
1950	-	-	-	-	39,245	25% higher than 1981 catches
1981	2,700	Baddyr and Guénette (2001)	11.63	1.25 times $CPUE_{1991}$	31,396	Based on CPUE and effort
1985	4,028	Do Chi and Idelhadj (1991)	-	-	-	-
1988	4,035	Baddyr and Guénette (2001)	-	-	-	-
1991	-	-	9.10	Boudi *et al.* (1990), Do Chi and Idelhadj (1991)	-	-
1994	6,000	Baddyr and Guénette (2001)	-	-	-	-
2002	8,831	Faraj (2009), adjusted by 50%	-	-	-	-
2004	15,881	Anon. (2005a), adjusted by 20%	-	-	-	-
2006	6,175	Faraj (2009)	-	-	-	-
2007	15,496	Boudinar (2007)	-	-	-	-
2010	15,112	Assumption	6.78	1.25 times $CPUE_{1991}$	-	-
Mediterranean northern areas						
1950	-	-	-		19,117	30% higher than 1981 catches
1981	1,343	25% of Atlantic effort adjusted by 67%	11.75	1.25 times $CPUE_{1991}$	14,705	Based on CPUE and effort
1985	2,000	25% of Atlantic effort adjusted by 67%	-		-	-
1988	2,007	25% of Atlantic effort adjusted by 67%	-		-	-
1994	2,985	25% of Atlantic effort adjusted by 67%	-		-	-
1999	2,547	www.inrh.org.ma [2011] adjusted by 60%[a]	-		-	-
2002	-	-	9.12	Malouli Idrissi *et al.* (2001), ONP (2005)	-	-
2004	4,411	25% of Atlantic effort adjusted by 41%[a]	-		-	-
2007	5,757	25% of the Atlantic effort adjusted by 36%[a]	-		-	-
2010	2,600	www.inrh.org.ma 2011, adjusted by 30%[a]	3.0	Al Asri 2010	-	-

a) The rate of adjustment is based on an interpolation from an under-reporting rate of 67% in 1988 to 30% in 2010.

Under-reported artisanal catches

Artisanal fishing effort in the Atlantic central and southern waters off Morocco and the corresponding catches are under-estimated (Lahnin *et al.* 1991; Anon. 2005a; Shelley 2008). Do Chi and Idelhadj (1991) estimated a catch per unit of effort (CPUE) of 57 kg·boat^{-1}·day^{-1} for 1991, where 36.4% is unreported crustaceans and cephalopods, for 170 days of fishing (Boudi *et al.* 1990), i.e., 9.7 t·boat^{-1}·year^{-1} (Table 1) compared to 1 t·boat^{-1}·year^{-1} provided by Baddyr and Guénette (2001). We assumed that the catch per boat in 1981 was 25% higher than in 1991, i.e., 11.63 t·boat^{-1}·year^{-1}. Due to continuing excessive effort (Peña *et al.* 2003), CPUE kept on decreasing after 1991 to reach 80% of the 1991 CPUE in 2010, i.e., 6.78 t·boat^{-1}·year^{-1}. Thus, we reconstructed small-scale catches for the period 1981 to 2010 based on these CPUE rates interpolated from 11.63 t·boat^{-1}·year^{-1} in 1981 to 9.7 t·boat^{-1}·year^{-1} in 1991 and to 6.78 t·boat^{-1}·year^{-1} in 2010. For the effort, we used data on the number of boats from 1981 to 1985, 1988, 1994, 1998, 1999, 2002 (which we adjusted by 50%, Faraj 2009), and 2004 (which we corrected by 20%, Anon. 2005a; Faraj 2009) and 2007. These data included the effort in the Mediterranean waters of Morocco; thus, we reduced the effort by 25% to exclude the Mediterranean effort (Do Chi and Idelhadj 1991). Thereafter, we interpolated linearly from each anchor point to bridge the gaps from 1981 to 2007, and carried the trend onward to estimate the effort for 2010 (Table 1). Thereafter, we multiplied the CPUEs by the number of boats from 1981 to 2010. For the period from 1950 to 1980, because of the presence of small-scale Spanish boats in the former Spanish Sahara waters, we assumed that the artisanal catch was 25% higher in 1950 than in 1980 and then performed a linear interpolation from 1950 to 1981. Here, we assumed that before 1975, 40% of catches were made off the southern areas mostly, because of the presence of the artisanal Spanish fleet (Ariz 1985); thereafter we assumed it decreased to be 30% of the total small-scale catches of the Atlantic area.

In the Mediterranean, the Moroccan CPUE was estimated to be 6.4 t·boat^{-1}·year^{-1} for 2000 (Malouli Idrissi *et al.* 2001), 11.85 t·boat^{-1}·year^{-1} for 2004 (ONP 2005), 2.1 t·boat^{-1}·year^{-1} for 2009 (ArtFiMed 2009) and 3 t·boat^{-1}·year^{-1} for 2010 (El Asri 2010). Since the official data provided by ONP (2005) represents an area of relatively high production, we averaged the first two estimates and obtained a CPUE of 9.12 t·boat^{-1}·year^{-1} for 2002 and used the catch per effort of 3 t·boat^{-1}·year^{-1} for

Table 2. Species composition of Mediterranean and Atlantic catches of Morocco for the period 1950-2010. Percentage composition derived from qualitative data in Barreira *et al.* (1998); Do Chi and Idelhadj (1991); Charbonnier and Caddy (1986); UNEP (2008); INRH (1999); Malouli Idrissi *et al.* (2001) and ArtFiMed (2009).

		Mediterranean	Atlantic
Common name	**Taxon name**	**Catch (%)**	**Catch (%)**
Gilthead seabream	*Sparus aurata*	5.0	-
Axillary seabream	*Pagellus acarne*	10.0	-
forkbeard	*Phycis* spp.	0.4	-
Shrimps	-	0.4	-
Other sparids	Sparidae	3.0	-
Norway lobster	*Nephrops norvegicus*	2.0	-
European eel	*Anguilla anguilla*	8.0	-
Octopus	*Octopus* spp.	22.0	-
Bullet tuna	*Auxis* spp.	5.0	-
Bonito	*Sarda sarda*	5.0	-
Swordfish	*Xiphias glaius*	1.0	-
European pilchard	*Sardina pilchardus*	8.0	-
Sharks	Various[a]	0.2	-
Blacktip grouper	*Epinephelus fasciatus*	0.3	-
Common dentex	*Dentex dentex*	2.0	-
Venus clam	*Chamelea gallina*	9.0	-
Bogue	*Boops boops*	11.0	-
European anchovy	*Engraulis encrasicolus*	2.0	-
Caramote prawn	*Penaeus kerathurus*	1.0	-
Miscellaneous	-	1.0	-
Blufin tuna	*Thunnus thynnus*	3.0	-
Bluespotted seabream	*Pagrus caeruleostictus*	1.0	-
Red porgy	*Pagrus pagrus*	2.0	-
Scorpaenids and Sparids	Scorpaenidae and Sparidae	1.0	-
Common two-banded seabream	*Diplodus* spp.	4.0	1
Surmulets	*Mullus* spp.	3.0	14
Sea breams, Pandora etc.	*Pagellus* spp.	4.0	1
Cuttlefish	*Sepia* spp.	10.0	5
Groupers	*Epinephelus* spp.	2.0	8
European conger	*Conger conger*	1.0	1
European squid	*Loligo vulgaris*	2.0	1
European seabass	*Dicentrarchus labrax*	6.0	1
Croaker	*Argyrosomus regius*	-	1
Sole	*Solea* spp.	-	1
Crayfish and lobsters	*Palinurus* spp.	-	15
Lobsters	*Homarus* spp.	-	15
Large pelagic fish	-	-	15
Other sharks	-	-	4
Bivalvia	-	-	4
Small pelagic fish	-	-	4
Barnacles	-	-	0 to 10%[b]
Finfish	-	-	0 to 10%[b]

a) Smooth-hound (*Mustelus mustelus*), sharpnose sevengill sharks (*Heptranchias griseus*), bluntnose sixgill shark (*Hexanchus griseus*) and sand tiger shark (*Carcharias taurus*).
b) A percentage of the illegal catches increasing from 0% in 1975 to 10% in 2010.

2010 (Table 1). Because of stock over-exploitation in the Mediterranean since the early 1980s (Oliver, 1983), we believe the catch per unit of effort was likely higher in the 1980s. Therefore, we conservatively assumed a CPUE of 11.75 t·boat^{-1}·year^{-1} in 1981 (20% higher) declining linearly to 9.12 t·boat^{-1}·year^{-1} in 2002, then 3 t·boat^{-1}·year^{-1} in 2010. Thereafter, we applied the same approach to the effort data available or derived from the Atlantic effort data, where the Mediterranean effort represented 25% of the Atlantic (Do Chi and Idelhadj 1991). We then adjusted the effort by an unreported factor of 67% in 1981 to 1985 (Charbonnier and Caddy 1986) to 30% in 2010 (Table 1), when artisanal fisheries were better documented. To complete the estimate for the period 1950 to 1980, we assumed conservatively that the catches in 1950 were 30% higher than in 1981 because of the presence of the French and Spanish boats (Oliver 1983); thereafter, we interpolated linearly.

Table 3. Unreported coastal demersal and pelagic landings per decade for Morocco.

