# Reconstructing Red Sea fisheries of Sudan: foreign aid and fisheries $^{1}$

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## Abstract

The fisheries catch in the Red Sea Exclusive Economic Zone (EEZ) of Sudan was reconstructed from 1950 to 2010, by major fisheries and taxa. Published papers, reports and interviews were used as a base for the reconstruction. For the years where data were missing, interpolations or extrapolations were made using assumptions based on current knowledge of the fisheries. The results showed that Sudanese fisheries went through major shifts. The catches were about 2,000 t·year<sup>-1</sup> in the 1950s, remained low, and took off at the end of 1970s, mainly due to development projects aided by foreign organizations, which led to a massive increase in artisanal fishing effort, and ultimately, to catches of more than 5,000 t·year<sup>-1</sup> in the 2000s. The fisheries also shifted from being dominated by a shellfish fishery in the early years to being dominated by an artisanal finfish fishery in the later years. The number of species or species groups with major contribution to the total catch is higher in the latter years. The contribution of the industrial fishery is generally low. The reconstructed catch is higher than the catch reported by the Food and Agriculture Organization of the United Nations (FAO) on behalf of Sudan in the early years. However, in later years, the opposite seems to occur, i.e., the catch by FAO is higher than the reconstructed catch. This was deemed to be due to over reporting by Sudan.

#### INTRODUCTION

Sudan borders the Red Sea (Figure 1) and its shore is characterized by a relatively narrow shelf (as compared to other Red Sea countries) of about 4,000 km<sup>2</sup>. Overall, Sudanese waters are deep; indeed, the deepest part of the Red Sea, about 3,040 m, is off Port Sudan. Inlets. or 'marsas' in Arabic, are common on the coast, and have deep narrow entrances with shallow fringing coral reefs, which drop rapidly to greater depth. These inlets are used as shelters by the artisanal fishers. They sail from their bases, usually in bigger ports and human settlements, to the inlets which they use as fishing camps, from which they venture out to the open water to fish. Sometimes, they stay in the inlets for months and their catches are collected by trucks on dirt roads. About half a mile from the shore, there are what are commonly referred to as 'boat channels'. They are relatively shallow, up to 6 m deep, and are the navigation routes of local fishing boats. The boat channels are bordered by fringing reefs, which are an important area for fishing mainly by the small boats. Fringing reefs separate the shallow boat channels from the deep channels, which are from 80 to 400 m deep. They are the migratory routes of some fishes and some fishing takes place in those areas as well. Offshore from the deep channel is the barrier reef, about 3 - 6 nautical miles from shore, with most of the artisanal fishery catch originating from this area. Most of the commercially important coral reef species, which are the target of the hand line fishery, are found in the barrier reef area. Handlining is the main fishing technique of the artisanal fishery for finfish in Sudan (Barrania 1979; Vine and Vine 1980).



**Figure 1.** The Red Sea coast of Sudan, its Exclusive Economic Zone (EEZ) and shelf waters to 200 m depth.

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A prominent feature of the Sudanese coast is the extensive reef development, one of the most developed reef structures in the Red Sea. The fringing reefs, which are cut off by inlet channels are common, and the barrier reef is virtually continuous along the coast. The Sudanese coast also boasts the famous Sengenab Atoll, the only atoll in the Red Sea. It has very high biodiversity and has been nominated as a UNESCO world heritage sites. In addition, Rumi reef (*'She'ab Rumi'* in Arabic), was the site Jacques-Yves Cousteau chose for his Oscar award-winning documentary 'World without Sun', where an underwater house was built and the life in and around the underwater habitat of several 'oceanauts' was documented for one month.

Despite the high biodiversity in the Sudanese waters, the fish catch is not high and more than 95% of the fish supply of Sudan originates from inland waters, i.e., the Nile river, lakes and dams (Chakraborty 1983; Tesfamichael and Pitcher 2006). Most marine fishing in Sudan is handlining using different kinds of boats. Common are dugout canoes of 2 - 3 m that take 1 - 2 fishers using paddles (or sometimes sail) to fish in the inlets and behind the fringing reef. They are also very important for shell collection (see below). Other common boat types are huries of 3 - 5 m, and used mainly for handlining along the fringing reefs and in deeper waters just off the reefs. They can take 2 - 3 fishers and usually have sail and paddles. Bigger than huries are the rare felukas of 5 - 7 m length, which unlike the huries, are fitted with transom stern and usually have sail. Both huries and felukas are sometimes equipped with outboard engine of 3 - 8 hp (huries) and 10 - 12 hp (felukas). The biggest boat types used by Sudanese fishers are launches, which range from 7 to 11 m and are usually fitted with an inboard engine of 30 - 100 hp. They are used for handlining further offshore. They are also used, albeit to a lesser extent, in gillnet fishing. The length of a single trip is proportional to the size of the boats. Canoes and huries usually spend a single day per trip, while launches can spend up to 6 days (MEPI 1993).

There are many fish landing sites along the Sudanese coast; the most important ones are Abu Hashish, Salobona and Khor Kilab (the last not used much anymore) around Port Sudar; Mohammed Qol in the north and Suakin in the south. The main fish market is in Port Sudan. Suakin has better facilities to deliver fish to Port Sudan, and is also closer (Figure 1). Fish from the Red Sea is usually consumed on the coast, i.e., do not supply the inland markets, where the population concentration is higher. This is mainly due to poor transportation facilities, and the fact that fresh water catches tend to cover the demand of the inland population. Sometimes, a small portion of fish caught by artisanal fishers is exported to neighboring countries such as Saudi Arabia and Egypt. In addition to the artisanal fishers, trawlers (and to a lesser extent purse seiners) from foreign countries operate in Sudanese waters.

Prior to the prominence of finfish in catches; shells were, for centuries, the main target in Sudan (MEPI 1993), which was a major exporter of shell (Eltayeb 2004). The shells collected were mainly trochus and mother-of-pearl. Though the catch of the former was much larger, the latter had greater economic importance as its unit price was quite high. Sudan was important for shell fisheries of the whole Red Sea in the 1950s and 1960s, and fishers would come from all countries in the region, including from as far as Somalia and Yemen to land their catch. More than half, and sometimes up to 90%, of the shells landed in Sudan used to come from other neighboring countries (Kristjonsson 1956; Reed 1962). The fishers were sea nomads, who used to land their catches in either Port Sudan or Suakin, though they also used Massawa, Eritrea or Jeddah, Saudi Arabia, when they received better prices and marketing conditions. They would sail for days for a small difference in price. Because they were using sails, it did not cost them much to sail from one port to another (Reed 1962). However, in the 1970s, marketing in Sudan became difficult for foreigners, and the importance of that country as a destination for shell collectors declined (Eltayeb 2004).

The fishery for finfish started to gain momentum after mass mortality of shells in 1969; and many of the shell fishers converted to finfish through various development projects (Barrania 1979). Two major projects had important influences on Sudanese fisheries. One was run by the British Overseas Development Agency (ODA) from 1975 to 1990, targeting the southern part of Sudan (around Suakin). The main aim was to motorize the sailing boats of the artisanal fishers and to enhance the infrastructure at the landing site by providing storage and workshops (ODA 1983). The second important project was an FAO/UNDP project (1979 – 1985), which emphasized the northern part of Sudan, around Mohammed Qol and Dungunab, where the shell industry faced a major crisis. The objective was to organize the fishers into cooperatives so that they could access technical and financial facilities (Barrania 1985). The Canadian International Development Agency (CIDA) was also involved in shell fish culture research. These projects changed the landscape of Sudanese fisheries, especially the artisanal sector.

In this report, the catch of the major Sudanese fisheries are reconstructed from 1950 to 2010. The major fishery sectors were treated separately and a few minor fisheries were also examined. The catch compositions of the different fisheries were then calculated. First, we introduce the fisheries with respect to their operation, the fish they target and their marketing. Then, we explain the methodology of the reconstruction, followed by results and a discussion.

# Artisanal finfish fishery

The two major sectors of the artisanal fisheries are shell collection, which is treated separately in this report, and the finfish fishery, which is the main artisanal fishery and sometimes referred as 'the artisanal fishery'. Until recently, the artisanal fishery mainly operated dugout canoes in the shallow waters near the shore, using handlining, which accounts for up to 80% of the fish caught (Kristjonsson 1956; MEPI 1993). The fishers target carnivorous fishes in rocky grounds or near coral reefs up to 200 m deep using stones as sinkers, which are tied in such a way that they are released by jerking the line when it gets to a suitable depth. Knowing the right depth for releasing the sinker is gained through experience. In the past, fishing trips would be single day-trips using sail-power and no ice was used, because it was expensive and the fish did not need to be held more than a few hours as the fishers could get a reasonably good catch in a single day. The fish commonly caught were groupers (Serranidae), snappers (Lutjanidae), emperors (Lethrinidae), jacks (Carangidae), and sharks (Elasmobranchii). Most of the catch was consumed within

Sudan and a large fraction of the catch was delivered to Port Sudan by trucks owned by merchants, only a small portion is consumed locally. Mullet (Mugilidae) catch used to be salted in barrels, locally called 'fissik' and exported to Egypt, lately some is consumed locally. Until the end of the 1960s, the traditional artisanal fishery was shell collection. However, in 1969 there was a mass mortality of shells in Sudan and most of the fishers that were active in shell fishery switched to finfish fishing or other activities such as farming and trading.

