THE FISHERIES OFF THE ATLANTIC COAST OF MOROCCO 1950-1997

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ABSTRACT

The reported landings for the whole coastline off Morocco have been assembled from FAO statistics, Moroccan and Spanish Ministries records, and FAO working group reports. The resulting estimate of reported landings is close to the published statistics from FAO for the years 1975-1997. For the period 1950-1974, the landings obtained are considered to be under-estimates as the reporting structure was not fully in place. Because the Spanish fisheries have been historically important on the coast of Morocco, a more complete description of their catch statistics have been included. In addition, discard rates and unreported landings have been estimated based on several studies in the region.

INTRODUCTION

This report attempts a reconstruction of the total extractions from the Atlantic coast of Morocco from 1950 to 1998 using estimates of the catch of small-scale fisheries, by-catch, as well as unreported catch sold through the black market or directly consumed. It also briefly describes the history of fishing in this region, as well as the evolution of the fleet size and fishing techniques used during this period.

The Atlantic coast of Morocco is nearly 3,000 km long, extending from Tangier (36° N) to Lagouira (20° N) on Cape Blanc (Figure 1). In 1975, Morocco incorporated the former Spanish Sahara (27° N to 20° N)[a)]. Considering the whole coast as an ecosystem, catch estimates are summarized for the whole region (Tangier-Cape Blanc) starting in 1950.

The width of the continental shelf varies from 18-126 km. Numerous upwellings cells, mainly between Safi (32° N) and Cape Blanc (20° N) are responsible for high primary production. The stocks of sardines (*Sardina pilchardus*) and octopus (*Octopus vulgaris*) are considered among the richest in the world.

HISTORY OF FISHERIES

In Morocco, fishing is a relatively new activity that was introduced by French, Spanish and Portuguese fishers. Although small dories (6 m in length) were operating in coastal villages before 1914, the development of the small-scale fishery started in 1930 (MPM, 1990). This development was the direct result of a forced labor law established by the French, from which fishers were exempt (Ayache, 1956).

Small-scale fishing is a seasonal activity located mainly in isolated coastal areas close to small villages and ports. The fishers use dories to catch fish, mollusks and crustaceans. This category also includes hand collection of algae and mussels and onshore fishing using lines. Most fishers live primarily from agriculture and livestock, and fishing activities represent a supplementary source of income. They fish mainly during spring and summer when the height of waves does not exceed 2 m.

The coastal fishery started around 1927 and was initiated by Spanish and Portuguese fishers. The 16 to 24 m wooden boats were made locally and had no catch preservation system onboard. They fished close to their port mainly on a day trip basis with local crews, targeting pelagic species using purse seines, and demersal species using long liners and bottom trawls.

The Moroccan industrial fleet started in 1972 and grew rapidly between 1973 and 1998. This fleet consists mainly of bottom trawlers targeting cephalopods and demersal species. The crews in charge of the fishing activity are mostly from foreign countries. The duration of fishing trips varies from 25 days to 3 months.

The Moroccan coast was used by foreign fishing interests as early as the 16th century. Starting in the 1960s, modern trawlers started fishing the Saharan coast more intensively. The size of the foreign fleet decreased as Morocco recognized the importance of fishing to its economy and extended its EEZ to 200 miles, as well as making large investments in the fishery sector.

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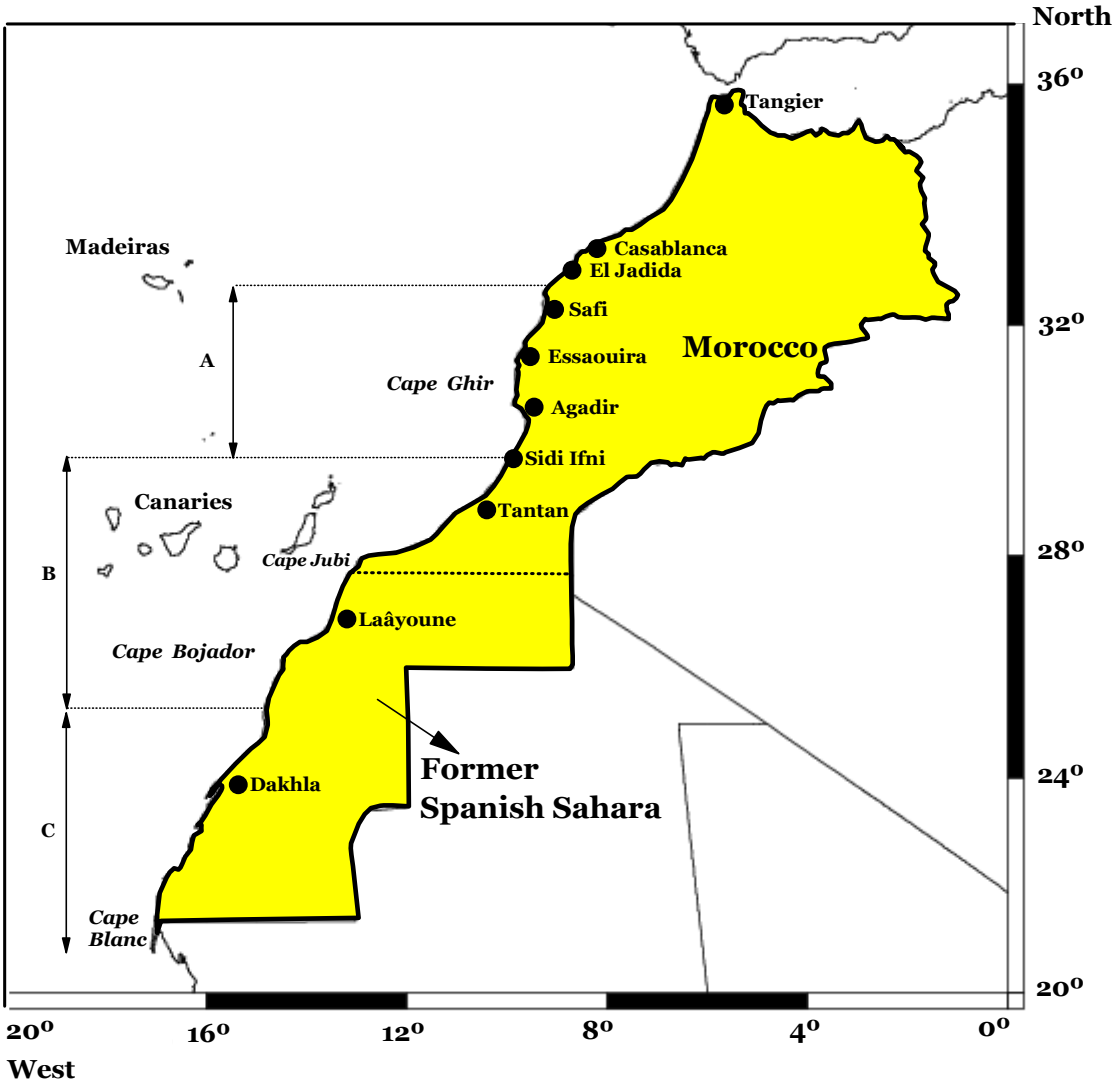

Figure 1. The Atlantic Moroccan coast showing the principal fishing ports, and the border with the former Spanish Sahara.

The Moroccan small-scale fleet

In the early days, the wooden dories measured 8 to 10 m in length and had a crew of 12. They were not mechanically powered and were not adapted to go through the surf in beaches from where they were launched. They were called 'korb' derived from the Arabic word meaning 'vessel'. Most of the catch was given locally to the French in exchange for food and clothes. Some of these vessels used purse seines to catch sardines in order to supply canning factories, e.g., in Agadir prior to 1960. This type of dory disappeared in the early sixties and was replaced by smaller ones of 5 to 6 m in length, carrying 2 to 3 fishers. In 1970, most dories were equipped with outboard motors of 6 to 25 horsepower.