Decade	Unreported landing (%)	Source
1950	60	Rojo-Diaz and Pitcher (2005)
1960	60	Rojo-Diaz and Pitcher (2005)
1970	23	Baddyr and Guénette (2001)
1980	23	El Hannach (1986)
1990	47	El Mamoun (1999)
2010	10	Modified from Anon. (2005c)

A part of this artisanal fisheries catch, estimated to be around 8.5% (Malouli Idrissi *et al.* 2001), is kept for personal consumption (i.e., here considered subsistence). However, this component is assumed to have been larger in the 1950s (around 30%). To estimate this subsistence catch, we interpolated personal consumption rates from 30% in 1950 to 8.5% in 2010, and then applied the estimates to the artisanal catch in the Mediterranean and the Atlantic.

Species disaggregation: Only a few authors described the taxonomic composition of small-scale fisheries catches for Moroccan central and southern areas. While Barreira *et al.* (1998) and Do Chi and Idelhadj (1991) described the species composition of catches as including: sparids, sole (*Solea* spp.), surmullets (*Mullus* spp.), European seabass (*Dicentrarchus labrax*), meager (*Argyrosomus regius*), conger (*Conger* spp.), groupers (*Epinephelus* spp.), cephalopods, bivalves and lobsters (*Homarus* and *Palinurus* spp.); Charbonnier and Caddy (1986) allocated a degree of importance to each species, i.e., 'important', 'average' or 'low', and UNEP (2008) described cephalopod catches. Here we used this information as a baseline and attributed a number to each degree of importance (Table 2). For the Mediterranean, a gear-based species disaggregation was provided by INRH (1999), from which we derived an average, in combination with the estimates provided by Malouli Idrissi *et al.* (2001) and ArtFiMed (2009) (Table 2).

Under-reported large-scale catches

Industrial fisheries: This component represents what is referred to as off-shore by Morocco, in contrast to coastal (semi-industrial fisheries which include coastal demersal and drfitnet fisheries). Industrial demersal catches are known to be under reported (Baddyr and Guénette 2001). The authors estimated the unreported industrial catch from 1972 (when the fishery started) to 1998 with a minimum under-reporting of 47%. Therefore, to complete the time series from 1999 to 2010, we applied an under reporting rate of 55% to the industrial catches from 1999 to 2010, which represents the average between the estimate by Durand (1995) (60% in the 1990s) and Pitcher *et al.* (2002) estimate of 50% to 60% in the 2000s.

Table 4. Number of active driftneters per year in the Mediterranean waters of Morocco.

Year	Number of boats	Source
1989	0	Tudela *et al.* (2005)
1993	120	Silvani *et al.* (1999)
1994	120	Silvani *et al.* (1999)
1995	200	Tudela *et al.* (2005)
1998	225	Abid (1998), Cornax *et al.* (2006)[a]
2002	267	Tudela *et al.* (2005), Rojo-Diaz and Pitcher (2005)[a]
2003	274	Cornax *et al.* (2006)
2004	300	Cornax *et al.* (2006), Srour and Abid (2004)[a]
2006	300	Abid and Idrissi (2007)
2007	300	Abid and Idrissi (2007)
2010	300	Assumed constant

[a] Average estimate.

Coastal demersal and pelagic fisheries: As for coastal pelagic and demersal fisheries, Baddyr and Guénette (2001) assumed an unreported catch of 23% in the 1970s, El Hannach (1986) reported the same rate for the 1980s which we applied here to the coastal catch. El Mamoun (1999) identified 47% of the catches as being unreported and Anon. (2005c) in the 2000s estimated only 8% to be unreported which is low given the prevalence of illegal marketing in Morocco (Rojo-Diaz and Pitcher 2005). To adopt a conservative approach, we assumed 10% of catches were not reported in 2010, and given the monitoring system development as reported by Morocco, interpolated from 47% in 1999 to 10% in 2010 (Rojo-Diaz and Pitcher 2005). For the 1950s and 1960s, we used Rojo-Diaz and Pitcher (2005) estimate of 60% which is justified by the total absence of a statistical monitoring system during this period (CGPM 1982; Oliver 1983) (Table 3).

Moroccan large-scale driftnet fishery: The driftnet fishery targets mainly swordfish and is considered under the coastal fisheries segment. The driftnet fishing effort developed quickly in the 1990s (Table 4) (Tudela *et al.* 2005; Anon. 2008). Although the net length is legally limited and reported to be 2 to 3 km (Abid and Idrissi 2009), it is largely under-estimated (Cornax *et al.* 2006). Driftnet fishers often fail to respect this regulation. Indeed, Anon. (2008) reported a length range of 3 to 14 km and Tudela *et al.* (2005) reported an average length of 6.8 km and a catch of 0.8 swordfishes per km of net per day for an average weight of 32 kg per fish (Srour and Abid 2002). This, when multiplied by the number of fishing days, i.e., 120 (Tudela *et al.* 2005), allowed estimating a swordfish CPUE of 20.9 t·boat^{-1}·year^{-1} for 2002 and 2003. Thereafter, we applied this estimate to the number of driftneters per year. We interpolated linearly between the years of known data to fill in the missing time periods (Table 4). Landed by-catch was then estimated, including sharks, 6% of bonito (*Sarda sarda*), 5% of pelagic stingrays (*Pteroplatytrygon*

spp.) and 0.5% of dolphinfish (*Coryphaena hippurus*) (Cornax *et al.* 2006), which we applied to the swordfish catch. Effort was relatively low from 1990 to 1994, we assumed that the unreported portion for this period was not significant. The progressive prohibition of driftnetting in Spain in 1991 (Silvani *et al.* 1999), and in Europe for driftnets of more than 2.5 km of length (Cornax *et al.* 2006), before being prohibited totally in 2002 (Tudela *et al.* 2005), contributed to the increase of such activity in Morocco, with nets exceeding 2.5 km since 1991. Furthermore, a possible decrease in the CPUE due to over-exploitation (Tudela 2000) would be compensated by an increase in gear capacity (i.e., total net length) per boat.

Illegal fisheries

Illegal fishing is defined as all fishing methods prohibited by the government of Morocco in waters under its sovereignty or jurisdiction. Dynamite fishing and illegal cephalopod fishing are the two main illegal domestic fishing activities. Although dynamite fishing is widespread along the Mediterranean coast of Morocco (Pitcher *et al.* 2002; Rojo-Diaz and Pitcher 2005; Tudela *et al.* 2005; Boudinar 2007), non-discarded catches are often reported; thus they are considered under small-scale fisheries catches. Illegal cephalopod fishing is mainly practiced along the Saharan (southern area) coastline (Barreira *et al.* 1998).

Illegal cephalopod fishery : Barreira *et al.* (1998) reported about 12,000 *pateras*, the majority of which are operating illegally (over the quota announced by the government), along the Saharan coast in 1998, targeting cephalopods and reportedly catching the same quantity as Spanish cephalopod boats, i.e., 20,000 $t \cdot year^{-1}$. Baddyr and Guénette (2001) documented that the legal artisanal fishery targeting cephalopods started in 1988; however, we assume that the illegal activities started along with the industrial fishery, i.e., in 1975 (Barreira *et al.* 1998). Therefore, we interpolated linearly from zero in 1975 to 20,000 $t \cdot year^{-1}$ in 1990 and kept this number unchanged to 2010, assuming that the number of *pateras* remained stable.

Discards

Small-scale fishery : Discards of the small-scale fishery were considered non-existent (Baddyr 1989) and therefore, not accounted for in Baddyr and Guénette (2001). However, due to the lack of preservation technology, the lack of carrying capacity of the boats and the opportunity of selling the products (Pitcher *et al.* 2002); Kelleher (2005) estimated a discard rate of 19%, and Weber and Durand (1986) reported a discard of 10% to 15%. Here, we estimated an average rate of 12.5% of the total small-scale catches for the period 1950 to 1989, then we interpolated linearly to 19% in 2010 (Table 5).

Table 5. Discard rates per fishing sector in the northen, central and southern areas of Morocco.

Year	Discard (%)	Source
Small-scale		
Northen, central and southern areas		
1950	12.5	Asumption
1989	12.5	Durand (1995)
2010	19.0	Kelleher (2005)
Industrial cephalopod		
Central and southern areas		
1970	66.0	Balguerías (1997)
1980	46.0	Balguerías (1997)
1990	30.0	Haddad (1994)
2002	45.0	Veguila (2011), Kelleher (2005)
2010	45.0	Veguila (2011), Kelleher (2005)
Coastal demersal trawl fishery		
Northern areas		
1950	75.0	Rojo-Diaz and Pitcher (2005)
1989	75.0	Rojo-Diaz and Pitcher (2005)
2000	43.0	El Mamoun (1999), Kelleher (2005)
2010	43.0	El Mamoun (1999), Kelleher (2005)
Central and southern areas		
1950	80.0	Weber and Durand (1986)
1989	80.0	Weber and Durand (1986)
2000	45.0	Kelleher (2005)
2010	45.0	Kelleher (2005)
Coastal pelagic fishery		
Northern, central and southern areas		
1950	4.0	El Mamoun (1999)
1980	4.0	El Mamoun (1999)
2000	2.5	Kelleher (2005)
2010	2.5	Kelleher (2005)

Large-scale fisheries: Large-scale fisheries include the cephalopod industrial fishery, coastal trawl demersal fishery, coastal small pelagic fishery and coastal driftnet fishery (in the northen areas).