# Artisanal invertebrate fishery

The artisanal invertebrate fishery in Sudan includes collection of shells in shallow waters and diving in deeper waters, for example for sea cucumber. Shell collection has a very long tradition in Sudan, where shell middens can be found all over the coast and on the islands. One oyster midden, estimated to consist of 3,000 t of shells, was found by radioactive dating to be 1,500 years old (MEPI 1993). In the contemporary history of Sudanese artisanal fishery, shell collection was dominant and the tradition continued until the end of the 1960s. However, most fishers previously active in the shell fishery switched to finfish fishing or other activities after the mass mortality of shells in the late 1960s. The major shells collected in Sudan are mother-of-pearl (*Pinctada* spp.) and trochus (*Trochus* spp.). Dungunab Bay, in the northern part of Sudanese Red Sea coast, is famous for its mother-of-pearl oysters.

Shells are collected by skin diving in shallow waters (down to 10 m). In the past, trips were usually done by bigger *sambuks* with 6 – 8 crew. When they reached a protected bay (*marsa*), they would anchor the *sambuk*; the divers then would take the *huries* they carried onboard to the diving sites and brought back their catch. Shell collection consisted of drifting with the *huries* over the shell beds, while monitoring the sea floor with a glass-bottomed bucket. The fisher then dove when they spotted oysters (Kristjonsson 1956). *Huries* with sail and motorized launches were also used to sail to the fishing ground. Some shells were collected by walking in the shallow waters near settlements. In the past, the fishers hardly used any snorkeling equipment for shell collection, but later, they started using masks, snorkels and flippers. The fishing season is the warm summer months. The season usually started around April but the main activity occurs between July and November, when the water is warm, clam and thus provides better visibility. There was no shell collection from January to March and the fishers switched to finfish fishing or other activities such as farming or trading (MEPI 1993).

The most important species in the shell fishery are black lip mother-of-pearl oyster *Pinctada margaritifera* var. *erythreaensis* and *Trochus dentatus*, in Arabic '*sedaf*' and '*kokian*', respectively (Reed 1962). Centuries ago, oysters were collected mainly for their pearl. Later, oyster shells started to be exported to Europe for the manufacturing of fancy buttons, inlay work, jewelry and artifacts. A small proportion is used locally for poultry feed as a source of calcium. Trochus is also exported for production of small buttons. Oysters and trochus were also used for making plaster, used for whitening walls. However, because it was very expensive, it is now abandoned; instead fossilized corals and other shells are used. Other mollusks are collected either for their meat and/or their opercula. The sun dried meat of mainly conchs (Family Strombidae, specifically *Stombus* spp. and *Lambis* spp.), locally called '*surumbak*', is consumed locally and some of it used to be exported to Saudi Arabia. The nail (opercula) of conchs and other gastropods such as *Fasciolaria* spp. locally called '*tsifri*' were also collected to be used as fixatives in the local production of perfumes (MEPI 1993).

Sea cucumber has been collected for export to Asian markets. Fishers started collecting sea cucumbers in shallow waters, and later moved to deeper water using skin diving. As those resources started to get scarce, SCUBA diving was introduced, and finally, fishers used boat hookah diving with compressors onboard so that they can stay longer in the water to collect more sea cucumbers. Some of these practices did not have enough safety measures and training and many serious accidents occurred. Once the sea cucumbers are collected, they are usually boiled and dried for export to Asian markets. The local fishers sometimes fish for shrimp in the shallow lagoons using cast net (Elnaiem 2002).

# Subsistence fishery

The definition of subsistence fisheries may vary. FAO defines it as "a fishery where the fish caught are consumed directly by the families of the fishers rather than being bought by middle-(wo)men and sold at the next larger market".<sup>2</sup> For the purpose of this research, in line with the FAO definition, we considered catch that is consumed by the crew, given to family, friends and part of the community who need the support (e.g., widows) as part of the subsistence fishery. In Sudan, like other Red Sea countries, it is a common practice for fishers to share part of their catch with the community before they land their catch. This portion of the catch is significant, sometimes half of the total catch, and never gets reported. It is a social obligation for everyone to do their duty and not contributing has social consequences. The part of the catch that is given freely to the community is the fish that is not directed for export, such as shark fins.

# Industrial fishery

Only a small fraction, about 700 km<sup>2</sup>, of the narrow continental shelf along the Sudanese coast, which is dominated by coral reefs, is suitable for bottom trawling (Sanders and Kedidi 1981). Most of this is in the southern part of the coast, including the Toker Delta. The Gulf of Agig, on the border with Eritrea, is also frequently visited by trawlers. The earliest trawling survey to explore trawl suitable grounds started intermittently in the late 1950s and the early

1960s (Reed 1962). On the other hand, the more concerted surveys performed from 1976 to 1981 by ODA and private companies ushered the beginning of commercial trawling operation in the early 1980s. Since the beginning, trawling has been undertaken by foreign companies from Egypt, China and others, targeting shrimp and some fish. Although trawling is done during the day and at night, the catch is found to be higher at night between 8 pm and 4 am (Elnaiem 2002). The shrimp catch usually accounts for only 3 - 10% of the total catch, and most of the bycatch ends up discarded at sea (Elawad 2002; Elnaiem 2002).

Purse seining is another industrial fishery that operates in Sudan, but less common than trawling. The main fishing areas are in the northern part of the Sudanese coast in and around the area disputed with Egypt (Figure 1), where Egyptian purse seiners have been fishing for decades without any permit from Sudan, which hardly has any fishing activities of its own in the area (MEPI 1993). Starting in 2002, purse seiners from Egypt started fishing in the southern part of the Sudanese coast with permits. All their catch was landed in Egypt.

## MATERIALS AND METHODS

Published papers, technical reports, government reports, archives, theses and research reports were searched for data and information on Sudanese marine fisheries. Early reports, from the mid-1950s to the late 1980s were authored mainly by FAO personnel who visited the country as expert advisors. The ODA project reports also provided some valuable information for the 1970s and 1980s. Information referring to later periods (after 1990) was available mainly from local reports and files of the Fisheries Administration in Port Sudan (FA 2007, 2012). On-site interviews were also carried out by the first author in 2007 to fill in information gaps (Tesfamichael *et al.* in press). Where information was not available at all, interpolation was used to estimate the catch given the best knowledge available at the time of the research. Since different procedures were used for the different fishery sectors, the method for each fishery is given separately.

# Artisanal finfish fishery

According to reports and the Fisheries Administration of Sudan, the small-scale finfish fisheries are divided into artisanal and semi-industrial. The main difference is that the former uses smaller boats and usually no motors, while the latter uses engines and larger boats. For the purpose of this research, they are all considered part of the artisanal fishery (the shell fishery is treated separately).

Kristjonsson (1956) was the first to publish an estimate of Sudanese finfish catch, i.e., 300 t-year<sup>-1</sup>. At the time, this fishery was mainly for local consumption and to supply a small market in Port Sudan. This estimate was later adopted by Oswald (1958) and Reed (1962). In the 1950s and 1960s, Sudanese fishers were more interested in shell collection than finfish fishing, as there was a lucrative market for shells. However, this changed in 1969 when a massive mortality of shell fish occurred. Thus, the estimate of 300 t-year<sup>-1</sup> is used here as the total catch of artisanal fishery from 1950 to 1969. The next catch estimates were from Barrania (1979), who quantified the annual amount of fish sold in the fish market of Port Sudan from 1975 to 1978. A later survey showed that about half of the fish consumed in Port Sudan did not go through the formal market channel; in addition, 300 t of fish were consumed every year outside Port Sudan (Chakraborty 1983). So, to estimate the total annual catch of the artisanal fishery from 1975 to 1978, the amount of fish sold in Port Sudan market is multiplied by two and 300 t added to it. An independent detailed fishing effort and catch survey for 1976 along the Sudanese coast was published by ODA (1983). The ODA estimate, 671 t for 1976, was higher than the one calculated using the data of Barrania (1979) and the method described above, i.e., 609 t. Thus the total catches for all years calculated using Barrania (1979) data from 1975 to 1978 were corrected using the ODA survey (Table 1). Catch estimates from 1970 to 1974 were interpolated so as to reflect the slight increase in total catch as fishers moved from shell collection to finfish fishery.

The Fisheries Hydrobiological Administration of Sudan (FHAS 1984) reported Sudanese catch for 1979 and 1980 using Port Sudan reported catch and the procedure described above, while Chakraborty (1983) also estimated catch for 1979, which was similar to FHAS estimate. The FHAS (1984) data were used here because they provided more details on the data collection procedure, including the taxonomic composition of the catch.

For the years 1981 – 1983, a number of catch estimates were published by the experts and consultants hired by the ODA and FAO/UNDP projects. The estimates of Chakraborty (1983) were obtained using the reported catch of Port Sudan. Kedidi (1984) based his estimate on effort data (number of fishers for 1981 and number of boats for 1982 and 1983), multiplied by the catch per unit of effort taken from a sample of boats, and ODA (1983) based their estimate on a survey of fishing villages for 1981 and the number of full time and part time fishers for 1982 (Table 2). The ODA estimates were used for 1981 and 1982, while Kedidi's estimate was used for 1983. These data points were chosen because they provided details that were missing from the other reports.

**Table 1.** Sources and adjustment to estimate the Sudanese artisanal finfish fishery catch (tonnes) from 1975 to 1978.

Year	Port Sudan	Total catch	ODA (1983)	Total, adjusted				
	(Barrania 1979)	(Port Sudan *2 + 300 t)	survey data	to ODA survey				
1975	56.2	412.4	-	454.2				
1976	154.6	609.2	671	671.0				
1977	135.3	570.6	-	628.5				
1978	148.3	596.6	-	657.1				

**Table 2.** Estimates of total catches (tonnes) of Sudanese artisanal finfish fishery by different authors from 1981 to 1983; the **bold** values are the ones used here.