The number of dories active in the small-scale fleet is difficult to assess and the actual estimates are not reliable. However, according to best estimates the total number of dories in Atlantic Morocco was approximately 3,600 in 1981-1982; 4,130 in 1983; 4,930 in 1984; 5,370 in 1985; 5,380 in 1988; and 8,000 in 1994 (MPM, 1990; MPM, 1994; Figure 2). The number of dories in the Atlantic coast account for approximately 75% of the total Moroccan dory fleet (Mediterranean and Atlantic; MPM, 1990). The spectacular increase of the number of dories was related to the new small-scale fishing activity in the Sahara which started in 1988 and targeted *Octopus vulgaris*. This fishery uses plastic pots weighted with cement, anchored on the bottom and hauled every 2 to 3 days (Baddyr, 1993). Fishing occurs at depths varying from a few meters to 120 m, and ranges from 100 m to 30 km from shore. Along

with the increase in number of dories, the number of pots also soared, reaching around 3,000 per boat (based on fishers interviews).

Squid (*Loligo vulgaris*) are fished using jigs, lead stem 5 cm in length with a ring of sharp needles at their lower end. Each dory carries two fishers using one jig line per hand or four jigs per boat. Fishing for squid occurs during daylight 300 to 400 m from shore, at depths of 10 to 20 m.

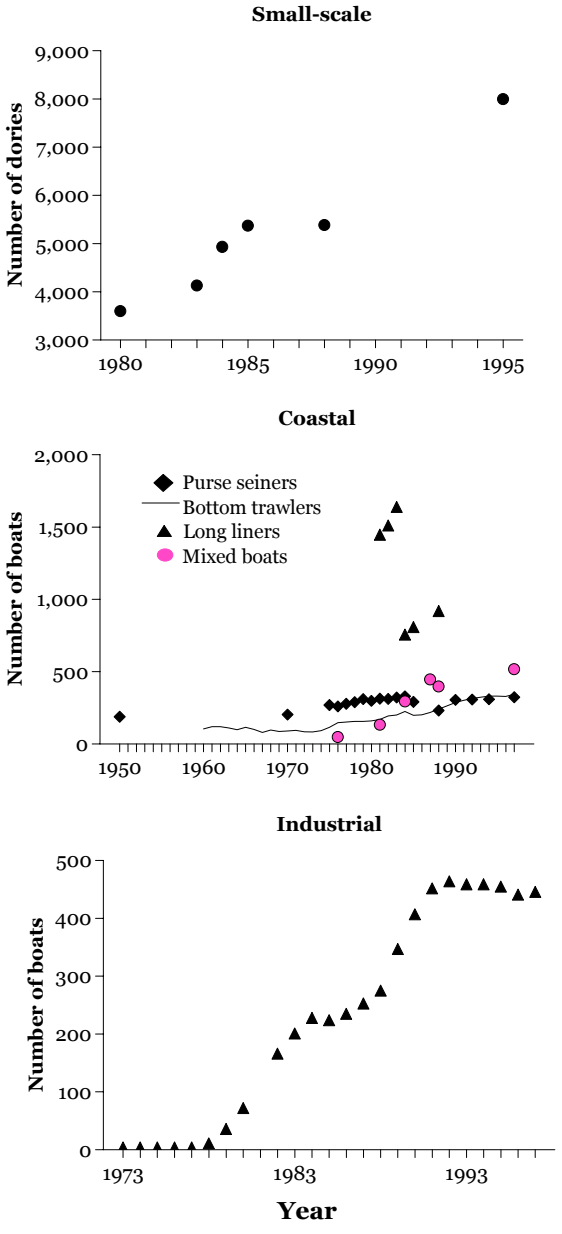

Figure 2. Development of Moroccan small-scale, coastal and industrial fleets.

Gill nets and trammel nets are used to catch fishes and crustaceans. The trammel net is 4m deep and has a stretched mesh size of 150 to 200 mm for the two outer trammel nets and 40 to 60 mm for the inner gill net. The mesh size of the gill net varies from 40 to 150 mm. These nets are anchored on the bottom at depths varying from 4 to 120 m and at distances ranging from 4 m to nearly 25 km offshore. The nets close to shore are hauled daily and the ones relatively far every three days. They also use hook and long lines to catch fish as well as traps to catch lobsters. Generally, sardines are used as bait.

Mussels are collected manually during low tide. Mussels are sun dried and sold locally or in nearby markets. Some mussel-related human deaths have been reported, and were due to accumulated toxins in their flesh caused by red algae blooms (Baddyr, 1992). Algae are also collected by hand during low tide. They are dried and sold to factories to extract agar-agar, and alginates used in the food industry as thickening agents.

The Moroccan coastal fleet

The Moroccan coastal fleet is composed of four types of boats: purse seiners, bottom trawlers, longliners and mixed gear boats.

Purse seiners

Purse seiners target mainly small pelagic species such as sardines, mackerels, anchovies and jacks. The boats leave port with a crew of 15 to 25 fishers on board late in the afternoon or at night. On the fishing grounds, fish stocks are detected using visual clues (birds, bubbles on the water surface) and echo-sounders. They use a seine net called 'cerco' that has a length of 250 to 400 m, a purse depth of 40 to 50 m, and a mesh size of 10 to 12 mm. Trips do not exceed 12 hours (Assabir, 1985).

In 1927, there were 26 purse seiners, and fishing was concentrated in the north of the country between Tangier and El Jadida (33° N, Figure 1). The fishing ports at that time were Larache, Mohammedia, Casablanca, and El Jadida (MPM, 1990). After the Second World War, a new and more important fishery was developed between 32°N and 30°N from the ports of Safi, Essaouira, and Agadir. The number of fishing boats in this area was over 180 (Belvèze, 1983) with an average of 34 GRT in Safi and 27 GRT in Agadir (bimodal distribution: 15 to 20 GRT; and 30 to 35 GRT).

The average power was 180 HP (Belvèze, 1971). In the 1980s, the stocks of pelagic species became more abundant in the southern part of the country. The biggest catches were landed in the ports of Tantan and Laâyoune.

The number of boats increased slowly, varying from 269 in 1975 to 323 in 1997 (Figure 2). The stagnation in the increase of boats during the last ten years is a consequence of the 1994 management policy halting the licensing for the construction of new boats. The age of the present fleet is about 40 years.

Bottom trawlers

Bottom trawlers, equipped with diesel engines of 120 to 450 HP (MPM, 1990), carry a crew of 10 to 15. They operate on a daily basis, leaving port at approximately 2 AM and return in the afternoon around 4 PM. Some trawlers might stay at sea up to one week when they fish in relatively distant fishing grounds. Fish are sorted by species onboard, and kept on ice. The trawl used on sandy or muddy ocean floor is called the 'atomic type', and has a mesh size of 25 mm at the cod-end. During each day trip, the boat undertakes two shots of 3 to 5 hours duration, depending on the availability of fish.

The number of coastal bottom trawlers tripled from 104 to 314 between 1960 to 1992 (Figure 2). However, their number was relatively low between 1960-1975, fluctuating between 104 to 116 vessels. The increase was then continuous from 1976 (148 boats) to 1994 (331 boats). The construction of trawlers has been halted since 1994. Approximately 80% of the Moroccan bottom trawlers work in the Atlantic (MPM, 1990).

