Reconstructing Red Sea fisheries of Egypt: Heavy investment and fisheries[1]

Dawit Tesfamichael[a,b] and Sahar Fahmy Mehanna[c]

[a] *Sea Around Us, Fisheries Centre, University of British Columbia,*
2202 Main Mall, Vancouver, BC, V6T 1Z4, Canada
[b] *Department of Marine Sciences, University of Asmara, Asmara, Eritrea.*
[c] *National Institute of Oceanography and Fisheries, Suez, Egypt*
d.tesfamichael@fisheries.ubc.ca; sahar_mehanna@yahoo.com

Abstract

The catch of Egyptian fisheries in its Red Sea Exclusive Economic Zone (EEZ) was reconstructed from 1950 to 2010. Five fisheries sectors were identified and their catch reconstructed by taxonomic group. Published papers, gray literature, reports, databases and on-site observations were used as sources. Where data gaps were identified, they were accommodated with assumptions based on the best available knowledge, which are clearly stated and can be substituted by different ones given better information. The result showed that purse seine is the dominant fishery, followed by trawl, subsistence, artisanal and recreational fisheries. The total catch of Egypt in its Red Sea EEZ was around 6,000 t·year⁻¹ in the early 1950s, which rapidly increased in 1960 and remained at a high level except for a sharp decline in 1973 due to the Israel-Arab war. The peak catch of about 50,000 t was obtained in 1993; catches then declined to about 25,000 t·year⁻¹ by the end of 2000s. A total of 42 taxonomic groups were identified in the catches, in addition to many which could not be individually identified and categorized as 'others'. Jacks (mainly horse mackerels), herring and scads were dominant and jointly accounted for 34% of the total catch. The reconstructed total catch was compared with data Egypt submitted to the Food and Agriculture Organization (FAO) and clear differences were observed. While, overall, the reconstructed total catch is 1.1 times what Egypt submitted to FAO, this relatively close match masks a much stronger dominance of the reconstructed over the official catches from 1950 to the mid-1990s, followed by a period of high official catches, which includes fish caught outside Egypt's Red Sea EEZ.

Introduction

Catch data are fundamental information to understand any fishery system (Watson and Pauly 2001). When coupled with information on effort, they can be used for basic and informative analysis to understand the fishery in question. However, these data are not usually readily available. Acquiring and analyzing a long time series of catch and effort data helps to understand the evolution of the fishery and predict the possible consequences of any plans. Historic reconstruction of catch data includes compiling data from different sources, cleaning, and standardizing them for presentation in usable form. Assumptions are usually made in the process. They should be presented openly for criticism and further refinement. The strongest criticism to such work has been that its results are unreliable, therefore should not be undertaken. In our opinion, this is not in any way helping to move forward in understanding fishery systems for proper assessment and conservation of livelihoods and ecosystems. Progress in the development of new approaches in fisheries is necessary to tackle pressing issues. Equally important are the basic data on catch and effort, which are absent or incomplete in many jurisdictions – both in developing and developed countries (Tesfamichael 2012). If the ultimate objective of fisheries science is to be effective in the management of fisheries, it has to look at historical time series catch, and the socio-economic and political mechanisms that drove changes in the system. Building a management system without

Figure 1. Egyptian exclusive economic zone (EEZ) and shelf area to 200 m depth in the Red Sea.

such foundation is most likely to fail. Thus, comprehensive catch reconstructions (Zeller *et al.* 2007), i.e., not only tabulating numbers and drawing graphs, but also understanding the mechanisms behind them, are important and critical steps to understand fisheries systems.

Egypt has access both to the Red Sea and Mediterranean Sea; besides expansive inland waters supplying fish; the main ones include the Nile and its canals, coastal and delta lakes and man-made Lake Nasser. Aquaculture is important in Egypt and accounts for more than 65% of the total fish products. During the 1980s, marine fisheries constituted about 22% of total fish catch, while the lakes formed about 50%; the Nile yielded 11% and aquaculture production was about 17%. In the 1990s, the percentages were 20% for marine fisheries, 32.7% for lakes, 13.3% for the Nile and 34% for aquaculture (Mehanna 2007). Based on annual fishery statistics data for Egypt, in 2009, the contributions of the Red sea and Mediterranean Sea were 4.4 and 7% of the total fish catch, respectively, while lakes contributed 15.7% and the Nile 8%; the lion's share – 65%–was from aquaculture (GAFRD 2012).

Egypt's coast along the Red Sea extends from the border with Israel in the Gulf of Aqaba to Sudan in the south. In terms of fisheries, the Gulf of Suez is the most important part of the Egyptian Red Sea, and most of Egypt's Red Sea catch originates from that area. The continental shelf of the Gulf of Suez covers 8,400 km², which is about the same as the rest of the Egyptian shelf in the Red Sea (Sanders and Morgan 1989). Egypt is divided into 27 governorates, out of which 3 border the Red Sea: Suez, Red Sea and South Sinai. Fishing is done mainly from Suez and Red Sea proper, while South Sinai is known for its coastal tourism.

Egypt has one of the most developed fisheries in the Red Sea (Tesfamichael and Pitcher 2006). Egypt's industrial fishery, which predominantly consists of trawling and purse seining, was the earliest to develop in the Red Sea. The industrial fishery is extensive and its vessels operate all over the Red Sea and outside the Red Sea, including in international waters as far as the eastern Atlantic (Feidi 1976). Because the number of industrial boats was growing too rapidly, the Egyptian government put a moratorium on the entry of new boats to the fishery (Mehanna and El-Gammal 2007). The main landing site in the Red Sea is Ataka, in the Gulf of Suez, while Hurgada and El-Tor are major landing sites as well. The other less important landing sites include Salakhana, Berenis, Quseir and Shalateen (Figure 1). Ataka has a detailed data recording system; for every vessel, boxes are weighed and species recorded for all types of fisheries, even the traditional fisheries. In Egypt, the management of fisheries lies under the jurisdiction of the General Authority for Fish Resources Development (GAFRD), which is mandated to collect landings data. A relatively good data recording system was initiated in 1979 by the "Project for the development of fisheries in areas of the Red Sea and Gulf of Aden", but the quality of data from remote areas remains debatable. Another institute involved in fisheries is the National Institute of Oceanography and Fisheries (NIOF), whose task is mainly research.

The Egyptian fisheries can be divided into 4 major sectors: industrial (i.e., large-scale commercial, mainly purse seine and trawl gears), artisanal (i.e., small-scale commercial, also called 'semi-industrial'), subsistence (labelled 'traditional' in Egypt) and recreational. The GAFRD database divides the Egyptian fisheries in to the first 3 categories, i.e., the recreational fishery does not appear in the database. Sometimes, the fishery records are divided geographically for administrative purposes. In this report, only the division by gear type is used, because it is an important criterion, which can be used in designing management tools. Purse seine and trawl are categorized here as industrial fisheries. Semi-industrial fishing (here referred to as artisanal) is done by motorized boats of smaller size than industrial vessels. The 'traditional' fishery, categorized here as subsistence fishery uses the least technologically advanced boats. Some of its practitioners have no boats, and fish from land. Both semi-industrial and traditional fisheries are mainly reef-associated fisheries.

The main fishing gears deployed by Egyptian fishers in the Red Sea are bottom trawl and purse seine (the industrial fishery), handline, longlines and gillnets (artisanal) and a variety of gears used by the traditional subsistence fishery. The industrial fisheries operate mainly in the Gulf of Suez and its adjacent areas, and Foul Bay, which borders Sudan. Semi-industrial fisheries are active around Ataka, Salakhana, Sakkala and El-Tor. Boats in Foul Bay, unlike the other areas, do not operate only one gear; the same boat can be involved in trawling, purse seining and handlining (Sanders *et al.* 1984b). The entire catch from the Red Sea is consumed within Egypt and none is exported. Egypt imports additional sea food from neighbouring and other countries.

Due to the lack of good and extensive data recording systems, the extent of Egyptian fisheries in the Red Sea and its effects are not well known. The objective of this research is, therefore, to reconstruct the Egyptian catch in the Red Sea by gear and its taxonomic composition from 1950 to 2010. First, each major fishery is introduced, followed by the catch reconstruction methods; finally, the results are presented and discussed.

Industrial fishery

Purse seine fishery

The purse seine fishery has been active in Egypt for a long time. The earliest operation began using sailing boats. The main operation, using motorized purse seiners, started in the Gulf of Suez in 1960 with five 150 hp vessels and in Hurgada in 1964 with four vessels. The number of purse seiners increased gradually, with the aim of identifying the level of fishing effort to generate the optimum catch (Rafail 1970, 1972). The vessels use lamps (gas or kerosene) to attract the fish; once the fish aggregate, they are entrapped in the purse seine and hauled to the deck of the vessel. The purse-seiners are operated at night using lighted dinghies. The operation starts in October and finishes at the end of May, and it ceases for about 10 days every month during the full moon. About 65% of the catch comes in the first three months, October to December (Sanders *et al.* 1984a). At the beginning of each season, the fishing trip takes two to five days because most fishing is undertaken relatively close to the landing site of Ataka at Suez city. Later in the season, fishing trips take more days as they have to venture further afield (Mehanna and El-Gammal 2007). The three distinct areas for purse seining along the Egyptian Red Sea coast are the Gulf of Suez, Hurgada area and Foul Bay (Rafail 1970).

Usually, about 82 purse seiners operate in the Gulf of Suez and 30 outside the gulf, mainly in Foul Bay. The vessels' lengths range between 12.5 and 30 m. They are powered by engines of 150 to 700 hp, with the majority in the 400-700 hp range. The net's length is between 200 and 300 m and its depth ranged from 50 to 80 m. The nets are hauled manually. The crew number ranged between 25 and 40 persons, and has not changed from the past (Barrania and El Shennawi 1979; El-Gammal and Mehanna 2002).

Purse seiners target small pelagic schooling fishes, which are also caught by artisanal trammel and gillnets in Salakhana and El-Tor (starting the 1970s). In the past, only 10% of the catch was consumed in Suez City, the rest was shipped to Cairo (Barrania and El Shennawi 1979); now, the majority of catch is sold in the Suez fish markets. The catch is consumed mainly fresh and some part salted. There are events where salted fish are consumed, e.g., Sham Al-Naseem Feast or Spring Festival. This feast is an Egyptian national holiday marking the beginning of spring; Egyptians eat salted fish, lettuce, and onions on this day.

Trawl fishery

Egypt has one of the earliest industrialized trawl fisheries in the Red Sea, which started in 1921, and increased after the Second World War. Egyptian investment in the industrial fisheries is unparalleled in the Red Sea. Egyptian trawlers first targeted shrimp using otter trawlers, which were allowed to operate only from September to June, because the rest of the year is the spawning period for many fishes. The best catches of shrimp were obtained from October to mid-January. A small proportion of shrimp was caught by seiners in shallow waters (Al-Khol and El-Hawary 1970). The fishing grounds are generally divided into the Gulf of Suez, areas adjacent to the Gulf of Suez and Foul Bay. At the beginning of the season, the vessels operate in the northern part of the gulf and their trips take about 5 days. Later in the season, they move further south and the trips take longer. Trips from Foul Bay can be up 20 days, out of which 6 days are to travel to and from the fishing ground. The main base for this trawl fishery is Ataka, although Sakkala is also used when vessels operate outside the gulf. Note that none of the trawlers operate exclusively outside the gulf. The vessels that operate in Foul Bay, which represents about 10% of the three trawling grounds, are used for purse seining as well (El-Gammal and Mehanna 1999).

In the mid-2000s, the number of vessels operating in the Gulf of Suez was 78 vessels, while about 100 vessels operated outside the gulf and outside Egyptian waters. The vessel length varied between 20 and 30 m, and each was powered by a main engine of 200 to 1200 hp (mostly 400-600 hp). All vessels had mechanized winches, and some of them echo-sounders. The trawl net they employed was of the Mediterranean type, and its length ranged between 20 and 30 m with an average mesh size of 1.5 cm in the cod-end, and a sweep length between 200 and 250 m. The fishing trip was about 5 to 10 days and the number of crew varied from 10 to 15. The trawl fishery is seasonal, generally from October to May. The number of fishing days during the first three months of the fishing season constitutes 42% of the total effort (Mehanna and El-Gammal 2007).

Artisanal fishery

'Artisanal fishery' is not a term commonly used by the Egyptian authorities. What we categorized as 'artisanal fishery', based on its mode of operation, is called 'semi-industrial fishery' in Egypt. The artisanal fishery uses motorized boats locally called launches, whose number varied between 93 and 178 in the Gulf of Suez and about 415 outside, with lengths ranging between 10 to 15 m, and inboard engines of 50 to 200 hp. The fishing trips take about 10 days, and the crew ranges from 2 to 10. The fishers on these boats use several fishing gears such as long-line, hand-line, gillnet, trammel net and beach-seine (Mehanna 1999).

The crew of the artisanal frequent on fishing grounds within and adjacent to Gulf of Suez, and land their catch in Ataka and Salakhana (in Suez City), Sakkala in Hurgada and El-Tor in South Sinai. Their main targets are reef-associated fishes and they use seines and cast nets to catch bait. Part of their catch is stored in ice boxes with ice and transported to Cairo. The reef-associated catch from Foul Bay used to be done by purse seines landed in Berenis, Shalateen and Abo Ramad and transferred directly to Hurgada and Cairo (Chakraborty 1984a, 1984b). Now, the purse seiners are prohibited from catching reef-associated species.

