Catch reconstruction of the fisheries of Saudi Arabia in the Gulf, 1950-2010[1]

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Abstract

The catch of Saudi Arabia in the Gulf is reconstructed from 1950–2010 by examining local records, Food and Agriculture Organization of the United Nations (FAO) data and general knowledge of the fisheries. The fishery was divided into sectors, the major ones being artisanal and industrial. In addition, subsistence, recreational and discards of the industrial trawl fishery, which are excluded from official report, were explicitly included. A previous catch reconstruction of Saudi Arabia's Red Sea fishery was used as a reference to calculate the catches of the sectors in the Gulf. The catches in each sector were further disaggregated to their taxonomic composition. The results showed that from 1950 – 2010, the total reconstructed catch (Red Sea and the Gulf) was 2.1 times what Saudi Arabia reports to FAO (2.4 times for the Gulf only). The artisanal fishery is by far the most important in the Gulf, contributing 51% of total catch and 77% when only the retained catch is considered. The industrial fishery is second in its contribution to total catch, followed by the subsistence and recreational fisheries. Most of the taxa caught are demersal fishes, reflecting the nature of the ecosystem, which is generally shallow, covered by sea grass beds, and sandy and muddy bottoms.

Introduction

The 'Gulf' (to avoid having to choose between Arabian and Persian Gulf) is a semi-enclosed and generally shallow sea with an average depth of 35 m and a maximum of 100 m in its southeastern part, near the Strait of Hormuz. It has high salinity due to high evaporation, low rainfall and limited water exchange with the adjacent Arabian Sea. Water temperature can reach up to 40°C in the summer and 20°C in winter. The shallow inshore areas are generally covered by sea grass beds, which act as nursery ground for many fish species. There is no well-developed coral reef system in the Gulf as compared to the Red Sea, but it still has a multitude of reef fishes (see Randall *et al.* 1978; Carpenter *et al.* 1997; and see www.fishbase.org). Most of the deeper sea floor is covered with coarse gravel, fine clay or mud, which makes it suitable for trawling, with shrimp being the most sought-after resource (Sheppard *et al.* 1992; Sakurai 1998). Unlike the Red Sea, where shrimp are targeted only by the industrial sector, they are targeted in the Gulf by both the artisanal and industrial sectors.

Saudi Arabia has a longer coastline in the Red Sea than in the Gulf (Figure 1). Nevertheless, as will be shown below, its fish catch has been higher in the Gulf than in the Red Sea in the last decades. Most of the Saudi fisheries in the Gulf are artisanal, at times accounting for more than 95% of the total catch. These artisanal fisheries were non-motorized until 1960. Although motorization started in early 1960s, it accelerated later, and was essentially completed in the late 1980s (Sakurai 1998). The major gears
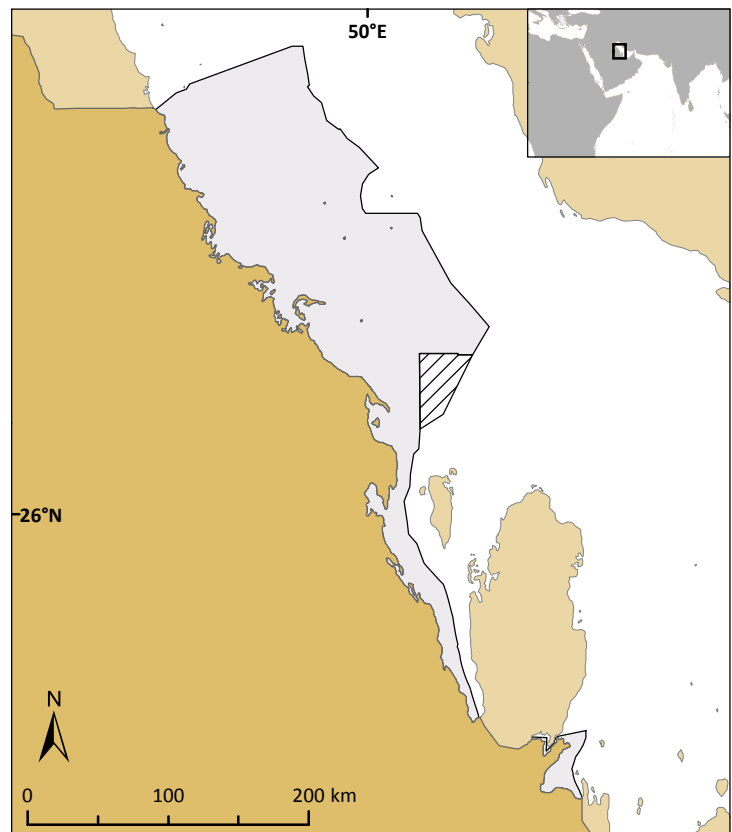

Figure 1. Map of Saudi Arabia, showing the extent of its EEZ (light grey area).

used by the Saudi artisanal sector in the Gulf are traps, which can generate for up to 50% of the catch. The main targets include emperors (family Lethrinidae), groupers (Serranidae), scads (Carangidae), snappers (Lutjanidae), seabreams (Sparidae) and rabbitfish (Siganidae). Other gears include gill net for pelagic species such as kingfish (*Scomberomorus* spp.) and tunas (Scombridae), and to a lesser extent handlines, longlines, trawling and trolling, with each accounting less than 5% of the total catch (DMF 2000). A single artisanal trip in the Gulf takes 5-6 days on the average, in contrast to the Red Sea, where it is usually a single day (Sakurai 1998).

Industrial fishing started along the Saudi coast of the Gulf in the early 1960s. Al-Gosaiby Fishing Company was the first industrial fishing venture that was given permit to fish and export its catch. In the 1960s and 1970s, foreign vessels from the ex-USSR and Australia were also operating in the Gulf under license from Saudi Arabia. The shrimp catch peaked in the later part of the 1970s, then declined drastically. In the mid-1990s, the Saudi government initiated a policy to reduce fishing effort and the number of industrial fishery vessels decreased, as did their contribution to the total catch (Sakurai 1998; Anon. 2011).

Recreational fishing (i.e., fishing for pleasure) has become common in Saudi Arabia since the oil-fuelled economic boom. It is usually done on the weekends (Thursday and Friday) using handlines. The fishery is not regulated except that nets of any kind may not be used. The catch can exceed 1,000 t per year, but it is not reported, although it is large enough to warrant complaints, mainly from artisanal fishers who disapprove of the lack of regulations for what they perceive as competition (Sakurai 1998).

MATERIALS AND METHODS

This reconstruction of the fishery catches of Saudi Arabia in the Gulf was based on local reports, the detailed catch reconstruction of Saudi Arabia's Red Sea fisheries, and on data reported to the Food and Agriculture Organization (FAO) of the United Nations (here referred to as 'FAO data'). The following steps were then carried out to perform the catch reconstruction:

1. Splitting the FAO data into Red Sea and Gulf catches;

2. Splitting the FAO data into artisanal and industrial catches;

3. Adjusting the artisanal and industrial catches in the Gulf for misreporting;

4. Estimating the taxonomic composition of the reconstructed catch, by sector;

5. Adding the catch of fisheries that were not accounted for in the official reports.

Step 1: *Splitting the FAO data into Red Sea and Gulf catches*

Saudi Arabia, as do other member countries, reports its annual total fishery catches to the FAO. For many countries with more than one coast, the total catch is split between the broad statistical areas which FAO uses to allocate catches geographically. Unfortunately, in the case of Saudi Arabia, both coasts fall in the same statistical area, the 'Western Indian Ocean', and thus we had to do the splitting ourselves. As shown in Table 1, an initial split was done based on Saudi Arabian statistical data reports available to us (for recent years), other literature (for earlier years), interpolations (for the years without any information), and backward extrapolation with adjustments (for the earliest years). Please note that this was only an inital split which gave the division of the total catch by coast. In latter steps the species breakdown information had to be taken into account which caused the proportions to change slightly and therefore this first split is not necessarily representative of the final data. However, this initial split is important for determining the misreporting ratio. The earliest available Red Sea-to-Gulf ratio was for 1979 (Barrania *et al.* 1980), followed by 1987-1998 (Sakurai 1998; DMF 2000) and 2000 (FAO 2003). For 2002, the Regional Commission for Fisheries (RECOFI 2009), which is active in the Gulf, reported the Gulf catch of Saudi Arabia, which in turn was used to calculate the percentage for the Red Sea. In more recent years, Saudi Arabia published annual fishery statistical reports, separate for each coast, which we relied on for 2004-2007 (DMF 2008). The latest year with data disaggregated between the two coasts was 2009, where statistical data were presented separately for the artisanal and industrial sectors in the Red Sea and the artisanal sector in the Gulf (Anon. 2011). The industrial catch in the Gulf was calculated using the ratio for the two sectors in 2007, where the industrial catch was 0.38% of the artisanal catch.