The industrial cephalopod fishery is associated with higher rates of discarding. In the 1970s, 66% of the industrial cephalopod fleet catches were thrown overboard and in the 1980s, discards represented 46% of the retained catch (Balguerías 1997). Haddad (1994) estimated that 30% of the catch was discarded in the 1990s and Rojo-Diaz and Pitcher (2005) and Kelleher (2005) estimated that 45% was discarded in the 2000s. We interpolated linearly to derive annual estimates for the periods 1970 to 1980, 1981 to 1990, 1991 to 2002. From 2002 onward, the discard rate was held constant at 45% due to the adoption of a global quota for the industrial cephalopod fishery in 2002 (Veguila 2011), which likely maintained a high discard rate. However, to remain conservative, we kept the rate constant (Table 5). Then, we applied these rates to the reconstructed cephalopod industrial catches.

By-catch from the demersal shrimp trawl fishery in North West Africa accounted for 85% of the shrimp catch (Kaczynski 1989). According to Rojo-Diaz and Pitcher (2005), 75% of this was discarded in the Atlantic areas, while Kelleher (2005) estimated that 20% to 70% was discarded. In Mediterranean Morocco, a discard rate of 12% is suggested by El Mamoun (1999). Here, we used a discard rate of 75% from 1950 to 1989, decreasing thereafter due to an increase in mesh size and boat capacity to an average rate of 43% in the 2000s. Weber and Durand (1986) reported higher discards of around 70% to 90% for the Atlantic coast. We applied the average discard rate of 80% to the reconstructed demersal catches from 1950 to 1989, and decreased the rate linearly thereafter to 45% in the 2000s (Kelleher 2005; Table 5).

Small pelagic fishery

Sardine fishery discards were estimated to be relatively low. For the 2000s, Kelleher (2005) provided a discard rate of 2.5%, for the 1990s, Haddad (1994) provided a discard of 5%, while El Mamoun (1999) estimated 4%. Here we applied a discard rate of 4% for the period 1950 to 1980, decreasing linearly to 2.5% in the 2000s (Table 5).

Driftnet fishery

The driftnet fishery mainly targets swordfish (Abid 1998) and generates high levels of by-catch and discards. Indeed, shark by-catch ranges from 50% (Cornax *et al.* 2006) to between 78% and 92% (Tudela *et al.* 2005) of total estimated swordfish catches. Here, we applied an average of 67.5% to the swordfish catch for the period from 1990, when driftneting began in Morocco, to 2010. The species composition of non-targeted catch was 33% blue sharks (*Prionace glauca*), 36% shortfin mako (*Isurus oxyrhinchus*) and 31% thresher sharks (*Alopias vulpinus*) (Tudela *et al.* 2005). A portion of this by-catch is discarded and therefore not reported nor accounted for in Baddyr and Guénette (2001). In this paper, since no data were available, we considered 50% as discarded and 50% as sold illegally. Driftneting also generates high levels of by-catch of non-commercial species, which are mainly discarded. Based on Tudela *et al.* (2005) estimate of discarded ocean sunfish (*Mola mola*) (508 sunfish for 2,990 swordfish) and an average weight of 46 kg for the ocean sunfish (www.fishbase.org [2011]), and 32 kg for the swordfish (Srour and Abid 2002), we derived a discard rate of 25% of swordfish catches. This is likely an under-estimate (see Stewart 2001) because of the average weight reported for ocean sunfish (about 1,000 kg)[2] is over 20 times higher than the one we used here. Then, we applied the previous discard rates to the annual swordfish catch from 1990 to 2010.

Subsistence fisheries

Bivalves were mainly caught to sustain subsistence fishers. Shafee (1999) documented a CPUE of 22 t·boat^{-1}·year^{-1} in the 1990s of which 70% was for subsistence. Catches have been steeply declining since the early 1980s (Anon. 2005b), therefore, we conservatively assumed the CPUE was 40% higher in 1980 than in 1990, i.e., 30.8 t·boat^{-1}·year^{-1} and we kept the trend declining and estimated a CPUE of 14.12 t·boat^{-1}·year^{-1} in 2010. The effort targeting bivalves decreased from 350 boats in 1980 to 233 boats in the 1990s and continued decreasing to an estimated 30% of the 1990s effort in 2010 due to a decreasing biomass (Shafee 1999). Here, we used CPUE and effort data to estimate catches from 1980 to 2010, then we assumed that the catches in 1950 were 20% higher than in 1980. Thereafter, we allocated 30% of these catches to the small-scale commercial fishery. This approach likely underestimates the real catch, since shore-based fishers (Shafee 1999) were not accounted for. We also conservatively assumed that the by-catch reported by Shafee (1999), often used as bait, was 5% of total bivalve catches. Here, bivalve catches were mainly documented for Mediterranean Morocco (Shafee 1999; Anon. 2005b), thus we assumed that the catches in the Mediterranean represented 70% of total removals, while 20% were caught along the central areas and 10% in the southern areas where the Zenaga were fishing for their subsistence along with the Imraguen of Mauritania (Gaudio 1984; de Brisson and Gaudio 1993); then assigned catch to species for the Mediterranean, where information was available (Shafee 1999) (Table 6). The portion of the catch taken home by artisanal fishers for personal consumption is also considered subsistence in the present study. Malouli Idrissi (2001) estimated the portion taken home to be 8.5% of the artisanal catch. Here, we assumed this rate was higher (30%) from 1950 to 1975, before the first fisheries plans were legislated, interpolated linearly to 8.5% in 1999 (Malouli Idrissi 2001), and kept the personal consumption rate constant between 1999 to 2010. We then applied this rate to the estimated artisanal catch for the northern, central and southern areas of Morocco.

Table 6. Catches composition for the Mediterranean bivalve subsistence fishery (in %).

Common name	Taxon name	Catch (%)
Spiny cockle	*Acanthocardia aculeata*	15.0
European prickly cockle	*Acanthocardia echinata*	14.0
Moroccan cockles	*Acanthocardia tuberculata*	14.0
Smooth callista	*Callista chione*	21.0
Donax	*Donax denticulatus*	2.0
Venus clam	*Chamelea gallina*	34.0
Total		100.0
		Bait use (%)
Olive green cockle	*Cerastoderma glaucum*	1.0
Pilose bittersweet	*Glycyremis pilosa*	0.5
Brown mussel	*Perna perna*	1.0
Queen scallop	*Aequipecten opercularis*	1.0
Sword razor	*Ensis ensis*	1.0
Cockle	*Glycyremis violacescens*	0.5
Total		5.0

Recreational fisheries

Recreational fisheries include rod and reel fishing and underwater spear-fishing. In the Mediterranean, these activities are becoming increasingly important (Zahri and Abdelaoui 2010). The number of fishing licenses and the species targeted in the Mediterranean

Table 7. Recreational fishing effort expressed in number of licenses in the northern area[a].

Year	Underwater spearfishing licences	Rod-fishing licenses
1950[b]	0	0
2004[c]	100	1,000
2005[c]	180	2,200
2006[c]	200	2,800
2007[c]	230	5,300
2008[c]	260	6,200
2009[c]	180	5,000
2010[c]	180	5,000

a) Effort in Atlantic derived from the effort in the Mediterranean; b) Assumption; c) from Abdelaoui (2010).

[2] http://www.websters-online-dictionary.org/definitions/ocean+sunfish [Accessed on 16/12/2011].

from 2004 to 2009, have been well documented (Gaudin *et al.* 2007; Abdelaoui 2010; Zahri and Abdelaoui 2010), however, no effort estimate was available for the Atlantic.

The number of spearfishing and rod-fishing licenses for the Mediterranean were available from 2004 to 2009[3] (Abdelaoui 2010). The number of fishing licenses indicates the number of spearfishers and rod-fishing boats, respectively. To estimate the number of spearfishers and rod-fishing boats for the period from 1950 to 2003, we assumed recreational fisheries started in 1950, i.e., zero spearfishers and zero rod-fishing boats, then interpolated linearly to 100 spearfishers and 1,000 rod-fishing boats in 2004. Since no effort data were available for the central and southern areas, we assumed the effort in the Mediterranean represented 70% of the total effort, 20% in the central areas, and in the southern areas where there was no spearfishing represented 10% of the total number of rod-fishing boats. The number of fishing days was also derived from Abdelaoui (2010) to be conservatively 70 days per year (i.e., during the summer) for the time period from 1950 to 2010, which allowed to estimate the total recreational effort (Table 7). We estimated a CPUE of 58.8 kg·fisher^{-1}·day^{-1} based on observations from recreational fishers (www.hassan-peche.com [2011]; www.pecheurmarocain.com [2011]) for Atlantic central and southern areas rod-fishing, and assumed a same CPUE for the Mediterranean recreational rod-fishing fleet. We also derived a spearfishing CPUE of 17.14 kg·fisher^{-1}·day^{-1} (www.hassan-peche.com [2011]) for Atlantic areas, while for the Mediterrean, the majority of the spearfishing catch per unit of effort (70%) was estimated to be 20.6 kg·day^{-1} of seabreams (Zahri and Abdelaoui 2010), i.e., a total CPUE of 28 kg·day^{-1}. Thereafter, to reconstruct recreational rod-fishing and spearfishing catches from 1950 to 2010, we applied these CPUE estimates to the effort of each segment in the Mediterranean, Atlantic Morocco and Western Sahara. This approach uses the same CPUE for the 1950 to 2010 time period; therefore, it accounts for the increasing popularity of recreational fishing by Moroccans and tourists (increasing number of fishing days).

Foreign fishing

Foreign fisheries catches were not estimated here. However, a global overview was available through the report by Guénette *et al.* (2001) by the Spanish fishing fleet, whose activities were prominent in Moroccan central and southern areas among the European fleets. Belhabib *et al.* (this volume) reconstructed foreign fishing through fishing access agreements, with a particular focus on Spain being prominent in the area. Although we believe illegal fishing activities have significant removals, we focused on the legal removals.