Subsistence fishery

As in the case of the artisanal fishery, Egyptian authorities generally do not use the term 'subsistence fishery'. The fishery referred to here as subsistence fishery is known as 'traditional fishery', and refers to small-scale fisheries mainly for their own consumption but a small portion may be sold in the local markets, and which have existed for longer time than any of the other fisheries. These fisheries include foot-fishers, sailing boats and a few motor boats, equipped mainly with outboard or small inboard engines. These fisheries operate in the near-shore waters along the Egyptian coast, including in South Sinai, which is known for its touristic attractions, but not for fishing. All the fisheries in Sinai are categorized as 'traditional' except in El-Tor (Chakraborty *et al.* 1983). The subsistence fishery targets mainly fishes in shallow waters and coral reef areas using handline, gillnet, trammel, seine nets and cast nets. In some areas, e.g., Quseir, large sail boats locally called 'Katira' are used to catch sardines, mullets and goatfish. The traditional fishers may occasionally use trucks and camels to transport food and fishing equipment from place to place (Chakraborty 1984a, 1984b).

Recreational fishery

Some form of recreational fishing has been practiced in Egypt for a very long time, starting from the time of the Pharaohs (Pitcher and Hollingworth 2002). The more contemporary recreational fishery started with the growth of tourism in the Egyptian Red Sea, i.e., after the 1967 Arab-Israeli war (Hawkins and Roberts 1994). Both tourists and the local population are involved in recreational fishing. They usually use line fishing (simple hook and line, longline and trolling) and more rarely nets (mainly to catch bait). The catch is usually consumed by the fishers, some given to friends and very rarely, in the case of a big catch, a small portion may be sold in the market. The number of boats involved in the recreational fishery has grown very fast in the last few years (FAO 2004, 2010).

Methods

As this research deals with historic statistics on the fisheries of Egypt, the methodology required the compilation of data from different sources, cleaning, and standardizing them for presentation in usable form (Tesfamichael and Pauly 2011). Whenever there were data gaps, they were filled using assumptions, which are stated openly for criticism and further refinement. An extensive search was made for fishery catch data of Egypt in the Red Sea in journal articles, gray literature, reports and databases. In addition, the knowledge of people (fishers and administrators) familiar with the statistical system was sought to fill in gaps and interpret data and the results of our analysis. We found that there are many published reports, mainly in national journals, on the Egyptian fisheries. After a close scrutiny of the literature, the main sources of Egyptian fisheries catch data can be categorized into three sources. The earlier ones were published (mainly in the 'Bulletin of the Institute of Oceanography and Fisheries') from the 1950s until the 1970s by local researchers in order to identify the potential of the resource using traditional stock assessment tools such as surplus-production models. The next category consists of reports from an FAO project titled 'Development of Fisheries in Areas of the Red Sea and Gulf of Aden', which ran from the late 1970s to the mid-1980s. The reports were very detailed and gave very good insight into the fisheries of Egypt by gear type, taxon and place. They were written mainly by foreign experts, sometimes with local co-authors. This phase is data rich and several similar reports, sometimes with overlapping contents, were written by different authors, mostly technical consultants to the project. The third category of data source is the database of GAFRD (2012), which presents data from 1979 to the present. Generally, the GAFRD database is informative, but it has gaps. The catch reconstruction was done separately for each major sector of the Egyptian fisheries in the Red Sea.

Industrial fisheries

Purse seine fishery

The earliest report for the purse seine fishery in the Egyptian Red Sea available to us was from Rafail (1970). Landings were given for Gulf of Suez from 1960 to 1965 for sardinella, *Sardinella gibbosa*, reported as *S. jussieu*, but also as goldstripe sardine in some reports (Chakraborty 1984a). The geographic distribution for S. gibbosa in Fishbase (Froese and Pauly 2012) included the Red Sea, but this was not the case for *S. jussieu*. The report gave the proportion of the taxon from the total purse seine fishery landings of the Gulf of Suez, which were used to calculate the total catch. For Hurgada, landings of sardinella, which accounted for 25% of the total purse seine catch in Hurgada, were given for two seasons (September – May) 1964/1965 and 1965/1966. First, the catches of Hurgada were converted to calendar year assuming that 63% was caught from September to December and the rest from January to May; this ratio is an average calculated based on reports from Sanders *et al.* (1984a) and data from GAFRD (GAFRD 2012). Catches were given for the Gulf of Suez and Hurgada separately, but not for Foul Bay, because the boats that fished in Foul Bay were from the Gulf of Suez and Hurgada, and it is probable that their catch was included in the reports from those two areas (Rafail 1970). For 1966, it was possible to calculate total catch only for Hurgada, as there was not any data given for the Gulf of Suez. Thus the total was calculated using the ratio of Hurgada to the Red Sea from 1965 and the total of Hurgada for 1966.

Prior to the industrial purse seiners, non-motorized sailing boats had already been purse seining, although at a smaller scale. Their catch was not recorded (based on interviews with fishers and administrators), thus it was estimated to be about 5% of the total purse seine catch. Thus, 5% of the purse seine catch for 1960, which was 133 t·year^{-1} annually, was assumed from 1950 to 1959. In addition, trawlers were also involved in purse seining starting 1960 (Sanders *et al.* 1984b) and their catch is assumed to be 1% of the total purse seine catch. Accordingly, 6% (5% from non-motorized boats and 1% from trawlers) was added to the catch from 1960 to 2010. There were no data from 1967 to 1969, and the catch was interpolated between 1966 and 1970.

From 1970 to 1978, the annual purse seine catches were available (Chakraborty 1984a) and from 1979 to 1982 (Sanders *et al.* 1984a). Unlike other reports, these catches were for the whole Red Sea, not only for the Gulf of Suez. Thus, these values were used as they were, but 6% was added to account for the unreported catch by sailing boats and others.

From 1980 to 2010, data were available from GAFRD (2012), but it was only for the Gulf of Suez. The data from 1979 to 1989 were presented by fishing season only, i.e., September to May. These data were first converted to calendar year using the same procedure as described above. From 1990 to 2004, there were two data sets: one presented by season, which was converted to calendar year, and another by calendar year. Comparison of the two data sets resulted in correlation coefficient of r = 0.91, which showed our conversion process to be reasonable. From 2005 to 2010, the only data available were presented by calendar year. The converted data were used from 1983 to 1989 and the other set from 1990 to 2010.

Once the annual total catches were calculated for the Gulf of Suez, they were scaled up to the whole Red Sea based on Sanders *et al.* (1984a), who reported that for 1980 and 1981 the Gulf of Suez accounted for 75% of the total Egyptian Red Sea purse seine catch. The total annual catch calculated from 1979 to 2010 were used except from 1980 to 1982, where the more detailed data from Sanders *et al.* (1984a) were used instead those from GAFRD (2012). To all the totals, 6% unreported catch was added (Figure 2).

The earliest catch composition data available for Egyptian purse seine fishery was the percentages of only *S. gibbosa*, which accounted for up to 95% of the total of the Gulf of Suez purse seine catch starting in 1960 (Rafail 1970). The difference between 100 and the percentages for *S. gibbosa* were allocated to 'others'. Since, from 1960 to 1964,
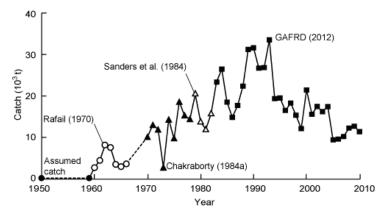

Figure 2. Sources and values used to reconstruct the Egyptian purse seine fishery in the Red Sea from 1950 to 2010.

purse seining occurred only in the Gulf of Suez, those percentages were used for the whole Red Sea. The ratios of 1960 were used from 1950 to 1959. From 1964 to 1966, catch composition ratios were given for both the Gulf of Suez and Hurgada landings (Rafail 1970). For 1965, the unidentified catch of 'others' was too high (72%) and for 1966 the data were incomplete; thus, for these two years, the ratios of 1964 were used. For 1964, the group 'others' had a value of 33% and it was reduced by dividing it to the taxa not represented for 1964, but were represented in a more detailed catch composition for 1980 (Sanders *et al.* 1984a). Because of the uncertainty in identifying the sardinellas into species level, we presented them here as *Sardinella* spp.

Better catch composition data were available from 1980 to 1982 (Sanders *et al.* 1984a) and 1983 (Chakraborty 1984a). In both sources, horse mackerels and scads were reported as one group. However, the two belong to two different genera and are reported separately in the FAO database. Hence the ratio given for the two together was divided equally between the two. In addition, there was a group called 'miscellaneous' and another one called 'others', which were combined. The ratios of 1980 were used from 1967 to 1979. From 1984 to 2010, GAFRD (2012) data presented the catch by taxonomic components. The data were first converted to calendar year. For most of the years, a large proportion was categorized in the group 'others'; this was disaggregated using the average catch composition ratios from the years where the group 'others' was less than 10% (1992 – 1994, 2000 and 2001). Similar to 1980 – 1983, the group 'horse mackerel and scads' was divided into two equal separate groups (Table 1).

Table 1. Sources used to calculate the catch composition (in tonnes) of Egyptian purse seine fishery in the Red Sea.

Year	Horse mackerel	Scads	Round herring	Sardinella	Slimy mackerel	Indian mackerel	Barracudas	Anchovies	Others	Source
1950–60	0.0	0.0	0.0	92.0	0	0.0	0.0	0.0	8.0	Rafail (1970)
1961	0.0	0.0	0.0	81.0	0	0.0	0.0	0.0	19.0	Rafail (1970)
1962	0.0	0.0	0.0	91.0	0	0.0	0.0	0.0	9.0	Rafail (1970)
1963	0.0	0.0	0.0	95.0	0	0.0	0.0	0.0	5.0	Rafail (1970)
1964	8.4	8.4	11.4	67.1	0	2.7	0.1	0.3	1.5	Rafail (1970)
1967- 80	20.9	20.9	28.4	18.2	0	6.7	0.3	0.7	3.8	Sanders *et al.* (1984a)
1981	25.2	25.2	15.0	26.3	0	6.3	0.1	0.1	1.7	Sanders *et al.* (1984a)
1982	25.9	25.9	16.4	21.2	0	5.9	0.1	0.2	4.4	Sanders *et al.* (1984a)
1983	22.9	22.9	22.2	22.0	0	6.5	0.2	0.4	2.9	Chakraborty (1984a)
1984–2010	25.2	25.2	27.1	4.6	12	1.7	0.0	0.0	4.1	GAFRD (2012)

Trawl fishery

The earliest Egyptian trawl fishery record available was the catch of shrimp from 1921 (Al-Khol and El-Hawary 1970) from the Gulf of Suez. Although the catch was given only for shrimp, we believe that at least some of the fishes were also retained, as implied in other reports on trawling (Latif and Shenouda 1972), which, however, presented data only for 1963. In addition, there are reports of demersal fish caught by trawling in Egyptian Red Sea data submitted to FAO. Thus, the total trawl catch from 1950 to 1961 was calculated based on reported shrimp catch. First, a continuous series of shrimp catches was established because the data from Al-Khol and El-Hawary (1970) were intermittent. Then the gaps in the shrimp catch from 1945 to 1955 were filled by interpolation, and scaled up to total retained catch for the Gulf of Suez, based on the ratio of shrimp from total catch, which was reported to be 10% (Chakraborty 1984a). The Gulf of Suez was later scaled up to the whole Red Sea based on Sanders *et al.* (1984b), who reported that the Gulf of Suez accounted for 90% of the total Egyptian Red Sea trawl catch. We used this procedure to reconstruct the catch from 1950 to 1961.

The next data set available was from 1963 to 1966 (Latif and Shenouda 1972). The value for 1963, however, was not used as it did not correspond to the other figures given in the same report. First, the Gulf of Suez catch was scaled up to the whole Red Sea, based on Sanders *et al.* (1984b), who reported that it accounted for 90% of the Red Sea total. The totals for 1962 and 1963 were interpolated using data from 1961 and 1964.

Chakraborty (1984a) presented the total catch of trawl fishery for the whole Red Sea from 1970 to 1983 with some years missing. However, only the data from 1970 to 1978 were used, as the years after that were not complete. Besides, there was a continuous data set from 1979 to 2010 from GAFRD (2012). In addition to Chakraborty (1984a), there were more sources for the years from 1980 to 1983, thanks to the FAO funded project, which employed many experts, e.g., Sanders *et al.* (1984b), who even presented monthly catches. However, all those data sets were very similar and because of its completeness and continuity, the data from GAFRD was used. It consisted of two sets: one only for the Gulf of Suez from 1979/80 to 2007/08 (except 2005/2006), by fishing season (September to May). The catch data therein were converted to calendar year using similar procedures we employed for the purse seine fishery (the value for 2005/06 was calculated as an average of 2004/05 and 2006/07).
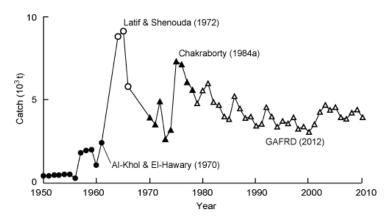

Figure 3. Sources and values used to reconstruct the retained part of the Egyptian trawl fishery in the Red Sea from 1950 to 2010.

The annual total of the Gulf of Suez was then scaled up to the whole Red Sea, based on data from Sanders *et al.* (1984b), who reported that the Gulf of Suez accounted for 90% of the total Egyptian trawl fishery catch in the Red Sea. The second data set were from 1990 to 2010, by calendar year. Comparison was carried out between the two datasets over the overlapping years, 1990 – 2008, and resulted in a correlation coefficient of r = 0.83, which indicated that our conversion process of the seasonal data to calendar year is reasonable. From 1979 to 1989, the converted data were used and from 1990 to 2010, data given by calendar year were used (Figure 3). The main unreported portion of the trawl fishery is discarded catch. Since this was a substantial amount, it is treated separately.

A good proportion of trawlers' catch is thrown back as discard. The only Egyptian study we found on this topic was El-Ganainy *et al.* (2005), who found, based on trawl surveys in 2003, that discards amounted to 56.1% of the total catch. Given that the trawl fishery in 1950 was mainly for shrimp, which has a discard amount of up to 90% in the Red Sea (Sanders and Morgan 1989; Tesfamichael and Pitcher 2007), a conservative estimate of discard of 80% of total catch was assumed for 1950. Using these data points, the discard proportion was interpolated from 1950 to 2010, to mimic the behaviour of the fishers who tend to retain more and more of the less valued fishes as the premium species, usually high-trophic level ones, start to decrease or disappear altogether in their catch (Pauly *et al.* 1998). Once the discard proportions were established, the discard amount was calculated based on the reconstructed retained catch.