For years where data were not available, they were estimated using different methods. For 1950-1960 and 1975-1978, the earliest available data (for 1979) were used. Using the 1979 Red Sea-Gulf ratio for 1961-1974 resulted in unreasonably high Red Sea catches, thus a different approach was used for this period. The closest period with data that separate the Red Sea and Gulf catches was for 1987-1994. Thus, an average ratio was calculated for the total reconstructed Red Sea catch without the industrial discard to the FAO catch of Red Sea from 1987-1994 (note that discarded catches are not reported to FAO at all). The result, that FAO Red Sea data were on average 92% of the reconstructed catch, was used to calculate the FAO Red Sea catch for 1961-1974. Then, the FAO Gulf catch was obtained by subtracting the Red Sea amount from the total Saudi catch in the FAO database. The same ratio was also

used for the period 1980-1986. Although there were ratios available for 1995-1996, they resulted in the FAO Red Sea catch being slightly higher than the reconstructed catch, which is unrealistic given the pattern for the other years. Thus, the reconstructed catch without industrial discard, was assumed to be equal to the FAO Red Sea catch. For 1999, 2001, 2003, 2008 and 2010, the ratios were interpolated linearly from the neighbouring years (Table 1).

Step 2: Splitting the FAO data into artisanal and industrial catches

Once the data Saudi Arabia submitted to FAO were divided into the Red Sea and the Gulf, the next step was to divide the Red Sea FAO data into artisanal and industrial sectors (by total only; adjustments by taxa will be done further along). This was done using the ratio of the sectors in the reconstructed catch for the Red Sea. Here, of course, the industrial discards were not considered, as they were excluded from the official reports (Tesfamichael and Rossing 2012).

Similar to the Red Sea, the Gulf FAO data, calculated in the previous step, were divided into artisanal and industrial sectors. From 1950-1961, all catches were allocated to artisanal because industrial fishing did not start until 1962 (Sakurai 1998). Data that divided the Gulf catch into artisanal and industrial were available for some years: 1987-1998 (DMF 2000), 2000 (FAO 2003), 2004-2007 (DMF 2008) and 2009 (Anon. 2011). For 2009, only artisanal catches in the Gulf were reported, because the industrial fishery was very small in the Gulf in recent years (DMF 2008). Nevertheless, the industrial catch was calculated using the ratio for 2007. Interpolations that assumed linear change were applied for 1999, 2001-2003, 2008 and 2010. For the earlier years of the Gulf catch, 1962-1986, there were no ratios available to split the catch into the two sectors. However, shrimp catches, which are the major target of the industrial sector, were available from 1962-2007 (Sakurai 1998; DMF 2008). Thus the shrimp catch was used to calculate the industrial catch. From 1962-1978, the shrimp catch was assumed to account for 90% of the reported catch, excluding discard. This was the period when a lot of emphasis was given to shrimp trawling and many new fishing grounds explored. The shrimp catch peaked in the late 1970s and declined thereafter due to instability in the region, which resulted in reduced fishing effort (Sakurai 1998). Thus, for the period 1979-1986, the shrimp catch was assumed to account for 50% of the industrial catch. This is a realistic assumption as the shrimp catch declined abruptly in 1979 and in the closest year available, 1987, shrimp accounted for 47%. The catch of the artisanal fishery in the FAO data from 1962-1986 was calculated by deducting the industrial catch from the total catch for the Gulf calculated in step 1 (Table 2).

Table 1. Percentages used in the initial division of the catch Saudi Arabia reported to FAO into the Red Sea and the Gulf.

Year	Red Sea	Gulf	Source/Remarks
1950-60	52.7	47.2	1979 values
1961	39.0	61.0	See footnote [a]
1962	35.2	64.7	See footnote [a]
1963	33.6	66.4	See footnote [a]
1964	35.8	64.2	See footnote [a]
1965	39.4	60.6	See footnote [a]
1966	38.7	61.3	See footnote [a]
1967	38.1	61.9	See footnote [a]
1968	43.7	56.3	See footnote [a]
1969	47.2	52.8	See footnote [a]
1970	47.8	52.2	See footnote [a]
1971	46.5	53.4	See footnote [a]
1972	44.8	55.2	See footnote [a]
1973	41.4	58.6	See footnote [a]
1974	47.5	52.5	See footnote [a]
1975-78	52.7	47.3	1979 values
1979	52.7	47.3	Barrania *et al*. (1980)
1980	48.1	51.9	See footnote [a]
1981	46.0	54.0	See footnote [a]
1982	44.7	55.3	See footnote [a]
1983	40.1	59.9	See footnote [a]
1984	40.6	59.4	See footnote [a]
1985	51.4	48.6	See footnote [a]
1986	52.7	47.3	See footnote [a]
1987	66.0	33.9	Sakurai (1998), DMF (2000)
1988	67.9	32.1	Sakurai (1998), DMF (2000)
1989	68.5	31.5	Sakurai (1998), DMF (2000)
1990	72.3	27.7	Sakurai (1998), DMF (2000)
1991	74.6	25.4	Sakurai (1998), DMF (2000)
1992	68.1	31.9	Sakurai (1998), DMF (2000)
1993	69.2	30.8	Sakurai (1998), DMF (2000)
1994	62.5	37.5	Sakurai (1998), DMF (2000)
1995	53.7	46.2	Sakurai (1998), DMF (2000)
1996	50.8	49.2	Sakurai (1998), DMF (2000)
1997	53.1	46.9	Sakurai (1998), DMF (2000)
1998	48.9	51.1	Sakurai (1998), DMF (2000)
1999	47.4	52.6	Interpolated
2000	45.7	54.3	FAO (2003)
2001	43.6	56.4	Interpolated
2002	41.9	58.1	RECOFI (2009)
2003	39.4	60.6	Interpolated
2004	36.8	63.1	DMF (2008)
2005	38.6	61.4	DMF (2008)
2006	35.8	64.2	DMF (2008)
2007	40.0	60.0	DMF (2008)
2008	40.1	59.9	Interpolated
2009	40.2	59.8	Anon. (2011)
2010	40.3	59.7	Interpolated

[a] FAO Red Sea catch assumed to be 92% of reconstructed catch.

Step 3: Adjusting the artisanal and industrial catch in the Gulf for misreporting

Splitting the reconstructed and FAO data into artisanal and industrial catches for the Red Sea allowed us to calculate the ratio of reconstructed catch to FAO data, which reflected the amount of misreporting in the Red Sea. This resulted in the reconstructed artisanal fishery being equivalent to 1.13 times the FAO reported catch; the corresponding value for the industrial was 1.10 times. Assuming that the same ratios apply in the Gulf as well (because the fisheries operate in similar fashion, as does their governance) allowed adjusting the artisanal and industrial catch to 113 % and 110 % of the values obtained in Step 2, respectively.

Step 4: *Estimating the taxonomic composition of the reconstructed catch, by sector*

The product of Step 3 is the total reconstructed catch of Saudi Arabia's fishery in the Gulf, separately for the artisanal and industrial fisheries. However, the taxonomic composition of these catches must also be considered. Catch composition data for the artisanal fishery in the Gulf were available for 2004-2007 (DMF 2008) and the mean of these four years was used to disaggregate the catches for the other years. The catch composition of the industrial was calculated by first deducting the reconstructed shrimp catch, which was available for the whole period, from the reconstructed industrial catch. The composition of the remaining (non-shrimp) catch was calculated using the catch composition of the total Gulf catch and qualitative information on the composition of industrial catch given in DMF (2000), which states that the main catch of the industrial fishery after shrimp were emperors, scads/jacks/trevallies, barracuda and crabs, with sea catfish, rabbitfish and cuttlefish also being caught. For emperors and scads/jacks/trevallies, the percentages given were 15.5% and 7.3%, respectively. A contribution of 5% was assumed for barracuda, 3% for crabs, with 2% each for the less important taxa catfish, rabbitfish and cuttlefishes, i.e., ratios similar to those of the industrial catch of the Saudi industrial fishery in the Red Sea. These percentages were then scaled up to 100%. A total of 10% was allocated to 'miscellaneous species', which was further disaggregated based on the detailed catch composition data of Saudi Arabia's industrial fishery in the Red Sea (Tesfamichael and Rossing 2012). For the later years, 2004-2007 (when the industrial catch was very low), catch composition data were available (DMF 2008) and for 2008-2010, the average of 2004-2007 was used.