Results

Total catches

Total reconstructed domestic catches for Morocco were estimated to be over 48.4 million tonnes for the period 1950 to 2010 compared to 28.3 million tonnes reported to the FAO (Figure 3a). In the 1950s, catches represented almost 3 times the data supplied to FAO on average compared to the 2000s when they were 50% higher than the data supplied to FAO. The Mediterranean fisheries of Morocco were two to three times the data submitted by the government of Morocco to the FAO over the period from 1950 to 2010, i.e., 3.8 million tonnes compared to 1.48 million tonnes supplied to the FAO. The unreported component accounted for about twice the reported catch in the 1950s, and decreased since the mid-1970s after Morocco declared its EEZ. Overall, total reconstructed catches for Morocco increased from about 311,000 t·year^{-1} in 1950 to around 1.6 million t·year^{-1} in 2010, reaching a peak of 1.8 million t·year^{-1}

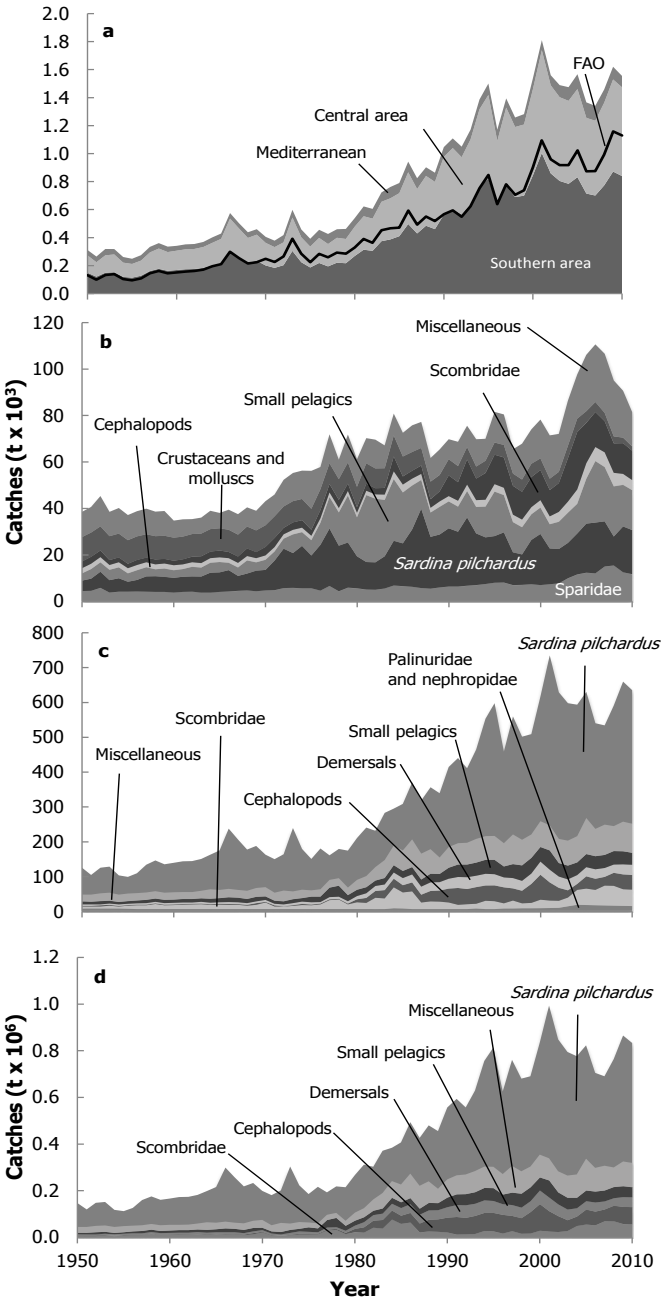

Figure 3. a) Estimated total marine fisheries catches by Morocco for the 1950-2010 time period as compared to the total catch reported to the FAO; b) seven most important taxa caught in the mediterranean; c) seven most important taxa caught in the central areas and; d) six most important taxa caught in the southern areas EEZ by the Moroccan fleet, 1950-2010.

[3] We assumed the same number of licenses for 2010.

in 2001, around 1 million tonnes of which were caught off the southern areas (Figure 3a).

Catches in the northern areas are dominated by sardines, other small pelagic species and scombrids, observing declining catches since the mid-2000s (Figure 3b). Catches in the central areas were dominated by sardines, cephalopods and other demersal species (Figure 3c), while catches in the southern areas were overwhelmingly dominated by sardines (Figure 3d).

Moroccan catches by sector in the northen and central areas

Artisanal catches

Small-scale reconstructed catches in Moroccan northern and central areas, mainly of crayfish, lobster, large pelagic fish and octopus, increased from 43,000 t·year^{-1} in 1950 to a maximum of 105,000 t·year^{-1} in 2004 and decreased afterwards (Figure 4). Catches increased substantially after the 1970s, when Morocco granted its first effort subsidies for fisheries. Reconstructed catches totaled around 2.8 million tonnes for the period 1950 to 2010, of which 44% were from the Mediterranean EEZ, i.e., 1.2 million tonnes (Figure 4). From a total of 2.8 million tonnes, more than 580,500 tonnes were used for personal consumption, thus not considered commercial. Personal consumption decreased from 12,800 t·year^{-1} in 1950 (1.5 kg·person^{-1}·year^{-1}) to 6,300 t·year^{-1} (0.6 kg·person^{-1}·year^{-1}) in 2010.

Unreported large-scale catch

Moroccan large-scale catches totaled 15.7 million tonnes over the period from 1950 to 2010 (Figure 5). This sector alone was over 47% higher than the data supplied to FAO for Atlantic Moroccan area (10.7 tonnes) (Figure 5). Coastal pelagic fisheries represented the bulk of Atlantic Moroccan (central areas) large scale catches with 83% of the total (13.1 million tonnes) over the study time period (Figure 5). Coastal demersal catches of over 793,700 tonnes represented 6% of total large scale catches. Coastal demersal catches increased from 7,620 t·year^{-1} in 1950 to a peak of 40,042 t·year^{-1} in 2000, and then decreased to around 25,100 t·year^{-1} in 2010 (Figure 5). Industrial catches which were estimated at over 1.6 million tonnes for the 1950-2010 time period, increased since the 1970s, when they started, to their maximum of about 86,100 t·year^{-1} in the early 1990s, and decreased thereafter (Figure 5).

Catches in the Mediterranean were reconstructed to be over 1.6 million tonnes compared to 1.2 million tonnes reported to the FAO over the period 1950 to 2010. The unreported component for the Mediterranean area decreased from 1,900 t·year^{-1} (42%) in 1950 to a maximum of approximately 18,000 t·year^{-1} in 2006, when 50% of the catches were not reported (Figure 5).

Driftnet unregulated fisheries

The bulk of unreported catches off the Mediterranean coast of Morocco started after the introduction of the driftnet fishery in the early 1990s, when swordfish, billfishes and sharks represented 46% of total unreported catches for the Mediterranean (Figure 6).

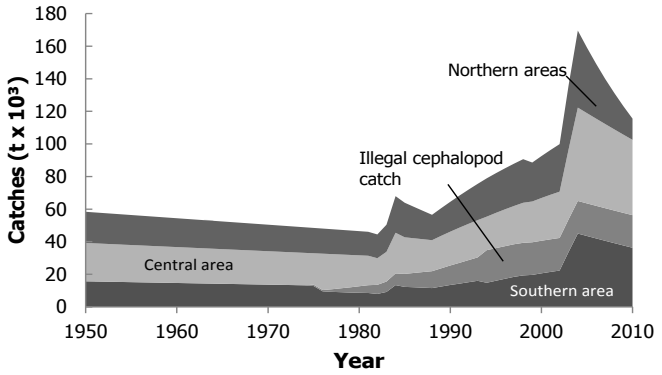

Figure 4. Morocco reconstructed small scale (artisanal) catches for the period 1950 to 2010.

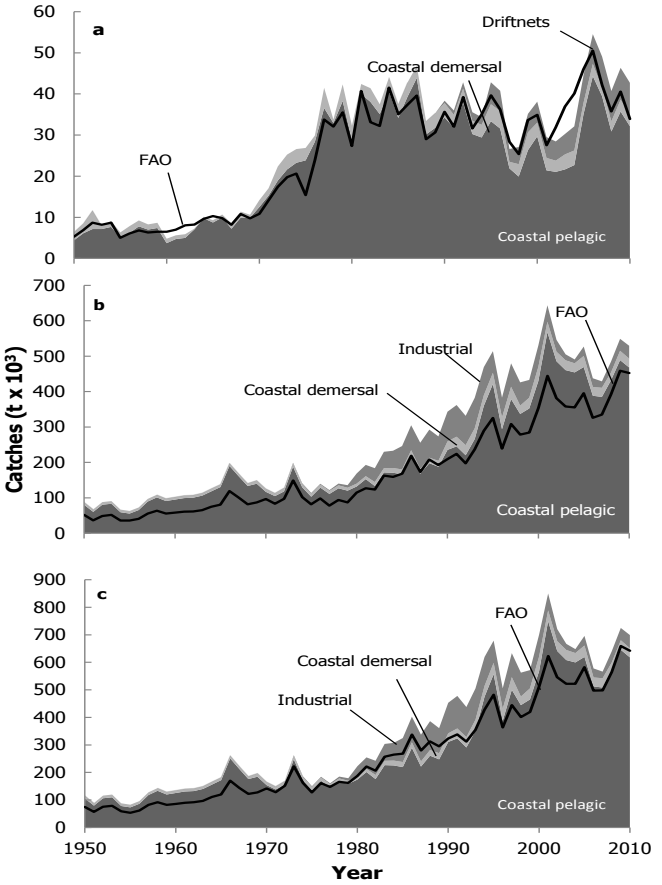

Figure 5. Domestic large-scale catches by a) Morocco in the North, compared to FAO data from Moroccan northern areas, and b) by Morocco from Atlantic central area compared to FAO data from the Moroccan Atlantic central EEZ and c) Morocco from the southern areas, compared to FAO data from the southern areas, 1950-2010.