Longliners

Longliners are smaller boats 8-10 m long with an average engine power of 50 HP and a capacity of 5 GRT. Their activity most likely started in the early 1930s. Each boat carries a crew of 13 to 14 and uses sardines as bait to catch demersal species. The long lines are hauled approximately every three days.

The number of longliners in Morocco increased from 1448 in 1981 to 1638 in 1983. Their number then dropped by half in 1984 to 756 units because of an increase in the mixed boats using long lines during this period. From 1984 to 1988, their number increased again from 756 to 920 (Figure 2). Nearly 96% of the total longliners operate in the Atlantic (MPM, 1990).

Mixed boats

These boats are permitted to use two fishing techniques depending on the availability of pelagic or demersal fish in their fishing zone. This permission was justified by the tremendous fluctuation in abundance of stocks near shore with seasons and years, jeopardizing the economic existence of boats using a single fishing technique only.

The number of mixed boats using purse seines and bottom trawl, or purse seines and long lines increased from 48 in 1976 to 517 in 1998 (Figure 2). The boats using bottom trawl and long lines did not exist before 1983, and their number increased from 36 in 1984 to 56 in 1988 (MPM, 1990).

The Moroccan Industrial fleet

The Moroccan industrial fleet started in 1973 with four boats based in Las Palmas (Canary Islands). The year 1975 marked the most significant development of the industrial fishing fleet, when Morocco incorporated the former Spanish Sahara. For the first time, the fishery sector was given particular attention in the 1973-1977 economic plan by the creation of the marine investment code. The marine investment code gave attractive loans (70% at low interest rate), 30% equipment bonuses, and established the 70 miles limit for the fishing exclusive economic zone (EEZ). In 1981, fisheries were recognized as a key sector of the Moroccan economy. A ministry of fisheries was created, the EEZ was extended to 200 miles, and large investments were made to build new fishing ports in the Sahara zone. From 1973 to 1986, the industrial fleet landed its catch in foreign ports, mainly in Las Palmas, and to a lesser extent in Portugal, Abidjan, and Dakar. In 1987, nearly two thirds of the fleet was based in Morocco in the ports of Agadir and Tantan. In 1992, all the boats landed in national ports.

The increase in the number of industrial boats over the years was considerable. They increased from 4 in 1973 to 166 in 1986, 452 in 1991, and 454 in 1998 (Figure 2). Stages of development followed beginning in 1973-1980 when 108 units (on average 12 per year) were bought using the loan advantages offered by the government. During the 1981-1984 period, 160 units were bought through association of Moroccan and

foreign investments, encouraged by the government. Between 1985-1988, the national financial institutions were more demanding in terms of loan acquisitions, which led to only 71 boat acquisitions. During the period 1989-1992, a total of 219 boats were bought through joint venture projects involving multinational fishing companies with investors from Morocco and other countries. Finally, during the period 1993-1998, the investment on this type of fishery was frozen by the government to avoid overexploitation of fish stocks. However, the replacement of old or damaged boats was permitted. In total 12 vessels were bought in this period.

Bottom trawlers fishing for cephalopods and demersal species represent, on average, 87% of the total of the industrial fleet, and operate in the Sahara zone. The duration of each fishing trip is 1 - 2 ½ months. The vessels are equipped with freezer holds, engines varying between 750 to 2,000 HP, and tonnage from 200 to 900 GRT. Bottom trawlers targeting shrimps as well as demersal species operate with a trip length of 50 days. They are smaller with engines of 550-850 HP and 140-250 GRT. In 1988 they represented 8% of the total of the industrial fleet. Trawlers equipped with a catch refrigeration system only, operate for short fishing trips of one or two weeks. They represented, on average, nearly 7% of the total fleet. Their tonnage ranges from 60 to 200 GRT.

The vessels fishing pelagic species use pelagic trawl as well as purse seines. They are equipped with freezers. Their tonnage varies from 600 to 1,300 GRT, and their engine power from 1,200 to 2,400 HP. They fish in the Sahara zone for up to two months at a time. The pelagic trawling net has a length of 110 m and a stretched mesh size of 40 mm. The length of the purse varies from 500 to 1,500 m. There were six pelagic freezer trawlers operating between 1982-1997, but were no longer operational by 1998 due to poor maintenance.

Foreign fleets

European vessels fished in the Moroccan Atlantic Ocean prior to 1918, mainly from Spain, Portugal, France, Italy, and Norway (Belvèze *et al.*, 1982). As Spain has a special historic link with the coast of Morocco, especially the Sahara, we describe their fisheries off this coast separately (see Guénette *et al.*, this volume).

In the 1960s, the existing foreign fleet size increased, and new ones came from Japan, South Korea, and Eastern Europe (USSR, Poland, Romania, and former East Germany), substantially increasing fishing pressures along the Saharan coast.

In 1988, Morocco signed the first four-year accord with the European Community (EC, now European Union, EU), in which 800 boats totaling 99,287 GRT were permitted to fish in the area. The Spanish fleet represented nearly 90% of the European boats. In 1992, a second accord for three years was signed in which 688 boats corresponding to 82,920 GRT were allowed to operate in the area. In 1995 a third accord for four years was signed in which 590, corresponding to a tonnage of 64,712 GRT were allowed to fish in the area. During this accord, the European fishing effort was reduced annually by 5 to 10% depending on the type of fishery. In November 1999, the fishing activity of the European feet was halted for an unknown period.

Spanish artisanal boats used 18 to 20 cylindrical traps to catch fish and crustaceans. In the Atlantic, the boats were allowed to fish from Tangier to El Jadida, and from El Jadida to Cape Ghir. Spanish cephalopod trawlers used bottom trawls similar to the one described for Moroccan vessels. The target species of these boats were cephalopods, mainly *Octopus vulgaris*. Hake (*Merluccius merluccius*) and shrimp trawlers also used the same type of trawl. In the Atlantic, cephalopod trawlers as well as boats that fish for hake were allowed to fish from Cape Bojador to Cape Blanc. The boats that fished for shrimps were allowed to fish from Tangier to El Jadida and from El Jadida to Cape Ghir. The European boats using purse seines targeted small pelagic species (sardines, anchovy), as well as tunas. The boats that targeted small pelagic species were allowed to fish in the Atlantic from Cape Ghir to Cape Blanc. The boats that fished for tunas were allowed to operate from Tangier to Cape Blanc. Spanish and Portuguese vessels using trammel nets, gill nets, and longlines targeted crustaceans and fish. These boats were also allowed to fish along the whole Moroccan Atlantic coast.

Japanese and South Koreans bottom trawlers started targeting cephalopods in the Sahara zone when abundant stocks were discovered in the area in the early 1960s (Voss, 1973). In 1969, the Japanese fleet left the area and moved further south to Mauritanian waters. In the early 1990s, Japanese longliners were permitted to fish tunas in the Moroccan Atlantic. This region is the obligatory passage for tunas towards their spawning grounds located in the Mediterranean Sea, and towards their feeding grounds in the

Gulf of Guinea. The secondary targets were sharks and other fishes. The scientific observers reported that the Japanese fishers kept the fins of the sharks onboard and discarded the rest. These boats were allowed to fish along the whole Atlantic coast of Morocco.

Countries from Eastern Europe fished mainly on small pelagic species. They used purse seines and semi-pelagic trawls. Factory boats were present in the fishing area processing the catch into canned fish and fishmeal products. They were allowed to fish from Cape Ghir to Cape Bojador and from Cape Bojador to Cape Blanc.