The composition of retained catch was calculated based on data from Sanders *et al.* (1984b) for 1980 – 1982, Chakraborty (1984a) for 1983, and GAFRD (2012) for 1984 – 2010. The categories 'miscellaneous' and 'pony fish' (i.e., Leiognathidae), which were less than 1% each, were added to the category 'others' from 1980 to 1983. From 1950 to 1979, the average proportions of 1980 – 1983 were used. All the sources put 'horse mackerel and scads' together. However, given that the two belong to different genera and are reported separately in the FAO database, the group was divided into two equal portions (Table 2).

The catch composition of the discarded catch was calculated using data from El-Ganainy *et al.* (2005), where the ratio of fish species and crustaceans were given separately. However, the proportion of each category to total discards was not given. It is assumed, by comparison with other Red Sea trawl fisheries, that fish discards contributed 75% and crustaceans 25% (Table 3). For a few taxa, the scientific names presented were not the valid names. For those taxa, valid scientific names were obtained from FishBase (www.fishbase.org) and SeaLifeBase (www.sealifebase.org).

Artisanal fishery

The earliest record available for the artisanal (semi-industrial reef) fishery was for the 1979/80 season, lasting from October 1979 to September 1980, and for the next three seasons, i.e., until September 1982, for the whole Red Sea (Chakraborty 1984a). GAFRD (2012) also had data from 1979/80 to 2004/05 pertaining, however, only to the Gulf of Suez. The data from Chakraborty (1984a) were used because they were based on extensive frame surveys, detailed and included catches from areas that are not included in the GAFRD data set. For the rest of the years, the GAFRD database was used. First, the GAFRD data, 1982/83 – 2004/05, were scaled up to the whole Red Sea by comparing the data for the overlapping years (1979/80 – 1981/82) between Chakraborty (1984a) and GAFRD (2012), which resulted in the Red Sea total being 2.29 times that of the Gulf of Suez catch. Then the data were adjusted to calendar year using data from Sanders *et al.* (1984c): October to December (22%) and January to September (78%). From 1990 to 2010, the GAFRD database, which presented the Gulf of Suez catch by calendar year, was used. Comparison of the overlapping years, 1990 – 2005, between the seasonal data converted to calendar year and the data already presented by calendar resulted in correlation coefficient of r = 0.98, which indicates that the conversion process performed well.

Based on our observation of the operation of this fishery, we believe that part of the catch of this fishery is not fully reported. Some of the catch is sold in informal markets where data recording does not happen. A conservative estimate of 10% was added to the totals to account for the unreported catch.

Table 2. Sources used to calculate the composition of Egyptian trawl retained catch (in tonnes) in the Red Sea.

Year	Lizard fish	Striped snappers	Threadfin bream	Horse mackerel	Scads	Red mullets	Shrimps	Cuttlefish	Others	Source
1950–79	46	12	8	2	2	4	10	3	14	a*
1980	41	13	9	2	2	3	11	2	17	b
1981	48	10	7	2	2	3	10	3	13	b
1982	50	13	8	2	2	6	7	3	10	b
1983	45	11	8	2	2	3	11	3	15	c
1984	26	14	8	4	4	3	20	5	15	d
1985	31	15	8	3	3	3	19	4	14	d
1986	51	10	5	2	2	3	11	3	12	d
1987	39	11	4	3	3	5	15	4	17	d
1988	22	18	3	3	3	7	16	2	26	d
1989	15	28	3	2	2	7	16	3	25	d
1990	11	29	2	2	2	8	22	4	19	d
1991	22	20	3	3	3	9	22	4	14	d
1992	24	19	3	1	1	11	15	3	22	d
1993	15	23	3	2	2	11	18	5	21	d
1994	15	20	4	4	4	11	19	8	14	d
1995	27	13	6	2	2	11	13	4	22	d
1996	26	11	5	2	2	9	13	4	28	d
1997	27	11	10	4	4	8	13	3	19	d
1998	29	13	14	4	4	8	11	3	14	d
1999	29	13	14	2	2	9	10	3	17	d
2000	27	14	10	3	3	10	12	4	17	d
2001	28	14	10	4	4	10	9	4	17	d
2002	32	12	11	3	3	10	7	5	18	d
2003	28	14	11	3	3	10	7	5	20	d
2004	31	15	11	1	1	11	15	7	8	d
2005	32	13	11	2	2	10	15	7	9	d
2006	28	9	10	5	5	10	8	5	21	d
2007	28	8	10	5	5	8	7	4	26	d
2008	28	9	10	5	5	7	8	4	26	d
2009	28	9	10	5	5	7	8	4	26	d
2010	28	9	10	5	5	7	8	4	26	d

*a = Average of 1980 – 1983; b = Sanders *et al.* (1984b); c = Chakraborty (1984a); d = GAFRD (2012)

No records were available for this fishery from 1950 to 1979. Approximate catches were derived for this period by assuming the level of catch in 1950 to be the same as 2010, where the catch declined to its lowest level, and interpolating between 1950 and 1979 (Figure 4).

The catch composition from 1980 to 1983 was calculated using data from Sanders *et al.* (1984c) and for 1984 from (Chakraborty 1984a). The only change made to the ratios given in those reports was that 10% of the category 'others' from the Gulf of Suez catch from 1980 to 1983 was deducted and allocated to Spanish mackerel, which appeared in other reports. Data from GAFRD (2012) gives the catch composition from 1979 to 2005, in which Spanish mackerel was presented separately and the average for 1980 to 1983 was 10% of the 'others'. For 1984, 10% of 'others' from the overall Red Sea catch composition was assigned to Spanish mackerel. The GAFRD database catch composition from 1984 to 2005 is highly aggregated under the category 'others'. Thus the catch composition of GAFRD is ignored and the average of 1980 to 1983 is used for 1984 to 2010 and 1950 – 1979 (Table 4).

Table 3. Percentages used to calculate the composition of Egyptian trawl discarded catch in the Red Sea.

Taxa	Common name	%
Leiognathus berbis	Berber ponyfish	26
Champsodon capensis	Gaper	19
Leiognathus elongatus[a]	Slender ponyfish	11
Pseudorhombus arsius	Large tooth flounder	8
Charybdis helleri	Spiny hands crab	5
Laganum depressum[b]	(Sand dollar)	3
Clypeaster reticulatus	(Sand dollar)	3
Callyspongia monilata	Finger sponge[d]	2
Cliona vastifica[c]	Red sponge[d]	1
Others	—	23

[a,b,c] Valid names for taxonomic names given in the paper: [a] *Equulites elongatus,* [b] *Jacksonaster depressum,* [c] *Pione vastifica.*
[d] Sponges are not considered by the *Sea Around Us*. Therefore, for the purposes of the database, these entries are not considered.

Subsistence fishery

Although the presence of a subsistence (traditional) fishery is acknowledged by many authors, we found only one estimate of its catch, for 1983, from a frame survey (Chakraborty 1984a). In the absence of other data, population size, based on the United Nations, Population Division (esa.un.org/unpd/wpp/Excel-Data/population.htm) was used as a proxy to estimate the subsistence fishery catch. This is a reasonable assumption, because catch of traditional fisheries is usually consumed locally, hence related to population size. Because the catches of the traditional fishery are almost exclusively consumed by local communities, this fishery is categorized as subsistence fishery in our reconstruction. First, the catch for 1983 was divided by total population. This per capita ratio was multiplied by 1.5 for 1950, assuming per capita rate of subsistence catch was 50% higher in 1950 when the resource was more abundant and the population size small. For 2010,

Figure 4. Sources and values used to reconstruct the Egyptian artisanal fishery in the Red Sea from 1950 to 2010.

the 1983 ratio was halved (50% less), reflecting the overall decline in fish abundance and increase in population size. Once these three points were established, the ratios for the rest of the years were interpolated. Then the total catch was calculated by multiplying these ratios by the population size. This is a very conservative estimate; as most of the estimates are less than the only report available, for 1983 (Figure 5). Traditional fishers are known to use a large proportion of their catch to feed their families and give to relatives and friends. Based on interviews in the Red Sea, this can be up to 50% of their total catch. It was also observed during the interviews that fishers used to give bigger proportion of their catch in the past, when there was less marketing of their catch, but later the ratio they give freely decreased. In order to estimate the proportion of the unreported catch of the traditional fishery, we used a conservative 30% for 1950 and 10% for 2010. The ratios were interpolated between the two years.

Table 4. Sources used to calculate the composition of Egyptian artisanal fishery catch (in tonnes) in the Red Sea.

Year	Groupers	Spangled emperor	Yellow tailed emperor	Jacks	Little tuna	Long spine bream	Parrot fish	Sharks	Spanish mackerel	Others	Source
1950–79	28	23	7	4	2	2	4	1	2	27	a*
1980	27	21	9	4	1	2	4	1	2	29	b
1981	31	21	6	5	2	2	4	1	2	27	b
1982	25	28	6	3	2	1	4	2	1	27	b
1983	29	21	8	4	2	2	4	1	3	26	c
1984–2010	28	23	7	4	2	2	4	1	2	27	a

*a =average of 1980 – 1983; b = Sanders *et al.* (1984c); c = Chackraborty (1984a)

The catch composition of the subsistence catch was calculated using the ratios given in Chakraborty (1984a) with minor modification (Table 5). In the report, sardines and anchovies were reported as one group. However, they are reported separately in the FAO database. Thus, we presented them separately, with each having a composition of 4.4%.

Recreational fishery

The presence of a recreational fishery in Egypt is mentioned in many reports, but catch data are very scarce. Indeed, the only quantitative information available for the recreational fishery of Egypt in the Red Sea was that there were 3,013 recreational fishers in 2003 (FAO 2004) and 5,079 in 2008 (FAO 2010). The term 'recreational fishers' in Egypt refers to full-time operators of boats taking tourists (local and foreign) on day trips of recreational fishing. The 2008 report also gives the number of boats involved in recreational fishing activity. In order to estimate the total catch of the recreational fishery, the numbers of operators from 2003 and 2008 were used. First, the proportion of the recreational fishers from total population (participation rate) was calculated for 2003 and 2008, which were 0.0043% and 0.0067%, respectively. The recreational fishery was assumed to start in 1968,
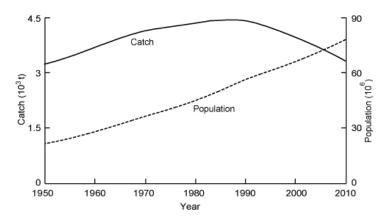

Figure 5. Estimated catch of the Egyptian subsistence fishery in the Red Sea from 1950 to 2010 (solid line), and the growth of the Egyptian population (dotted line), as used in the estimation of this catch (see text).

after Egypt's war with Israel in 1967. The tourism industry in the Red Sea started after the war (Hawkins and Roberts 1994) and tourism has major impacts on the recreational fishery. The participation rate for 1967, therefore, was assumed to be zero. The rates were interpolated between 1967 and 2003 and again from 2003 to 2008. The slope of change from 2007 to 2008 was used to calculate the participation rate for 2009 and 2010.

Once the participation rates were estimated from 1967 to 2010, the total number of participants was calculated by multiplying the participation rates by the population of Egypt, obtained from the United Nations, Population Division (esa.un.org/unpd/wpp/Excel-Data/population.htm; see also Figure 5). In addition to the number of participants, data on number of days per year and the catch rate per day are needed for the estimation of total catch. The number of days per year we assumed a conservative 250 days·year^{-1} based on the report from FAO (2010), stating that the recreational boats sail on more than 280 days per year. For the catch rate per operator, we assumed 2 kg·day^{-1} for 1968 and 1 kg·day^{-1} for 2010. This is again a conservative catch rate assumption. The catch rate was interpolated between 1968 and 2010, to mimic the change in catch rate as the intensity of fishing increases and abundance decreases. The total catch was then calculated by multiplying the number of operators by the number of days per year they fish multiplied by the catch rate (Figure 6). Since the estimated number of recreational operators was for the whole of Egypt's EEZ, i.e., both the Mediterranean and the Red Sea, the Red Sea part was calculated by assuming that 75% of the recreational fishery occurs in the Red Sea (Figure 6), based on the report that most of the recreational fishing takes place in the Red Sea (FAO 2010).

The catch composition of the Egyptian recreational fishery in the Red Sea is estimated based on the field observation by the second author. The dominant taxa in catch are groupers (Serranidae), pelagic jacks and mackerels (Carangidae) and snappers (Lutjanidae). Emperors (Lethrinidae) and large sized threadfin breams (Nemipteridae) are also common in the catch, although not as dominant as the three previously listed ones. We assumed a contribution of 20% each for the three dominant taxa, 15% each for emperors and threadfin breams and 10% was allocated to the 'others'.

Table 5. Catch composition of Egyptian subsistence fishery in the Red Sea.