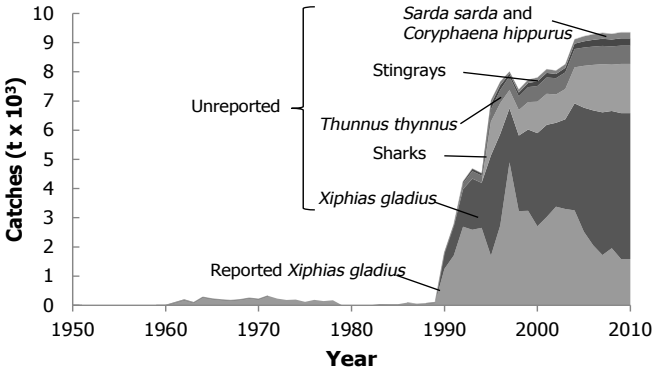

Figure 6. Reconstructed domestic driftnet catches by Morocco from the Mediterranean coast of Morocco, 1950-2010.

Unreported driftnet catches totaled approximately 100,000 tonnes for the period from 1990 (when the fishery started) including 65% of swordfish (64,000 tonnes) and 23% of sharks and stingrays (23,000 tonnes) over the period between 1990 and 2010 (Figure 6). Morocco failed to report increasing bluefin tuna (*Thunnus thynnus*) catches from 188 t·year^{-1} in 1990 to 630 t·year^{-1} in 2004 (Figure 6). Unreported bluefin tuna catches remained stable thereafter (Figure 6).

Discards

Discarded by-catch in Atlantic Morocco represented 9% of total catches from 1950 to the late 1970s, with average discards of 12,300 t·year^{-1} (Figure 7). Discarding from the 1980s onward increased to an average of 48,000 t·year^{-1} in the 2000s, due to the development of industrial fisheries as well as coastal demersal fisheries after Morocco launched its 'encouragement code' for fisheries investments in the mid-1970s and consecutive four-year plans in the 1980s and 1990s (Figure 7). The total discards estimated here were over 1.7 million tonnes from 1950 to 2010. Industrial fisheries were responsible for the bulk of discards, with over 550,000 tonnes from 1973 to 2010, whereas coastal pelagic fisheries represented 27% from 1950 to 2010, and demersal fisheries 29% (505,000 tonnes). Small-scale discards which totaled 225,000 tonnes from 1950 to 2010, increased by a factor of 4 during the same time period (Figure 7).

Discards in the Mediterranean are relatively low, with 286,000 tonnes discarded over the period 1950 to 2010 (Figure 7). However, the driftnet fishery alone contributed to 28% of Mediterranean discards since its introduction to Morocco in 1990, reaching over 44,000 tonnes from 1990 to 2010 (Figure 7), consisting of ocean sunfish (49%) and sharks (51%).

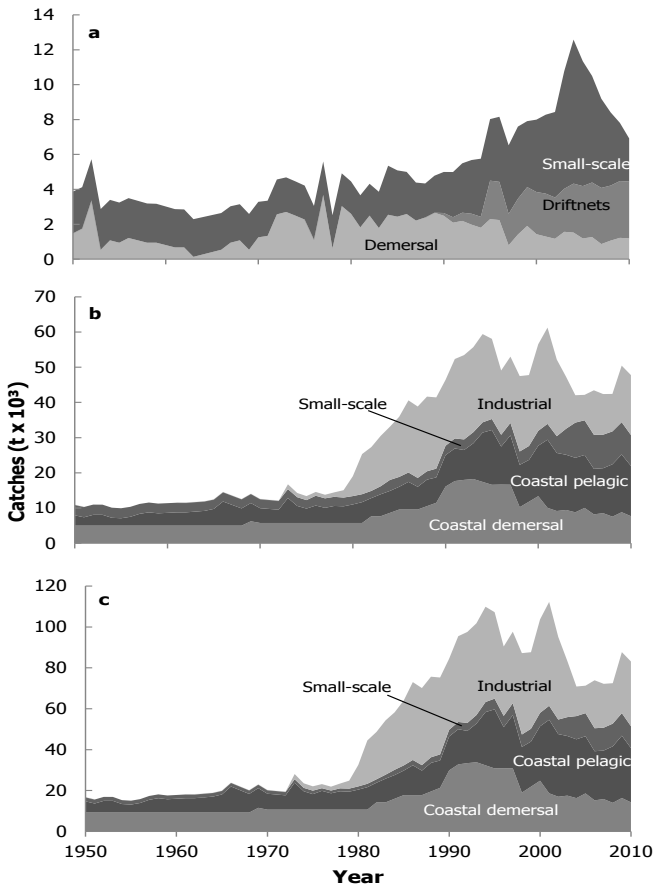

Figure 7. Estimated discards by sector for a) Mediterranean Morocco, b) Atlantic central areas and ; c) southern areas , 1950 to 2010.

Subsistence fisheries

Morocco does not supply subsistence catch data to the FAO. The total reconstructed subsistence catches from Atlantic Morocco were estimated to be 409,310 tonnes from 1950 to 2010 (Figure 8), of which 32% were bivalves (134,000 tonnes). Subsistence catches for the Mediterranean, consisting of 63% of bivalves (dominant in weight and caught manually or using small boats) decreased from 14,700 t·year^{-1} in 1950 to around 1,800 t·year^{-1} in 2010 (Figure 8).

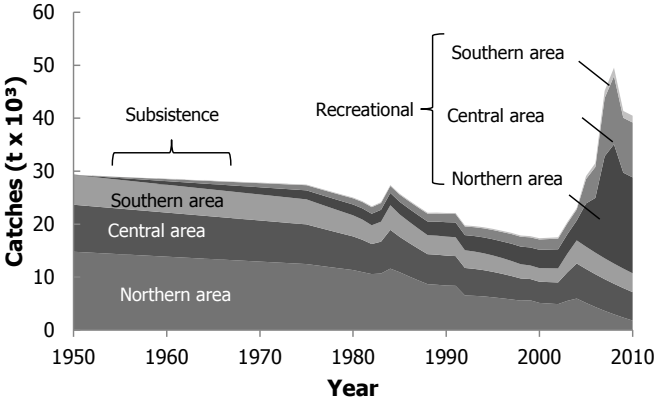

Figure 8. Estimated subsistence and recreational catches for Morocco, 1950-2010.

Recreational fisheries

Recreational catches in the central areas of Morocco were estimated at 113,000 tonnes for the period 1950 to 2010, increasing from 40 t·year^{-1}, right before independence of Morocco, to 10,400 t·year^{-1} in 2010 (Figure 8). Similarly, in the Mediterranean, recreational catches increased from 70 t·year^{-1} to 18,000 t·year^{-1} in 2010 (Figure 8), with a total of 198,000 tonnes for the 1950 to 2010 time period (Figure 8).

Moroccan (and former Spanish Saharan) catches by sector from the southern areas

Artisanal catches

Small-scale reconstructed catches in the southern areas increased from 15,700 t·year^{-1} in 1950 to a maximum of 45,000 t·year^{-1} in 2004 and decreased afterwards (Figure 4). Catches from the southern areas of Morocco were reconstructed to be around 1.5 million tonnes, of which 31% were illegally caught cephalopods from 1950 to 2010 (Figure 4). More than 224,000 tonnes have been used for personal consumption, thus not considered commercial. Personal consumption remained relatively stable over the 60 year time period at an average of 3,700 t·year^{-1}.

Unreported large scale catch

Coastal pelagic fisheries catches off the southern areas of Morocco were estimated at 17.3 million tonnes over the period from 1950 to 2010. These catches increased from an average of 101,000 t·year^{-1} in the 1950s to a peak of about 750,000 t·year^{-1} in 2001, and decreased thereafter to less than 618,000 t·year^{-1} in 2010 (Figure 5). Coastal demersal catches were reconstructed to be over 1.3 million tonnes for the 60 year time period (Figure 5). Catches increased by a factor of five from the 1950s (10,000 t·year^{-1}) to 2000 (53,000 t·year^{-1}), then decreased by almost half in 2010, when catches were estimated at 33,000 t·year^{-1} (Figure 5). Industrial fisheries removed 3,300 t·year^{-1} in 1973, the year they began, and increased to a maximum of 118,000 t·year^{-1} in the early 1990s (Figure 5). Overall, large scale catches (including coastal and industrial sectors) were estimated to be over 20.7 million tonnes for the 1950-2010 time period, compared to 16.1 million tonnes supplied by Morocco to FAO for these areas (Figure 5).

Illegal and unregulated fisheries

Illegal cephalopod catches in the southern areas totaled 480,000 tonnes for the period from 1950 to 2010, increasing from 800 t·year^{-1} in 1972, when the fishery started to a plateau of 20,000 t·year^{-1} from 1994 to 2010 (Figure 4).