METHODODLOGY

Recorded landings

Moroccan small-scale fishery

Besides the seaweeds and mussels already accounted for in the FAO statistics, small-scale fleet landings are largely unknown. They were estimated by assuming a constant landing per dory. Thus, for the years 1981-1988 and 1995, the global catch of year i (C_i) was estimated as:

$$C_i = a * n_i \qquad ...1$$

where a is the average landing per dory in the small-scale fishery observed in Tifnit in 1986 equal to 1 tonne/dory/year (Baddyr, 1989), and n_i = number of dories in the Atlantic in year i (MPM, 1990; Anon., 1995). These estimates were based on the assumption that the average landing per dory per year was similar in all the fishing locations along the Atlantic coast, and that this average was constant throughout the years. The number of dories being unknown for the period 1950-1980, the total landings was assumed to amount to 1% of the sum of the coastal and industrial landings based on the percentage calculated from later in the 1980s.

$$C_i = 0.01 * T_i \qquad ...2$$

where T_i = total landings of coastal and industrial Moroccan fleet for year i. For the period 1989-1993 and 1996-1998, the total landings was assumed to amount to 3.5% of the sum of the coastal and industrial landings based on the percentages calculated for 1994-1995. Unfortunately, the catch composition observed in Tifnit in 1986 could not be extended to other sites in the Atlantic, since according to fishers, the catch composition varies greatly among years, and regions of the coast.

The Moroccan coastal and industrial fleets

The recorded landings of the Moroccan coastal fleet were taken from the FAO electronic database for years 1950-1962, 1964-1965 and 1967-1988; Collignon (1964, 1967) for years 1963 and 1966; and the Ministry of Fisheries (MPM, 1994, 1995, 1998) for the period 1989-1998.

In absence of collected data, the minimum Moroccan industrial catch for years 1973 to 1978 was estimated by multiplying the number of Moroccan trawlers by the annual average landing per boat derived from the Spanish trawlers using FAO data. Both Moroccan and Spanish cephalopod trawlers are similar and operate in the same fishing zone using the same fishing technique. Moreover, Moroccan boats are operated by experienced officers from foreign fleets. The 1979 catch statistics were taken from Shimura (1979, in Idelhadji, 1984). From 1980 to 1998, data from the Ministry of Fisheries was used. The catch composition of the different species was reconstructed throughout the years by using a combination of information found in the FAO statistics, the Ministry of Fisheries, Belvèze *et al.* (1982), Dochi and Lahlou (1983), Haddad (1994), and Kabadou (1996).

The foreign fleets

The recorded landings of the foreign fleet were based on the FAO electronic data set for the period 1972-1997 and on the printed Statistical Bulletin for the years 1964-1971 (FAO, 1976, 1979). Most industrial foreign fleets only started in the 1960s, except for Spain and Portugal. Data for the period 1950-1963 were difficult to obtain as fish were landed in foreign ports and reported without reference to the origin of the catch. We obtained partial landings for Spain (see Guénette *et al.*, this volume) but our estimation of the landings are likely underestimates for this period. This information was modified using catch data found in various working group reports (Anon., 1978a, b, c, 1982, 1986, 1990a, b; Lamboeuf *et al.*, 1984; Lamboeuf, 1997a, b, c).

Unreported landings

In 1984, the unreported landings of the coastal fisheries was estimated at 23% of the total reported landings in the ports of Tangier, Casablanca and Agadir (El Hannach *et al.*, 1986). El Mamoun (1999a, b), in a study using direct observations and a fishers' survey, described illegal trading of fishery products. The ports

studied in the Atlantic (Tangier, Casablanca and Agadir) are important ports through which a large proportion of the coastal fleet landings transit. Except for Tangier, landings arriving from boats or transiting through ports are reported in a larger proportion (30-60%) than those being transported by trucks (land transportation: 12%) (see Appendix 1). Under-reporting seemed to be more important for cephalopods and crustaceans.

The difference between the results obtained in 1984 and 1999 are large (Table 1) and most likely correspond to a change in social and economic incentives in Morocco. Prior to the 1990s fish were not consumed much by the local population, thus opportunities to sell the fish locally and directly were scarce. In the 1990s, the demand for fish increased sharply at the same time as the human population increased (24,285,960 in 1990 to 29,596,788 in 1999) and facilities to transport fish in refrigerated trucks increased.

The percentage of unreported catch has not been studied for the industrial fleet. However, it is likely that the unreported catch was very large during the 1970s when most vessels were landing in the Canaries and other foreign ports. In absence of data, the unreported catch of the industrial fleet demersal and pelagic species is assumed to be 47%, the same as in the coastal fishery of the 1990s (Table 1).

A 1993 study of the marketing of fish in Morocco estimated that the landings processed through illegal channels amounted to 60% of total landings (Durand, 1995). Although the Moroccan ports were under surveillance for one week only, interviews showed that buyers at different levels were obtaining 60% of their merchandise through illegal channels. The authors described several processes by which part of the landings are hidden to avoid taxes. For example, the crew share of fish (fakira) supposedly amounting to no more than one tonne for species landed in large quantities, is in reality more than 10 tonnes, unreported and sold directly. Mackerels and anchovies were mentioned as valuable species frequently sold this way by the fishers.

We assumed conservatively that the unreported landings of the Moroccan coastal fishery amounted to 23% or 47% depending on the fleet and the decade of the total landings (Table 1). However, we also applied the value of 60% for the Moroccan catches for comparison purposes. We do not have any information about the amount of unreported landings for the foreign fleet. However, we can assume that foreign fleets also have incentives not to declare all their catches. Thus, we utilized minimum and maximum rates of 23 and 47% (Table 1).

Table 1. Percentage of unreported landings and discard rate by decade.

Fleet	Fishery	1970s	1980s	1990s
		Unreported landings [a]		
Coastal	all	23 (assumed)	23 (El Hannach et al. 1986)	47 (El Mamoun, 1999) or 60 (Durand, 1995)[d]
Industrial	all	?	47 (assumed)	47 or 60 (Durand, 1995)[d]
		Discards [b]		
Coastal	pelagic	?	4 (assumed)	4 (El Mamoun, 1999)
	demersal	?	?	12 (El Mamoun, 1999)
Industrial	demersal trawlers	66% (Balguerías, 1997) [c]	46 (Balguerías, 1997) [c]	30 (Haddad, 1994)

[a] Expressed as the percentage of the total landing
[b] Expressed as the percentage of the total catch
[c] Cephalopod trawlers
[d] Used only for Morocco

Discarded catch

Based on observations of the small-scale fishery of Tifnit, discards were considered non-existent, since local fishers sold or consumed the total catch (Baddyr, 1989).

The discard estimates for the coastal fleet were based on research in the port of Agadir, Tangier and Casablanca in the Atlantic (El Mamoun, 1999a, b). The pelagic fisheries were found to discard 4% of the catch of sardines (Table 1). Discarded sardines were those eliminated from net cleaning operations, and those thrown overboard at sea due to their poor condition or their low price in the market on a given day. Sardines represented 94% of discarded pelagic fishes (Oueld Taleb, 1988). Coastal bottom trawlers were found to discard 12% of their catches (El Mamoun, 1999a, b). Discards included undersized and badly damaged commercial species, as well as non-commercial species dominated by boarfishes (*Macrorhamphorus scolopax* and *M. gracilis*), small-spotted catshark (*Scyliorhinus canicula*), rays, silver scabbardfish (*Lepidopus caudatus*), crabs, conger eel *(Conger conger)* and rockfishes. Since bottom trawlers landed more than 90% of the catch of demersal species, discard rates were not distinguished among demersal fishing gears.