Taxa	%
Mullets	20.0
Carangids	17.0
Breams	9.4
Stripped snapper	8.0
Shrimps	7.0
Sardines	4.4
Anchovy	4.4
Rabbit fish	3.5
Barracuda	1.0
Cuttle fish	0.3
Queenfishes	0.2
Croakers	0.1
Other	24.7

Comparing reconstructed catch with FAO data for Egypt in the Red Sea

The catch data we reconstructed from different sources was compared with the Egyptian Red Sea catch as reported in the FAO database (www.fao.org/fishery/statistics/software/fishstat/en). Although Egypt has access both to the Red Sea and Mediterranean Sea, they belong to two different FAO statistical areas; hence, the FAO data for Egypt is separate for the two seas. To compare our data with Egypt's FAO Red Sea data, we first checked for taxa not included in the different sectors of the reconstructed catch, but reported to FAO, and vice versa. Some groups: 'silversides (sand smelts) nei', 'largehead hairtail' and 'flatfishes nei' were reported by Egypt to FAO for a few years, but not represented in the reconstructed catch. We assigned their low catch to the group 'others'. Other taxa, found in the FAO data but not the reconstruction, were allocated to the appropriate sector in the reconstruction. Their amount in the reconstructed catch was taken to be the same proportion they had in the total FAO
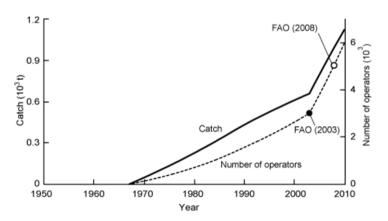

Figure 6. Reconstructed total catch of the Egyptian recreational fishery in the Red Sea from 1950 to 2010 and the number of recreational fishing operators used to estimate the catch.

catch. The amounts were later deducted from the 'others' of the sector to which they were allocated. For each sector, for the years in which the group 'others' was higher than 10%, it was reduced to 10% and the rest distributed to the taxa already identified according to their proportion in each sector. These procedures changed the original taxonomic composition of the catches described in each sector in the above. Hence, the final catch composition is different from the taxonomic composition tables given for each sector in the methods. Those tables are procedural tables and not final ones. Each taxon in the reconstructed catch was compared with its corresponding value in the FAO data. The part of the reconstructed catch that is accounted in the FAO data is referred as 'reported catch' in our result. The difference was presented either as unreported or over-reported catch depending whether the reconstructed value was higher or lower than the FAO value.

Egyptian fishery outside its waters in the Red Sea

Egyptian fishery is the most developed in the Red Sea and the earliest to expand and use advanced technology. The concentration of fishing fleets is so high that the government banned new entry to the fishery (Mehanna and El-Gammal 2007). The Egyptian fishing fleet has been known to roam the whole Red Sea, i.e., outside Egypt's exclusive economic zone (EEZ) with or without formal agreements with the other Red Sea bordering countries. There are even reports that Egyptian vessels fishing outside the Red Sea, besides Egyptian waters in the Mediterranean, as far as the eastern Atlantic (Feidi 1976). The Egyptian fleets that venture out of Egyptian waters are mainly large trawlers and purse seiners. Based on the catch reconstruction of Sudan (Tesfamichael and Elawad 2012), Eritrea (Tesfamichael and Mohamud 2012) and Yemen (Tesfamichael *et al.* 2012), we were able to estimate the total catch of Egyptian vessels in those countries (Figure 7). It is worth noting that the

Figure 7. Total catches of the Egyptian fisheries in the Red Sea waters of Sudan, Eritrea and Yemen from 1950 to 2010.

values in Figure (7) represent what Egyptian vessels catch under formal agreement with the respective countries. It does not include the illegal fishing activities carried out by Egyptian vessels, which are not uncommon occurrences. Several Egyptian vessels and their crew have been arrested in Eritrea and interviews with fishers in Sudan revealed their grievance of their resources being exploited illegally by Egyptian vessels and how that had affected their catch.

Results and discussion

The reconstructed total Egyptian Red Sea catch deemed taken within the Egyptian EEZ or EEZ-equivalent waters (i.e., prior to the formal declaration of the EEZ) is shown in Figure (8) and appendix Table (A1), together with the catch Egypt reported to FAO from statistical area 51 to which the Red Sea belong. The reconstructed and FAO catches were more or less the same at the beginning until around 1960. Then two distinct patterns appeared with clear demarcation in 1993. The earlier pattern, from the early 1960s to 1993, was one where the annual reconstructed catches for Egyptian waters were clearly higher than the FAO reported. From 1993 on, the opposite occurred, where the FAO reported catches were much higher than the reconstructed catch. Our explanation, given all the information we have, is that the catch was underreported from the early 1960s to the early 1990s, but the later part included catches made outside Egypt's own waters, which were not included in the reconstructed catch for Egypt in its EEZ. Egyptian boats, mainly industrial ones, have
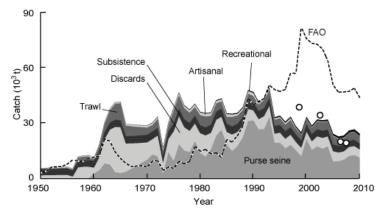

Figure 8. Reconstructed catch of the Egyptian fishery in the Egyptian Red Sea EEZ by sector and the data Egypt submitted to FAO from 1950 to 2010 for FAO area 51. Open circles indicate Egyptian catch reported to FAO without what is possibly caught outside its EEZ put for comparison purpose.

been expanding their operations to the other Red Sea countries mainly since the early 1990s and Egypt's catch from those waters were presented in their respective country (Tesfamichael and Elawad 2012; Tesfamichael and Mohamud 2012; Tesfamichael *et al.* 2012), see Figure (7) in the above for what Egypt caught in Sudanese, Eritrean and Yemeni waters.

Here, we are primarily interested in getting a better estimate of what is caught in the ecosystem, i.e., where the catch comes from, and secondly who (or which country) is catching it. Thus, what Egypt caught in Sudanese, Eritrean and Yemen is reported in the respective countries reconstruction reports with clear indication that it was caught by Egyptian vessels. Nevertheless, adding the values of Egyptian catch outside its EEZ (Figure 7) to the reconstruction will not fill the gap between the reconstructed catch and FAO data of Figure (8). Since the gap is big, it is imperative to explain the difference. In order to do that, we dug deeper into Egyptian catch by area, which we were able to obtain for few years from the Egyptian authority (GAFRD 2012). The overall total Egyptian catches in the Red Sea match what is reported in the FAO data. However, when the data were dissected by region a different picture appears. The areas reported include the 'Gulf of Suez' (or catch landed in the ports in Suez, the main landing sites), 'Aqaba', and what is vaguely labeled as 'south' or 'southern Red Sea', and 'outside'. These terms sometimes refer to the catch caught 'outside Gulf of Suez' or fish caught in the southern Red Sea including areas outside Egypt's EEZ. For comparison, those catches were taken out from what Egypt reports to FAO for area 51, and we obtained

estimates closer to our reconstructed catch, the open circles in Figure (8). On the other hand, FAO's database shows what a country catches in FAO described statistical areas; hence what Egypt caught outside its waters in the Red Sea would be rightly reported under Egypt. As catch data can be used in managing ecosystems, we believe reporting the catch by EEZs gives a better resolution.

The sudden sharp dip in the reconstructed total catch in 1973 was the consequence of the 1973 Arab-Israel war, which destabilized the region and destroyed infrastructure. The effect of the previous 1967 Arab-Israel 6 day war is also shown by the smaller dip in the late 1960s. The first rapid increase in the early 1960s was mainly due to the trawl fishery, which was rapidly expanding at the time. The reconstructed total catch remained stable, albeit with minor fluctuations until it declined in 1993, which may be due to Egyptian vessels sailing outside their EEZ for a better return in their operation than staying in the heavily-fished Egyptian EEZ. Logically, it makes sense that they would put more effort (fuel and time) to go further south, decreasing the total catch from Egyptian EEZ, but then they will get much higher catch (or catch rate) putting the total catch, i.e., what is reported to FAO much higher. Otherwise, their venturing outside the Egyptian EEZ would not be economically rewarding. It is also important to note that Egypt has a very high concentration of fishing vessels, and the fishery authority banned new entry, thus even existing vessels were forced to explore new grounds as the catches from the traditional fishing grounds began to decline.

Overall, from 1950 to 2010, purse seining contributed the largest share to the total catch (42%), followed by trawling (27% discarded and 13% retained catches). The trawl fishery was dominant in the early years, i.e., the 1960s until the mid-1970s, after which it was more or less at par with purse seining, which took over in recent years. The subsistence fishery was the third most important fishery by total catch (14%). The artisanal fishery and recreational fisheries had low contributions (3% and 1%, respectively). The subsistence fishery kept more or less the same level throughout, which is the case in the other Red Sea countries as well (Tesfamichael and Elawad 2012; Tesfamichael and Mohamud 2012; Tesfamichael *et al.* 2012). The subsistence fishery is less affected by external factors, such as international market demand. They are conducted mainly for subsistence and they operate as long as there are people, mainly their families and communities, to consume their catches.

Figure 9. Reconstructed catch of the Egyptian fishery in the Egyptian Red Sea EEZ by component from 1950 to 2010. Reported catch refers to the part of the reconstructed catch accounted in the FAO data.

The reconstructed total catch in Egypt's EEZ can be divided into the catch that can be found in the official report to FAO (reported catch), unreported landed catch and the discarded catch, which is also not reported to FAO. The unreported landed catch contributes 43% of total catch, while reported catch is 30% and discarded catch 27% (Figure 9, Table A2).

Looking at the fishery sectors separately, the industrial purse seine fishery had a continuous, although fluctuating, upward trend from its beginning until it peaked in 1993. After 1993, it declined, but again with fluctuations (Figure 10, Table A3). The trend of the purse seine fishery shaped the trend of the overall reconstructed catch for Egypt, especially in the later years because it was the fishery with the highest contribution. As far as the composition of the purse seine fishery is concerned, three taxa contributed more than 70% of the total catch. They were red-eye round herring (*Etrumeus sadina*, 26%), jacks (Carangidae, 23%) and scads (*Decapterus* spp., 23%).
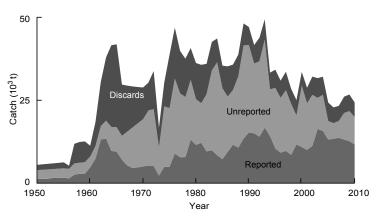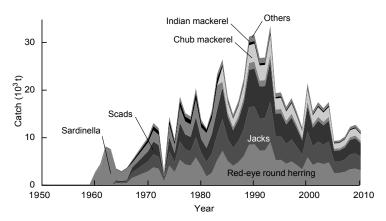

Figure 10. Catch composition of the Egyptian purse seine fishery in the Red Sea from 1950 to 2010.

The industrial trawl fishery expanded very quickly at the beginning of the 1960s after its exploratory phase throughout the 1950s; then there was a sudden decline during both the 1967 and 1973 Arab-Israel wars (Figure 11, Table A4). Since its recovery in 1974, the trawl fishery exhibited fluctuations with a slight declining trend. In the earlier period, the trawl fishery had the highest contribution to the total catch until it was taken over by purse seine. Although the main prized target of trawl fishery is shrimp, lizardfishes (Synodontidae) had the highest contribution by far (40%), followed by snappers (Lutjanidae; 14%), while shrimp was the third with 12% of the retained catch. The three taxa contributed more than 66% of the total landed catch from 1950 to 2010. The discarded trawl catch (Figure 12, Table A5) followed a similar pattern, except that the decline was stronger. This is because the percentage of discarded catch to the total catch was lower in the later years as more and more of the lower-grade fishes were retained in the catch when the most sought-after fishes started to decrease. Berber ponyfish (*Leiognathus berbis*) had the highest contribution to the discarded catch (26%).

The artisanal fishery (sometimes described as 'semi-industrial' in Egyptian national reports), reached its peak in 1990 (Figure 13, Table A6). There was a continuous increase from 1950 to 1979, largely driven by our estimation process, and thus ignoring potential inter-annual variability. We did not have data for that period for the fishery and we assumed the lowest catch that was realized, which was the catch of 2010, for 1950 and linearly interpolated the rest of the period. For the period we had data, the fishery had a declining trend with fluctuations. In terms of the composition of the catch, groupers (*Epinephelus* spp.) had the highest share (31%) and second was emperors (Lethrinidae; 25%).

The subsistence (traditional) fishery had the most stable pattern (Figure 14, Table A7). Because of its diffuse and least regulated nature, this fishery sector was the most difficult in terms of getting estimates as to its size or catch. This is the catch taken by the smallest boats, some even without boats, who mostly fish for their own family consumption and is the least affected by markets and other external factors. Mullets (Mugilidae) had the biggest share of the total catch (23%), followed by jacks (Carangidae; 20%) and porgies and seabreams (Sparidae; 11%).

The recreational fishery was the fishery with the least contribution to the total catch and also the fishery that started last. Since then, however, it is the only fishery with a continuously increasing trend (Figure 15, Table A8). The number of boats involved in recreational fishing has increased considerably as sea-based tourism (both international and local) has increased in Egypt and became economically quite important. As compared to the other sectors, there was no dominant taxon in this fishery. The recreational fishery does not seem to get attention from the Egyptian fishery authority, possibly because of its limited size and/or that it does not fall into the commonly accepted fisheries in the country: fishering solely done for commercial purposes or to feed one's family.

For all fisheries combined, the composition of the reconstructed total catch is dominated by jacks (Carangidae; 13%), red-eye round herring (*Etrumeus sadina*; 11%), scads (*Decapterus* spp.; 10%) and sardinella (*Sardinella* spp.; 6%) from the dominant purse seine fishery. The other dominant taxa are Berber ponyfish (*Leiognathus berbis*; 7%) and lizardfishes (Synodontidae; 5%) (Figure 16), both from the trawl fishery; the former is a discarded species, but the latter is retained. The total number of taxa identified in the Egyptian fishery was quite large (42), which accounted for 89% of the total catch. The remaining 11% was a mix of many taxa not identified separately, as their contribution was small. They were lumped in the 'others' group. In Figure (16), only the taxa that have major contributions to the total catch are presented. The actual catch composition data by taxonomic group identified in the catch reconstruction is given in Table (A9).