Discards

Fisheries off the southern areas accounted for 60% of the discards for the period 1950 to 2010, with over 3 million tonnes discarded, increasing after 1976, when Morocco took control of the area (Figure 7). Discards represented 12% of the total reconstructed catch in the southern areas, where in 2010, they were 5 times (83,000 t·year^{-1}) as high as discards in 1950 (16,600 t·year^{-1}) with a peak of 112,000 t·year^{-1} in the early 2000s (Figure 7). Small-scale discards represented 8% of total discards with 232,000 t·year^{-1} for the study period; coastal fisheries represented 59% of discards with coastal pelagic fisheries responsible for over 870,000 tonnes and demersal coastal fisheries for 938,000 tonnes (Figure 7). Industrial fisheries which started in 1973, were responsible for over a third of total discards in the southern areas, i.e., 1 million tonnes over the 1950-2010 time period.

Subsistence fisheries

Subsistence and recreational catches in the southern areas were estimated to be 261,000 tonnes from 1950 to 2010. Subsistence catches in these areas decreased overall from 5,600 t·year^{-1} in 1950 to less than 3,600 t·year^{-1} in 2010 (Figure 8), the lowest in the areas under Morocco's jurisdiction.

Recreational fisheries

Recreational catches were estimated at 14,000 tonnes for the period 1950 to 2010. Recreational catches in the southern areas increased from 5 t·year^{-1} in 1950, when the area was under the Spanish rule, to 1,300 t·year^{-1} in 2010 (Figure 8).

Discussion

Our reconstruction of Moroccan domestic fisheries accounts for various fisheries sectors (commercial and non-commercial) not previously included in statistical time series supplied to the FAO. Thus, it represents the most comprehensive estimate available of total domestic marine fisheries catches for Morocco. Moreover, it provides catch estimates by species or taxon and it allocates data to three separate areas, i.e., Mediterranean versus central and southern Atlantic areas.

Total marine fisheries catches by Morocco in the Mediterranean and the Moroccan Atlantic EEZ were approximately 48.4 million tonnes for the period from 1950 to 2010, which is nearly two times higher than the data supplied to the FAO. The southern areas, with the largest contribution to the sardine landings (Machu *et al.* 2009), accounted for a large part of Moroccan catches, with an estimated 25.4 million tonnes for the 1950-2010 time period.

Although the artisanal sector is important, accounting for 16% of the total removals, it remains relatively neglected (Charbonnier and Caddy 1986) in terms of management and monitoring, with a high portion of catches not being presented in the official statistics. Coastal fisheries accounted for 71% of the domestic catch, which drives the general trend of the Moroccan fisheries during the period from 1950 to 2010.

Domestic catches had an overall increasing trend; however, catches increased at a higher rate after Morocco introduced its first 'encouragement code' for fisheries in the 1970s followed by a succession of subsidies. The resulting increase in subsidized effort added further pressure on already depleted and over-exploited stocks: pelagic fisheries since the mid-1990s (Zahri 2006; Menioui 2007), and demersal resources since the mid-1980s (Balguerías *et al.* 2000; Slimani and Hamdi 2004; Menioui 2007). Demersal fisheries, especially in southern areas, where the continental shelf area remained freely accessible to fishing vessels after the Spanish occupation ended, have been heavily exploited (Garcia and Newton 1994). A plateau, with a slight decreasing tendency, is observed since 2001 where the catch was 1.8 million t·year^{-1} and reached 1·6 million t·year^{-1} in 2010.

The Moroccan population, particularly in the southern areas, suffers from malnutrition and anemia as a result of a lack of animal protein (Skretteberg 2008), while 80% of the Morocco's large-scale fleet output is exported to overseas markets (Suárez *et al.* 1996). Furthermore, these waters are subject to a constant fishing pressure by foreign fishing vessels under agreements or joint ventures with Morocco (Kaczynski 1989; Riché 2004, Belhabib *et al.* This volume).

In the Mediterranean area, the gradual prohibition of driftnets by European countries and an increasing demand for swordfish has contributed to the increasing use of driftnets in Moroccan waters (Cornax *et al.* 2006). Moreover, poverty in some fishing areas has encouraged the use of dynamite for fishing (Boudinar 2007), which although not considered here, usually leads to high discard rates and unrecovered mortality, as well as substantial habitat destruction.

Illegal fishing practices (Boudinar 2007), foreign fishing pressure (Porter 1997), lack of control and surveillance (Kaczynski 1989), fish habitat loss (Menioui 2007) and high rates of discards have led to the over-exploitation of demersal resources. Heavy trawling activity led to shifting stocks (Balguerías *et al.* 2000) and declining stock abundance (Faraj and Bez 2007). In addition, inequity of domestic fishing license attribution has favored an increasing migration of Moroccans and thus Moroccan fishing vessels towards southern waters (Veguila 2011). This, combined with the 2002 management decision to adopt a quota for cephalopods (Faraj and Bez 2007), led to the development of informal markets and thus illegal fishing, in addition to increasing the competition between the industrial and the artisanal sectors over the resource, thus increasing conflicts among fishers.

This raises the question of the resource rent not captured by the Moroccan southern populations, but mainly transferred to northern areas of Morocco via migrant flows (Veguila 2011). Furthermore, the unreliability of Moroccan statistics, both in the Mediterranean and in the Atlantic areas, is highlighted by the substantial difference between our reconstructed estimate and total landings data as supplied to the FAO by Morocco.

Given the extent of foreign fishing in Morocco, the question of how fishing access agreements contribute to the local economy needs to be raised. Access fees are often diverted to activities other than direct improvements to the management of fisheries resources. Decision-makers often negotiate access-agreements that are harmful to sustainable fisheries for their own personal gain. Therefore, allowing foreign fleets access to Moroccan waters does little to benefit the majority of the Moroccan population (Porter 1997).

Acknowledgements

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Appendix Table A1a: Annual catches by the Moroccan fleet.

Year	Mediterranean	FAO	Central areas	Southern areas	FAO Atlantic
1950	38,515	5,300	123,866	148,933	126,600
1951	40,624	6,900	102,897	121,070	93,000
1952	45,302	8,700	123,956	149,321	123,900
1953	38,545	8,200	126,658	152,962	130,500
1954	40,182	8,700	101,626	119,538	94,700
1955	37,125	5,000	97,537	114,137	89,200
1956	38,782	6,100	107,642	127,776	102,000
1957	39,885	6,800	132,562	161,200	138,200
1958	38,648	6,300	144,520	177,286	155,300
1959	38,895	6,500	133,682	162,901	137,800
1960	34,746	6,500	137,832	168,528	144,100
1961	35,297	6,981	142,025	174,212	150,500
1962	35,421	8,049	143,133	175,748	153,400
1963	36,104	8,235	149,062	183,762	162,000
1964	38,975	9,635	161,649	200,566	186,047
1965	38,111	10,298	173,909	217,124	200,188
1966	39,505	9,782	235,780	300,007	289,198
1967	37,578	8,185	205,625	259,745	245,171
1968	40,462	10,793	176,651	221,040	203,882
1969	39,027	9,756	186,262	234,621	214,641
1970	43,129	10,869	161,238	200,871	238,308
1971	45,967	14,130	148,334	183,793	211,754
1972	52,361	17,437	162,756	202,790	248,599
1973	55,245	19,756	238,158	304,939	371,425
1974	56,239	20,631	177,834	224,065	264,282
1975	56,142	15,419	148,830	186,660	209,397
1976	57,860	23,932	178,994	218,668	259,314
1977	71,891	33,791	159,683	194,391	225,664
1978	60,969	32,071	177,943	220,788	260,040
1979	71,800	35,539	173,277	216,860	249,034
1980	61,187	27,328	209,352	268,764	302,049
1981	70,223	40,730	239,033	313,465	348,835
1982	69,601	33,121	229,983	305,531	329,205
1983	67,104	32,193	281,379	374,368	420,129
1984	80,839	41,557	293,613	387,113	424,323
1985	72,554	35,052	307,234	410,134	436,732
1986	75,786	37,378	369,454	497,221	556,366
1987	77,195	39,597	317,219	429,704	452,777
1988	61,660	28,975	355,905	484,612	521,383
1989	65,350	30,655	337,422	460,665	487,756
1990	69,778	35,660	412,995	563,769	531,777
1991	68,712	32,018	438,647	601,232	562,565
1992	75,599	39,239	409,576	564,506	509,896
1993	69,809	31,623	463,535	637,827	591,262
1994	69,951	34,999	551,535	764,653	717,576
1995	81,530	39,669	596,259	822,624	807,775
1996	80,422	36,268	456,957	633,676	602,216
1997	65,487	28,374	558,695	770,007	752,819
1998	67,830	25,369	500,642	689,573	679,908
1999	73,974	33,647	508,415	699,534	704,475
2000	78,237	34,902	615,412	844,691	866,242
2001	71,466	27,517	734,885	1,004,123	1,066,906
2002	72,088	31,856	629,114	858,820	927,647
2003	86,280	36,959	598,196	804,752	880,026
2004	97,641	40,090	592,614	784,268	877,203
2005	106,043	45,973	629,621	831,465	977,487
2006	110,562	50,523	540,742	714,613	822,929
2007	106,496	42,137	534,213	700,530	833,106
2008	95,051	35,752	589,938	773,152	956,934
2009	90,600	40,578	658,018	871,604	1,118,463
2010	81,449	33,913	633,938	839,759	1,095,090

Appendix Table A1b: Annual catches by the Moroccan fleet.