The amount of discards of industrial pelagic boats is considered insignificant (Haddad, 1994). Based on reports of Moroccan scientific observers working onboard foreign trawlers for the years 1989-1993, Haddad (1994) reported similar discard rates for various foreign fisheries observed: hake trawlers 16-45% and longline 30%, cephalopod trawlers 30% and Spanish shrimp trawlers 20-30%. We retained a discarding rate of 30% for the industrial bottom trawlers in the 1990s.

Studies of discards for the Spanish cephalopod commercial trawl fishery documented larger rates of discards (Balgueíras *et al.*, 1993; Balguerías, 1997). The 1976-1977 (103 hauls) study mentioned discards of 66% of the total catch, while the 1989-90 (22 hauls) study reported a rate of 46% (Balguerías, 1997). The species composition of the discards was dominated by invertebrates other than cephalopods (16-28%), seabreams (4-9%), Elasmobranchs (5%), Triglidae (searobins, 10%) and various other demersal species (Haddad, 1994). For comparison, Mauritanian cephalopod trawlers fishing in Mauritania and in Senegal were found to discard 72% and 60-75% of their catch, while the Senegalese mixed fleet (targeting finfish and shrimps in shallow waters) had a discard rate of 67% (Balguerías, 1997). As an indication of shrimps fisheries, the Senegalese shrimp trawlers operating in Senegal and Guinea are thought to have discarded 38.5% of their catch in the mid-1980s.

Moroccan and foreign trawlers only differ in that foreign trawlers are not allowed within 12 miles of the coast. In absence of more precise data, it was assumed that the amount of non-commercial species discarded at sea is the same for both foreign and Moroccan trawlers. However, extrapolating the species composition would be difficult as it is likely to change depending on area fished, methods used, depth, population abundance and market conditions. We assumed that the discard rate given by Haddad (1994) may be underestimated compared with the Spanish studies. We have no data of discards for tuna and other large pelagics which should not have a large impact on the total estimated catch.

RESULTS AND DISCUSSION

Moroccan fleets

The recorded landings of the Moroccan fisheries in the Atlantic increased by a factor of 2 from 1950 (139.7 thousand tonnes) to 1974 (264.3 thousand tonnes) and a factor of five from 1950 to 1998 (708.7 thousand tonnes, Figure 3). The maximum catch of 843.5 thousand tonnes was recorded in 1995. This substantial increase was related to an increase in the fishing effort of all fleet (small-scale, coastal, and industrial) and to the inclusion of the former Spanish Sahara in 1975, almost doubling the coast length. The coastal fleet dominated the recorded landings of the Moroccan fishing fleet. It represented, on average, 96.5% of the annual total recorded landing for the period 1950-1972, and more than 75% for 1973-1998 (Figure 3).

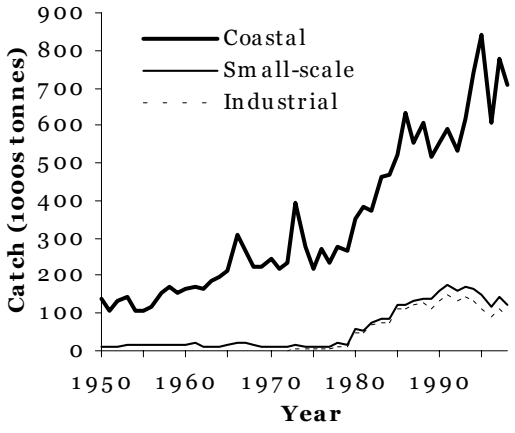

Figure 3. Recorded landings of Moroccan fishing fleets (cumulative graph).

Our estimate of landings for the small-scale fleet was approximately 25 thousand tonnes in 1993 (Figure 4). Durand (1995) reported an estimate of 30 thousand tonnes for this sector and the whole coast of Morocco, including the Mediterranean, and considered this number to be grossly underestimated. Thus, our reconstruction of the landings are probably very conservative for the whole period. During the period 1985-1998, demersal species were dominant in the landings, their catch increasing from 5.4 thousand tonnes in 1985 to 23.7 thousand tonnes in 1998. The spectacular increase at the end of 1989 was due to the development of the 'pot' trap technique to catch octopus in the southern part of Morocco (Dakhla). The landings of octopus increased from 3,000 tonnes in 1993 to 15,000 tonnes in 1998. In 1996, dories landed 22.3% of the total catch of octopus in the Atlantic. Their catch is so substantial and unregulated that the owners of the industrial fleet started to complain of unfair competition. Marine plants, collected by hand along the coast, dominated the catch in small-scale fisheries for the period 1950-1974, with their tonnage ranging from 10 to 18 thousand tonnes (Figure 4). The red Seaweeds (*Celidium* and *Graciliaris,* 90%) dominated the marine plants. The remaining is represented by *Laminaria*. Plants extracts were used as thickener agents in the food industry.

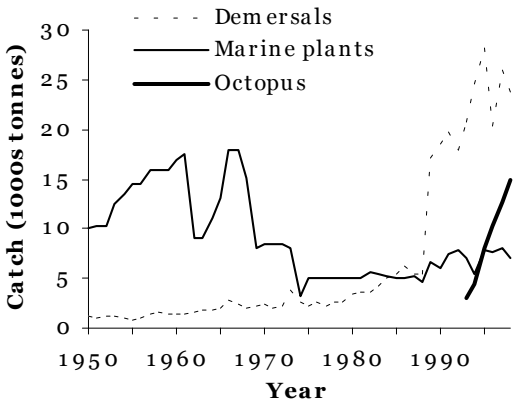

Figure 4. Composition of the recorded landings of the Moroccan small-scale fishery. The landings of octopus are already included in the demersals landings, estimated from the number of boats. Marine plants were taken from the FAO database. Sea mussels are not shown due to very small tonnage.

Small pelagic species have always dominated the total catch of the coastal fleet (Figure 5). Their catch increased from 110.8 thousand tonnes in 1950 to 485.5 thousand tonnes in 1998. The maximum catch of 618.1 thousand tonnes was recorded in 1995. The sardine (*Sardina pilchardus*) represented more than 85% of the annual landings from 1950 to 1998 (Figure 5).

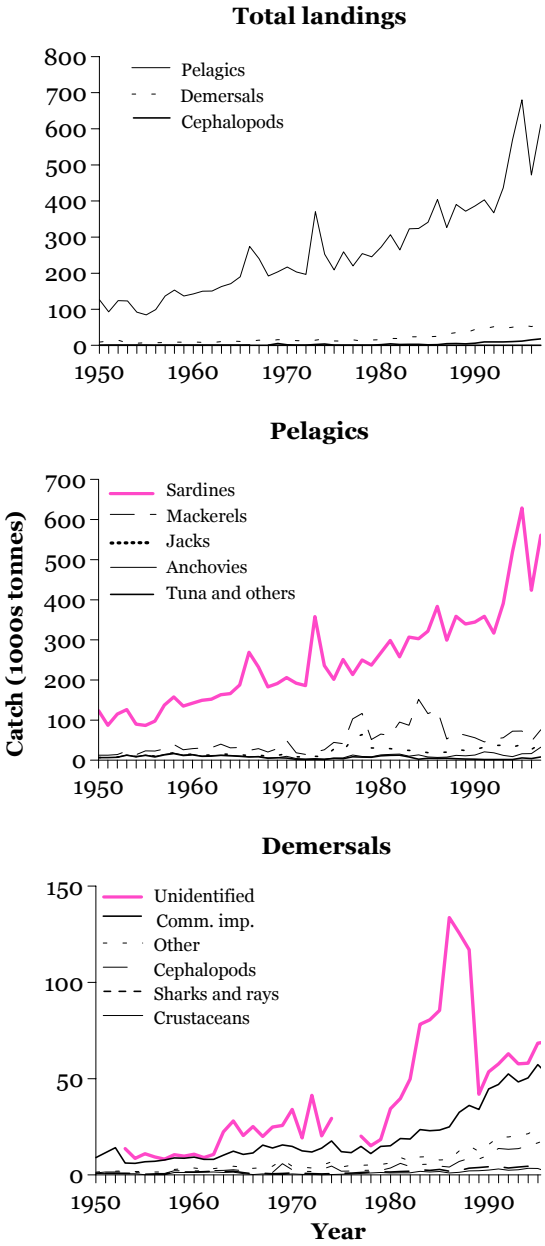

Figure 5. Composition of the recorded landings of the Moroccan coastal fishery. Crustaceans are mainly composed of European Rose shrimp. Commercially important demersals (Comm. imp.) include species from the following families: Trichiuridae, Sparidae, Merluccidae, Pleuronectiformes, Scianenidae, Haemulidae and Gadidae.