Figure 11. Catch composition of the Egyptian trawl fishery (retained) in the Red Sea from 1950 to 2010.
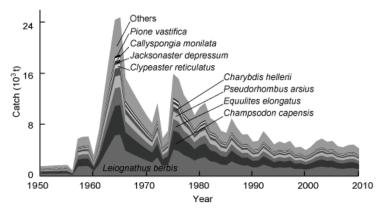

Figure 12. Catch composition of the Egyptian trawl fishery discards in the Red Sea from 1950 to 2010.
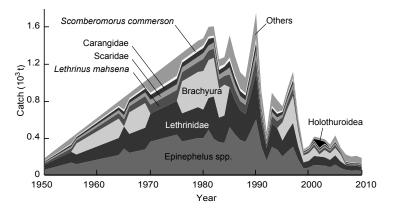

Figure 13. Catch composition of the Egyptian artisanal fishery in the Red Sea from 1950 to 2010.

This reconstructed catch of Egypt in the Egyptian Red Sea EEZ is quite detailed in terms of its comprehensive coverage of the sectors and the composition of their catches, incorporating all the information available to us. To our knowledge, this is the only attempt made to clarify and standardize the Egyptian fisheries catch data for the Red Sea. When necessary assumptions were made, they are clearly stated. The methods and results are standardized and can be used for any further analysis of the fishery. We believe this work will help to better understand the Egyptian

fishery in the Red Sea in assessing, managing and conserving the livelihoods and the ecosystem (which cannot be separated from each other) and improve the practice of data collection and presentations of fishery data in the future. Most of the assumptions we had to make can be, in the future, replaced by some simple procedures in the data collections systems.
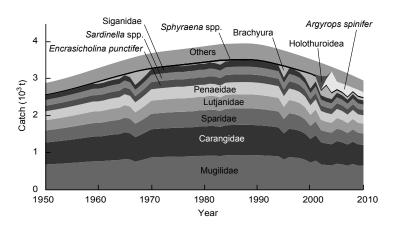
ACKNOWLEDGEMENTS

Figure 14. Catch composition of the Egyptian subsistence fishery in the Red Sea from 1950 to 2010.
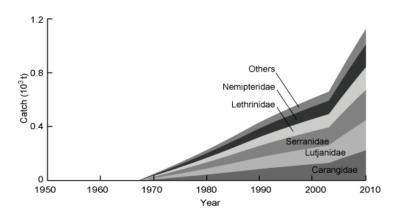

Figure 15. Catch composition of the Egyptian recreational fishery in the Red Sea from 1950 to 2010.
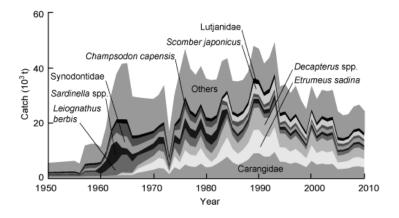

Figure 16. Composition of the total Egyptian fishery catch in the Red Sea from 1950 to 2010 .

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Appendix Table A1: Reconstructed catch (in tonnes) of the Egyptian fishery in the Red Sea by sector and the data Egypt submitted to FAO from 1950 to 2010.

Year	FAO landings	Reconstructed total catch	Purse seine	Discards	Subsistence	Trawl	Artisanal	Recreational
1950	2,900	5,535	133	1,578	3,236	394	194	0
1951	3,900	5,683	133	1,625	3,270	418	237	0
1952	6,100	5,832	133	1,669	3,308	441	281	0
1953	6,400	5,980	133	1,710	3,349	464	324	0
1954	6,500	6,130	133	1,749	3,392	488	368	0
1955	7,800	6,278	133	1,785	3,438	511	411	0
1956	10,101	5,247	133	907	3,486	267	454	0
1957	9,401	11,839	133	5,895	3,535	1,778	498	0
1958	9,300	12,397	133	6,215	3,586	1,922	541	0
1959	11,000	12,570	133	6,237	3,637	1,978	585	0
1960	11,600	11,271	2,650	3,248	3,689	1,056	628	0
1961	12,000	18,417	4,398	7,207	3,740	2,400	672	0
1962	21,400	30,454	8,154	13,268	3,791	4,526	715	0
1963	20,300	37,840	7,547	19,043	3,841	6,651	758	0
1964	14,300	41,475	3,460	24,546	3,890	8,777	802	0
1965	10,800	41,749	2,913	24,930	3,937	9,124	845	0
1966	8,200	29,647	3,619	15,392	3,983	5,764	889	0
1967	6,500	29,328	5,240	13,831	4,027	5,298	932	0
1968	6,700	29,088	6,860	12,334	4,069	4,833	976	16
1969	6,900	28,905	8,481	10,900	4,106	4,367	1,019	32
1970	6,200	28,776	10,102	9,525	4,138	3,901	1,062	48
1971	9,400	30,225	13,031	8,358	4,166	3,499	1,106	65
1972	9,600	33,700	11,956	11,433	4,189	4,891	1,149	82
1973	4,400	16,729	2,666	5,958	4,209	2,604	1,193	99
1974	6,168	30,235	14,350	7,124	4,228	3,181	1,236	116
1975	5,526	38,618	9,580	16,055	4,247	7,322	1,280	134
1976	9,303	46,756	18,606	15,289	4,266	7,120	1,323	152
1977	7,899	39,750	15,130	12,740	4,286	6,058	1,366	170
1978	9,140	37,421	14,424	11,507	4,306	5,586	1,410	188
1979	17,542	40,630	20,358	9,552	4,327	4,733	1,453	207
1980	14,783	36,123	13,741	10,844	4,348	5,484	1,480	226
1981	15,774	35,589	11,923	11,510	4,369	5,939	1,602	246
1982	13,386	35,869	15,716	9,098	4,391	4,790	1,608	266
1983	13,908	42,474	23,320	8,588	4,413	4,613	1,254	286
1984	11,343	43,490	26,437	7,140	4,419	3,912	1,276	306
1985	21,256	35,339	18,483	6,795	4,425	3,797	1,512	327
1986	19,708	35,119	14,829	9,059	4,431	5,163	1,289	348
1987	23,300	35,658	17,688	7,621	4,435	4,429	1,116	369
1988	28,450	38,651	22,342	6,546	4,436	3,879	1,057	391
1989	43,580	48,012	31,200	6,599	4,429	3,986	1,386	412
1990	39,924	46,970	31,596	5,431	4,413	3,345	1,753	432
1991	41,937	41,521	26,705	5,566	4,387	3,494	917	452
1992	43,300	43,714	26,840	7,060	4,352	4,517	474	471
1993	50,740	49,255	33,512	6,082	4,311	3,966	894	490
1994	48,300	33,232	19,323	4,997	4,267	3,321	816	508
1995	47,300	34,119	19,470	5,458	4,220	3,697	749	525
1996	48,435	30,835	16,435	5,169	4,172	3,567	949	543
1997	57,417	33,507	18,266	5,542	4,122	3,897	1,120	560
1998	57,063	28,347	15,347	4,503	4,070	3,225	625	577
1999	82,400	24,983	12,093	4,621	4,016	3,372	287	594
2000	75,972	33,454	21,404	4,105	3,961	3,052	321	611
2001	73,559	28,684	15,547	4,656	3,905	3,526	423	627
2002	72,881	32,044	17,411	5,495	3,847	4,238	410	643
2003	70,408	31,586	16,182	5,915	3,788	4,647	395	659
2004	63,914	31,994	17,436	5,422	3,727	4,339	341	729
2005	50,732	24,248	9,292	5,542	3,664	4,517	436	797
2006	46,940	22,783	9,372	4,722	3,598	3,919	307	865
2007	46,986	23,248	10,177	4,539	3,531	3,838	231	932
2008	47,361	26,003	12,229	4,893	3,461	4,213	209	998
2009	49,031	26,662	12,661	4,974	3,388	4,361	216	1,062
2010	43,974	24,279	11,355	4,381	3,312	3,911	195	1,125

Appendix Table A2: Reconstructed catch (in tonnes) of the Egyptian fishery in the Red Sea by component from 1950 to 2010.

Year	Reported	Unreported	Discards
1950	1,290	2,667	1,578
1951	1,314	2,744	1,625
1952	1,339	2,824	1,669
1953	1,591	2,679	1,710
1954	1,622	2,758	1,749
1955	1,654	2,838	1,785
1956	1,455	2,885	907
1957	2,559	3,385	5,895
1958	2,842	3,340	6,215
1959	2,889	3,443	6,237
1960	4,782	3,240	3,248
1961	7,387	3,823	7,207
1962	13,094	4,092	13,268
1963	13,443	5,355	19,043
1964	9,719	7,209	24,546
1965	9,483	7,336	24,930
1966	7,067	7,188	15,392
1967	5,351	10,147	13,831
1968	4,540	12,213	12,334
1969	4,759	13,245	10,900
1970	5,054	14,198	9,525
1971	5,308	16,558	8,358
1972	5,185	17,081	11,433
1973	2,306	8,464	5,958
1974	4,929	18,182	7,124
1975	4,919	17,643	16,055
1976	8,950	22,517	15,289
1977	7,809	19,201	12,740
1978	7,876	18,039	11,507
1979	13,095	17,982	9,552
1980	11,536	13,743	10,844
1981	12,148	11,932	11,510
1982	9,563	17,208	9,098
1983	9,918	23,967	8,588
1984	8,395	27,956	7,140
1985	7,245	21,299	6,795
1986	9,452	16,607	9,059
1987	11,585	16,453	7,621
1988	10,692	21,412	6,546
1989	13,405	28,007	6,599
1990	15,243	26,296	5,431
1991	15,005	20,949	5,566
1992	13,993	22,662	7,060
1993	16,700	26,473	6,082
1994	14,202	14,032	4,997
1995	10,453	18,209	5,458
1996	9,181	16,484	5,169
1997	9,714	18,251	5,542
1998	8,538	15,306	4,503
1999	11,666	8,697	4,621
2000	10,876	18,473	4,105
2001	10,008	14,020	4,656
2002	11,232	15,318	5,495
2003	16,302	9,369	5,915
2004	15,706	10,865	5,422
2005	13,144	5,563	5,542
2006	13,352	4,709	4,722
2007	13,649	5,059	4,539
2008	13,132	7,977	4,893
2009	12,639	9,049	4,974
2010	11,637	8,261	4,381

Appendix Table A3: Catch composition (in tonnes) of the Egyptian purse seine fishery in the Red Sea from 1950 to 2010.

Year	Etrumeus sadina	Carangidae	Decapterus spp.	Sardinella spp.	Scomber japonicus	Rastrelliger kanagurta	Encrasicholina punctifer	Sphyraena spp.	Others
1950	0	0	0	122	0	0	0	0	11
1951	0	0	0	122	0	0	0	0	11
1952	0	0	0	122	0	0	0	0	11
1953	0	0	0	122	0	0	0	0	11
1954	0	0	0	122	0	0	0	0	11
1955	0	0	0	122	0	0	0	0	11
1956	0	0	0	122	0	0	0	0	11
1957	0	0	0	122	0	0	0	0	11
1958	0	0	0	122	0	0	0	0	11
1959	0	0	0	122	0	0	0	0	11
1960	0	0	0	2,438	0	0	0	0	212
1961	0	0	0	3,563	0	0	0	0	836
1962	0	0	0	7,420	0	0	0	0	734
1963	0	0	0	7,170	0	0	0	0	377
1964	395	290	290	2,324	0	93	10	4	53
1965	333	244	244	1,956	0	78	9	3	45
1966	413	304	304	2,430	0	97	11	4	56
1967	1,490	1,095	1,095	955	0	351	39	15	201
1968	1,951	1,433	1,433	1,250	0	460	51	20	263
1969	2,412	1,772	1,772	1,545	0	568	63	24	325
1970	2,872	2,110	2,110	1,841	0	677	75	29	387
1971	3,705	2,722	2,722	2,374	0	873	97	37	499
1972	3,400	2,498	2,498	2,179	0	801	89	34	458
1973	758	557	557	486	0	179	20	8	102
1974	4,080	2,998	2,998	2,615	0	961	107	41	550
1975	2,724	2,001	2,001	1,746	0	642	71	27	367
1976	5,291	3,887	3,887	3,390	0	1,247	139	53	713
1977	4,302	3,161	3,161	2,757	0	1,014	113	43	580
1978	4,101	3,013	3,013	2,628	0	966	107	41	553
1979	5,789	4,253	4,253	3,710	0	1,364	152	58	780
1980	3,907	2,871	2,871	2,504	0	921	102	39	527
1981	1,788	3,007	3,007	3,136	0	754	13	11	207
1982	2,579	4,072	4,072	3,331	0	925	26	16	693
1983	5,177	5,340	5,340	5,130	0	1,516	93	47	676
1984	7,169	6,669	6,669	1,220	3,171	457	0	0	1,082
1985	5,012	4,662	4,662	853	2,217	320	0	0	757
1986	4,021	3,741	3,741	684	1,779	256	0	0	607
1987	4,796	4,462	4,462	816	2,122	306	0	0	724
1988	6,058	5,636	5,636	1,031	2,680	386	0	0	915
1989	8,460	7,870	7,870	1,440	3,742	540	0	0	1,277
1990	8,568	7,970	7,970	1,458	3,790	546	0	0	1,294
1991	7,241	6,736	6,736	1,233	3,203	462	0	0	1,093
1992	7,278	6,771	6,771	1,239	3,219	464	0	0	1,099
1993	9,087	8,453	8,453	1,547	4,019	580	0	0	1,372
1994	5,240	4,874	4,874	892	2,318	334	0	0	791
1995	5,280	4,911	4,911	899	2,335	337	0	0	797
1996	4,457	4,146	4,146	759	1,971	284	0	0	673
1997	4,953	4,608	4,608	843	2,191	316	0	0	748
1998	4,162	3,871	3,871	708	1,841	265	0	0	628
1999	3,279	3,050	3,050	558	1,450	209	0	0	495
2000	5,804	5,399	5,399	988	2,567	370	0	0	876
2001	4,216	3,922	3,922	718	1,865	269	0	0	636
2002	4,721	4,392	4,392	804	2,088	301	0	0	713
2003	4,388	4,082	4,082	747	1,941	280	0	0	662
2004	4,728	4,398	4,398	805	2,091	302	0	0	714
2005	2,520	2,344	2,344	429	1,114	161	0	0	380
2006	2,541	2,364	2,364	433	1,124	162	0	0	384
2007	2,760	2,567	2,567	470	1,221	176	0	0	417
2008	3,316	3,085	3,085	564	1,467	211	0	0	501
2009	3,433	3,194	3,194	584	1,519	219	0	0	518
2010	3,079	2,864	2,864	524	1,362	196	0	0	465

Appendix Table A4: Catch composition (in tonnes) of the Egyptian trawl fishery (retained) in the Red Sea from 1950 to 2010.