The data Saudi Arabia reported to FAO are divided into more taxa (127) than the reconstructed catch, which is strange given that we used the Saudi official national and technical reports for our catch reconstruction. The large number of taxa started in 2000 when the country introduced an extensive data recording and reporting system. Most of the taxa that were included starting in 2000 have very low catch amounts and they were aggregated as 'miscellaneous' in the national reports we used. To make full use of the additional information on catch composition in the FAO data, it was used to further disaggregate the reconstructed catch composition. First the distribution of the taxa were verified using FishBase (www.fishbase.org) to check if each taxon was to be included in both the Red Sea and the Gulf or only in one of these bodies of water. Then, for the taxa included in the FAO data, but not in the reconstruction, the ratios of the taxa in the FAO data were used to disaggregate the catch composition of the reconstructed data. For example, in the reconstructed catch, there was only one taxon item for groupers (Serranidae), but in the FAO data there were 18 taxon items for groupers, mainly species, but also including Serranidae. Overall, the "Serranidae" of the reconstructed Gulf catch was disaggregated into 17 groups using their ratios in the FAO data.

The final reporting baseline was determined by applying the Red Sea-to-Gulf proportion of each species in the total reconstructed catch to the corresponding category in the FAO data.

Step 5: *Adding the catch of fisheries that were not accounted for in the official reports.*

Saudi Arabia produces statistical reports of its catch and submits the data to FAO. There are fisheries, however, which are not included in any kind of reporting. Three categories of fisheries are identified in this section: subsistence, recreational and discards of the industrial trawl fishery. The subsistence catch is fish consumed by the fishing crew and fish freely given by artisanal fishers to family and friends according to tradition

Table 2. Percentages used in the initial division of the catch Saudi Arabia reported to FAO for the Gulf into artisanal and industrial fisheries.

Year	Artisanal	Industrial	Source/Remarks
1950-61	100.0	0.0	Industrial fishery started in 1962
1962	99.7	0.3	See footnote [a]
1963	97.5	2.5	See footnote [a]
1964	96.1	3.9	See footnote [a]
1965	81.5	18.5	See footnote [a]
1966	77.0	23.0	See footnote [a]
1967	48.0	52.0	See footnote [a]
1968	39.1	60.9	See footnote [a]
1969	37.9	62.1	See footnote [a]
1970	40.6	59.4	See footnote [a]
1971	50.2	49.8	See footnote [a]
1972	45.9	54.0	See footnote [a]
1973	46.9	53.0	See footnote [a]
1974	59.3	40.7	See footnote [a]
1975	51.8	48.2	See footnote [a]
1976	50.5	49.5	See footnote [a]
1977	47.9	52.0	See footnote [a]
1978	72.4	27.6	See footnote [a]
1979	90.8	9.2	See footnote [b]
1980	96.8	3.2	See footnote [b]
1981	92.3	7.7	See footnote [b]
1982	74.6	25.4	See footnote [b]
1983	78.0	22.0	See footnote [b]
1984	76.5	23.5	See footnote [b]
1985	71.3	28.7	See footnote [b]
1986	71.7	28.3	See footnote [b]
1987	77.0	23.0	DMF (2000)
1988	74.7	25.3	DMF (2000)
1989	76.2	23.8	DMF (2000)
1990	75.8	24.2	DMF (2000)
1991	78.0	22.0	DMF (2000)
1992	84.1	15.8	DMF (2000)
1993	84.3	15.7	DMF (2000)
1994	88.5	11.5	DMF (2000)
1995	95.3	4.7	DMF (2000)
1996	91.1	8.9	DMF (2000)
1997	92.2	7.7	DMF (2000)
1998	93.8	6.2	DMF (2000)
1999	96.0	3.9	Interpolated
2000	98.3	1.7	FAO (2003)
2001	98.7	1.3	Interpolated
2002	99.0	1.0	Interpolated
2003	99.4	0.6	Interpolated
2004	99.8	0.2	DMF (2008)
2005	99.7	0.3	DMF (2008)
2006	99.8	0.2	DMF (2008)
2007	99.6	0.4	DMF (2008)
2008	99.6	0.4	Interpolated
2009	99.6	0.4	Anon. (2011)
2010	99.6	0.4	Interpolated

[a] Shrimp assumed to be 90% of industrial catch.
[b] Shrimp assumed to be 50% of industrial catch.

in the region. This catch can be substantial, up to 50% of the catch of the artisanal fisheries based on interviews with fishers in the region (Tesfamichael *et al.* in press), and it does not appear in any fishery data recording system. The fish is either consumed or given before it can be recorded. The subsistence fishery catch was estimated based on the artisanal fishery catch. Similar to the Red Sea, subsistence catch was assumed to be 30% of artisanal catch until 1963, when motorization started to have effect on the fishery. For the later years, 20% was allocated to 1964 and 10% to 2010, and the percentage was linearly interpolated between 1965-2009. Before these percentages were applied, some taxa which are not usually given
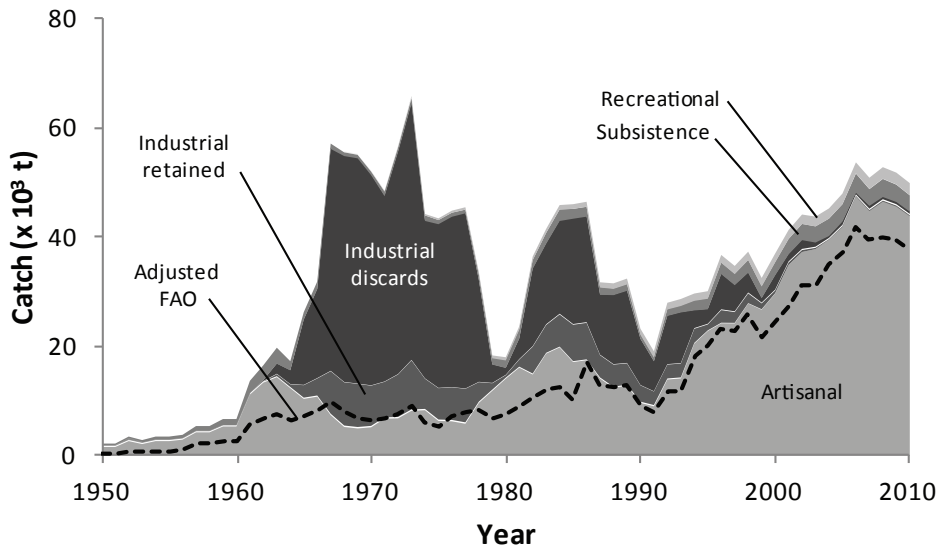
Figure 2. Total reconstructed catch for Saudi Arabia by sector, 1950-2010.

freely, were eliminated. These included taxa usually intended for export market, i.e., sharks fished for their fins and many invertebrates such as shrimp, crab and lobster. Traditionally, most of these taxa were not consumed locally and their consumption was introduced by foreign (mainly European) visitors to the region. However, nowadays, these non-traditional species are consumed by people mainly in the affluent larger urban centers and are not usually given freely to family and friends. Interestingly, the local names of most of these taxa are based on European names, rather than Arabic, as is the case for most of the fish species (Tesfamichael and Awadh 2012).

The other sector not included in official reporting is the recreational fishery, which started with the oil boom, when Saudi citizens started fishing for pleasure. Although recreational fishing occurs in Saudi Arabia's Gulf waters, the only data available were for 1996, when it was reported that there were 2,528 boats involved in the recreational fishery in the Gulf, while in the Red Sea there were 2,446 (Sakurai 1998). Thus, the recreational fishery and its composition for the Gulf were calculated using the ratio of boats for 1996 and the reconstructed recreational fishery of the Red Sea (Tesfamichael and Rossing 2012).

Finally, the discards of the industrial trawl fishery are not reported. The level of discarding in the Gulf was calculated using the total shrimp catch in the Gulf and the ratio of total discard to shrimp catch for the Red Sea, which was 5.8 (Tesfamichael and Rossing 2012). The composition of the discarded catch was also calculated based on the Red Sea data. The artisanal fishery targets a wide range of taxa, including shrimp, and almost every species caught is kept (unlike the industrial fishery); hence, discarding in the artisanal sector is negligible.