Mackerels are the second most important species in the small pelagic landings reaching a maximum in 1984 and 1986 of 127.3 and 101.7 thousand tones, respectively. Chub mackerel (*Scomber japonicus*) represented nearly 90% of the catch of mackerels (Belvèze *et al.*, 1982) while Atlantic mackerel (*Scomber scombrus*) is not important in the catch as the most southern limit of its geographical distribution is located near Agadir (30° N) and its abundance is low. Jacks (mainly the Atlantic horse mackerel *Trachurus*

trachurus) and anchovies (*Engraulis encrasicholus*) are landed in small quantities.

During the period 1950-1967, the catch of tuna species ranged from 4.1 to 13.5 thousands tonnes, and their annual average catch was 7.9 thousand tonnes. During the period 1968-1998, catches decreased substantially, ranging from 0.3 to 12.4 thousand tonnes, an average of 4.3 thousand tonnes per year.

The landings of demersal species is dominated by a mixture of unidentified species (Figure 5). Their landings varied from 1,700 tonnes in 1950 to 62,100 tonnes in 1998. The maximum was observed in 1986 with 120,000 tonnes (Figure 5). The catch of cephalopods, including octopus (*Octopus vulgaris*), squid (*Loligo vulgaris*), and cuttlefish (*Sepia officinalis*) increased from 200 tonnes in 1950 to 23,900 tonnes in 1998. The catch of sparids also increased from 5,400 tonnes in 1950 to 8,600 tonnes in 1998, with a maximum catch of 11,400 tonnes in 1992. Again, the opening of the Saharan coast to fishers of this fleet explains the increase in landings. The catch of hake (*Merluccius merluccius*) increased from 1.7 thousand tonnes in 1950 to 4.3 thousand tonnes in 1997. The maximum catch of 6.2 thousand tonnes was recorded in 1990.

With the exception of 1987, the catch of the Moroccan industrial fleet (composed to 94% of bottom trawlers) is dominated by demersal species (Figure 6), pelagic trawlers being present only from 1980-1998. Sardines (*Sardina pilchardus*) dominated the catch composition of small pelagic species (Figure 6) with landings increasing from 5,742 tonnes in 1980 to 29,034 tonnes in 1997. The maximum catch of 61,600 tonnes was recorded in 1987. The catch composition of demersals showed that cephalopods are the main targeted species (Figure 6) and during the period between 1973 to 1998, they represented a annual average of 68% of the total catch of demersal species. Their catch varied from 21,000 tonnes in 1973 to 63,000 tonnes in 1998. The overall annual catch of cephalopods is composed to 57 % of octopus, 15.7% of cuttlefish, and 9.4% of squid (Figure 6). The catch of sparids (seabreams) decreased from 13,124 tonne in 1984 to 3,240 tonnes in 1998, suggesting that these species may be overfished. The catch of flatfish species was relatively steady from 1980 to 1998 with an average catch of 3,800 tonnes per year. The catch of crustaceans started in 1986 with 812 tonnes and increased to 8,812 tonnes in 1998.

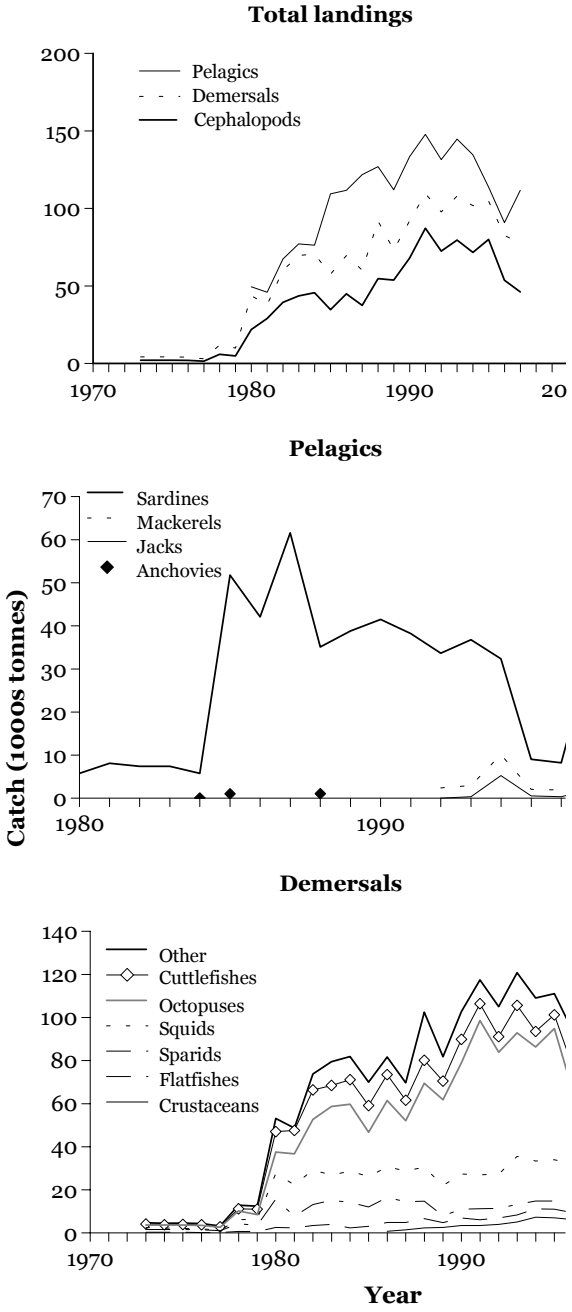

Figure 6. Recorded landings of the Moroccan industrial fishery. Composition of the total landings and of the pelagic and demersal species. Crustaceans consist mainly of Norway lobsters, shrimps and prawns.