Year	Synodontidae	Lutjanidae	Penaeidae	Nemipteridae	Mullidae	Sepiidae	Carangidae	*Decapterus* spp.	Others
1950	190	49	41	32	15	11	8	8	39
1951	201	52	43	34	16	12	9	9	42
1952	212	55	45	36	17	12	9	9	44
1953	224	58	48	38	18	13	10	10	46
1954	235	61	50	40	19	14	11	11	49
1955	246	64	53	42	19	14	11	11	51
1956	128	33	27	22	10	7	6	6	27
1957	856	222	183	145	68	50	38	38	178
1958	926	240	198	157	73	54	41	41	192
1959	953	247	203	162	75	55	43	43	198
1960	508	132	109	86	40	29	23	23	106
1961	1,156	299	247	196	92	67	52	52	240
1962	2,180	564	465	370	173	126	97	97	453
1963	3,204	829	684	543	254	186	143	143	665
1964	4,227	1,094	903	717	335	245	189	189	878
1965	4,394	1,138	938	746	348	255	196	196	912
1966	2,776	719	593	471	220	161	124	124	576
1967	2,552	661	545	433	202	148	114	114	530
1968	2,328	603	497	395	184	135	104	104	483
1969	2,103	544	449	357	167	122	94	94	437
1970	1,879	486	401	319	149	109	84	84	390
1971	1,685	436	360	286	133	98	75	75	350
1972	2,356	610	503	400	187	137	105	105	489
1973	1,254	325	268	213	99	73	56	56	260
1974	1,532	397	327	260	121	89	68	68	318
1975	3,527	913	753	598	279	204	158	158	732
1976	3,429	888	732	582	271	199	153	153	712
1977	2,918	755	623	495	231	169	130	130	606
1978	2,690	696	575	456	213	156	120	120	559
1979	2,279	590	487	387	180	132	102	102	473
1980	2,465	758	651	521	171	136	117	117	548
1981	2,964	641	641	441	174	190	147	147	594
1982	2,399	630	354	360	288	125	82	82	469
1983	2,195	561	522	385	142	132	107	107	461
1984	1,065	600	836	342	108	226	172	172	391
1985	1,224	592	760	322	122	156	121	121	380
1986	2,661	547	598	277	183	132	124	124	516
1987	1,843	549	724	168	223	198	141	141	443
1988	1,023	830	738	146	348	118	144	144	388
1989	695	1,338	779	120	322	130	102	102	399
1990	424	1,076	818	70	288	156	89	89	334
1991	799	741	817	101	338	132	108	108	349
1992	1,242	998	781	151	598	178	59	59	452
1993	697	1,032	814	125	482	236	92	92	397
1994	538	710	655	129	374	277	153	153	332
1995	1,134	559	550	275	456	190	82	82	370
1996	1,172	485	573	236	395	165	92	92	357
1997	1,184	494	582	413	365	147	161	161	390
1998	992	424	356	463	277	105	143	143	323
1999	1,073	479	349	526	311	123	87	87	337
2000	902	459	382	332	320	147	102	102	305
2001	1,064	529	361	377	366	172	152	152	353
2002	1,481	573	314	498	469	215	132	132	424
2003	1,445	705	368	567	546	258	146	146	465
2004	1,352	648	665	496	458	303	41	41	335
2005	1,448	586	674	494	469	304	74	74	394
2006	1,256	412	362	434	446	212	202	202	392
2007	1,280	386	319	442	362	172	246	246	384
2008	1,426	437	382	491	349	182	262	262	421
2009	1,476	452	396	509	362	189	271	271	436
2010	1,324	405	355	456	324	169	243	243	391

Appendix Table A5: Catch composition (in tonnes) of the Egyptian trawl fishery (discarded) in the Red Sea from 1950 to 2010.

Year	Leiognathus berbis	Champsodon capensis	Equulites elongatus	Pseudorhombus arsius	Charybdis hellerii	Clypeaster reticulatus	Jacksonaster depressum	Callyspongia monilata	Pione vastifica	Others
1950	414	296	178	118	79	39	39	28	20	367
1951	427	305	183	122	81	41	41	28	20	378
1952	438	313	188	125	83	42	42	29	21	388
1953	449	321	192	128	86	43	43	30	21	398
1954	459	328	197	131	87	44	44	31	22	407
1955	468	335	201	134	89	45	45	31	22	415
1956	238	170	102	68	45	23	23	16	11	211
1957	1,547	1,105	663	442	295	147	147	103	74	1,371
1958	1,631	1,165	699	466	311	155	155	109	78	1,445
1959	1,637	1,169	702	468	312	156	156	109	78	1,450
1960	853	609	365	244	162	81	81	57	41	755
1961	1,892	1,351	811	541	360	180	180	126	90	1,676
1962	3,483	2,488	1,493	995	663	332	332	232	166	3,085
1963	4,999	3,571	2,142	1,428	952	476	476	333	238	4,427
1964	6,443	4,602	2,761	1,841	1,227	614	614	430	307	5,707
1965	6,544	4,674	2,805	1,870	1,247	623	623	436	312	5,796
1966	4,040	2,886	1,732	1,154	770	385	385	269	192	3,579
1967	3,631	2,593	1,556	1,037	692	346	346	242	173	3,216
1968	3,238	2,313	1,388	925	617	308	308	216	154	2,868
1969	2,861	2,044	1,226	817	545	272	272	191	136	2,534
1970	2,500	1,786	1,072	714	476	238	238	167	119	2,214
1971	2,194	1,567	940	627	418	209	209	146	104	1,943
1972	3,001	2,144	1,286	857	572	286	286	200	143	2,658
1973	1,564	1,117	670	447	298	149	149	104	74	1,385
1974	1,870	1,336	801	534	356	178	178	125	89	1,656
1975	4,215	3,010	1,806	1,204	803	401	401	281	201	3,733
1976	4,013	2,867	1,720	1,147	764	382	382	268	191	3,555
1977	3,344	2,389	1,433	956	637	319	319	223	159	2,962
1978	3,021	2,158	1,295	863	575	288	288	201	144	2,675
1979	2,507	1,791	1,075	716	478	239	239	167	119	2,221
1980	2,847	2,033	1,220	813	542	271	271	190	136	2,521
1981	3,021	2,158	1,295	863	575	288	288	201	144	2,676
1982	2,388	1,706	1,023	682	455	227	227	159	114	2,115
1983	2,254	1,610	966	644	429	215	215	150	107	1,997
1984	1,874	1,339	803	536	357	179	179	125	89	1,660
1985	1,784	1,274	764	510	340	170	170	119	85	1,580
1986	2,378	1,699	1,019	679	453	226	226	159	113	2,106
1987	2,000	1,429	857	572	381	191	191	133	95	1,772
1988	1,718	1,227	736	491	327	164	164	115	82	1,522
1989	1,732	1,237	742	495	330	165	165	115	82	1,534
1990	1,426	1,018	611	407	272	136	136	95	68	1,263
1991	1,461	1,044	626	417	278	139	139	97	70	1,294
1992	1,853	1,324	794	529	353	176	176	124	88	1,641
1993	1,596	1,140	684	456	304	152	152	106	76	1,414
1994	1,312	937	562	375	250	125	125	87	62	1,162
1995	1,433	1,023	614	409	273	136	136	96	68	1,269
1996	1,357	969	581	388	258	129	129	90	65	1,202
1997	1,455	1,039	623	416	277	139	139	97	69	1,289
1998	1,182	844	507	338	225	113	113	79	56	1,047
1999	1,213	866	520	347	231	116	116	81	58	1,074
2000	1,078	770	462	308	205	103	103	72	51	954
2001	1,222	873	524	349	233	116	116	81	58	1,082
2002	1,442	1,030	618	412	275	137	137	96	69	1,277
2003	1,553	1,109	665	444	296	148	148	104	74	1,375
2004	1,423	1,017	610	407	271	136	136	95	68	1,261
2005	1,455	1,039	624	416	277	139	139	97	69	1,289
2006	1,239	885	531	354	236	118	118	83	59	1,098
2007	1,192	851	511	340	227	113	113	79	57	1,055
2008	1,284	917	550	367	245	122	122	86	61	1,138
2009	1,306	933	560	373	249	124	124	87	62	1,156
2010	1,150	821	493	329	219	110	110	77	55	1,019

Appendix Table A6: Catch composition (in tonnes) of the Egyptian artisanal fishery in the Red Sea from 1950 to 2010.

Year	*Epinephelus* spp.	Lethrinidae	Brachyura	*Lethrinus mahsena*	Scaridae	Carangidae	*Scomberomorus commerson*	Sparidae
1950	67	55	0	18	9	9	5	4
1951	83	67	0	22	12	11	6	5
1952	98	80	0	26	14	14	7	6
1953	113	92	0	30	16	16	8	7
1954	128	104	0	33	18	18	9	8
1955	143	117	0	37	20	20	10	9
1956	127	104	118	33	18	18	9	8
1957	140	114	130	37	19	19	10	9
1958	152	124	141	40	21	21	10	10
1959	164	134	152	43	23	23	11	11
1960	176	144	163	46	25	24	12	12
1961	188	154	175	49	26	26	13	12
1962	201	164	186	53	28	28	14	13
1963	213	173	197	56	30	29	15	14
1964	225	183	209	59	31	31	15	15
1965	294	240	0	77	41	41	20	19
1966	249	203	231	65	35	35	17	16
1967	261	213	242	68	37	36	18	17
1968	274	223	254	72	38	38	19	18
1969	286	233	265	75	40	40	20	19
1970	369	301	0	97	52	51	25	24
1971	384	313	0	101	54	53	26	25
1972	400	326	0	105	56	55	27	26
1973	415	338	0	109	58	57	29	27
1974	430	350	0	113	60	59	30	28
1975	445	363	0	116	62	62	31	29
1976	371	303	344	97	52	51	26	24
1977	383	313	355	100	54	53	26	25
1978	395	322	367	104	55	55	27	26
1979	408	332	378	107	57	56	28	27
1980	406	308	414	131	61	55	29	30
1981	496	343	407	100	57	72	24	32
1982	399	456	416	101	63	53	22	22
1983	364	263	311	100	50	50	36	25
1984	358	292	332	94	50	50	25	23
1985	526	429	0	138	73	73	36	34
1986	448	365	0	117	63	62	31	29
1987	388	316	0	102	54	54	27	25
1988	367	300	0	96	51	51	25	24
1989	482	393	0	126	67	67	33	32
1990	609	497	0	160	85	84	42	40
1991	319	260	0	83	44	44	22	21
1992	165	134	0	43	23	23	11	11
1993	311	254	0	81	43	43	21	20
1994	284	231	0	74	40	39	20	19
1995	210	171	195	55	29	29	14	14
1996	266	217	247	70	37	37	18	17
1997	314	256	291	82	44	43	22	21
1998	175	143	163	46	24	24	12	11
1999	81	66	75	21	11	11	6	5
2000	90	73	83	24	13	12	6	6
2001	119	97	93	31	17	16	8	8
2002	115	94	24	30	16	16	8	8
2003	111	90	79	29	15	15	8	7
2004	96	78	70	25	13	13	7	6
2005	122	100	80	32	17	17	8	8
2006	86	70	76	23	12	12	6	6
2007	65	53	2	17	9	9	4	4
2008	59	48	1	15	8	8	4	4
2009	61	49	1	16	8	8	4	4
2010	54	44	1	14	8	8	4	4

Table A6 continued

Year	Euthynnus affinis	Elasmobranchii	Holothuroidea	Serranidae	Variola louti	Panulirus	Epinephelus tauvina	Lethrinus borbonicus	Others
1950	4	3	0	0	0	0	0	0	19
1951	5	3	0	0	0	0	0	0	24
1952	6	4	0	0	0	0	0	0	28
1953	7	4	0	0	0	0	0	0	32
1954	8	5	0	0	0	0	0	0	37
1955	9	6	0	0	0	0	0	0	41
1956	8	5	0	0	0	0	0	0	6
1957	8	5	0	0	0	0	0	0	7
1958	9	6	0	0	0	0	0	0	7
1959	10	6	0	0	0	0	0	0	8
1960	11	7	0	0	0	0	0	0	9
1961	11	7	0	0	0	0	0	0	9
1962	12	8	0	0	0	0	0	0	10
1963	13	8	0	0	0	0	0	0	10
1964	14	9	0	0	0	0	0	0	11
1965	18	11	0	0	0	0	0	0	85
1966	15	10	0	0	0	0	0	0	12
1967	16	10	0	0	0	0	0	0	13
1968	17	11	0	0	0	0	0	0	13
1969	17	11	0	0	0	0	0	0	14
1970	22	14	0	0	0	0	0	0	106
1971	23	15	0	0	0	0	0	0	111
1972	24	16	0	0	0	0	0	0	115
1973	25	16	0	0	0	0	0	0	119
1974	26	17	0	0	0	0	0	0	124
1975	27	17	0	0	0	0	0	0	128
1976	22	14	0	0	0	0	0	0	18
1977	23	15	0	0	0	0	0	0	19
1978	24	15	0	0	0	0	0	0	19
1979	25	16	0	0	0	0	0	0	20
1980	11	13	0	0	0	0	0	0	22
1981	40	10	0	0	0	0	0	0	21
1982	26	30	0	0	0	0	0	0	22
1983	25	12	0	0	0	0	0	0	16
1984	22	14	0	0	0	0	0	0	17
1985	32	20	0	0	0	0	0	0	151
1986	27	17	0	0	0	0	0	0	129
1987	23	15	0	0	0	0	0	0	112
1988	22	14	0	0	0	0	0	0	106
1989	29	19	0	0	0	0	0	0	139
1990	37	24	0	0	0	0	0	0	175
1991	19	12	0	0	0	0	0	0	92
1992	10	6	0	0	0	0	0	0	47
1993	19	12	0	0	0	0	0	0	89
1994	17	11	0	0	0	0	0	0	82
1995	13	8	0	0	0	0	0	0	10
1996	16	10	0	0	0	0	0	0	13
1997	19	12	0	0	0	0	0	0	15
1998	11	7	0	0	0	0	0	0	9
1999	5	3	0	0	0	0	0	0	4
2000	5	3	1	0	0	0	0	0	4
2001	7	5	17	0	0	0	0	0	6
2002	7	4	82	0	0	0	0	0	6
2003	7	4	21	0	0	3	0	0	5
2004	6	4	1	0	0	17	0	0	5
2005	7	5	1	0	0	33	0	0	6
2006	5	3	1	0	0	3	0	0	4
2007	4	3	0	25	21	1	11	0	3
2008	4	2	0	25	26	0	2	0	3
2009	4	2	0	28	19	1	3	3	3
2010	3	2	0	28	14	1	2	6	3

Appendix Table A7: Catch composition (in tonnes) of the Egyptian subsistence fishery in the Red Sea from 1950 to 2010.