RESULTS AND DISCUSSION

From 1950 – 2010, the total reconstructed catch for the Gulf is 2.4 times what was assumed to be reported to FAO for that area (Figure 2; Appendix Table A1). The highest annual total catch was achieved in 1973, with most of the catch being industrial discards. The total catch (minus discards) exhibited a generally increasing trend, with a slight decreasing period in the 1980s. The major continuous increase of retained catch occurred after 1991, until it levelled off (after 2005). Throughout this period (1950-2010), the artisanal fishery had the lion's share of total catch (51%). The difference between reconstructed and reported catch
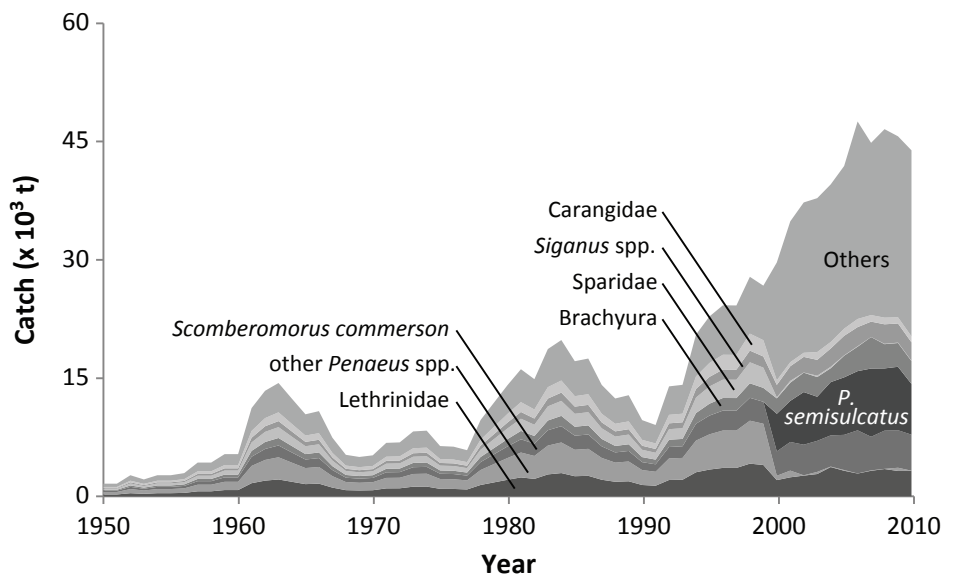
Figure 3. Composition of the dominant taxa in the Saudi artisanal fishery in the Gulf. Note that the group 'Others' is partially disaggregated in Appendix Table A2.

is higher for years with large industrial discards, i.e., in 1964-1978 and 1981-1989. During these periods the relative contribution of the industrial trawl fishery was high and its discards, which are much larger than the retained catch and not reported to FAO at all, meant that total reconstructed catch was much higher than the FAO data. Nevertheless, even for the years where the industrial catch is not high, e.g., 2000-2010, the reconstructed catch remains greater than the FAO data. Of all the sectors, the recreational fishery was the smallest contributor to the total reconstructed catch at 2.4%. The contribution of discarded catch to total catch at 33% is second to the artisanal sector. The retained industrial catch (discards

Figure 4. Dominant taxa in the retained catch of the Saudi industrial trawl fishery in the Gulf. Note 'Others' is partially disaggregated in Appendix Table A3.

excluded) at 8% is the third largest contributor to total catch, and subsistence is fourth at 5%. It is worth noting the definition used for subsistence fishery in this study is the catch amount given to family and friends for free. In other classifications, the total artisanal fishery may be categorized as subsistence, but according to the Saudi fisheries administration that is not classified as such. We also followed the classification of the country while the subsistence fishery is clearly accounted.

The total artisanal fishery catch in the Gulf was quite low until 1960, when motorization started and the catch increased (Figure 3). The second increase happened in the 1980s when the momentum of motorization was high; by then almost all the artisanal boats were motorized (Sakurai 1998); however, the catch declined in the mid-1980s due to political instability in the Gulf area. The drastic increase in total catch started the beginning of the 1990s until it levelled off (from 2005 on). The dominant species in artisanal fishery are demersal, reflecting the shallow nature of the sea and the major gear used (traps). Trawl also contributed to the demersal catch, even though it is not the dominant gear. There is limited use of gillnet for pelagic species. As the Gulf does not support extensive coral reef ecosystems, coral reef fishes are not as important as in the Red Sea. Still, the total number of taxa in the catch of the Saudi Gulf artisanal fishery is very high (> 100), with most of them contributing very little to the total catch. Only 8 taxa are dominant, contributing more than 5% each to the total catch (Figure 3); the rest are pooled together as 'Others' to simplify the graphic presentation of the composition. A full catch composition, listing all taxa, is given in Appendix Table A2.

Since its introduction in 1962, the trawl fishery saw a rapid increase in its catch (Figure 4). The main decline towards the end of the 1970s was due to the Iraq-Iran war, as most of the foreign trawlers operating under license from Saudi Arabia left (Sakurai 1998). In 1981, Saudi Arabia started its own industrial fishery in the Gulf, which increased the catch in the mid-1980s. However, the catch quickly declined because the government introduced a policy to reduce trawl fishing effort by reducing the number of vessels allowed to operate in the Gulf (Anon. 2011). After 2005, the catch became negligible. The main target of the industrial trawl fishery is shrimp, which accounted for 71% of the total
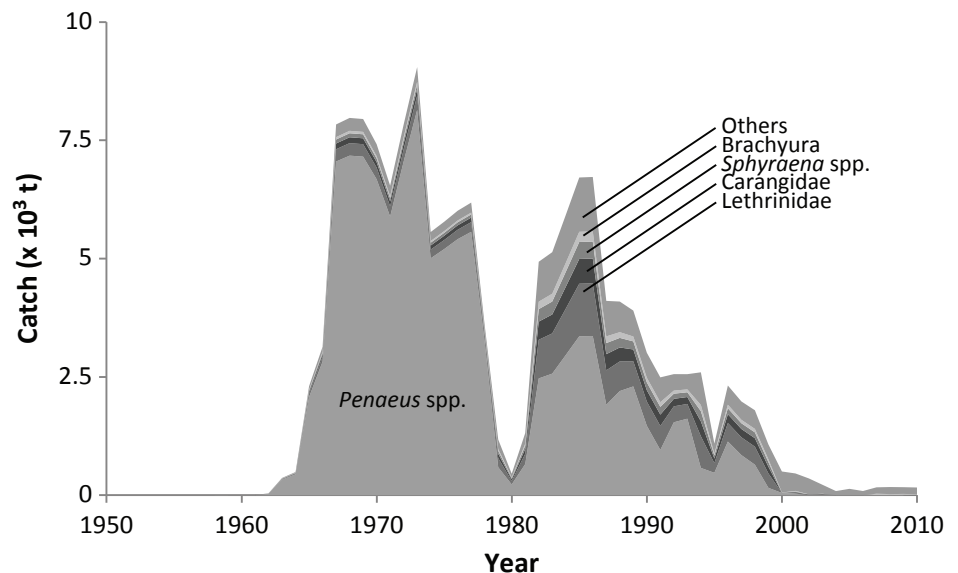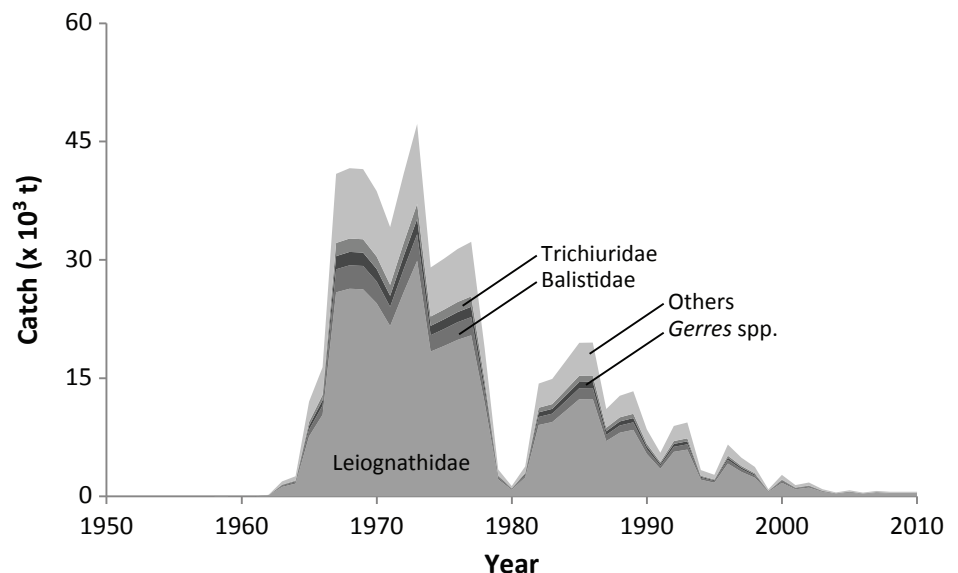
Figure 5. Composition of the discarded catch of the industrial trawl fishery of Saudi Arabia in the Gulf. Note 'Others' is disaggregated in Appendix Table A4.

retained catch (Figure 4). The discarded catch of the industrial trawl fishery is, however, more than four times what is retained (Figure 5). Besides shrimp, other taxa that have economic value are retained in the fishery. The second most retained taxa by the industrial trawl fishery are emperors (Lethrinidae), which account for only 9%. Other important retained taxa include jacks (Carangidae, 4%), barracudas (*Sphyraena*, 3%) and crabs (*Brachyura*, 2%). Other taxa are also retained, but their contribution is minor (Appendix Table A3). The discarded trawl fishery catch follows the same pattern as the retained one, because the former is calculated as a ratio of the latter. The discarded catch is dominated by

Figure 6. Catch composition of the subsistence fishery of Saudi Arabia in the Gulf. Note 'Others' is partially disaggregated in Appendix A5.

ponyfish (Leiognathidae), which accounts for 63%, followed by triggerfish (Balistidae) with a contribution of 7%. The detailed list of discarded taxa is given in Appendix Table A4.