Year	Chakraborty (1983)	ODA (1983)	Kedidi (1984)
1981	1050	1628	1102
1982	1109	1441	1191
1983	1167	-	1443

Data for 1984 and 1989 were available from MEPI (1993). Again, the total catch was calculated using Port Sudan reported catch multiplied by two and adding 300 to it. However, the estimate of 300 t-year-1 for fish consumed outside Port Sudan used in the 1970s calculation, which was still being used in the 1980s and 1990s, was here assumed to change with increase in population size. Thus, we assumed it to be 300 t-year-1 in 1980; for the other years, this figure was increased based on the ratio of population of the respective year to the population of 1980. Data from 1985 to 1988 were interpolated (Figure 2). From 1990 to 2010, catch data of fish sold in the Port Sudan market were compiled by the authors from the files of the Fisheries Administration (FA 2007, 2012) in Port Sudan. Those values were multiplied by two and the catch consumed outside Port Sudan was added based on the population size adjustment outlined above (Figure 2).

There was a mullet fishery using veranda nets by Egyptian fishers along the Sudanese coast all the way south to the Eritrean waters, which caught an estimated 1,000 t year 1 (Sanders and Morgan 1989). The fish were salted in barrels, producing what is locally called 'fissik'. According to records and experts from the Fisheries Administration in Port Sudan, this fishery existed only from 1986 to 1991 and was experimental. There were about 4 - 6 boats operating only 4 months per year. It is believed the 1,000 t-year<sup>-1</sup> is an over estimate for the Sudanese coast, partly because the fishers were fishing all over the Red Sea. Thus the annual 1,000 t was not used for Sudan, instead the annual average catch was calculated taking the average of 5 boats operating 4 months and a catch per day of half a tonne, resulting in 300 t·year-1, which was added to the totals of 1986 - 1991. Figure (3) shows the summary of the sources and procedures of the reconstructed catch of the Sudanese Red Sea artisanal fishery compiled for the whole period studied, 1950 – 2010.



**Figure 2.** Sources and procedure for reconstructing artisanal finfish fishery catch of Sudan from 1984 to 2010. The stars in 1985 and 1986 indicate the addition of 300 t of mullet to the total catch starting 1986 (see text).



**Figure 3.** Catch reconstruction of the artisanal finfish fishery of Sudan. The values until 1969 (the star) are assumed values, after 1969 it is interpolated between 1969 and 1975. The stars in 1985 and 1986 represent the addition of mullet to total catch (see Figure (2) and text).

The catch of the artisanal fishery consists of many species; however, only a few are dominant. Different authors estimated the catch composition and their percentages were used to calculate the catch composition of the reconstructed total catch (Table 3). In some cases, data from a single year was used to calculate the catch compositions for a longer period. For example, Barrania (1979) estimated the catch composition for 1978, which was used for the period 1950 – 1978. Data files from the Fisheries Administration, Port Sudan office (FA 2007) provided the composition of the fish landed in Port Sudan for 2006 and were used for 1990 – 2010. For 1981 – 1982, the weighted average of 1979 – 1980 was used. For the calculated total catch composition 300 t-year<sup>-1</sup> of mullet was added from 1986 to 1991. The blue-spotted sea bass reported in Chakraborty (1984) for 1983 was lumped together with the grouper category.

 Table 3.
 Sudanese artisanal finfish fishery catch composition percentages, 1950–2010.

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Period	Groupers	Snappers	Emperors	Jacks	Sharks	Mullets	Unicorns	Others	Source
1950-78	30.11	23.26	13.54	7.65	5.10	7.81	2.55	10.00	Barrania (1979)
1979	19.86	27.91	14.25	6.06	8.59	10.31	3.02	10.00	FHAS (1984)
1980	27.71	22.57	19.17	6.12	6.20	7.09	1.13	10.00	FHAS (1984)
1981-82	24.13	25.03	16.93	6.10	7.26	8.57	1.99	10.00	Calculated*
1983	47.07	17.76	25.17	0.00	0.00	0.00	0.00	10.00	Chakraborty (1984)
1984-89	20.58	32.28	17.22	11.03	2.70	5.11	1.08	10.00	MEPI (1993)
1990-10	19.95	15.09	14.65	7.33	7.88	25.10	0.00	10.00	FA (2007)

\* Weighted mean of 1979 and 1980

Figure (4) shows the reconstructed catch composition of the Sudanese artisanal finfish fishery (see Appendix Table A1). All the catch composition figures presented here are after the adjustment and comparison procedure described above were carried out. The taxa represented in the figures are only the dominant ones for better representation; therefore, the list of taxa in the catch composition may be bigger than the taxa in the figure. Expanded tables of catch composition data are given in the appendix.

## Artisanal invertebrate fishery

The trochus shells landed in Sudan were almost exclusively destined for export; as a result, reliable records were available starting in the early 20th century. Export data were available for 1950 – 1961 (Reed 1962), 1966 – 1989 (MEPI 1993), 1992 – 2002 (Eltayeb 2004), 2003 – 2006 (FA 2010) and 2007 – 2010 (FA 2012). Not all shells that were landed were exported; some of them were discarded simply because the shells lost their nacreous layer making them unsuited for export (Eltayeb 1999). Data of landed and export amounts were available from 1997 to 1999 (Eltayeb 1999) and the average discarded amount was 42.5% of the exported shell weight. This ratio was used to scale up the export amount to total landing. There was no export of trochus in 1990 and 1991 (Eltayeb 1999). However, MEIP (1993) reported a total catch of 114.8 t annually for the early 1990s, and this value was used for 1990 and 1991. Data were not available from 1962 to 1965 and an interpolation was used to fill in the gap (Figure 5).

The ovster fishery in Sudan was also almost exclusively for export, thus records existed starting in the early 20<sup>th</sup> century. Data were available from 1950 to 1961 (Reed 1962), while MEPI (1993) had export data for 1966 – 1979, 1984, 1987, 1989 and 1992. Records from the Fisheries Administration indicated a catch of 1 t for 2003, and none thereafter (FA 2010, 2012). Reed (1962) reported that the fishers could not tell if the oyster they picked was large enough for the export market. Thus, about 20% of the ovsters collected were undersize and they had to be discarded at sea, with many eventually dying. Later, a method was introduced for planting the small oysters in wired trays to grow them until they were large enough for the market. We assumed that about half of the 20% undersized oysters died. So, 10% was added to the export value to calculate the total catch of oysters. For the years data were not available, interpolation was applied to estimate the catch (Figure 6).



**Figure 4.** Catch composition of the artisanal finfish fishery of Sudan, 1950 - 2010.



Figure 5. Catch reconstruction of the trochus shell fishery of Sudan, 1950-2010.



**Figure 6.** Catch reconstruction of the oyster shell fishery of Sudan, 1950–2010.

There were few data points for the export of dried sea cucumber: MEPI (1993) reported 15 t in 1981, and FA (2007) 10 t and 3 t for 1985 and 1986, respectively. A continuous dataset was also available from 2001 to 2010 from the files of the Fisheries Administration of Sudan in Port Sudan (FA 2012). These values were converted to wet weight based on dry weight corresponding to 10% of wet weight (Tesfamichael and Mohamud 2012). The estimates from 1982 to 1984, and from 1987 to 2000 were interpolated. From 1950 to 1980, we assumed a catch of 27 t-year<sup>-1</sup>, the lowest of available data points (Figure 7). There was only one data point for the sun dried meat of conchs (*Strombus* spp. and *Lambis* spp. of family Strombidae), locally called '*surumbak*' for 1992 from MEPI (1993), which estimated the annual total catch to be 44 t. In the absence of other data points and in the knowledge that this activity has been going on for a long time, this estimate is assumed to be the annual value from 1950 to 2010. Similarly, only one data as the annual value from 1950 to 2010.

#### Subsistence fishery

The total catch and composition of the subsistence fishery was calculated based on the information and knowledge obtained through the reconstruction of the finfish artisanal fishery. Data on the artisanal shell and shark fisheries were not included, because they are exclusively for export, hence it does not satisfy our definition of a subsistence fishery, which is catch given freely to family and friends and does not get recorded. To estimate the extent of the subsistence fishery, the time line of the artisanal fishery was divided into two periods, 1950-1979 and 1980-2010, based on the motorization of boats, which even if started earlier (Barrania 1979), accelerated in 1980 (Chakraborty 1983). We assumed the subsistence fishery to be 30% of the artisanal fishery from 1950 to 1979. This is a reasonably conservative estimate, because interviews with fishers indicated that before motorization and strong commercialization of fishery, they used to give up to half of their catch



**Figure 7.** Catch reconstruction of Sudanese sea cucumber fishery in the Red Sea; the star at 1980 indicates the end of the assumed values from 1950 to 1980 (see text).

to family and friends. Once motorization accelerated, we assumed 20% of the artisanal fishery to be subsistence, and by 2010 we assumed this had declined to 10%. The ratio of subsistence was interpolated from 1980 to 2010. The catch composition of artisanal fishery was used to calculate the composition of subsistence fishery, except sharks and rays were excluded because they are mainly for export markets (Figure 8, Table A2).

## Industrial fishery

The earliest report of industrial fishery was documented by Reed (1962) for exploratory trawling for shrimp during his assignment in Sudan from 1958 to 1961. The trials were sporadic and aimed to identify trawling grounds. He reported best catches of up to 100 individual shrimp per hour at night, with lower values during daytime. The next trawling surveys were conducted by ODA in 1976 and 1981 (ODA 1983), which we used as data anchor points. The 1976 shrimp catch was 14.7 t, with 114.5 t of discards, while in 1981, the shrimp catch was 26 t and retained fish catch was 13 t. Although the main target of trawling at the time was shrimp, some fish were kept for the local market. The fish catch for 1976 was not available and was estimated using the shrimpfish ratio for 1981, while the discard for 1981 was calculated using the shrimp discard ratio of



Figure 8. Catch composition of the subsistence fishery of Sudan, 1950-2010.