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1950	774	664	364	310	270	170	170	136	0	39	0	11	0	4	324
1951	782	672	368	313	273	172	172	137	0	39	0	12	0	4	327
1952	791	679	372	317	276	174	174	139	0	39	0	12	0	4	331
1953	801	688	377	321	280	176	176	140	0	40	0	12	0	4	335
1954	811	697	382	325	283	178	178	142	0	40	0	12	0	4	339
1955	822	706	387	329	287	181	181	144	0	41	0	12	0	4	344
1956	834	716	392	334	291	183	183	146	0	42	0	12	0	4	349
1957	846	726	398	338	295	186	186	148	0	42	0	13	0	5	354
1958	858	736	403	343	299	188	188	150	0	43	0	13	0	5	359
1959	870	747	409	348	304	191	191	152	0	43	0	13	0	5	364
1960	871	748	410	349	304	191	191	153	41	43	0	13	0	5	369
1961	880	755	414	352	307	193	193	154	55	44	0	13	0	5	374
1962	894	768	421	358	312	196	196	157	47	45	0	13	0	5	379
1963	904	776	425	362	316	199	199	158	54	45	0	13	0	5	384
1964	912	783	429	365	318	200	200	160	69	45	0	14	0	5	389
1965	942	808	443	377	329	207	207	165	0	47	0	14	0	5	394
1966	926	795	435	371	323	203	203	162	101	46	0	14	0	5	398
1967	862	740	405	345	301	189	189	151	382	43	0	13	0	5	403
1968	900	772	423	360	314	198	198	158	276	45	0	13	0	5	407
1969	942	809	443	377	329	207	207	165	149	47	0	14	0	5	411
1970	990	850	466	396	346	217	217	173	0	49	0	15	0	5	414
1971	996	855	469	399	348	219	219	175	0	50	0	15	0	5	417
1972	1,002	860	471	401	350	220	220	176	0	50	0	15	0	5	419
1973	1,007	864	473	403	351	221	221	176	0	50	0	15	0	5	421
1974	1,011	868	476	405	353	222	222	177	0	50	0	15	0	5	423
1975	1,016	872	478	407	355	223	223	178	0	51	0	15	0	5	425
1976	1,015	871	477	406	354	223	223	178	20	51	0	15	0	5	427
1977	1,022	877	481	409	357	224	224	179	12	51	0	15	0	6	429
1978	1,025	880	482	410	358	225	225	180	20	51	0	15	0	6	431
1979	1,033	887	486	414	361	227	227	181	5	52	0	15	0	6	433
1980	1,034	888	486	414	361	227	227	181	23	52	0	15	0	6	435
1981	1,045	897	491	418	365	229	229	183	2	52	0	15	0	6	437
1982	1,041	894	490	417	363	229	229	182	35	52	0	15	0	6	439
1983	1,027	882	483	411	358	226	226	180	107	51	0	15	0	6	441
1984	1,054	905	496	422	368	232	232	185	11	53	0	16	0	6	442
1985	1,058	909	498	424	369	233	233	185	0	53	0	16	0	6	443
1986	1,060	910	498	424	370	233	233	186	0	53	0	16	0	6	443
1987	1,061	911	499	425	370	233	233	186	0	53	0	16	0	6	444
1988	1,061	911	499	425	370	233	233	186	0	53	0	16	0	6	444
1989	1,059	909	498	424	370	233	233	186	0	53	0	16	0	6	443
1990	1,055	906	496	422	368	232	232	185	0	53	0	16	0	6	441
1991	1,049	901	494	420	366	230	230	184	0	52	0	16	0	6	439
1992	1,041	894	490	417	363	229	229	182	0	52	0	15	0	6	435
1993	1,031	885	485	413	360	227	227	181	0	51	0	15	0	6	431
1994	1,021	876	480	408	356	224	224	179	0	51	0	15	0	6	427
1995	923	792	434	369	322	203	203	162	327	46	0	14	0	5	422
1996	998	857	469	399	348	219	219	175	0	50	0	15	0	5	417
1997	986	846	464	394	344	216	216	173	1	49	0	15	0	5	412
1998	964	827	453	386	336	212	212	169	36	48	0	14	0	5	407
1999	918	788	432	367	320	202	202	161	161	46	0	14	0	5	402
2000	833	715	392	334	291	183	183	146	426	42	0	12	4	4	396
2001	891	765	419	357	311	196	196	156	135	44	0	13	25	5	391
2002	778	668	366	311	271	171	171	136	122	39	0	12	415	4	385
2003	758	651	357	303	265	167	167	133	355	38	164	11	94	4	323
2004	746	640	351	299	260	164	164	131	168	37	628	11	3	4	121
2005	798	685	375	319	278	175	175	140	71	40	224	12	1	4	366
2006	777	667	365	311	271	171	171	136	65	39	249	12	1	4	360
2007	741	637	349	297	259	163	163	130	62	37	326	11	0	4	353
2008	787	676	370	315	275	173	173	138	49	39	101	12	2	4	346
2009	745	639	350	298	260	164	164	130	69	37	178	11	0	4	339
2010	735	631	346	294	256	161	161	129	63	37	153	11	0	4	331

1: Mugilidae; 2: Carangidae; 3: Sparidae; 4: Lutjanidae; 5: Penaeidae; 6: *Encrasicholina punctifer*; 7: *Sardinella* spp.; 8: Siganidae; 9: Brachyura;
10: *Sphyraena* spp.; 11: *Argyrops spinifer*; 12: Sepiidae; 13: Holothuroidea; 14: Sciaenidae; 15: Others

Appendix Table A8: Catch composition (in tonnes) of the Egyptian recreational fishery in the Red Sea from 1950 to 2010.

Year	Carangidae	Lutjanidae	Serranidae	Lethrinidae	Nemipteridae	Others
1950	0	0	0	0	0	0
1951	0	0	0	0	0	0
1952	0	0	0	0	0	0
1953	0	0	0	0	0	0
1954	0	0	0	0	0	0
1955	0	0	0	0	0	0
1956	0	0	0	0	0	0
1957	0	0	0	0	0	0
1958	0	0	0	0	0	0
1959	0	0	0	0	0	0
1960	0	0	0	0	0	0
1961	0	0	0	0	0	0
1962	0	0	0	0	0	0
1963	0	0	0	0	0	0
1964	0	0	0	0	0	0
1965	0	0	0	0	0	0
1966	0	0	0	0	0	0
1967	0	0	0	0	0	0
1968	3	3	3	2	2	2
1969	6	6	6	5	5	3
1970	10	10	10	7	7	5
1971	13	13	13	10	10	6
1972	16	16	16	12	12	8
1973	20	20	20	15	15	10
1974	23	23	23	17	17	12
1975	27	27	27	20	20	13
1976	30	30	30	23	23	15
1977	34	34	34	25	25	17
1978	38	38	38	28	28	19
1979	41	41	41	31	31	21
1980	45	45	45	34	34	23
1981	49	49	49	37	37	25
1982	53	53	53	40	40	27
1983	57	57	57	43	43	29
1984	61	61	61	46	46	31
1985	65	65	65	49	49	33
1986	70	70	70	52	52	35
1987	74	74	74	55	55	37
1988	78	78	78	59	59	39
1989	82	82	82	62	62	41
1990	86	86	86	65	65	43
1991	90	90	90	68	68	45
1992	94	94	94	71	71	47
1993	98	98	98	73	73	49
1994	102	102	102	76	76	51
1995	105	105	105	79	79	53
1996	109	109	109	81	81	54
1997	112	112	112	84	84	56
1998	115	115	115	87	87	58
1999	119	119	119	89	89	59
2000	122	122	122	92	92	61
2001	125	125	125	94	94	63
2002	129	129	129	96	96	64
2003	132	132	132	99	99	66
2004	146	146	146	109	109	73
2005	159	159	159	120	120	80
2006	173	173	173	130	130	87
2007	186	186	186	140	140	93
2008	200	200	200	150	150	100
2009	212	212	212	159	159	106
2010	225	225	225	169	169	112

Appendix Table A9: Composition of the total Egyptian fishery catch (in tonnes) in the Red Sea from 1950 to 2010.

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1950	682	0	8	414	292	190	296	0	359	774	178	311	118	368
1951	692	0	9	427	294	201	305	0	365	782	183	316	122	373
1952	702	0	9	438	296	212	313	0	372	791	188	322	125	379
1953	713	0	10	449	298	224	321	0	379	801	192	327	128	384
1954	725	0	11	459	300	235	328	0	386	811	197	333	131	390
1955	737	0	11	468	303	246	335	0	393	822	201	340	134	396
1956	739	0	6	238	305	128	170	0	367	834	102	318	68	401
1957	784	0	38	1,547	308	856	1,105	0	560	846	663	478	442	407
1958	799	0	41	1,631	310	926	1,165	0	583	858	699	497	466	413
1959	812	0	43	1,637	313	953	1,169	0	595	870	702	507	468	420
1960	795	0	23	853	2,629	508	609	0	480	871	365	413	244	421
1961	833	0	52	1,892	3,756	1,156	1,351	0	651	880	811	554	541	426
1962	893	0	97	3,483	7,616	2,180	2,488	0	922	894	1,493	778	995	434
1963	949	0	143	4,999	7,368	3,204	3,571	0	1,191	904	2,142	1,000	1,428	439
1964	1,293	395	479	6,443	2,524	4,227	4,602	0	1,459	912	2,761	1,221	1,841	444
1965	1,290	333	441	6,544	2,163	4,394	4,674	0	1,515	942	2,805	1,267	1,870	462
1966	1,257	413	428	4,040	2,634	2,776	2,886	0	1,089	926	1,732	916	1,154	452
1967	1,985	1,490	1,209	3,631	1,144	2,552	2,593	0	1,006	862	1,556	846	1,037	422
1968	2,351	1,951	1,537	3,238	1,448	2,328	2,313	0	966	900	1,388	811	925	441
1969	2,721	2,412	1,866	2,861	1,752	2,103	2,044	0	928	942	1,226	778	817	462
1970	3,105	2,872	2,194	2,500	2,058	1,879	1,786	0	892	990	1,072	747	714	490
1971	3,719	3,705	2,797	2,194	2,593	1,685	1,567	0	848	996	940	708	627	494
1972	3,535	3,400	2,603	3,001	2,399	2,356	2,144	0	1,027	1,002	1,286	853	857	497
1973	1,554	758	613	1,564	707	1,254	1,117	0	747	1,007	670	619	447	501
1974	4,017	4,080	3,066	1,870	2,837	1,532	1,336	0	825	1,011	801	680	534	504
1975	3,119	2,724	2,159	4,215	1,969	3,527	3,010	0	1,346	1,016	1,806	1,108	1,204	507
1976	4,993	5,291	4,040	4,013	3,613	3,429	2,867	0	1,324	1,015	1,720	1,087	1,147	502
1977	4,256	4,302	3,291	3,344	2,982	2,918	2,389	0	1,198	1,022	1,433	980	956	506
1978	4,106	4,101	3,134	3,021	2,853	2,690	2,158	0	1,144	1,025	1,295	932	863	508
1979	5,340	5,789	4,355	2,507	3,937	2,279	1,791	0	1,045	1,033	1,075	848	716	513
1980	3,975	3,907	2,987	2,847	2,731	2,465	2,033	0	1,217	1,034	1,220	1,012	813	516
1981	4,172	1,788	3,154	3,021	3,365	2,964	2,158	0	1,109	1,045	1,295	1,005	863	523
1982	5,153	2,579	4,154	2,388	3,560	2,399	1,706	0	1,100	1,041	1,023	717	682	511
1983	6,437	5,177	5,448	2,254	5,356	2,195	1,610	0	1,029	1,027	966	881	644	508
1984	7,856	7,169	6,841	1,874	1,452	1,065	1,339	3,171	1,083	1,054	803	1,204	536	519
1985	5,830	5,012	4,783	1,784	1,086	1,224	1,274	2,217	1,081	1,058	764	1,130	510	532
1986	4,906	4,021	3,864	2,378	917	2,661	1,699	1,779	1,041	1,060	1,019	968	679	528
1987	5,641	4,796	4,603	2,000	1,050	1,843	1,429	2,122	1,048	1,061	857	1,094	572	524
1988	6,819	6,058	5,780	1,718	1,264	1,023	1,227	2,680	1,333	1,061	736	1,108	491	523
1989	9,030	8,460	7,972	1,732	1,673	695	1,237	3,742	1,844	1,059	742	1,148	495	530
1990	9,136	8,568	8,060	1,426	1,690	424	1,018	3,790	1,585	1,055	611	1,186	407	536
1991	7,880	7,241	6,845	1,461	1,463	799	1,044	3,203	1,251	1,049	626	1,184	417	514
1992	7,840	7,278	6,830	1,853	1,468	1,242	1,324	3,219	1,509	1,041	794	1,144	529	500
1993	9,571	9,087	8,545	1,596	1,773	697	1,140	4,019	1,543	1,031	684	1,174	456	505
1994	6,044	5,240	5,027	1,312	1,116	538	937	2,318	1,220	1,021	562	1,011	375	499
1995	5,920	5,280	4,993	1,433	1,101	1,134	1,023	2,335	1,033	923	614	872	409	448
1996	5,240	4,457	4,238	1,357	978	1,172	969	1,971	993	998	581	921	388	487
1997	5,770	4,953	4,769	1,455	1,060	1,184	1,039	2,191	1,000	986	623	926	416	484
1998	4,982	4,162	4,015	1,182	920	992	844	1,841	925	964	507	692	338	465
1999	4,055	3,279	3,137	1,213	760	1,073	866	1,450	966	918	520	670	347	437
2000	6,351	5,804	5,501	1,078	1,171	902	770	2,567	915	833	462	672	308	398
2001	4,981	4,216	4,074	1,222	913	1,064	873	1,865	1,011	891	524	672	349	427
2002	5,336	4,721	4,524	1,442	975	1,481	1,030	2,088	1,013	778	618	586	412	373
2003	5,026	4,388	4,228	1,553	913	1,445	1,109	1,941	1,141	758	665	633	444	364
2004	5,239	4,728	4,439	1,423	969	1,352	1,017	2,091	1,092	746	610	925	407	357
2005	3,279	2,520	2,418	1,455	604	1,448	1,039	1,114	1,065	798	624	953	416	383
2006	3,418	2,541	2,566	1,239	603	1,256	885	1,124	896	777	531	633	354	371
2007	3,645	2,760	2,813	1,192	633	1,280	851	1,221	870	741	511	578	340	353
2008	4,230	3,316	3,347	1,284	737	1,426	917	1,467	951	787	550	657	367	374
2009	4,325	3,433	3,465	1,306	748	1,476	933	1,519	963	745	560	656	373	354
2010	3,971	3,079	3,107	1,150	686	1,324	821	1,362	925	735	493	612	329	349