	FAO	Artisanal	Industrial	Recreational	Subsistence	Discards	Total reconstructed
1950	131,900	41,101	210,456	112	29,170	30,942	311,780
1951	99,900	40,823	165,672	112	28,986	29,417	265,010
1952	132,600	40,545	216,239	223	28,803	31,385	317,195
1953	138,700	40,266	220,659	335	28,619	31,528	321,408
1954	103,400	39,988	165,173	447	28,436	29,096	263,139
1955	94,200	39,709	152,586	558	28,253	27,955	249,061
1956	108,100	39,431	176,916	670	28,069	29,123	274,209
1957	145,000	39,152	234,096	781	27,886	31,630	333,546
1958	161,600	38,874	260,436	893	27,702	32,799	360,704
1959	144,300	38,596	236,559	1,005	27,519	31,967	335,645
1960	150,600	38,317	245,260	1,116	27,336	32,442	344,471
1961	157,481	38,039	255,627	1,228	27,152	32,810	354,856
1962	161,449	37,760	259,657	1,340	26,969	32,815	358,541
1963	170,235	37,482	273,604	1,451	26,785	33,383	372,706
1964	195,682	37,203	304,754	1,563	26,602	34,125	404,247
1965	210,486	36,925	332,732	1,674	26,419	35,693	433,443
1966	298,980	36,647	471,588	1,786	26,235	41,458	577,714
1967	253,356	36,368	402,241	1,898	26,052	38,627	505,185
1968	214,675	36,090	340,932	2,009	25,868	35,795	440,694
1969	224,397	35,811	358,657	2,121	25,685	38,874	461,148
1970	249,177	35,533	306,462	2,233	25,501	35,140	404,869
1971	225,884	35,254	281,306	2,344	25,318	34,520	378,743
1972	266,036	34,976	320,478	2,456	25,135	33,873	416,917
1973	391,181	34,698	487,847	2,568	24,951	47,482	597,545
1974	284,913	34,419	354,996	2,679	24,768	40,483	457,346
1975	224,816	34,133	285,953	2,791	24,584	38,166	385,627
1976	283,246	34,290	354,973	2,902	23,969	40,424	456,557
1977	259,455	34,432	326,924	3,014	23,360	38,377	426,107
1978	292,111	34,565	365,223	3,126	22,758	40,589	466,261
1979	284,573	34,691	360,977	3,237	22,164	42,597	463,667
1980	329,377	34,809	426,892	3,349	21,576	54,158	540,785
1981	389,565	34,919	498,768	3,461	20,783	72,457	630,387
1982	362,326	34,071	469,539	3,572	19,704	76,306	603,192
1983	452,322	39,076	575,022	3,684	20,380	85,122	723,284
1984	465,880	53,301	592,848	3,795	23,490	90,628	764,063
1985	471,784	50,701	615,645	3,907	21,754	98,260	790,267
1986	593,744	49,273	755,469	4,019	20,400	111,933	941,093
1987	492,374	47,822	644,013	4,130	19,096	107,383	822,444
1988	550,358	46,350	716,131	4,242	17,842	114,798	899,362
1989	518,411	50,209	673,856	4,354	17,759	113,125	859,302
1990	567,437	54,034	841,867	4,465	17,582	122,730	1,040,678
1991	594,583	57,825	881,689	4,577	17,469	137,963	1,099,522
1992	549,135	61,574	820,030	4,689	15,029	140,828	1,042,150
1993	622,885	65,281	929,615	4,800	14,788	147,213	1,161,696
1994	752,575	68,900	1,133,323	4,912	14,466	160,054	1,381,655
1995	847,444	72,378	1,247,066	5,023	14,049	156,864	1,495,381
1996	638,484	75,798	938,164	5,135	13,561	131,128	1,163,787
1997	781,193	79,158	1,150,130	5,311	13,007	142,319	1,389,924
1998	705,277	82,457	1,023,658	5,424	12,389	132,722	1,256,650
1999	738,122	81,323	1,050,086	5,537	12,163	132,043	1,281,152
2000	901,144	84,923	1,277,743	5,650	11,658	155,319	1,535,293
2001	1,094,423	88,378	1,531,976	5,763	11,635	171,892	1,809,643
2002	959,503	91,685	1,308,931	5,876	11,610	146,505	1,564,606
2003	916,985	125,282	1,220,038	5,989	14,394	129,519	1,495,221
2004	917,293	155,770	1,190,656	6,102	16,901	112,460	1,481,888
2005	1,023,460	146,215	1,284,382	13,330	15,719	112,238	1,571,885
2006	873,452	137,162	1,083,940	16,897	14,596	118,002	1,370,597
2007	875,243	128,609	1,054,373	31,632	13,530	114,859	1,343,003
2008	992,686	120,708	1,175,018	36,982	12,537	116,141	1,461,386
2009	1,159,041	113,256	1,330,788	29,755	11,597	138,035	1,623,431
2010	1,129,003	106,258	1,284,503	29,755	10,709	131,899	1,563,124

Appendix Table A2a: Most important taxa caught by domestic fisheries in the Mediterranean EEZ of Morocco, 1950-2010.

Year	Sparidae	*Sardina pilchardus*	Other small pelagics	Cephalopods	Scombroids	Crustaceans	Molluscs and bivalves	Miscellaneous
1950	5,534	4,801	3,749	2,866	3,359	479	10,497	7,229
1951	5,614	5,540	4,692	2,956	3,499	478	10,437	7,408
1952	6,845	7,273	4,631	2,856	3,407	478	10,378	9,434
1953	4,895	5,605	5,019	2,707	2,614	470	10,314	6,922
1954	5,205	6,095	5,232	2,794	2,642	468	10,253	7,493
1955	5,183	4,578	4,216	2,762	2,454	462	10,191	7,280
1956	5,293	5,263	4,727	2,849	2,681	460	10,131	7,380
1957	5,198	6,880	4,493	2,733	2,493	458	10,070	7,560
1958	5,088	7,054	3,500	2,708	2,648	453	10,009	7,187
1959	5,088	6,785	4,111	2,690	2,540	450	9,948	7,284
1960	4,959	6,455	3,820	2,753	2,425	442	9,885	4,008
1961	5,061	6,814	3,849	2,536	2,704	440	9,824	4,070
1962	5,160	6,833	4,651	2,516	2,961	437	9,763	3,101
1963	4,962	6,997	4,382	2,499	3,446	434	9,702	3,682
1964	4,979	8,605	4,774	2,590	3,302	434	9,642	4,648
1965	5,072	8,624	5,011	2,567	3,431	430	9,581	3,395
1966	5,180	9,478	3,701	2,553	3,135	428	9,521	5,509
1967	5,466	6,692	4,170	2,526	3,180	422	9,459	5,662
1968	5,684	7,502	6,162	2,418	3,744	421	9,399	5,131
1969	5,272	9,145	4,050	2,392	3,055	417	9,337	5,359
1970	5,666	9,045	4,873	2,412	4,121	424	9,278	7,309
1971	5,692	13,021	4,420	2,434	4,386	440	9,235	6,339
1972	6,658	17,156	4,808	2,387	3,257	430	9,161	8,503
1973	6,676	15,260	8,511	2,479	3,696	447	9,101	9,074
1974	6,557	18,440	6,427	2,427	3,706	434	9,082	9,166
1975	6,508	14,365	7,058	2,405	3,046	414	8,979	13,367
1976	5,495	19,906	9,989	2,378	4,028	441	8,911	6,712
1977	7,463	24,922	14,011	2,384	4,081	428	8,848	9,755
1978	5,099	19,837	14,779	2,304	3,931	444	8,774	5,802
1979	6,628	19,682	20,609	2,364	3,571	420	8,963	9,563
1980	6,302	14,037	17,129	2,365	2,808	391	8,660	9,495
1981	5,705	12,086	29,197	2,245	3,353	395	8,701	8,543
1982	5,604	12,027	27,713	2,286	2,963	393	8,417	10,198
1983	6,240	14,077	24,628	2,739	3,238	435	8,292	7,455
1984	7,781	19,482	27,031	3,883	6,877	859	8,572	6,354
1985	7,364	18,669	22,371	3,877	3,950	539	8,384	7,401
1986	7,034	24,910	19,255	3,377	3,795	503	7,804	9,108
1987	6,372	34,305	12,733	2,969	3,922	465	7,337	9,092
1988	5,940	22,526	10,761	2,358	3,930	410	7,419	8,318
1989	6,569	22,931	12,209	2,599	4,653	447	6,839	9,102
1990	6,885	25,285	11,877	2,662	8,593	492	6,686	7,298
1991	6,912	23,819	11,074	2,908	7,225	504	6,688	9,582
1992	7,262	29,620	11,667	3,141	9,568	547	4,934	8,860
1993	7,534	22,429	11,732	3,237	7,478	554	4,924	11,922
1994	8,033	20,257	13,514	3,341	9,912	576	4,924	9,394
1995	8,571	20,242	19,443	3,522	8,754	578	4,911	15,510
1996	8,600	21,761	16,329	3,448	9,479	606	4,932	15,267
1997	7,480	14,266	13,284	3,504	10,169	588	4,850	11,346
1998	7,526	13,275	11,979	3,510	8,892	603	4,941	17,104
1999	7,758	19,153	11,256	3,254	9,660	545	5,337	17,011
2000	7,430	22,122	11,548	3,496	9,060	612	4,618	19,350
2001	7,809	15,504	10,677	3,627	7,550	628	4,464	21,206
2002	8,205	14,941	11,934	4,597	8,872	690	4,320	18,530
2003	10,526	15,443	13,340	5,100	15,035	952	4,738	21,146
2004	12,341	17,853	13,153	6,671	20,373	1,126	5,015	21,109
2005	12,950	21,328	19,646	7,048	12,462	959	4,334	27,317
2006	12,618	21,979	26,787	6,334	9,671	811	3,694	28,668
2007	15,392	19,579	23,624	6,643	7,609	645	3,089	29,914
2008	15,837	12,519	21,786	6,047	7,099	561	2,535	28,666
2009	12,796	19,800	18,034	4,938	7,228	490	2,026	25,288
2010	11,833	19,155	17,289	4,394	6,678	395	1,551	20,154

Appendix Table A2b: Most important taxa caught by the domestic fisheries in the central areas of Morocco, 1950-2010.