The subsistence fishery follows a pattern similar to the artisanal fishery because it was obtained as a ratio of the latter (Figure 6; Appendix Table A5). The peaks in the mid-1960s and 1980s are more accentuated in the subsistence than the artisanal fishery (Figure 3). This reflects the fact that the fishery is becoming more commercialized with time; hence a higher ratio was used to calculate the subsistence fishery in the earlier years. The taxonomic composition of the subsistence catch is similar to that of the artisanal fishery, except the taxa that are targeted for export (such as shrimp) are excluded from the subsistence fishery. Except for the periods where there were declines in total catch for all the fisheries due to instability in the region, the subsistence fishery shows small changes in its catch, as is common for such fisheries (Béné *et al.* 2007). They are a source of food for the local communities and their levels, contrary to the case of the other fisheries, do not fluctuate much in response to external factors, such as market fluctuations.

The recreational fishery of Saudi Gulf has the least contribution to the total catch (Figure 3); and is also the youngest fishery (Figure 7; Appendix Table A6). This fishery is not regulated at all, except that fishers are not allowed to use any gear besides handlining; its catch is not recorded at all.

Overall, this catch reconstruction of Saudi Arabia in the Gulf provides insights into the fisheries of the country both in terms of the length of time examined and scope. The long-term study period allowed us to examine changes over time and helped in the understanding of the major events that affected the country's fisheries. It is encouraging that Saudi Arabia has improved its fishery data recording system and data dissemination through its annual fishery statistics reports for the artisanal and industrial fisheries. These two sectors may be relatively easier to monitor than the fisheries which are not included either because of their small contribution to total catch (recreational), their diffuse nature (subsistence) or lack of economic value (industrial discards). Nevertheless, it will be very useful to establish a data collection system protocol for these unreported fisheries, even if it may not be as detailed as the
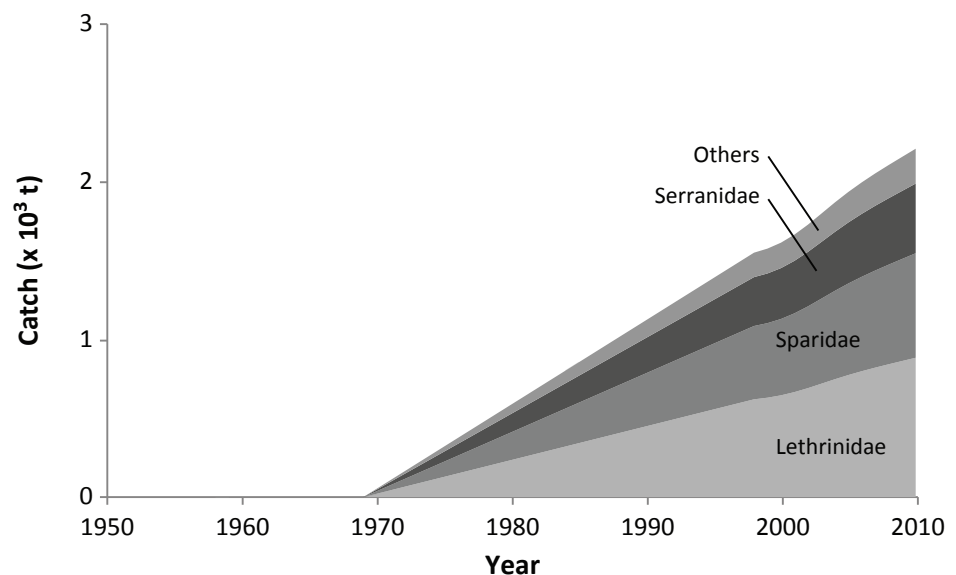
Figure 7. Catch composition of the recreational fishery of Saudi Arabia in the Gulf.

artisanal and industrial fisheries. For example, licensing for the recreational fishery can give an idea as to the size of the fishery, which, when coupled with a sampling scheme of catch rates, can help to estimate the scale of the fishery, and its impact on the ecosystem. For industrial discards, on board sampling can be done at minimum cost. Although, getting an idea as to the magnitude of the subsistence fishery can be difficult, it is possible to estimate its catch through an interview-based survey method. Once the estimates of all the sectors of the fishery are made, it will be possible to move to ecosystem-based management (Pikitch *et al.* 2004), which is needed in the Gulf, as it is elsewhere.

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Appendix Table A1. Total reconstructed catch (t) of Saudi Arabia fishery in the Gulf by sector, and catch reported by Saudi Arabia to FAO from 1950-2010.

| Year | Artisanal | Industrial | | Subsistence | Recreational | FAO[1] |
		Retained	Discard			
1950	1,610	0	0	330	0	350
1951	1,610	0	0	330	0	350
1952	2,680	0	0	550	0	778
1953	2,140	0	0	440	0	628
1954	2,680	0	0	550	0	774
1955	2,680	0	0	550	0	770
1956	2,950	0	0	600	0	869
1957	4,280	0	0	880	0	2,032
1958	4,280	0	0	880	0	2,027
1959	5,350	0	0	1,100	0	2,511
1960	5,350	0	0	1,100	0	2,506
1961	11,190	0	0	2,300	0	5,496
1962	13,390	40	190	2,750	0	6,607
1963	14,380	360	1,890	2,950	0	7,404
1964	12,370	490	2,550	1,690	0	6,541
1965	10,410	2,300	12,020	1,410	0	7,310
1966	10,810	3,140	16,380	1,450	0	8,305
1967	7,440	7,840	40,910	980	0	9,935
1968	5,270	7,970	41,630	690	0	8,001
1969	5,000	7,950	41,510	650	0	6,919
1970	5,200	7,420	38,730	670	50	6,551
1971	6,780	6,540	34,150	860	110	6,569
1972	6,840	7,830	40,900	850	160	7,559
1973	8,230	9,050	47,240	1,020	210	9,036
1974	8,330	5,560	29,030	1,020	270	6,071
1975	6,380	5,780	30,160	770	320	5,206
1976	6,300	6,010	31,380	750	370	6,996
1977	5,850	6,180	32,280	690	430	8,074
1978	9,670	3,590	18,730	1,120	480	8,229
1979	11,890	1,180	3,410	1,360	530	6,814
1980	14,100	450	1,310	1,590	590	7,347
1981	16,120	1,310	3,800	1,800	640	8,933
1982	14,860	4,930	14,310	1,640	690	10,445
1983	18,680	5,140	14,890	2,030	750	12,214
1984	19,820	5,920	17,170	2,120	800	12,427
1985	17,140	6,710	19,470	1,810	860	10,003
1986	17,480	6,730	19,500	1,820	910	17,096
1987	14,130	4,110	11,080	1,450	960	12,709
1988	12,410	4,090	12,760	1,260	1,020	12,429
1989	12,830	3,900	13,330	1,280	1,070	12,944
1990	9,670	3,010	8,500	950	1,120	9,055
1991	9,050	2,490	5,530	870	1,180	7,902
1992	13,950	2,560	8,930	1,330	1,230	11,852
1993	14,150	2,560	9,370	1,320	1,280	11,795
1994	20,520	2,600	3,330	1,890	1,340	18,270
1995	22,820	1,090	2,730	2,070	1,390	20,171
1996	24,240	2,320	6,570	2,160	1,440	23,024
1997	24,210	1,980	4,900	2,120	1,500	22,892
1998	27,850	1,790	3,730	2,400	1,550	25,752
1999	26,730	1,070	890	2,260	1,580	21,630
2000	29,670	500	2,720	2,470	1,610	24,196
2001	34,880	460	1,430	2,850	1,670	27,404
2002	37,280	350	1,750	2,990	1,730	31,073
2003	37,820	220	910	2,980	1,800	31,086
2004	39,560	80	490	3,210	1,870	35,049
2005	41,910	130	770	3,190	1,940	37,090
2006	47,550	90	470	3,530	2,000	41,675
2007	44,840	160	680	3,090	2,050	39,552
2008	46,580	170	580	3,320	2,110	39,982
2009	45,670	170	580	3,190	2,160	39,706
2010	43,890	160	580	3,000	2,210	37,470

[1] Portion of FAO data that is assumed to be representative of the reported Gulf data, including adjustments.