1: Carangidae; 2: *Etrumeus sadina*; 3: *Decapterus* spp.; 4: *Leiognathus berbis*; 5: *Sardinella* spp.; 6: Synodontidae; 7: *Champsodon capensis*; 8: *Scomber japonicus*; 9: Lutjanidae; 10: Mugilidae; 11: *Equulites elongatus*; 12: Penaeidae; 13: *Pseudorhombus arsius*; 14: Sparidae

Table A9 continued

Year	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1950	79	0	32	67	55	15	170	39	39	0	136	22	28	20
1951	81	0	34	83	67	16	172	41	41	0	137	23	28	20
1952	83	0	36	98	80	17	174	42	42	0	139	24	29	21
1953	86	0	38	113	92	18	176	43	43	0	140	25	30	21
1954	87	0	40	128	104	19	178	44	44	0	142	26	31	22
1955	89	0	42	143	117	19	181	45	45	0	144	26	31	22
1956	45	0	22	127	104	10	183	23	23	118	146	20	16	11
1957	295	0	145	140	114	68	186	147	147	130	148	62	103	74
1958	311	0	157	152	124	73	188	155	155	141	150	66	109	78
1959	312	0	162	164	134	75	191	156	156	152	152	68	109	78
1960	162	0	86	176	144	40	191	81	81	204	153	42	57	41
1961	360	0	196	188	154	92	193	180	180	230	154	80	126	90
1962	663	0	370	201	164	173	196	332	332	233	157	140	232	166
1963	952	0	543	213	173	254	199	476	476	252	158	199	333	238
1964	1,227	93	717	225	183	335	211	614	614	278	160	259	430	307
1965	1,247	78	746	294	240	348	216	623	623	0	165	269	436	312
1966	770	97	471	249	203	220	214	385	385	332	162	175	269	192
1967	692	351	433	261	213	202	228	346	346	625	151	161	242	173
1968	617	460	397	274	225	184	249	308	308	530	158	148	216	154
1969	545	568	362	286	238	167	270	272	272	414	165	136	191	136
1970	476	677	326	369	308	149	293	238	238	0	173	124	167	119
1971	418	873	296	384	323	133	316	209	209	0	175	112	146	104
1972	572	801	412	400	338	187	309	286	286	0	176	151	200	143
1973	298	179	228	415	353	99	241	149	149	0	176	88	104	74
1974	356	961	277	430	368	121	329	178	178	0	177	104	125	89
1975	803	642	618	445	383	279	294	401	401	0	178	219	281	201
1976	764	1,247	605	371	325	271	361	382	382	364	178	214	268	191
1977	637	1,014	520	383	338	231	337	319	319	368	179	184	223	159
1978	575	966	485	395	351	213	332	288	288	387	180	171	201	144
1979	478	1,364	418	408	363	180	379	239	239	383	181	147	167	119
1980	542	921	555	406	342	171	329	271	271	437	181	152	190	136
1981	575	754	478	496	380	174	242	288	288	409	183	206	201	144
1982	455	925	400	399	496	288	255	227	227	451	182	141	159	114
1983	429	1,516	428	364	306	142	319	215	215	418	180	147	150	107
1984	357	457	388	358	338	108	232	179	179	343	185	242	125	89
1985	340	320	371	526	478	122	233	170	170	0	185	172	119	85
1986	453	256	329	448	418	183	233	226	226	0	186	148	159	113
1987	381	306	223	388	372	223	233	191	191	0	186	214	133	95
1988	327	386	204	367	358	348	233	164	164	0	186	134	115	82
1989	330	540	182	482	455	322	233	165	165	0	186	146	115	82
1990	272	546	135	609	562	288	232	136	136	0	185	172	95	68
1991	278	462	168	319	328	338	230	139	139	0	184	147	97	70
1992	353	464	222	165	205	598	229	176	176	0	182	193	124	88
1993	304	580	199	311	327	482	227	152	152	0	181	251	106	76
1994	250	334	206	284	308	374	224	125	125	0	179	292	87	62
1995	273	337	353	210	250	456	203	136	136	521	162	204	96	68
1996	258	284	317	266	298	395	219	129	129	247	175	180	90	65
1997	277	316	497	314	340	365	216	139	139	292	173	162	97	69
1998	225	265	549	175	230	277	212	113	113	198	169	119	79	56
1999	231	209	615	81	155	311	202	116	116	236	161	136	81	58
2000	205	370	424	90	165	320	183	103	103	508	146	160	72	51
2001	233	269	471	119	191	366	196	116	116	228	156	186	81	58
2002	275	301	595	115	190	469	171	137	137	146	136	226	96	69
2003	296	280	666	111	189	546	167	148	148	434	133	269	104	74
2004	271	302	605	96	187	458	164	136	136	239	131	314	95	68
2005	277	161	614	122	219	469	175	139	139	151	140	316	97	69
2006	236	162	564	86	200	446	171	118	118	141	136	224	83	59
2007	227	176	582	65	193	362	163	113	113	63	130	183	79	57
2008	245	211	641	59	197	349	173	122	122	49	138	194	86	61
2009	249	219	668	61	209	362	164	124	124	70	130	200	87	62
2010	219	196	625	54	213	324	161	110	110	64	129	180	77	55

15: *Charybdis hellerii*; 16: *Rastrelliger kanagurta*; 17: Nemipteridae; 18: *Epinephelus* spp.; 19: Lethrinidae; 20: Mullidae;
21: *Encrasicholina punctifer*; 22: *Clypeaster reticulatus*; 23: *Jacksonaster depressum*; 24: Brachyura; 25: Siganidae; 26: Sepiidae;
27: *Callyspongia monilata*; 28: *Pione vastifica*

Table A9 continued

Year	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
1950	18	0	39	9	0	5	4	0	3	4	0	0	0	0	760
1951	22	0	39	12	0	6	5	0	3	4	0	0	0	0	781
1952	26	0	39	14	0	7	6	0	4	4	0	0	0	0	802
1953	30	0	40	16	0	8	7	0	4	4	0	0	0	0	822
1954	33	0	40	18	0	9	8	0	5	4	0	0	0	0	842
1955	37	0	41	20	0	10	9	0	6	4	0	0	0	0	862
1956	33	0	42	18	0	9	8	0	5	4	0	0	0	0	603
1957	37	0	42	19	0	10	8	0	5	5	0	0	0	0	1,919
1958	40	0	43	21	0	10	9	0	6	5	0	0	0	0	2,014
1959	43	0	43	23	0	11	10	0	6	5	0	0	0	0	2,030
1960	46	0	43	25	0	12	11	0	7	5	0	0	0	0	1,450
1961	49	0	44	26	0	13	11	0	7	5	0	0	0	0	3,135
1962	53	0	45	28	0	14	12	0	8	5	0	0	0	0	4,660
1963	56	0	45	30	0	15	13	0	8	5	0	0	0	0	5,864
1964	59	0	49	31	0	15	14	0	9	5	0	0	0	0	7,038
1965	77	0	50	41	0	20	18	0	11	5	0	0	0	0	7,232
1966	65	0	50	35	0	17	15	0	10	5	0	0	0	0	4,621
1967	68	0	58	37	0	18	16	0	10	5	0	0	0	0	4,362
1968	72	3	65	38	0	19	17	0	11	5	0	0	0	0	4,036
1969	75	6	71	40	0	20	17	0	11	5	0	0	0	0	3,724
1970	97	10	78	52	0	25	22	0	14	5	0	0	0	0	3,517
1971	101	13	87	54	0	26	23	0	15	5	0	0	0	0	3,326
1972	105	16	84	56	0	27	24	0	16	5	0	0	0	0	4,147
1973	109	20	58	58	0	29	25	0	16	5	0	0	0	0	2,298
1974	113	23	91	60	0	30	26	0	17	5	0	0	0	0	3,083
1975	116	27	78	62	0	31	27	0	17	5	0	0	0	0	5,398
1976	97	30	104	52	0	26	22	0	14	5	0	0	0	0	5,440
1977	100	34	94	54	0	26	23	0	15	6	0	0	0	0	4,612
1978	104	38	92	55	0	27	24	0	15	6	0	0	0	0	4,256
1979	107	41	110	57	0	28	25	0	16	6	0	0	0	0	3,948
1980	131	45	91	61	0	29	11	0	13	6	0	0	0	0	4,076
1981	100	49	63	57	0	24	40	0	10	6	0	0	0	0	3,960
1982	101	53	68	63	0	22	26	0	30	6	0	0	0	0	3,765
1983	100	57	98	50	0	36	25	0	12	6	0	0	0	0	3,620
1984	94	61	53	50	0	25	22	0	14	6	0	0	0	0	3,624
1985	138	65	53	73	0	36	32	0	20	6	0	0	0	0	3,343
1986	117	70	53	63	0	31	27	0	17	6	0	0	0	0	3,836
1987	102	74	53	54	0	27	23	0	15	6	0	0	0	0	3,531
1988	96	78	53	51	0	25	22	0	14	6	0	0	0	0	3,413
1989	126	82	53	67	0	33	29	0	19	6	0	0	0	0	3,833
1990	160	86	53	85	0	42	37	0	24	6	0	0	0	0	3,550
1991	83	90	52	44	0	22	19	0	12	6	0	0	0	0	3,312
1992	43	94	52	23	0	11	10	0	6	6	0	0	0	0	3,722
1993	81	98	51	43	0	21	19	0	12	6	0	0	0	0	3,752
1994	74	102	51	40	0	20	17	0	11	6	0	0	0	0	2,844
1995	55	105	46	29	0	14	13	0	8	5	0	0	0	0	2,921
1996	70	109	50	37	0	18	16	0	10	5	0	0	0	0	2,716
1997	82	112	49	44	0	22	19	0	12	5	0	0	0	0	2,910
1998	46	115	48	24	0	12	11	0	7	5	0	0	0	0	2,471
1999	21	119	46	11	0	6	5	0	3	5	0	0	0	0	2,372
2000	24	122	42	13	0	6	5	5	3	4	0	0	0	0	2,598
2001	31	125	44	17	0	8	7	43	5	5	0	0	0	0	2,531
2002	30	129	39	16	0	8	7	497	4	4	0	0	0	0	2,869
2003	29	132	38	15	164	8	7	114	4	4	0	3	0	0	2,897
2004	25	146	37	13	628	7	6	4	4	4	0	17	0	0	2,508
2005	32	159	40	17	224	8	7	2	5	4	0	33	0	0	2,515
2006	23	173	39	12	249	6	5	3	3	4	0	3	0	0	2,324
2007	17	212	37	9	326	4	4	0	3	4	21	1	11	0	2,305
2008	15	224	39	8	101	4	4	2	2	4	26	0	2	0	2,508
2009	16	241	37	8	178	4	4	0	2	4	19	1	3	3	2,559
2010	14	253	37	8	153	4	3	0	2	4	14	1	2	6	2,321

29: *Lethrinus mahsena*; 30: Serranidae; 31: *Sphyraena spp.*; 32: Scaridae; 33: *Argyrops spinifer*; 34: *Scomberomorus commerson*; 35: *Euthynnus affinis*; 36: Holothuroidea; 37: Elasmobranchii; 38: Sciaenidae; 39: *Variola louti*; 40: Panulirus; 41: *Epinephelus tauvina*; 42: *Lethrinus borbonicus*; 43: Others