Year	Palinuridae and Nephropidae	Scombridae	Cephalopods	Demersal fishes	Small pelagics	Miscellaneous	*Sardina pilchardus*
1950	6,993	6,713	1,958	3,650	7,734	20,442	76,304
1951	6,948	6,541	2,164	3,820	6,984	21,099	55,288
1952	6,903	6,823	2,155	3,866	7,908	22,607	73,667
1953	6,858	8,178	2,146	3,869	7,883	23,039	74,614
1954	6,813	5,715	2,008	3,915	6,900	21,361	54,868
1955	6,768	8,034	2,085	3,874	7,124	21,835	47,773
1956	6,723	9,253	1,946	4,093	7,987	20,760	56,871
1957	6,678	9,388	1,980	4,354	9,006	21,105	79,976
1958	6,633	13,148	2,014	4,400	9,180	21,020	88,084
1959	6,587	9,326	2,005	4,618	8,922	20,849	81,301
1960	6,542	10,019	1,996	4,750	9,164	21,108	84,176
1961	6,497	11,529	1,944	4,107	9,880	19,903	88,084
1962	6,452	11,937	1,935	3,852	9,683	20,292	88,859
1963	6,407	12,557	1,969	5,018	9,973	21,498	91,556
1964	6,362	10,785	2,046	4,676	10,693	27,442	99,421
1965	6,317	11,833	2,166	4,808	11,479	23,438	113,633
1966	6,272	11,392	2,243	5,328	13,785	24,128	172,429
1967	6,226	11,130	2,104	5,417	12,922	22,019	145,072
1968	6,181	8,559	2,483	5,204	11,844	23,656	117,843
1969	6,136	11,456	4,397	5,473	12,655	25,415	120,535
1970	6,101	17,801	2,237	5,390	9,739	27,088	92,625
1971	6,062	7,774	1,971	4,694	8,748	22,988	95,897
1972	6,022	6,207	1,722	4,504	8,571	31,457	104,016
1973	5,956	8,385	2,030	5,778	11,399	22,035	182,296
1974	5,920	10,846	3,282	6,717	9,892	24,324	116,631
1975	5,745	10,433	2,028	6,320	16,097	18,075	89,918
1976	6,661	12,091	2,226	4,548	15,220	20,981	117,022
1977	6,430	24,489	2,166	6,695	26,462	22,338	70,936
1978	6,176	26,308	2,220	5,949	31,339	21,750	84,002
1979	5,962	12,760	2,247	6,720	17,134	21,701	106,429
1980	6,073	18,373	8,799	9,308	17,660	28,828	120,063
1981	5,427	17,201	14,576	13,184	17,279	32,259	138,834
1982	4,919	32,823	19,299	14,495	15,256	38,844	104,098
1983	5,482	30,336	23,578	16,502	18,261	51,867	135,057
1984	7,470	60,195	24,619	17,603	21,000	56,754	105,712
1985	6,781	46,030	21,067	20,025	20,051	59,526	133,503
1986	6,392	49,714	25,426	22,582	21,030	80,093	163,702
1987	6,039	17,749	22,612	22,954	20,602	73,958	152,508
1988	5,717	21,271	30,334	24,167	25,027	70,309	177,918
1989	5,994	20,262	32,136	23,993	23,281	47,665	183,899
1990	6,223	17,929	39,813	28,195	31,501	59,678	229,325
1991	6,450	10,905	48,077	31,930	35,170	61,684	244,019
1992	6,642	12,298	43,643	33,702	36,120	63,308	213,674
1993	6,817	13,522	47,946	32,192	37,911	67,898	256,799
1994	6,130	22,805	43,778	33,441	39,659	68,596	337,021
1995	6,457	21,327	45,417	32,112	40,891	68,890	380,673
1996	6,764	14,753	45,818	28,760	30,752	67,419	262,413
1997	7,040	22,646	34,805	29,532	39,801	85,290	338,822
1998	7,363	14,313	36,086	28,546	43,994	73,926	295,341
1999	7,495	15,288	54,618	29,732	44,323	68,119	287,631
2000	7,850	24,063	71,789	37,244	41,842	74,602	357,219
2001	8,199	21,226	51,975	36,756	55,033	72,571	487,311
2002	8,598	20,133	37,249	32,567	38,480	69,105	421,216
2003	12,971	25,126	21,069	31,068	39,011	72,518	394,372
2004	17,235	42,851	17,271	25,076	36,536	75,444	377,332
2005	16,654	47,070	35,320	26,230	37,113	104,291	361,487
2006	16,099	43,871	31,881	27,389	37,244	78,598	303,380
2007	15,607	56,958	25,182	25,277	37,104	87,259	284,953
2008	15,039	56,965	37,170	23,624	38,355	71,821	346,031
2009	14,446	47,465	42,656	28,825	37,171	85,567	401,373
2010	13,909	46,855	42,390	28,777	34,345	83,689	383,401

Appendix Table A2c: Most important taxa caught by Morocco from the southern areas, 1950-2010.

Year	Scombroids	Cephalopods	Demersal fishes	Small pelagics	Miscellaneous	*Sardina pilchardus*
1950	6,561	1,663	5,102	7,774	23,985	102,377
1951	6,349	1,941	5,328	6,781	24,931	74,306
1952	6,736	1,935	5,383	8,041	26,907	98,961
1953	8,543	1,929	5,381	8,025	27,517	100,213
1954	5,301	1,752	5,436	6,714	25,279	73,680
1955	8,382	1,860	5,377	7,023	25,832	64,228
1956	10,009	1,683	5,660	8,194	24,335	76,470
1957	10,203	1,734	6,000	9,585	24,773	107,445
1958	15,190	1,785	6,055	9,845	24,301	118,377
1959	10,151	1,779	6,338	9,511	24,056	109,267
1960	11,082	1,773	6,507	9,852	24,381	113,139
1961	13,094	1,710	5,651	10,820	22,770	118,377
1962	13,648	1,704	5,307	10,575	23,095	119,402
1963	14,483	1,754	6,843	10,982	24,900	123,075
1964	12,155	1,862	6,385	11,958	32,684	133,580
1965	13,556	2,027	6,554	13,031	27,486	152,655
1966	12,988	2,135	7,236	16,164	28,892	231,459
1967	12,656	1,958	7,348	15,008	25,914	194,790
1968	9,271	2,464	7,061	13,567	28,175	158,292
1969	13,117	5,001	7,559	14,665	30,757	161,993
1970	21,522	2,151	7,386	10,794	32,852	124,593
1971	8,278	1,805	6,460	9,493	26,065	128,810
1972	6,221	1,482	6,203	9,269	38,713	139,439
1973	9,116	1,896	8,372	13,132	26,498	244,629
1974	12,385	3,557	9,544	11,082	29,511	156,661
1975	11,901	2,721	8,998	19,432	21,168	120,959
1976	12,998	2,544	6,479	17,094	20,693	157,232
1977	29,491	3,302	9,303	32,148	22,419	95,965
1978	32,009	4,215	8,411	38,856	21,289	113,513
1979	14,205	5,093	9,730	20,309	22,232	143,117
1980	21,751	14,604	14,424	21,291	33,783	161,415
1981	20,324	23,090	21,611	21,071	38,735	186,561
1982	41,214	30,225	23,969	18,751	48,578	140,249
1983	37,669	36,578	27,235	22,627	65,580	181,730
1984	76,255	38,392	28,972	25,523	72,087	142,925
1985	57,856	34,626	33,021	24,739	76,713	179,782
1986	62,883	41,250	37,629	26,384	105,406	220,419
1987	20,768	38,388	38,061	26,071	97,511	204,914
1988	25,575	49,456	40,119	32,249	93,122	239,056
1989	24,122	52,588	39,634	29,969	62,409	246,802
1990	20,928	63,493	45,173	40,944	78,336	307,739
1991	11,526	75,173	51,647	45,833	81,673	327,332
1992	13,277	70,071	54,505	47,140	84,911	286,818
1993	14,815	76,526	52,586	49,660	91,000	344,684
1994	27,399	76,787	54,502	53,240	91,159	452,705
1995	25,302	78,897	51,800	54,878	91,309	511,203
1996	16,478	79,375	45,748	41,296	88,951	352,432
1997	26,796	64,764	46,933	53,361	114,080	455,086
1998	15,629	66,399	45,772	58,735	97,051	396,585
1999	16,861	90,882	47,059	59,135	89,828	386,317
2000	28,304	113,524	58,735	55,809	97,943	479,573
2001	24,403	87,263	58,639	73,294	95,345	654,128
2002	22,815	67,733	50,986	51,197	90,774	565,282
2003	27,442	45,547	46,276	50,007	95,758	529,388
2004	48,984	39,766	35,528	44,887	100,785	506,749
2005	54,817	63,735	36,537	45,850	136,244	485,576
2006	50,840	59,288	39,557	46,172	101,904	407,674
2007	68,394	50,530	35,410	46,204	106,162	383,231
2008	68,650	66,480	32,445	48,151	83,964	465,048
2009	56,330	73,832	41,933	46,864	106,730	539,004
2010	55,764	73,576	42,111	43,312	104,104	514,172