1976. From 1977 to 1980, data were not available for trawling. However, Sanders and Morgan (1989) reported that a company called Ross Sea Food International was doing exploratory trawling in 1978 and 1979, and estimated the potential catch of shrimp from the Sudanese coast to be 30 t-year-1; however, their actual catch during the operation was not reported. Thus, the catches for 1978 and 1979 were interpolated using the data for 1976 and 1981 as anchors. Ross Sea Food International abandoned their operation when they concluded that the 30 t-year<sup>-1</sup> shrimp potential was not worthwhile for a commercial venture. The catches in 1977 and 1980 were set to zero as there were no trawling activities reported for those years (ODA 1983; Sanders and Morgan 1989). Starting in the early 1980s, Sudan started issuing trawling permits to foreign vessels, mainly from Egypt (MEPI 1993). The annual catch from 1982 to 1984 was estimated based on Elawad (2002), who reported the minimum trawling total catch, including discards, from 1979 to 2000 was 90 t-year<sup>1</sup>. This value was assumed until 1984. The next reference available was for 1990, the last year the Egyptian trawlers operated before they were stopped for a few years. There were, however, a few other trawlers operating in Sudan. The total catch for 1990 was 544.2 t (MEPI 1993; Elawad 2002). The total catches from 1985 to 1989 were interpolated to depict the increase in the trawling activity during those years. The catch declined to 137 t year 1 in 1991 (MEPI 1993). The next data reference was for 1998, being 290 t (Elawad 2002), when a special permit was given for trawling for Egyptian vessels. The catch from 1992 to 1997 was kept constant at the level of catch in 1991. Catches for 1999, 2002 – 2010 were available from the files of Fisheries Administration and Fisheries Research Centre (FA 2007, 2012). Catches for 2000 and 2001 were interpolated (Figure 9).

The catch composition of the trawl catch in 2004 was taken from files of the Fisheries Administration (FA 2007), i.e., 5% shrimp (Penaeidae), 27% lizard fish (Saurida spp.), 7% threadfin bream (Nemipterus spp.), 4% goatfish (Mullidae) and 57% discards. These ratios were used from 1982 to 2006. From 1976 to 1981, the catches of shrimp, all fish and discard were calculated as mentioned in the previous paragraph. The shrimp catch and discard were used directly in the catch composition, while the fish total was divided according to the fish ratios from 2004 (Figure 10, Table A3). The main shrimp species were deep-water species, i.e., Penaeus semisulcatus, Metapenaeus monoceros and *Melicertus latisulcatus*, which contributed more than 90% of the catch. For coastal lagoon, which contributed less to the total catch, P. monodon and P. indicus were the only species reported (Elnaiem 2002). The composition of the discarded catch was calculated according to data from Yemen (Tesfamichael et al. 2012b), since trawl operations are similar between the two countries (Figure 11; Table A4).

The purse seine fishery in Sudan started in 2002 by vessels from Egypt. Data were available for the total catch and catch composition from 2002 to 2005 (FA 2007) and from 2006 to 2010 (FA 2012) from the Fishery Administration in Port Sudan. This fishery is assumed to not generate any discards. In addition, as a relatively limited and controlled fishery, there is good data recording system; hence the values were used as they were (Figure 12, Table A5).

## Comparing reconstructed catches with FAO data

The reconstructed catches were compared to the composition of Sudanese catch in the FAO data (www.fao.org/fishery/statistics/software/ fishstat/en). Annual catches are reported for Sudan in the FAO database. From 1950 to 1997, all the catch data are given as 'Marine fishes nei' without compositional breakdown. From 1998 to 2010, the two taxa 'narrow-barred Spanish mackerel' and 'sharks, rays, skates etc. nei' are represented separately and the rest lumped as 'Marine fishes nei'. The FAO data for Sudan were not refined enough to provide information about any of the fisheries.

The taxonomic group 'others' in the reconstructed catch, which includes the miscellaneous taxa not reported separately, was very high for some years. It was first reduced to 10% of the total of Sudan, 1950 - 2010. 0.9r Others

Figure 10. Composition of the retained catch of trawl fishery in the EEZ



Figure 11. Composition of the discarded catch of trawl fishery in the EEZ of Sudan, 1950-2010.

catch, and the difference was distributed to the previously identified taxa in proportion to their reported percentage except 'sharks'. The procedure was needed because when the unidentified group 'others' assumes high proportion of the total catch, the resolution of the catch is not very informative. The group 'sharks' was excluded because it was reported separately in the FAO data. Then the FAO category 'marine fishes nei' was disaggregated further using the ratios in the reconstructed catch, again after excluding 'narrow-barred Spanish mackerel' and 'sharks'. Finally, each taxon in the reconstructed catch was compared to the FAO data to calculate misreporting. The part of the reconstructed catch that is accounted in the FAO data is referred to as 'reported catch' in our result. If the value of a taxon in the reconstructed catch was higher than its value in the FAO data, then the difference was labeled as 'unreported catch', and if the FAO value for a taxon was higher than the reconstructed catch, the difference is overreported catch.



Figure 9. Catch reconstruction of the trawl fishery in the EEZ of Sudan, 1950 - 2010. The stars (1978 and 1979) represent interpolations line between 1976 and 1981. The star in 1997 represents the end of the assumed value from 1991 to 1997.



#### RESULTS

The reconstructed total catch of all the fisheries in the Sudanese EEZ in the Red Sea was generally low, below 2,000 t, until the end of the 1970s (Figure 13, Appendix Table A6). The total catch includes the amount caught by foreign vessels, trawling and purse seining as explained in the above, in the Sudanese EEZ. Between the 1980s and end of 2000, it was somewhat higher until it showed a rapid increase following the turn of the century. The FAO database provides the total catch reported by Sudan (<u>www.fao.org/fishery/statistics/software/fishstat/en</u>). Until Until 1992, the reconstructed data were higher than the FAO data except in 1962 and 1983. After 1992, the FAO data were significantly higher except in 2005 where they were more or less the same. As with many countries, this is not a case of either Sudan fishing in other countries' EEZs, for example Egypt fishing in Sudanese, Eritrea and Yemeni waters (Tesfamichael and Mehanna 2012), or vessels from other countries fishing with Sudanese flag of convenience. Sudan is not listed as a country of flag of convenience, see www.itfglobal.org/flags-convenience/flagsconvenien-183.cfm. The most reasonable explanation is that Sudan has misreported its catch to FAO as is the case with many countries (Watson and Pauly 2001; Pauly and Froese 2012).

The shell fishery was the main contributor to the total catch until the mid-1970s, where it started to decline and the catch of artisanal finfish fishery started to increase. The artisanal fishery then became dominant, and remained more or less stable until the present. The rapid increase in the total catch after 2001 was mainly due to the large catch from industrial fisheries, trawling and purse seining (Figure 13; Table A6).

Looking at the components of the reconstructed catch, the unreported landed catch was relatively higher until the end of the 1980s (Figure 14, Table A7). Overall the unreported landed catch accounted for 30% of the total catch from 1950 to 2010. The decline in the proportion of the unreported landed catch, starting in the 1990s, corresponds to the decline of the shell fishery. which had the worst data recording system and accounted for the highest ratio of the unreported landed catch when it was active. The reported catch (part of the reconstructed catch accounted in the FAO data) has the highest contribution to the total catch with 64%. The discarded catch, almost exclusively by trawling, was generally low, 5% from 1950 to 2010, and appears only later, starting the mid-1970s.

Trochus was the main species in the total catch until the beginning of the 1970s. As soon as the artisanal finfish fishery started growing, in the mid-1970s, the number of species in the catch



**Figure 12.** Catch composition of the purse seine fishery in the EEZ of Sudan, 1950 - 2010.



**Figure 13.** Reconstructed catch in the EEZ of Sudan by gear type and what is reported to FAO, 1950 - 2010.



**Figure 14.** Reconstructed catch in the EEZ of Sudan by components, 1950 – 2010. Reported catch refers to the part of the reconstructed catch accounted in the FAO data.

increased. The catch of uncategorized species (i.e., 'others') also became very large. This pattern continued until the catch of industrial fisheries also became very important, i.e., after 2001. However, what became most prominent from the industrial fisheries was the high proportion of discards (Figure 15; Table A8).

# DISCUSSION

The total catch in the EEZ of Sudan is the lowest in the Red Sea after Israel and Jordan (Tesfamichael and Pitcher 2006; Tesfamichael et al. 2012a). To a large extent, this can be attributed to the very narrow continental shelf along the Sudanese coast. Nevertheless, the Sudanese fishery has not developed well to fish in its shelf; for example, there has not been a continuous trawl fishery in the trawl suitable grounds and all the trawling has been done by foreign vessels (MEPI 1993). The major catch of the other countries bordering the Red Sea comes from bottom trawling and pelagic species, which are not well developed in Sudan due to the shelf characteristics. Also, the nutrient rich waters that flow into the Red Sea from the Gulf of Aden through the narrow straight 'Bab al Mendab' does not reach the Sudanese coast. Thus, the marine fishery sector in Sudan is very small, although still important to the livelihood of the



**Figure 15.** Composition of the reconstructed total catch in the EEZ of Sudan, 1950 - 2010.

coastal communities. The contribution of Red Sea fisheries to the total fish supply of the country is only around 5%. The major supply comes from inland waters: the Nile River, lakes and reservoirs (Chakraborty 1983).

The catches reported by the FAO on behalf of Sudan are thought to be highly exaggerated, and Sudan appears to submit not accurate estimates of its annual catch data on a regular basis. This has been a common problem for FAO to compile an accurate data of global fisheries catch (Garibaldi 2012). This is why the FAO data were higher than the reconstructed catches in Figure (13). The big spike of total catch according to data submitted to FAO in 1983 is probably an error due to Kedidi (1984), who wrote the potential annual catch to be 4,550 t, which is the value reported in the FAO database. However, the catch for 1983, also in Kedidi (1984), was 1,443 t and this value is used as a basis for the reconstructed catch.