Appendix Table A2. Catch (t) composition of the artisanal fishery of Saudi Arabia in the Gulf, 1950-2010.

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1950	240	310	170	0	110	150	90	120	100	48	38	0	0	0	31	200
1951	240	310	170	0	110	150	90	120	100	48	38	0	0	0	31	200
1952	400	520	280	0	180	260	140	210	170	80	63	0	0	0	52	330
1953	320	420	220	0	140	210	110	170	140	64	50	0	0	0	42	260
1954	400	520	280	0	180	260	140	210	170	80	63	0	0	0	52	330
1955	400	520	280	0	180	260	140	210	170	80	63	0	0	0	52	330
1956	440	580	310	0	190	280	160	230	190	88	69	0	0	0	57	360
1957	640	840	450	0	280	410	230	330	270	128	100	0	0	0	83	520
1958	640	840	450	0	280	410	230	330	270	128	100	0	0	0	83	520
1959	800	1,050	560	0	350	510	280	410	340	159	125	0	0	0	104	650
1960	800	1,050	560	0	350	510	280	410	340	159	125	0	0	0	104	650
1961	1,670	2,190	1,170	0	740	1,070	590	870	720	333	262	0	0	0	218	1,370
1962	1,990	2,620	1,390	0	880	1,280	710	1,040	860	399	314	0	0	0	260	1,630
1963	2,140	2,810	1,500	0	950	1,380	760	1,110	920	428	337	0	0	0	280	1,750
1964	1,840	2,420	1,290	0	820	1,190	660	960	790	369	290	0	0	0	241	1,510
1965	1,550	2,040	1,080	0	690	1,000	550	810	670	310	244	0	0	0	202	1,270
1966	1,610	2,120	1,130	0	710	1,040	570	840	690	322	253	0	0	0	210	1,320
1967	1,110	1,460	770	0	490	710	400	580	480	222	174	0	0	0	145	910
1968	780	1,030	550	0	350	510	280	410	340	157	123	0	0	0	102	640
1969	740	980	520	0	330	480	270	390	320	149	117	0	0	0	97	610
1970	770	1,020	540	0	340	500	280	400	330	155	122	0	0	0	101	630
1971	1,010	1,330	710	0	450	650	360	520	440	202	159	0	0	0	132	830
1972	1,020	1,340	710	0	450	660	360	530	440	204	160	0	0	0	133	830
1973	1,230	1,610	860	0	540	790	440	640	530	245	193	0	0	0	160	1,000
1974	1,240	1,630	870	0	550	800	440	640	530	248	195	0	0	0	162	1,020
1975	950	1,250	660	0	420	610	340	490	410	190	149	0	0	0	124	780
1976	940	1,230	660	0	420	600	330	490	400	188	148	0	0	0	122	770
1977	870	1,150	610	0	390	560	310	450	380	174	137	0	0	0	114	710
1978	1,440	1,890	1,010	0	640	930	510	750	620	288	227	0	0	0	188	1,180
1979	1,770	2,330	1,240	0	790	1,140	630	920	760	354	279	0	0	0	231	1,450
1980	2,100	2,760	1,470	0	930	1,350	750	1,090	900	420	330	0	0	0	274	1,720
1981	2,400	3,160	1,680	0	1,070	1,550	860	1,250	1,030	406	378	0	0	0	314	2,040
1982	2,210	2,910	1,550	0	980	1,430	790	1,150	950	379	348	0	0	0	289	1,880
1983	2,780	3,660	1,950	0	1,230	1,790	990	1,450	1,200	452	438	0	0	0	363	2,380
1984	2,950	3,880	2,060	0	1,310	1,900	1,050	1,530	1,270	492	464	0	0	0	385	2,520
1985	2,550	3,360	1,790	0	1,130	1,640	910	1,330	1,100	431	402	0	0	0	333	2,170
1986	2,600	3,420	1,820	0	1,150	1,680	930	1,350	1,120	521	410	0	0	0	340	2,130
1987	2,100	2,770	1,470	0	930	1,360	750	1,090	910	421	331	0	0	0	275	1,720
1988	1,850	2,430	1,290	0	820	1,190	660	960	800	370	291	0	0	0	241	1,510
1989	1,910	2,510	1,340	0	850	1,230	680	990	820	382	301	0	0	0	249	1,560
1990	1,440	1,890	1,010	0	640	930	510	750	620	288	226	0	0	0	188	1,180
1991	1,350	1,770	940	0	600	870	480	700	580	270	212	0	0	0	176	1,100
1992	2,080	2,730	1,450	0	920	1,340	740	1,080	890	415	327	0	0	0	271	1,700
1993	2,110	2,770	1,470	0	930	1,360	750	1,090	910	421	331	0	0	0	275	1,730
1994	3,050	4,020	2,140	0	1,360	1,970	1,090	1,590	1,320	611	481	0	0	0	399	2,500
1995	3,400	4,470	2,380	0	1,510	2,190	1,210	1,770	1,460	680	535	0	0	0	304	2,920
1996	3,610	4,740	2,520	0	1,600	2,320	1,290	1,870	1,550	722	568	0	0	0	352	3,080
1997	3,600	4,740	2,520	0	1,600	2,320	1,290	1,870	1,550	721	567	0	0	0	304	3,120
1998	4,150	5,450	2,900	0	1,840	2,670	1,480	2,150	1,790	829	652	0	0	0	278	3,660
1999	3,980	5,230	2,780	0	1,770	2,560	1,420	2,070	1,710	796	626	0	0	0	290	3,490
2000	2,060	550	3,090	4,770	1,960	130	1,580	590	530	435	695	1,550	1,360	610	296	9,460
2001	2,410	850	3,630	5,220	2,300	240	1,850	510	660	565	817	1,800	1,550	730	364	11,370
2002	2,630	40	3,880	6,680	2,460	20	1,980	520	710	714	874	1,390	1,500	870	425	12,580
2003	2,830	270	3,940	5,590	2,500	170	2,010	990	570	885	886	1,850	1,680	990	46	12,620
2004	3,710	60	3,960	6,760	1,760	180	2,320	820	1,200	540	1,014	1,740	1,860	1,140	25	12,480
2005	3,250	90	4,460	7,300	2,740	40	2,480	910	870	735	1,084	2,180	1,800	1,110	29	12,830
2006	2,890	10	5,470	7,510	3,100	60	2,430	1,030	740	2,021	921	2,280	1,860	1,320	29	15,880
2007	3,240	50	4,260	8,660	3,990	10	1,950	830	940	838	1,025	1,940	1,930	1,400	25	13,750
2008	3,460	20	4,850	7,890	3,080	50	2,470	850	790	1,178	1,091	2,050	1,930	1,310	40	15,520
2009	3,220	410	4,760	8,050	3,020	50	2,430	780	820	1,139	1,070	1,730	2,190	1,440	33	14,540
2010	3,220	30	4,570	6,440	2,900	40	2,330	760	710	1,042	1,028	1,710	1,880	1,290	33	15,920

1: Lethrinidae; 2: *Penaeus* spp.; 3: *Scomberomorus commerson*; 4: *P. semisulcatus*; 5: Brachyura; 6: Sparidae; 7: *Siganus* spp.; 8: Carangidae; 9: Serranidae; 10: Sepiidae; 11: Elasmobranchii; 12: *Argyrops spinifer*; 13: *Lethrinus lentjan*; 14: *Rhabdosargus haffara*; 15: Scombridae; 16: Others.

Appendix Table A3. The retained catch (t) composition of the industrial fishery of Saudi Arabia in the Gulf, 1950-2010.