Foreign fleet

Spain and Eastern European countries are the most important fishing countries on the coast of Morocco (Figure 7). During the period 1972-1990 the East European average landings (998.4 thousand tonnes) were more than two times larger than those of Morocco (402.2 thousand tonnes). For the same period, average Spanish

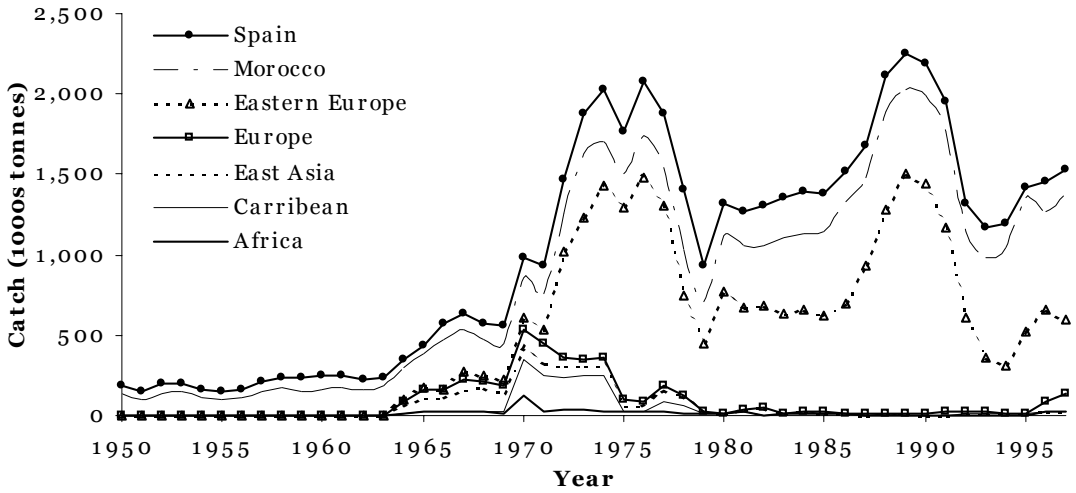

Figure 7. Recorded landings of foreign countries compared with Morocco.

landings amounted to 255 thousand tonnes, that is 86% of the Moroccan landings. These proportions decreased as access became increasingly restricted. Pelagic species, more precisely sardines, were the principal target species (Figure 8) and constituted 85% (62-92%) of the Eastern European landings. Spanish landings were dominated by demersal species, including cephalopods and crustaceans (see Guénette *et al.*, this volume). Note that a large part of the catch was reported as unidentified fish.

Landings reported by Japan were composed to 80% of cephalopods and demersal fish, with average catches between 1964-1979 of 46.5 and 12.5 thousand tonnes a year for cephalopods and fish, respectively. African countries, except Mauritania (i.e., São Tome, South Africa, Lybia and Ghana) have been fishing periodically in Moroccan waters, taking about 18 thousand tonnes a year between 1964-1979. However most of their catches remained unidentified. Mauritania's landings peaked at 30 thousand tonnes in 1972-1973, declining to 5,000 tonnes in the last two decades. European countries (excluding Spain) caught about 50 thousand tonnes of fish in the 1970s. Exceptional landings of about 40,000 t of round sardinella (*Sardinella aurita*) and 25,000 t of jacks (e.g., *Trachurus* spp.) in 1970-1971, and 41 and 87 thousand tomes of round sardinella in 1996 and 1997, respectively, inflated the catch of small pelagics for these countries.

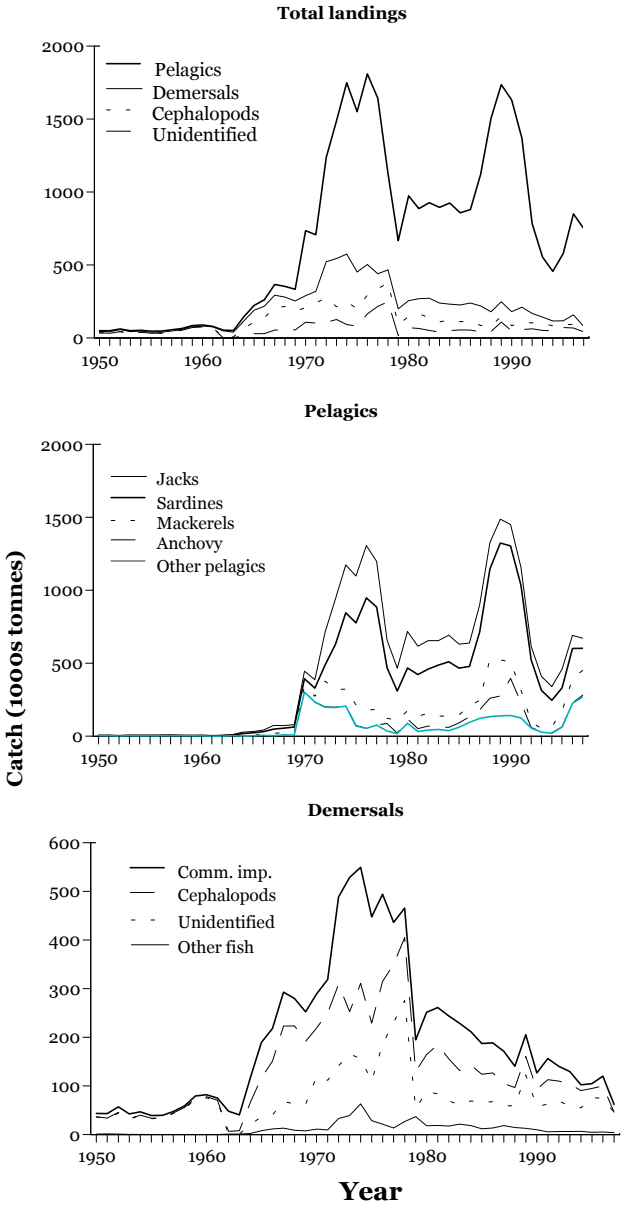

Figure 8. Composition of foreign landings. The demersal category in the total landings panel includes crustaceans, cephalopods, other invertebrates, shark and rays and demersal fish.

Comparing Reconstructed and FAO statistics

As FAO electronic data were not available before 1972 for the foreign fleet, statistics found in the various working group reports and those obtained from the official Spanish statistics (see Guénette *et al.*, this volume) were very important in reconstructing the catch before 1972. For the period 1950-1964, the new data added about 63 thousand tonnes or 45% of the reported landings. However, it is likely that our reconstruction for this earlier period is an underestimate.

For the period 1964 - 1997, the average difference between the reconstructed landings and FAO statistics is about 100,000 tonnes per year, or 9% of the reported landings (Figure 9). The difference for the foreign fleets is mainly due to the addition of catch data for hake (*Merluccius merluccius*), sardines (*Sardina pilchardus*), cephalopods, and seabreams from the various working groups. For Moroccan landings, the main difference is the addition of the artisanal landings which is still probably underestimated.

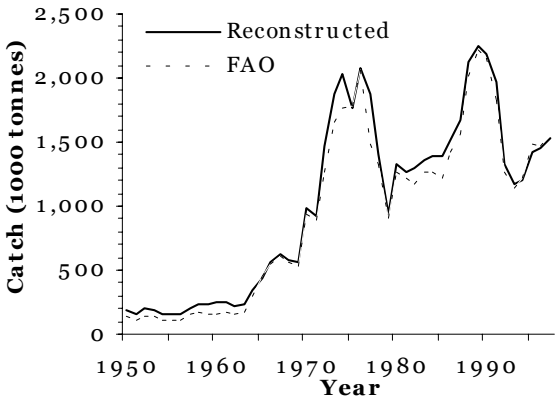

Figure 9. Comparison of FAO and reconstructed recorded landings.

Unreported landings and discards

For simplicity we computed average tonnage of discards and unreported landings and average total catch over each decade throughout this section.

For the Moroccan coastal pelagic fishery, where discards are estimated to be a small percentage of total catch (4%), unreported landings are the major source of discrepancy between the reported landings and total catch. This is especially so in the 1990's when unreported landings were estimated to be 47% to 60% of total landings (Table 1). Using these percentages, the average total catch for this decade was estimated to range from 858,028 tonnes to 1,136,160 tonnes (Figure 10), compared to reported landings of 436,564 tonnes for this period. Estimated total average catch for the 1980s, where a percentage of 23% was applied for unreported landings (no discard rate was available), total average catch was estimated as 384,551 tonnes compared to an average reported landing of 296,104 tonnes for that decade (Figure 10).