The exploitation levels of Sudanese fisheries may not be very high (Tesfamichael and Pitcher 2006), as the artisanal sector has not expanded in recent years (Tesfamichael and Pauly 2011). Thus, it is not uncommon to still see large sized fishes in the catch and in markets. However, there is no reliable catch survey and data recording system in place to provide reliable estimations as to the status of the fisheries. We believe the present reconstruction to be a good starting point to assess the fishery, as it provides a more comprehensive and accurate estimate of catches, which is key for assessment and management (Pauly and Zeller 2003; Tesfamichael 2012). The general trends are clear, and the major shifts in the fisheries are the decline in the shell fishery, replaced by an artisanal finfish fishery, with a foreign industrial fishery added in recent years. The artisanal fishery calls for serious assessment of the states of the states of the stocks.

This is the first comprehensive catch reconstruction and fishery review for Sudan. Because there were some clear gaps in data, we had to make many assumptions, based on our knowledge of the fishery. These assumptions are open to criticism and can be replaced whenever better information is available.

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## References

Barrania A (1985) The socio-economic impact of project's activities in Mohamed Qol, Sudan. FAO/UNDP Proj. for Development of Fisheries in Areas of the Red Sea and Gulf of Aden, Rome.

Barrania AA (1979) The exploratory socio-economic survey of the Sudanese Red Sea fisheries. FAO/UNDP Proj. for Development of Fisheries in Areas of the Red Sea and Gulf of Aden, Rome.

Chakraborty D (1983) Marine fisheries statistics in Sudan-an expanded plan of development. FAO, Rome. 39 p.

Chakraborty D (1984) Fish landings on the Red Sea and Gulf of Aden coast of the member countries: A preliminary estimate. Development of Fisheries in Areas of the Red Sea and Gulf of Aden, United Nations Development Programme (UNDP) and Food and Agriculture Organization (FAO) of the United Nations, Suez, Egypt. 29 p.

- Elawad AN (2002) Some biological aspects of fish by-catch from Sudanese Red Sea Shrimp Trawling. MSc, University of Khartoum, Department of Zoology, Khartoum. 133 p.
- Elnaiem AG (2002) Aspects of shrimp fisheries on Sudanese Red Sea coast. PhD, University of Khartoum, Department of Zoology, Khartoum. 70 p.
- Eltayeb MM (1999) Studies on the biology, ecology and fisheries of Tectus dentatus (Kokian) in the Sudanese Red Sea. MSc, University of London, Department of Geography. 92 p.
- Eltayeb MM (2004) Review of the trochus fishery in Sudan. SPC Trochus Information Bulletin 11: 5-7.
- FA (2007) Fishery statistics of Sudan: based on the files of Fisheries Administration office in Port Sudan. Fisheries Administration, Khartoum.
- FA (2010) Fishery statistics of Sudan: based on the files of Fisheries Administration office in Port Sudan. Fisheries Administration, Khartoum.
- FA (2012) Fishery statistics of Sudan: based on the files of Fisheries Administration office in Port Sudan. Fisheries Administration, Khartoum.
- FHAS (1984) Fish production in Sudan a study on the methodology and the data collected during 1979 and 1980. FAO/UNDP, SUEZ (EGYPT).
- Garibaldi L (2012) The FAO global capture production database: A six-decade effort to catch the trend. Marine Policy 36(3): 760-768.
- Kedidi SM (1984) The Red Sea reef associated fishery of the Sudan catches, efforts and catches per fishing effort survey conducted during 1982-1984. Project for the development of fishries in the areas of the Red Sea and Gulf of Aden, FAO/UNDP, Cairo.
- Kristjonsson H (1956) Sudan–A brief survey of the Sudanese red sea fisheries–Report to the government.
- MEPI (1993) Identification study for Sudan Red Sea fisheries. Ministry of Economic Planning and Investment, Khartoum. 213 p.
- ODA (1983) Report on project activities in Sudan. Overseas Development Agency, U.K.
- Oswald E (1958) Sudan–Red sea fisheries–Report to the government. FAO, Rome.
- Pauly D and Froese R (2012) Comments on FAO's State of Fisheries and Aquaculture, or 'SOFIA 2010'. Marine Policy 36(3): 746-752.
- Pauly D and Zeller D (2003) The global fisheries crisis as a rationale for improving the FAO's database of fisheries statistics. pp. 1–9 In Zeller D, Booth S, Mohammed E and Pauly D (eds.), From Mexico to Brazil: Central Atlantic fisheries catch trends and ecosystem models. Fisheries Centre Research Reports, Vol. 11 (6), Vancouver, Canada.
   Reed W (1962) Sudan–the sudanese shell industry and red sea fisheries–Report to the government.
- Sanders MJ and Kedidi SM (1981) Summary Review of Red Sea Commercial Fisheries Catches and Stock Assessments Including Maps of Actual and Potential Fishing Grounds.
- Sanders MJ and Morgan GR (1989) Review of the fisheries resources of the Red Sea and Gulf of Aden. FAO, Rome. 138 p.
- Tesfamichael D (2012) Assessment of the Red Sea ecosystem with emphasis on fisheries. PhD, University of British Columbia, Resource Management and Environmental Studies, Vancouver. 241 p.
- Tesfamichael D, Govender R and Pauly D (2012a) Preliminary reconstruction of fisheries catches of Jordan and Israel in the inner Gulf of Aqaba, Red Sea, 1950-2010. In Tesfamichael D and Pauly D (eds.), Catch reconstruction for the Red Sea large marine ecosystem by countries (1950 – 2010). Fisheries Centre Research Reports, Vol. 20 (1), Vancouver.
- Tesfamichael D and Mehanna SF (2012) Reconstructing Red Sea fisheries of Egypt: Heavy investment and fisheries. In Tesfamichael D and Pauly D (eds.), Catch reconstruction for the Red Sea large marine ecosystem by countries (1950 – 2010). Fisheries Centre Research Reports, Vol. 20 (1), Vancouver.
- Tesfamichael D and Mohamud S (2012) Reconstructing Red Sea fisheries of Eritrea: A case study of the relationship between political stability and fisheries development. In Tesfamichael D and Pauly D (eds.), Catch reconstruction for the Red Sea large marine ecosystem by countries (1950 – 2010). Fisheries Centre Research Reports, Vol. 20 (1), Vancouver.
- Tesfamichael D and Pauly D (2011) Learning from the Past for Future Policy: Approaches to Time-series Catch Data Reconstruction. Western Indian Ocean J. Mar. Sci. 10(2): 99-106.
- Tesfamichael D and Pitcher TJ (2006) Multidisciplinary evaluation of the sustainability of Red Sea fisheries using Rapfish. Fisheries Research 78(2-3): 227-235.
- Tesfamichael D, Pitcher TJ and Pauly D (in press) Assessing changes in fisheries using fishers' knowledge to generate long time series of catch rates: a case study from the Red Sea. Ecology and society.
- Tesfamichael D, Rossing P and Awadh H (2012b) The marine fisheries of Yemen with emphasis on the Red Sea and cooperatives. In Tesfamichael D and Pauly D (eds.), Catch reconstruction for the Red Sea large marine ecosystem by countries (1950 2010). Fisheries Centre Research Reports, Vol. 20 (1), Vancouver.
- Vine PJ and Vine MP (1980) Ecology of Sudanese coral reefs with particular reference to reef morphology and distribution of fishes.
- Watson R and Pauly D (2001) Systematic distortions in world fisheries catch trends. Nature 414(6863): 534-536.

Year	Serranidae	Mugilidae	Lutjanidae	Lethrinidae	Caranx spp.	Elasmobranchii	Acanthuridae	Others
1950	90	23	70	41	23	15	8	30
1951	90	23	70	41	23	15	8	30
1952	90	23	70	41	23	15	8	30
1953	90	23	70	41	23	15	8	30
1954	90	23	70	41	23	15	8	30
1955	90	23	70	41	23	15	8	30
1956	90	23	70	41	23	15	8	30
1957	90	23	70	41	23	15	8	30
1958	90	23	70	41	23	15	8	30
1959	90	23	70	41	23	15	8	30
1960	90	23	70	41	23	15	8	30
1961	90	23	70	41	23	15	8	30
1962	90	23	70	41	23	15	8	30
1963	90	23	70	41	23	15	8	30
1964	90	23	70	41	23	15	8	30
1965	90	23	70	41	23	15	8	30
1966	90	23	70	41	23	15	8	30
1967	90	23	70	41	23	15	8	30
1968	90	23	70	41	23	15	8	30
1969	90	23	70	41	23	15	8	30
1970	98	25	76	44	25	17	8	33
1971	106	27	82	48	27	18	9	35
1972	114	29	88	51	29	19	10	38
1973	121	31	94	55	31	21	10	40
1974	129	33	100	58	33	22	11	43
1975	137	35	106	62	35	23	12	45
1976	202	52	156	91	51	34	17	67
1977	189	49	146	85	48	32	16	63
1978	198	51	153	89	50	34	17	66
1979	157	82	221	113	48	68	24	79
1980	276	71	225	191	61	62	11	100
1981	393	139	407	276	99	118	32	163
1982	348	123	361	244	88	105	29	144
1983	679	0	256	363	0	0	0	144
1984	317	79	498	266	170	42	17	154
1985	304	75	476	254	163	40	16	148
1986	266	437	417	223	143	38	14	171
1987	253	432	396	211	135	36	13	164
1988	239	427	375	200	128	34	12	157
1989	226	423	354	189	121	33	12	151
1990	211	652	159	155	77	94	0	150
1991	238	691	180	175	88	106	0	164
1992	276	347	209	203	101	109	0	138
1993	248	312	187	182	91	98	0	124
1994	243	305	183	178	89	96	0	122
1995	265	333	200	195	97	105	0	133
1996	296	373	224	218	109	117	0	148
1997	219	275	165	161	80	86	0	110
1998	241	304	183	177	89	95	0	121
1999	278	349	210	204	102	110	0	139
2000	251	316	190	185	92	99	0	126
2001	257	324	195	189	95	102	0	129
2002	247	311	187	181	91	97	0	124
2003	263	331	199	193	97	104	0	132
2004	297	374	225	218	109	117	0	149
2005	321	404	243	236	118	127	0	161
2006	369	464	279	271	135	146	0	185
2007	322	405	244	236	118	127	0	161
2008	321	404	243	236	118	127	0	161
2009	325	409	246	239	119	128	0	163
2010	326	410	247	240	120	129	0	163

Appendix Table A2. Catch composition (in tonnes) of the subsistence fishery of Sudan, 1950 - 2010.