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1951	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1952	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1953	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1954	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1955	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1956	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1957	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1958	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1959	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1960	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1961	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1962	33	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
1963	327	12	6	4	2	2	2	2	0	1	1	1	1	1	0	4
1964	440	16	8	5	3	2	2	2	0	2	1	1	1	1	1	5
1965	2,072	76	36	25	15	10	10	10	0	7	4	4	3	3	3	25
1966	2,823	104	49	34	20	13	13	13	0	10	5	5	5	4	4	34
1967	7,053	260	122	84	50	33	33	33	0	25	13	12	12	11	9	85
1968	7,177	264	124	85	51	34	34	34	0	26	13	12	12	11	9	86
1969	7,156	263	124	85	51	34	34	34	0	26	13	12	12	11	9	86
1970	6,677	246	116	79	48	32	32	32	0	24	13	11	11	10	9	80
1971	5,888	217	102	70	42	28	28	28	0	21	11	10	10	9	8	71
1972	7,051	259	122	84	50	33	33	33	0	25	13	12	12	11	9	85
1973	8,144	300	141	97	58	39	39	39	0	29	15	14	14	13	11	98
1974	5,006	184	87	59	36	24	24	24	0	18	9	9	8	8	7	60
1975	5,201	191	90	62	37	25	25	25	0	19	10	9	9	8	7	63
1976	5,411	199	94	64	39	26	26	26	0	19	10	9	9	8	7	65
1977	5,566	205	96	66	40	26	26	26	0	20	10	9	9	9	7	67
1978	3,230	119	56	38	23	15	15	15	0	12	6	5	5	5	4	39
1979	588	195	92	63	38	25	25	25	0	19	10	9	9	8	7	64
1980	225	75	35	24	14	10	10	10	0	7	4	3	3	3	3	24
1981	655	217	102	70	42	24	28	28	0	21	11	10	10	9	8	75
1982	2,467	817	385	264	158	90	105	105	0	80	42	38	37	34	29	283
1983	2,568	850	401	274	165	89	110	110	0	83	43	39	38	36	30	299
1984	2,960	981	462	316	190	105	127	127	0	96	50	45	44	41	35	342
1985	3,357	1,112	524	359	215	121	143	143	0	108	57	51	50	47	40	387
1986	3,363	1,114	525	359	216	144	144	144	0	109	57	51	50	47	40	365
1987	1,910	727	343	235	141	94	94	94	0	71	37	34	33	31	26	238
1988	2,200	627	295	202	121	81	81	81	0	61	32	29	28	26	22	205
1989	2,298	531	250	171	103	69	69	69	0	52	27	25	24	22	19	174
1990	1,465	512	241	165	99	66	66	66	0	50	26	24	23	22	18	168
1991	954	508	239	164	98	66	66	66	0	50	26	23	23	21	18	166
1992	1,539	337	159	109	65	44	44	44	0	33	17	16	15	14	12	110
1993	1,615	312	147	101	60	40	40	40	0	30	16	14	14	13	11	102
1994	574	669	315	216	130	86	86	86	0	65	34	31	30	28	24	219
1995	471	205	96	66	40	26	26	26	0	20	7	9	9	9	7	70
1996	1,132	392	185	126	76	51	51	51	0	38	15	18	18	17	14	133
1997	846	376	177	121	73	48	48	48	0	37	12	17	17	16	13	130
1998	643	381	179	123	74	49	49	49	0	37	10	18	17	16	14	134
1999	153	304	143	98	59	39	39	39	0	30	9	14	14	13	11	106
2000	44	5	1	2	2	1	1	1	385	0	0	0	0	0	0	55
2001	31	33	6	6	14	5	9	9	188	0	2	3	1	0	3	149
2002	2	8	1	2	3	1	2	2	276	1	0	1	0	0	1	51
2003	6	10	3	4	4	2	3	3	118	0	0	1	0	0	1	63
2004	1	0	0	0	0	0	0	0	77	0	0	0	0	0	0	8
2005	1	0	0	0	0	0	0	0	118	0	0	0	0	0	0	13
2006	0	0	0	0	0	4	0	0	71	0	0	0	0	0	0	11
2007	1	0	0	0	28	14	0	0	105	0	0	0	0	0	0	16
2008	0	0	0	0	21	42	0	0	86	0	0	0	0	0	0	21
2009	5	0	0	0	20	39	0	0	90	0	0	0	0	0	0	13
2010	0	0	0	0	18	34	0	0	75	0	0	0	0	0	0	33

1: *Penaeus* nei; 2: Lethrinidae; 3: Carangidae; 4: *Sphyraena* spp.; 5: Brachyura; 6: Sepiidae; 7: *Siganus* spp.; 8: *Netuma thalassina*; 9: *P. semisulcatus*; 10: *Gerres* spp.; 11: Scombridae; 12: *Bothus pantherinus*; 13: Lutjanidae; 14: Sparidae; 15: Elasmobranchii; 16: Others.

Appendix Table A4. Catch (t) composition of the discard of the industrial fishery of Saudi Arabia in the Gulf, 1950-2010.

Year	1	2	3	4	5	6	7	8	9	10	11	12	13
1950	0	0	0	0	0	0	0	0	0	0	0	0	0
1951	0	0	0	0	0	0	0	0	0	0	0	0	0
1952	0	0	0	0	0	0	0	0	0	0	0	0	0
1953	0	0	0	0	0	0	0	0	0	0	0	0	0
1954	0	0	0	0	0	0	0	0	0	0	0	0	0
1955	0	0	0	0	0	0	0	0	0	0	0	0	0
1956	0	0	0	0	0	0	0	0	0	0	0	0	0
1957	0	0	0	0	0	0	0	0	0	0	0	0	0
1958	0	0	0	0	0	0	0	0	0	0	0	0	0
1959	0	0	0	0	0	0	0	0	0	0	0	0	0
1960	0	0	0	0	0	0	0	0	0	0	0	0	0
1961	0	0	0	0	0	0	0	0	0	0	0	0	0
1962	120	14	8	8	4	4	4	4	4	2	2	2	16
1963	1,200	135	77	77	39	39	39	39	39	19	19	19	155
1964	1,610	182	104	104	52	52	52	52	52	26	26	26	208
1965	7,600	858	491	491	245	245	245	245	245	123	123	123	981
1966	10,360	1,170	668	668	334	334	334	334	334	167	167	167	1,337
1967	25,880	2,922	1,670	1,670	835	835	835	835	835	417	417	417	3,339
1968	26,330	2,973	1,699	1,699	850	850	850	850	850	425	425	425	3,398
1969	26,260	2,965	1,694	1,694	847	847	847	847	847	424	424	424	3,388
1970	24,500	2,766	1,581	1,581	790	790	790	790	790	395	395	395	3,161
1971	21,600	2,439	1,394	1,394	697	697	697	697	697	348	348	348	2,788
1972	25,870	2,921	1,669	1,669	835	835	835	835	835	417	417	417	3,339
1973	29,880	3,374	1,928	1,928	964	964	964	964	964	482	482	482	3,856
1974	18,370	2,074	1,185	1,185	592	592	592	592	592	296	296	296	2,370
1975	19,080	2,155	1,231	1,231	616	616	616	616	616	308	308	308	2,462
1976	19,850	2,242	1,281	1,281	640	640	640	640	640	320	320	320	2,562
1977	20,420	2,306	1,318	1,318	659	659	659	659	659	329	329	329	2,635
1978	11,850	1,338	765	765	382	382	382	382	382	191	191	191	1,529
1979	2,160	243	139	139	70	70	70	70	70	35	35	35	278
1980	830	93	53	53	27	27	27	27	27	13	13	13	107
1981	2,410	272	155	155	78	78	78	78	78	39	39	39	310
1982	9,050	1,022	584	584	292	292	292	292	292	146	146	146	1,168
1983	9,420	1,064	608	608	304	304	304	304	304	152	152	152	1,216
1984	10,860	1,226	701	701	350	350	350	350	350	175	175	175	1,402
1985	12,320	1,391	795	795	397	397	397	397	397	199	199	199	1,590
1986	12,340	1,393	796	796	398	398	398	398	398	199	199	199	1,592
1987	7,010	791	452	452	226	226	226	226	226	113	113	113	904
1988	8,070	911	521	521	260	260	260	260	260	130	130	130	1,041
1989	8,430	952	544	544	272	272	272	272	272	136	136	136	1,088
1990	5,380	607	347	347	173	173	173	173	173	87	87	87	694
1991	3,500	395	226	226	113	113	113	113	113	56	56	56	452
1992	5,650	638	364	364	182	182	182	182	182	91	91	91	729
1993	5,930	669	382	382	191	191	191	191	191	96	96	96	765
1994	2,110	238	136	136	68	68	68	68	68	34	34	34	272
1995	1,730	195	111	111	56	56	56	56	56	28	28	28	223
1996	4,160	469	268	268	134	134	134	134	134	67	67	67	536
1997	3,100	350	200	200	100	100	100	100	100	50	50	50	400
1998	2,360	266	152	152	76	76	76	76	76	38	38	38	304
1999	560	63	36	36	18	18	18	18	18	9	9	9	73
2000	1,720	194	111	111	55	55	55	55	55	28	28	28	222
2001	900	102	58	58	29	29	29	29	29	15	15	15	116
2002	1,110	125	72	72	36	36	36	36	36	18	18	18	143
2003	570	65	37	37	19	19	19	19	19	9	9	9	74
2004	310	35	20	20	10	10	10	10	10	5	5	5	40
2005	490	55	31	31	16	16	16	16	16	8	8	8	63
2006	300	34	19	19	10	10	10	10	10	5	5	5	39
2007	430	49	28	28	14	14	14	14	14	7	7	7	56
2008	370	41	24	24	12	12	12	12	12	6	6	6	47
2009	370	41	24	24	12	12	12	12	12	6	6	6	47
2010	370	41	24	24	12	12	12	12	12	6	6	6	47

1: Leiognathidae; 2: Balistidae; 3: *Gerres* spp.; 4: Trichiuridae; 5: Platycephalidae; 6: Tetraodontidae; 7: Soleidae; 8: Bramidae; 9: Brachyura; 10: Clupeidae; 11: Mullidae; 12: Squillidae; 13: Others;

Appendix Table A5. Catch (t) composition of the subsistence fishery of Saudi Arabia in the Gulf, 1950-2010.