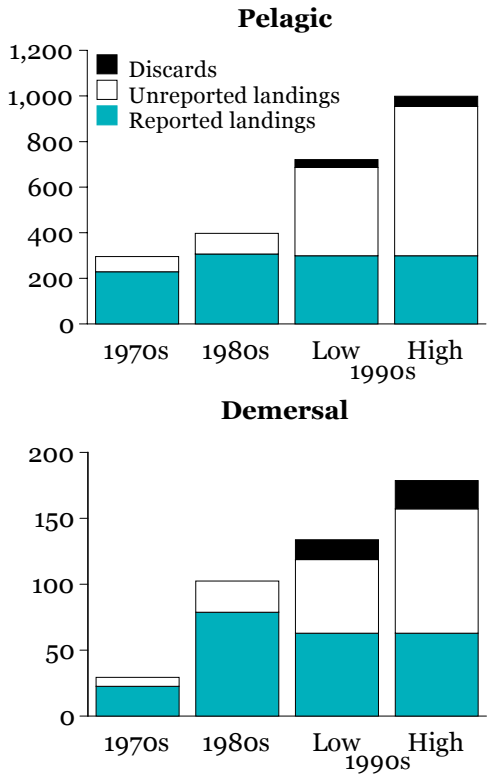

Figure 10. Decadal average reported landings, unreported landings and discards of the Moroccan coastal fishery. Missing discards correspond to missing estimates.

The two percentages (47% and 60%) of unreported landings were also applied to the Moroccan coastal demersal fishery, yielding estimates of unreported landings of 45,150 and 76,370 tonnes for the 1990s. (Figure 10). Discards, estimated at 12%, added another 12,266 to 17,357 tonnes for this decade. Thus, average total catches ranged from 108,329 tonnes to 144,640 tonnes (depending on percentage used for unreported landings) compared to the reported landings of 50,913 tonnes.

Similarly, unreported landings for the Moroccan industrial fishery in the 1990s, were estimated at 25,978 and 43,941 tonnes for the pelagic fishery (no discard percentage estimated) and 85,815 and 145,156 tonnes for the demersal industrial fishery (Figure 11). Discards for the latter would amount to 134,045 to 177,610 tonnes. Demersal discards and unreported landings totaled 316,632 tonnes to 419,537 tonnes compared to reported landings of 96,770 tonnes. Pelagic total catches would amount to 55,272 tonnes to 73,235 tonnes, compared to reported landings of 29,294 tonnes. If the proportion of unreported landings mentioned in Durand (1995) is a realistic estimation and widespread, the impacts on stock assessments and fisheries management could be considerable.

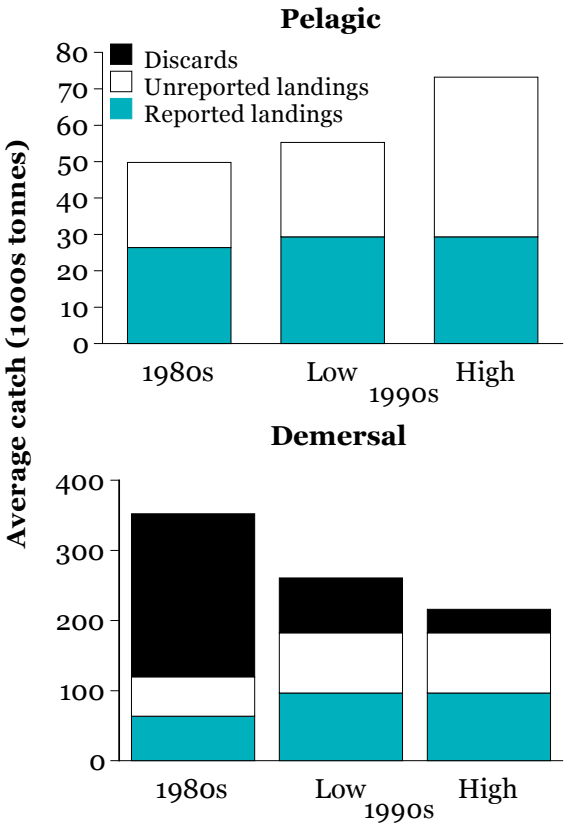

Figure 11. Decadal average of reported landings, unreported landings and discards of the Moroccan industrial fishery.

Discards and unreported landings for the foreign fishery (Figure 12) were calculated assuming similar rates as for Moroccan coastal and industrial fleets (23 to 47%). Unreported landings for the demersal fishery would vary between 71 and 211 thousand tonnes in the 1980s, and between 44 and 130 thousand tonnes in the 1990s. Similarly, unreported landings for the pelagic fishery vary between 252 and 789 thousand tonnes in the 1980s, and 205 and 608 thousand tonnes in the 1990s (no discard estimates available). Discards contributed an estimated minimum of 132,613 t in the 1908s and 81,677 t based on a discard proportion of 30% (Table 1).

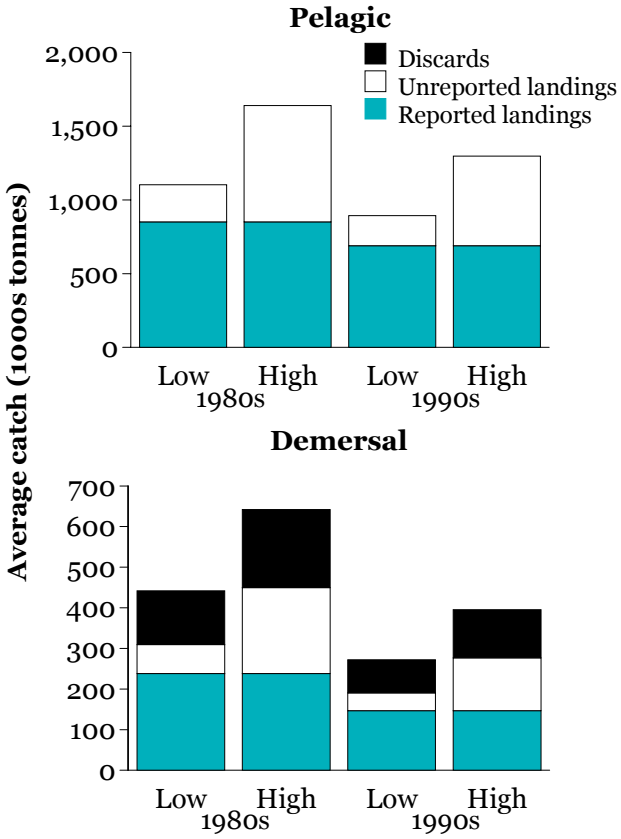

Figure 12. Decadal average of discards and reported and unreported landings for the foreign industrial fishery.

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APPENDIX 1. DISCARDS AND UNREPORTED LANDINGS AS REPORTED BY EL MAMOUN (1999a, b)

Percentage of discards and unreported landings for the coastal fleet according to El Mamoun (1999a, b). The percentage of discards relate to the total catch, while the unreported landings are expressed as the percentage of total landings (after discarding takes place).

	Total landings in 1997 (tonnes)	**Trawlers and longliners**		**Sardine boats**	**All sources**	**Average**
		seaway	**transit only**	**seaway**	**land transportation**	
Casablanca	26,465	-	-	-	-	-
discards	-	10	-	6	-	8.0
non-reported	-	67	67	55	88	69.3
Agadir	63,283	-	-	-	-	-
discards	-	12.46	-	3	-	15.5
non-reported	-	47	37	40	-	41.3
Tangier	5,984	-	-	-	-	-
discards	-	8	-	-	-	8.0
non-reported	-	17	-	-	3	10.0
weighted average discards		***11.5***	-	***3.9***	-	-
weighted average non-reported		-	-	-	-	***47.1***