Year	Serranidae	Lutjanidae	Mugilidae	Lethrinidae	Caranx spp.	Acanthuridae	Others
1950	27	21	7	12	7	2	9
1951	27	21	7	12	7	2	9
1952	27	21	7	12	7	2	9
1953	27	21	7	12	7	2	9
1954	27	21	7	12	7	2	9
1955	27	21	7	12	7	2	9
1956	27	21	7	12	7	2	9
1957	27	21	7	12	7	2	9
1958	27	21	7	12	7	2	9
1959	27	21	7	12	7	2	9
1960	27	21	7	12	7	2	9
1961	27	21	7	12	7	2	9
1962	27	21	7	12	7	2	9
1963	27	21	7	12	7	2	9
1964	27	21	7	12	7	2	9
1965	27	21	7	12	7	2	9
1966	27	21	7	12	7	2	9
1967	27	21	7	12	7	2	9
1968	27	21	7	12	7	2	9
1969	27	21	7	12	7	2	9
1970	30	23	8	13	8	3	9
1971	32	25	8	14	8	3	10
1972	34	26	9	15	9	3	
1973	37	28	9	16	9	3	11
1974	39	30	10	18	10	3	12
1975	41	32	11	19	10	3	13
1976	61	47	16	27	15	5	19
1977	57	47	15	26	15	5	18
1978	60	46	15	20	15	5	19
1979	48	67	25	34	15	7	22
1980	56	45	14	38	12	2	19
1981	78	۹ <u>۶</u> 81	28	55	20	6	30
1982	68	70	20	48	17	6	26
1983	129	49	0	69	0	0	20
198/	59	93	15	50	32	3	28
1985	56	88	1/	17	30	3	26
1986	/8	75	79	40	26	3	30
1987	45	70	77	27	20	2	28
1988	,5 ⊿2	65	7/	25	27	2	20
1989	 28	60	72	22	22	2	27
1990	25	27	110	26	12	0	23
1001	50 22	20	11/	20	1/	0	25
1007	72	2/	56	23	16	0	20
1002	50 +2	5U 24	70	20	1/	0	20 1 Q
100/	38	30 28	45 /17	29	14 1 <i>1</i>	0	17
1995	30 20	20	47 50	20	15	0	12
1006	40	20	50	23	15	0	20
1007	44 22	33 24	32	32 22	10	0	2U 14
1000	5Z 24	24	40 40	20 25	12	0	14 16
1000	24 20	20	45 10	20	17	0	10
7322	20 21	23	40 10	20 2⊑	14 10	0	10 15
2000	54 54	20	45 43	20	12	0	15
2001	34	20	43	25	12	0	10
2002	32	24	40	23	12	0	14
2003	33	25	41	24	12	U	15
2004	36	27	45	26	13	U	16
2005	38	29	48	28	14	0	1/
2006	42	32	53	31	15	0	19
2007	36	27	45	26	13	0	16
2008	35	26	43	25	13	0	16
2009	34	26	43	25	12	0	16
2010	33	25	41	24	12	0	15

tonne	s) of trawn lishe	Ty III the EEZ OI	Suuali, 1950 -	2010.
Year	Synodontidae	Nemipterus spp.	Penaeidae	Mullidae
1950	0	0	0	0
1951	0	0	0	0
1952	0	0	0	0
1953	0	0	0	0
1954	0	0	0	0
1055	0	0	0	0
1056	0	0	0	0
1950	0	0	0	0
1957	0	0	0	0
1958	0	0	0	0
1959	0	0	0	0
1960	0	0	0	0
1961	0	0	0	0
1962	0	0	0	0
1963	0	0	0	0
1964	0	0	0	0
1965	0	0	0	0
1966	0	0	0	0
1967	0	0	0	0
1968	0	0	0	0
1969	0	0	0	0
1970	0	0	0	0
1971	0 0	0	0 0	0 0
1972	0	0	0	0
1072	0	0	0	0
1975	0	0	0	0
1974	0	0	0	0
1975	0	0	0	0
1976	5	1	15	1
1977	0	0	0	0
1978	7	2	19	1
1979	7	2	21	1
1980	0	0	0	0
1981	9	3	26	1
1982	24	7	4	4
1983	24	7	4	4
1984	24	7	4	4
1985	44	12	8	7
1986	64	18	12	10
1987	84	24	15	13
1988	104	29	19	16
1000	125	25	15	10
1000	1/5	30	25	13
1990	145	40	20	22
1991	30	10	/	6
1992	36	10	/	6
1993	36	10	/	6
1994	36	10	7	6
1995	36	10	7	6
1996	36	10	7	6
1997	36	10	7	6
1998	77	22	14	12
1999	119	33	22	18
2000	122	34	22	19
2001	125	35	23	19
2002	127	35	23	20
2003	147	41	27	23
2004	412	115	2 <i>7</i> 75	63
2005	387	108	71	60
2005	0	0	0	0
2000	61	17	11	0
2007	110	117	11	3
2008	418	11/	70	04 22
2009	209	58	38	32
2010	0	0	0	0

**Appendix Table A3.** Composition of the retained catch (in tonnes) of trawl fishery in the EEZ of Sudan, 1950 - 2010.

Year

Appendix Table A4. Composition of the discarded catch (in ton

nnes) of trawl fishery in the EEZ of Sudan, 1950 - 2010							
7	8	9	10	11	12		
0	0	0	0	0	0		
0	0	0	0	0	0		
0	0	0	0	0	0		
0	0	0	0	0	0		
0	0	0	0	0	0		
0	0	0	0	0	0		
0	0	0	0	0	0		
0	0	0	0	0	0		
0	0	0	0	0	0		
0	0	0	0	0	0		
0	0	0	0	0	0		
0	0	0	0	0	0		
0	0	0	0	0	0		
0	0	0	0	0	0		
0	0	0	0	0	0		
0	0	0	0	0	0		
0	0	0	0	0	0		
0	0	0	0	0	0		
0	0	0	0	0	0		
0	0	0	0	0	0		
0	0	0	0	0	0		
0	0	0	0	0	0		
0	0	0	0	0	0		
0	0	0	0	0	0		
0	0	0	0	0	0		
0	0	0	0	0	0		

1954	0	0	0	0	0	0	0	0	0	0	0	0
1955	0	0	0	0	0	0	0	0	0	0	0	0
1956	0	0	0	0	0	0	0	0	0	0	0	0
1957	0	0	0	0	0	0	0	0	0	0	0	0
1958	0	0	0	0	0	0	0	0	0	0	0	0
1959	0	0	0	0	0	0	0	0	0	0	0	0
1960	0	0	0	0	0	0	0	0	0	0	0	0
1961	0	0	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0 0	0
1965	0	0	0	0	0	0	0	0 0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0	0
1067	0	0	0	0	0	0	0	0	0	0	0	0
1069	0	0	0	0	0	0	0	0	0	0	0	0
1900	0	0	0	0	0	0	0	0	0	0	0	0
1909	0	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0	0	0
1976	72	5	5	2	2	2	2	2	1	1	1	18
1977	0	0	0	0	0	0	0	0	0	0	0	0
1978	95	6	6	3	3	3	3	3	2	2	2	23
1979	106	7	7	3	3	3	3	3	2	2	2	26
1980	0	0	0	0	0	0	0	0	0	0	0	0
1981	128	8	8	4	4	4	4	4	2	2	2	31
1982	32	2	2	1	1	1	1	1	1	1	1	8
1983	32	2	2	1	1	1	1	1	1	1	1	8
1984	32	2	2	1	1	1	1	1	1	1	1	8
1985	60	4	4	2	2	2	2	2	1	1	1	14
1986	87	6	6	3	3	3	3	3	1	1	1	21
1987	114	7	7	4	4	4	4	4	2	2	2	28
1988	142	9	9	5	5	5	5	5	2	2	2	34
1989	169	11	11	5	5	5	5	5	3	3	3	41
1990	196	13	13	6	6	6	6	6	3	3	3	48
1991	49	3	3	2	2	2	2	2	1	1	1	12
1992	49	3	3	2	2	2	2	2	1	1	1	12
1992	19	2	2	2	2	2	2	2	1	1	1	12
100/	45 70	2	2	2	2	2	2	2	1	1	1	12
1005	49	3	3	2	2	2	2	2	1	⊥ 1	1	12
1006	49	2	2	2	2	2	2	2	1	1	1	12
1990	49	2 2	2 2	2	2	2	2	2	1	1	1	12
1997	49	3	3	2	2	2	2	2	1	1	1	12
1998	105	/	/	3	3	3	3	3	2	2	2	25
1999	162	10	10	5	5	5	5	5	3	3	3	39
2000	165	11	11	5	5	5	5	5	3	3	3	40
2001	169	11	11	5	5	5	5	5	3	3	3	41
2002	173	11	11	6	6	6	6	6	3	3	3	42
2003	199	13	13	6	6	6	6	6	3	3	3	48
2004	559	36	36	18	18	18	18	18	9	9	9	135
2005	525	34	34	17	17	17	17	17	8	8	8	127
2006	0	0	0	0	0	0	0	0	0	0	0	0
2007	82	5	5	3	3	3	3	3	1	1	1	20
2008	567	37	37	18	18	18	18	18	9	9	9	137
2009	283	18	18	9	9	9	9	9	5	5	5	69
2010	0	0	0	0	0	0	0	0	0	0	0	0