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1950	72	50	46	37	26	31	0	0	9	7	8	5	7	0	5	26
1951	72	50	46	37	26	31	0	0	9	7	8	5	7	0	5	26
1952	120	84	77	62	43	52	0	0	16	12	13	8	12	0	9	43
1953	96	67	62	50	34	41	0	0	12	10	10	6	10	0	7	34
1954	120	84	77	62	43	52	0	0	16	12	13	8	12	0	9	43
1955	120	84	77	62	43	52	0	0	16	12	13	8	12	0	9	43
1956	132	92	85	68	47	57	0	0	17	13	14	9	13	0	10	47
1957	191	134	123	99	68	82	0	0	25	19	21	13	19	0	15	69
1958	191	134	123	99	68	82	0	0	25	19	21	13	19	0	15	69
1959	239	167	154	124	85	103	0	0	31	24	26	16	24	0	18	86
1960	239	167	154	124	85	103	0	0	31	24	26	16	24	0	18	86
1961	500	350	322	260	178	215	0	0	65	50	54	34	50	0	38	180
1962	598	418	385	311	213	258	0	0	78	60	65	41	60	0	46	215
1963	642	449	414	334	229	277	0	0	84	64	70	44	64	0	49	231
1964	368	258	237	191	131	159	0	0	48	37	40	25	37	0	28	132
1965	306	214	197	159	109	132	0	0	40	31	33	21	31	0	23	110
1966	315	220	203	164	112	136	0	0	41	32	34	21	31	0	24	113
1967	214	150	138	111	76	92	0	0	28	21	23	15	21	0	16	77
1968	150	105	97	78	54	65	0	0	20	15	16	10	15	0	11	54
1969	141	98	91	73	50	61	0	0	18	14	15	10	14	0	11	51
1970	145	101	93	75	52	62	0	0	19	15	16	10	14	0	11	52
1971	187	131	120	97	67	80	0	0	24	19	20	13	19	0	14	67
1972	186	130	120	97	66	80	0	0	24	19	20	13	19	0	14	67
1973	221	155	142	115	79	95	0	0	29	22	24	15	22	0	17	79
1974	221	155	142	115	79	95	0	0	29	22	24	15	22	0	17	79
1975	167	117	108	87	60	72	0	0	22	17	18	11	17	0	13	60
1976	163	114	105	85	58	70	0	0	21	16	18	11	16	0	12	59
1977	150	105	96	78	53	64	0	0	20	15	16	10	15	0	11	54
1978	244	171	157	127	87	105	0	0	32	24	27	17	24	0	19	88
1979	296	207	191	154	106	128	0	0	39	30	32	20	30	0	23	106
1980	347	243	223	180	124	149	0	0	45	35	38	24	35	0	26	125
1981	391	274	252	203	140	169	0	0	51	39	43	27	39	0	30	141
1982	356	249	229	185	127	153	0	0	46	36	39	24	36	0	27	128
1983	441	309	284	229	158	190	0	0	58	44	48	30	44	0	34	159
1984	462	323	298	240	165	199	0	0	60	46	50	31	46	0	35	166
1985	394	276	254	205	141	170	0	0	51	39	43	27	39	0	30	141
1986	396	277	255	206	141	171	0	0	52	40	43	27	40	0	30	142
1987	316	221	203	164	113	136	0	0	41	32	34	21	32	0	24	113
1988	273	191	176	142	97	118	0	0	36	27	30	19	27	0	21	98
1989	278	195	179	145	99	120	0	0	36	28	30	19	28	0	21	100
1990	206	144	133	107	74	89	0	0	27	21	22	14	21	0	16	74
1991	190	133	123	99	68	82	0	0	25	19	21	13	19	0	14	68
1992	289	202	186	150	103	124	0	0	38	29	31	20	29	0	22	104
1993	288	202	186	150	103	124	0	0	38	29	31	20	29	0	22	104
1994	412	288	265	214	147	177	0	0	54	41	45	28	41	0	31	148
1995	451	315	290	234	161	194	0	0	40	45	49	31	45	0	34	180
1996	471	329	303	245	168	203	0	0	46	47	51	32	47	0	36	185
1997	462	323	298	240	165	199	0	0	39	46	50	31	46	0	35	188
1998	523	366	337	271	187	225	0	0	35	52	57	35	52	0	40	221
1999	493	345	318	256	176	212	0	0	36	49	54	33	49	0	38	206
2000	251	376	16	71	192	65	189	166	36	41	8	36	0	74	0	948
2001	289	434	28	61	222	79	216	186	43	17	21	42	0	88	17	1,109
2002	309	456	2	61	232	83	163	176	50	22	8	44	0	102	0	1,284
2003	326	454	20	114	231	65	213	193	5	44	11	44	0	115	2	1,143
2004	420	447	20	93	262	135	197	211	3	24	13	52	0	128	4	1,205
2005	360	495	5	101	275	97	241	200	3	15	21	51	0	123	5	1,204
2006	314	595	6	112	264	81	248	202	3	28	11	40	0	144	2	1,483
2007	345	454	1	89	208	100	207	206	3	19	13	48	0	149	2	1,243
2008	361	506	5	88	258	82	213	202	4	23	10	49	0	137	3	1,382
2009	329	486	5	80	248	84	177	224	3	17	13	47	0	147	2	1,328
2010	322	457	4	76	233	71	171	188	3	19	12	44	0	129	6	1,267

1: Lethrinidae; 2: *Scomberomorus commerson*; 3: Sparidae; 4: Carangidae; 5: *Siganus* spp.; 6: Serranidae; 7: *Argyrops spinifer*; 8: *Lethrinus lentjan*; 9: Scombridae; 10: *Sphyraena* spp.; 11: Lutjanidae; 12: *Netuma thalassina*; 13: *Scomberoides* spp.; 14: *Rhabdosargus haffara*; 15: Haemulidae; 16: Others.

Appendix Table A6. Catch (t) composition of the recreational fisheries of Saudi Arabia in the Gulf, 1950-2010.

Year	Lethrinidae	Sparidae	Serranidae	Others
1950	0	0	0	0
1951	0	0	0	0
1952	0	0	0	0
1953	0	0	0	0
1954	0	0	0	0
1955	0	0	0	0
1956	0	0	0	0
1957	0	0	0	0
1958	0	0	0	0
1959	0	0	0	0
1960	0	0	0	0
1961	0	0	0	0
1962	0	0	0	0
1963	0	0	0	0
1964	0	0	0	0
1965	0	0	0	0
1966	0	0	0	0
1967	0	0	0	0
1968	0	0	0	0
1969	0	0	0	0
1970	21	16	11	5
1971	43	32	21	11
1972	64	48	32	16
1973	86	64	43	21
1974	107	80	53	27
1975	128	96	64	32
1976	150	112	75	37
1977	171	128	86	43
1978	192	144	96	48
1979	214	160	107	53
1980	235	176	118	59
1981	257	192	128	64
1982	278	208	139	69
1983	299	225	150	75
1984	321	241	160	80
1985	342	257	171	86
1986	364	273	182	91
1987	385	289	192	96
1988	406	305	203	102
1989	428	321	214	107
1990	449	337	225	112
1991	470	353	235	118
1992	492	369	246	123
1993	513	385	257	128
1994	535	401	267	134
1995	556	417	278	139
1996	577	433	289	144
1997	599	449	299	150
1998	620	465	310	155
1999	630	473	315	158
2000	645	484	323	161
2001	666	500	333	167
2002	691	518	346	173
2003	719	539	360	180
2004	748	561	374	187
2005	774	581	387	194
2006	799	599	399	200
2007	821	616	411	205
2008	843	632	421	211
2009	863	647	432	216
2010	884	663	442	221