1: Leiognathidae; 2: Gerreidae; 3: Trichiuridae; 4: *Parastromateus niger*; 5: Platycephalidae; 6: *Portunus pelagicus*; 7: Soleidae; 8: Tetraodontidae; 9: Clupeidae; 10: Mullidae; 11: Stomatopoda; 12: Others

Year	Sardinella spp.	Scomberomorus commerson	Sphyraena spp.	Carangidae
1950	0	0	0	0
1951	0	0	0	0
1952	0	0	0	0
1953	0	0	0	0
1954	0	0	0	0
1955	0	0	0	0
1956	0	0	0	0
1957	0	0	0	0
1958	0	0	0	0
1959	0	0	0	0
1960	0	0	0	0
1961	0	0	0	0
1962	0	0	0	0
1963	0	0	0	0
1964	0	0	0	0
1965	0	0	0	0
1966	0	0	0	0
1967	0	0	0	0
1968	0	0	0	0
1969	0	0	0	0
1970	0	0	0	0
1971	0	0	0	0
1972	0	0	0	0
1973	0	0	0	0
1974	0	0	0	0
1975	0	0	0	0
1976	0	0	0	0
1977	0	0	0	0
1978	0	0	0	0
1979	0	0	0	0
1980	0	0	0	0
1981	0	0	0	0
1982	0	0	0	0
1983	0	0	0	0
1984	0	0	0	0
1985	0	0	0	0
1986	0	0	0	0
1987	0	0	0	0
1988	0	0	0	0
1989	0	0	0	0
1990	0	0	0	0
1991	0	0	0	0
1992	0	0	0	0
1993	0	0	0	0
1994	0	0	0	0
1995	0	0	0	0
1996	0	0	0	0
1997	0	0	0	0
1998	0	0	0	0
1999	0	0	0	0
2000	0	0	0	0
2001	0	0	0	0
2002	452	25	15	10
2003	764	42	25	17
2004	1,474	82	49	33
2005	1,319	73	44	29
2006	0	0	0	0
2007	0	0	0	0
2008	0	0	0	0
2009	302	17	10	7
2010	0	0	0	0

Appendix Table A5. Catch composition (in tonnes) of the purse seine fishery in the EEZ of Sudan, 1950 - 2010.

Appendix Table A6. Reconstructed catch (in tonnes) in the EEZ of Sudan by gear type and what is reported to FAO, 1950 - 2010.

~		67
0, 1950 - 2010.	0, 1950 ·	- 2010.

Year	FAO landings	Reconstructed total catch	Artisanal finfish	Artisanal invertebrates	Subsistence	Discards	Trawl	Purse seining
1950	500	1,946	300	1,561	85	0	0	0
1951	500	1.721	300	1.335	85	0	0	0
1952	1 000	2 133	300	1 748	85	0	0	0
1052	1 300	1 972	300	1 5 8 7	85	0	0	0
1054	1,300	1,372	300	1,567	85	0	0	0
1954	1,100	1,749	300	1,304	85	0	0	0
1955	1,100	1,663	300	1,277	85	0	0	0
1956	1,200	1,761	300	1,376	85	0	0	0
1957	800	1,311	300	925	85	0	0	0
1958	900	1,309	300	923	85	0	0	0
1959	1,100	1,622	300	1,237	85	0	0	0
1960	1,100	1,418	300	1,032	85	0	0	0
1961	1,200	1,324	300	938	85	0	0	0
1962	1,600	1,475	300	1,089	85	0	0	0
1963	1.000	1.626	300	1.241	85	0	0	0
1964	700	1.777	300	1,392	85	0	0	0
1965	700	1 928	300	1 543	85	0	0	0
1966	1 000	2 080	300	1,545	85	0	0	0
1900	1,000	2,080	300	1,054	8J 8F	0	0	0
1907	800	1,765	300	1,590	05	0	0	0
1968	800	1,393	300	1,008	85	0	0	0
1969	800	1,/13	300	1,328	85	0	0	0
1970	800	2,085	326	1,667	93	0	0	0
1971	800	1,319	351	867	100	0	0	0
1972	800	1,672	377	1,187	107	0	0	0
1973	800	1,580	403	1,062	115	0	0	0
1974	800	1,367	429	816	122	0	0	0
1975	800	955	454	372	129	0	0	0
1976	800	1,562	671	563	191	115	22	0
1977	600	1.041	628	233	179	0	0	0
1978	750	1.355	657	332	187	150	29	0
1979	700	2 576	792	1 367	217	168	32	0
1980	950	1 781	996	598	187	0	0	0
1001	970	2 570	1 6 2 9	412	207	202	20	0
1901	070 1 050	2,379	1,020	412	297	205	29	0
1982	1,050	2,328	1,441	239	258	51	39	0
1983	4,450	2,106	1,443	300	274	51	39	0
1984	1,328	2,262	1,542	350	280	51	39	0
1985	409	2,364	1,475	460	263	94	71	0
1986	1,190	2,420	1,708	170	301	138	104	0
1987	1,200	2,892	1,641	651	283	181	136	0
1988	1,200	2,959	1,574	726	267	224	169	0
1989	1,200	3,764	1,507	1,539	251	267	201	0
1990	1,500	2,567	1,500	289	234	310	234	0
1991	1,500	2,354	1,643	323	251	78	59	0
1992	2,000	2,408	1,383	684	204	78	59	0
1993	2,500	2,431	1,242	873	179	78	59	0
1994	4.000	2.080	1,215	556	172	78	59	0
1995	4 000	2 342	1 328	693	184	78	59	0
1996	4 500	2,312	1 / 85	634	201	78	59	0
1007	5,000	2,-57	1,405	024	1/5	70	50	0
1000	5,000	2,312	1,090	1 1 0 2	145	165	125	0
1998	5,500	2,758	1,210	1,102	150	202	125	0
1999	5,500	2,764	1,391	749	175	255	192	0
2000	5,000	2,762	1,260	889	155	261	197	0
2001	5,000	2,738	1,291	824	155	267	201	0
2002	5,000	3,189	1,237	827	144	273	206	502
2003	5,000	3,575	1,318	705	150	315	237	849
2004	5,500	5,410	1,489	568	165	884	666	1,638
2005	5,200	5,310	1,608	609	173	829	625	1,466
2006	5,000	2,486	1,848	444	193	0	0	0
2007	5,699	2,469	1,614	463	164	130	98	0
2008	5,695	3,864	1,609	524	158	897	676	0
2009	5,690	2,993	1,631	87	155	448	337	335
2010	5,700	1,873	1,635	88	151	0	0	0
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Discards Year Reported Unreported 1,446 1,221 1,000 1,133 1,300 1,100 1,100 1,200 1,100 1,100 1,200 1,374 1,000 1,077 1,228 1,000 1,080 1,285 1,709 1,506 1,050 1,227 1,781 1,328 1,861 1,190 1,092 1,200 1,512 1,200 1,535 1,200 2,297 1,500 1,500 2,000 2,076 1,734 1,975 2,061 2,003 2,386 2,279 2,290 2,294 2,753 3,077 4,275 4,221 2,226 2,127 2,761 2,318 1,659 

**Appendix Table A7.** Reconstructed catch (in tonnes) in the EEZ of Sudan by components, 1950 – 2010. Reported catch refers to the part of the reconstructed catch accounted in the FAO data.

Appendix Table A8. Composition of the reconstructed total catch (in tonnes) in the EEZ of Sudan, 1950 - 2010.

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1950	1.365	118	30	91	53	27	30	0	0	15	0	123	44	0	0
1951	1 033	118	30	91	53	27	30	0	0	15	0	230	44	0	0
1952	1 530	118	30	91	53	27	30	0	0	15	0	145	44	0	0
1052	1 364	110	30	01	53	27	30	0	0	15	0	151	11	0	0
105/	1 150	110	30	01	53	27	30	0	0	15	0	122	44	0	0
1954	1,135	110	20	91	55	27	20	0	0	15	0	100	44	0	0
1955	1,097	110	20	91	55	27	20	0	0	15	0	100	44	0	0
1950	1,129	110	30	91	55	27	30	0	0	15	0	1/5	44	0	0
1957	750	118	30	91	53	27	30	0	0	15	0	103	44	0	0
1958	/61	118	30	91	53	27	30	0	0	15	0	90	44	0	0
1959	1,070	118	30	91	53	27	30	0	0	15	0	95	44	0	0
1960	848	118	30	91	53	27	30	0	0	15	0	112	44	0	0
1961	781	118	30	91	53	27	30	0	0	15	0	85	44	0	0
1962	932	118	30	91	53	27	30	0	0	15	0	85	44	0	0
1963	1,083	118	30	91	53	27	30	0	0	15	0	85	44	0	0
1964	1,234	118	30	91	53	27	30	0	0	15	0	86	44	0	0
1965	1,385	118	30	91	53	27	30	0	0	15	0	86	44	0	0
1966	1,536	118	30	91	53	27	30	0	0	15	0	86	44	0	0
1967	1,270	118	30	91	53	27	30	0	0	15	0	56	44	0	0
1968	866	118	30	91	53	27	30	0	0	15	0	69	44	0	0
1969	1,130	118	30	91	53	27	30	0	0	15	0	125	44	0	0
1970	1,542	128	33	99	57	27	32	0	0	17	0	53	44	0	0
1971	, 751	138	36	106	62	27	35	0	0	18	0	44	44	0	0
1972	1.073	148	38	114	66	27	38	0	0	19	0	42	44	0	0
1973	931	158	41	122	71	27	40	0	0	21	0	59	44	0	0
1974	725	168	44	130	76	27	43	0	0	22	0	19	44	0	0
1975	276	178	46	138	80	27	45	0	0	23	0	23	44	0	0
1976	1/2	263	68	203	118	27	67	72	0	20	5	50	11	1	15
1077	1/1	205	64	100	111	27	63	,2	0	27	0	20	44	0	15
1070	257	240	67	100	116	27	65	05	0	24	7	20	44	2	10
1970	1 2 2 2 7	200	100	199	147	27	60	100	0	54	7	כ כד	44	2	19
1979	1,223	205	100	200	147	27	03 72	100	0	68	/	/3	44	2	21
1980	520	332	00 1 C 7	270	229	27	110	120	0	110	0	10	44	0	20
1981	209	4/1	167	488	330	147	119	128	0	118	9	10	44	3	26
1982	345	415	148	431	291	135	105	32	0	105	24	14	44	/	4
1983	114	808	0	305	432	123	0	32	0	0	24	18	44	/	4
1984	1/2	3//	94	591	315	110	202	32	0	42	24	22	44	/	4
1985	298	359	89	564	301	98	193	60	0	40	44	19	44	12	8
1986	81	314	515	493	263	27	168	87	0	38	64	17	44	18	12
1987	543	297	509	466	249	49	159	114	0	36	84	14	44	24	15
1988	601	281	502	440	235	70	150	142	0	34	104	9	44	29	19
1989	1,398	264	495	414	221	92	141	169	0	33	125	3	44	35	23
1990	115	246	762	186	181	114	90	196	0	94	145	15	44	40	26
1991	115	278	805	210	204	136	102	49	0	106	36	28	44	10	7
1992	442	320	403	242	235	158	118	49	0	109	36	40	44	10	7
1993	613	287	361	217	211	179	105	49	0	98	36	36	44	10	7
1994	277	280	352	212	206	201	103	49	0	96	36	33	44	10	7
1995	396	305	384	231	224	223	112	49	0	105	36	29	44	10	7
1996	319	340	428	257	250	245	125	49	0	117	36	26	44	10	7
1997	600	250	315	189	184	266	92	49	0	86	36	22	44	10	7
1998	750	276	347	208	202	288	101	105	0	95	77	19	44	22	14
1999	379	316	397	239	232	310	116	162	0	110	119	15	44	33	22
2000	500	285	359	216	210	332	105	165	0	99	122	12	44	34	22
2001	417	291	366	220	214	354	107	169	0	102	125	8	44	35	23
2002	335	278	350	211	205	442	102	173	452	97	127	5	44	35	23
2003	364	296	372	224	217	295	109	199	764	104	147	1	44	41	27
2007	336	222	Δ1Q	257	2/5	187	122	550	1 4 7 4	117	<u></u> Δ12	0	<u>⊿</u> ⊿	115	2, 75
2004	367	320	419 /[51	271	243	106	127	535	1 210	127	227	0	 //	102	71
2003	201	 ∕\11	4JI 517	2/1 211	203	00 T30	152	0	т,515 О	1/6	0	0	44	100	0
2000	201	3E0 4TT	750	)11 )71	202	70 120	121	0 07	0	107	61	0	44	17	11
2007	200	220	400	Z/1	205	100	101	02	0	121	OT	0	44	T/	TT

1: Trochus spp.; 2: Serranidae; 3: Mugilidae; 4: Lutjanidae; 5: Lethrinidae; 6: Holothuroidea; 7: Caranx spp.; 8: Leiognathidae;

9: Sardinella spp.; 10: Elasmobranchii; 11: Synodontidae; 12: Pinctada spp.; 13: Strombidae; 14: Nemipterus spp.; 15: Penaeidae

Table A8 continued.

Year	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1950	10	0	0	0	0	0	0	0	0	0	0	0	0	0	1	39
1951	10	0	0	0	0	0	0	0	0	0	0	0	0	0	1	39
1952	10	0	0	0	0	0	0	0	0	0	0	0	0	0	1	39
1953	10	0	0	0	0	0	0	0	0	0	0	0	0	0	1	39
1954	10	0	0	0	0	0	0	0	0	0	0	0	0	0	1	39
1955	10	0	0	0	0	0	0	0	0	0	0	0	0	0	1	39
1956	10	0	0	0	0	0	0	0	0	0	0	0	0	0	1	39
1957	10	0	0	0	0	0	0	0	0	0	0	0	0	0	1	39
1958	10	0	0	0	0	0	0	0	0	0	0	0	0	0	1	39
1959	10	0	0	0	0	0	0	0	0	0	0	0	0	0	1	39
1960	10	0	0	0	0	0	0	0	0	0	0	0	0	0	1	39
1961	10	0	0	0	0	0	0	0	0	0	0	0	0	0	1	39
1962	10	0	0	0	0	0	0	0	0	0	0	0	0	0	1	39
1963	10	0	0	0	0	0	0	0	0	0	0	0	0	0	1	39
1964	10	0	0	0	0	0	0	0	0	0	0	0	0	0	1	39
1965	10	0	0	0	0	0	0	0	0	0	0	0	0	0	1	39
1966	10	0	0	0	0	0	0	0	0	0	0	0	0	0	1	39
1967	10	0	0	0	0	0	0	0	0	0	0	0	0	0	1	39
1968	10	0	0	0	0	0	0	0	0	0	0	0	0	0	1	39
1969	10	0	0	0	0	0	0	0	0	0	0	0	0	0	1	39
1970	11	0	0	0	0	0	0	0	0	0	0	0	0	0	1	42
1971	12	0	0	0	0	0	0	0	0	0	0	0	0	0	1	45
1972	13	0	0	0	0	0	0	0	0	0	0	0	0	0	1	48
1973	14	0	0	0	0	0	0	0	0	0	0	0	0	0	1	52
1974	14	0	0	0	0	0	0	0	0	0	0	0	0	0	1	55
1975	22	2	5	5	0	2	2	2	2	2	0	0	1	1	1	104
1077	22	0	0	0	0	0	0	0	0	0	0	0	0	0	1	104 Q1
1977	21	3	6	6	0	3	3	3	3	3	0	0	2	2	1	107
1979	31	3	7	7	0	3	3	3	3	3	0	0	2	2	1	127
1980	13	0	,	0	0	0	0	0	0	0	0	0	0	0	1	118
1981	39	3	8	8	0	4	4	4	4	4	0	0	2	2	1	224
1982	34	4	2	2	0	1	1	1	1	1	0	0	1	1	1	178
1983	0	4	2	2	0	1	1	1	1	1	0	0	1	1	1	180
1984	20	4	2	2	0	1	1	1	1	1	0	0	1	1	1	190
1985	19	8	4	4	0	2	2	2	2	2	0	0	1	1	1	188
1986	16	11	6	6	0	3	3	3	3	3	0	0	1	1	1	222
1987	16	15	7	7	0	4	4	4	4	4	0	0	2	2	1	220
1988	15	18	9	9	0	5	5	5	5	5	0	0	2	2	1	218
1989	14	22	11	11	0	5	5	5	5	5	0	0	3	3	1	217
1990	0	25	13	13	0	6	6	6	6	6	0	0	3	3	1	221
1991	0	6	3	3	0	2	2	2	2	2	0	0	1	1	1	201
1992	0	6	3	3	0	2	2	2	2	2	0	0	1	1	1	171
1993	0	6	3	3	0	2	2	2	2	2	0	0	1	1	1	154
1994	0	6	3	3	0	2	2	2	2	2	0	0	1	1	1	151
1995	0	6	3	3	0	2	2	2	2	2	0	0	1	1	1	163
1996	0	6	3	3	0	2	2	2	2	2	0	0	1	1	1	181
1997	0	6	3	3	0	2	2	2	2	2	0	0	1	1	1	136
1998	0	14	7	7	0	3	3	3	3	3	0	0	2	2	1	162
1999	0	21	10	10	0	5	5	5	5	5	0	0	3	3	1	196
2000	0	21	11	11	0	5	5	5	5	5	0	0	3	3	1	181
2001	0	22	11	11	0	5	5	5	5	5	0	0	3	3	1	185
2002	0	22	11	11	25	6	6	6	6	6	15	10	3	3	1	180
2003	0	26	13	13	42	6	6	6	6	6	25	17	3	3	1	195
2004	0	/3	36	36	82	18	18	18	18	18	49	33	9	9	1	301
2005	0	68	34	34	/3	1/	1/	1/	1/	1/	44	29	8	8 C	1	305
2006	0	0	U	0	U	0	0	0	0	0	0	0	U	U	1	204
2007	0	11	5 דר	5 70	0	ح 10	خ 10	خ 10	ح 10	う 10	0	0	U L	U L	1	71 V
2008 2000	0	74 27	3/ 10	5/ 10	17	70	Ω Δ1	0 70	0 TQ	Ω Δ1	10	U 7	9	9	1	514 217
2009	0	رد ۱	0 70	U TQ	T)	9	9 0	9 0	9	9 0	10	/	5	0	1	247 170

16: Acanthuridae; 17: Mullidae; 18: Gerreidae; 19: Trichiuridae; 20: *Scomberomorus commerson*; 21: *Parastromateus niger*; 22: Platycephalidae; 23: *Portunus pelagicus*; 24: Soleidae; 25: Tetraodontidae; 26: *Sphyraena* spp.; 27: Carangidae; 28: Clupeidae; 29: Stomatopoda; 30: Gastropoda; 31: Others