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Abstract

Jordan has a short coastline in the Gulf of Aqaba, to the north of the Red Sea. It is the only access the country has to sea, and thus numerous economic activities are concentrated there. The fisheries catch taken within the small Exclusive Economic Zones (EEZ) of Jordan in the inner Gulf of Aqaba is presented, based on a variety of government and non-government sources for the years 1950–2010, and compared with the catch Jordan reports annually to the Food and Agriculture Organization of the United Nations (FAO). The different sectors of the fisheries are treated separately and the composition of the catches estimated. There are strong discrepancies between the reconstructed catch and FAO data, in part due to Jordan's fishing fleets having operated outside of their waters, in Saudi Arabian waters, from 1950 to 1984, and to an overall lack of interest for what are rather small operations, generating very low catches. The catch was around 150 t·year⁻¹ from 1950 to the mid-1960s, then declined, due to conflicts in the area, and started to increase again in the mid-1980s, with some fluctuations. The highest catch of 330 t was achieved in 2009. Overall, the estimated reconstructed catch of Jordan from 1950 to 2010 was 1.7 times what is reported in the FAO database. This reconstruction exercise, with its explicitly stated procedures and assumptions and accounting all the sectors comprehensively, can serve as starting point to improve the quality of the data for Jordan, and for better management of its marine resources, which are under increasing pressure from fishing and other developments in the region.

Keywords

Catch time series • Fisheries • Catch composition • Mis-reported catch • Gulf of Aqaba

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Introduction

The Hashemite Kingdom of Jordan has access to the north-eastern tip of the Gulf of Aqaba, Red Sea, via a small Exclusive Economic Zones of about 95 km² (Al Ouran 2005) (Fig. 7.1). This unique region harbors the world's northernmost coral reef ecosystem (Khalaf and Disi 1997; MoE 2002) and its waters are hypersaline, psu averaging 42 (Sneh and Friedman 1985). This is in part due to its semi-enclosed nature (Hargreaves 1981), which allows for a complete renewal of the water basin only once every 20 years (Lapidoth-Eschelbacher 1982). These factors not only lead to a high degree of endemism in the region, but also increase

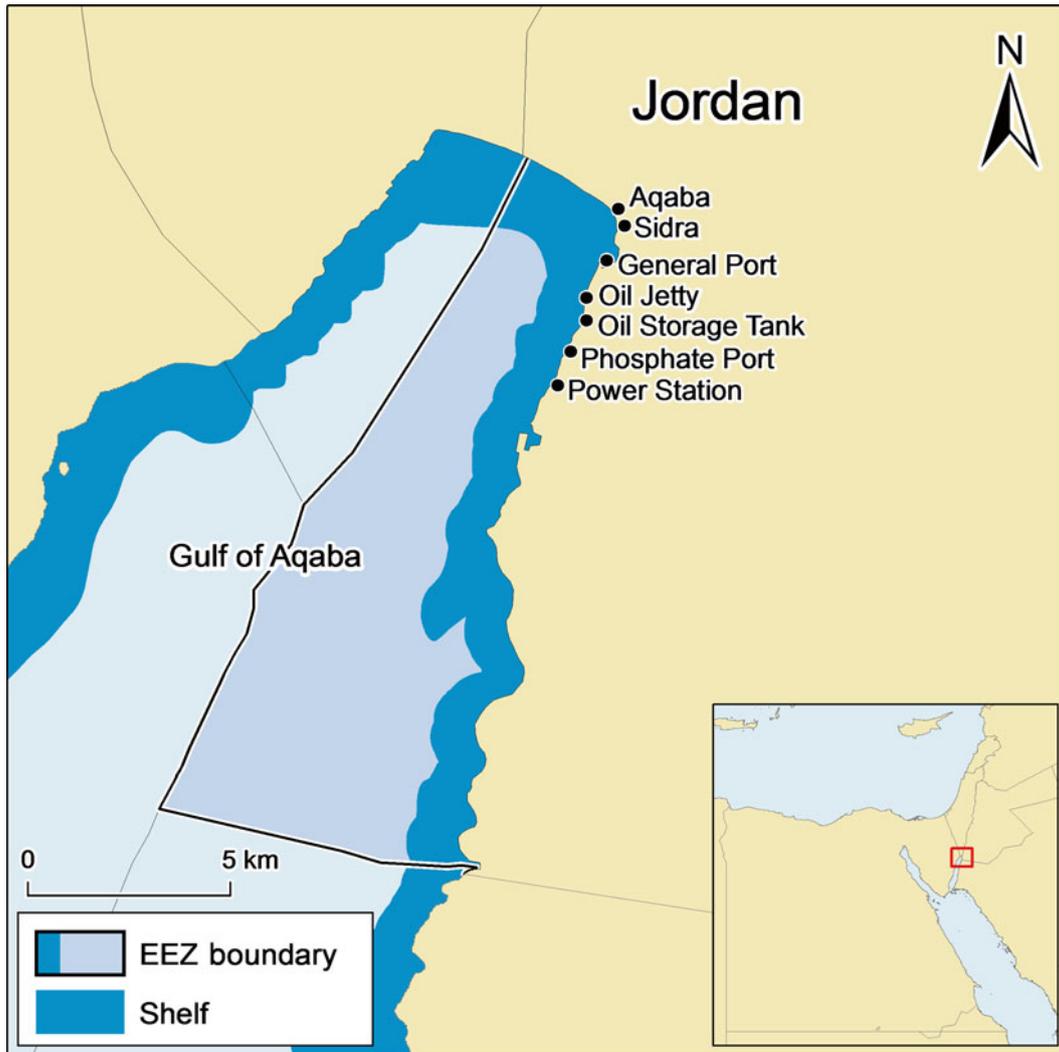


Fig. 7.1 The shelf areas, Exclusive Economic Zone (EEZ) and major sites of Jordan in the Gulf of Aqaba, Red Sea

the susceptibility to pollution, which, jointly with overfishing, affect the diversity and abundance of the fish stocks, as well as the health of the coral reefs (Tellawi 2001). The major settlement is the city of Aqaba (Fig. 7.2), the sole port in Jordan. The fish landing site is at Sidra, near the town of Aqaba, where fish are sold directly to merchants, hotels and restaurants based in Aqaba (PERSGA 2002).

One of the main human activities impacting the Jordanian Red Sea coast is fishing. However, the state of the fisheries in the inner Gulf of Aqaba cannot be assessed using only the catch data Jordan submits to the Food and Agriculture Organization (FAO) of the United Nations (Pauly and Zeller 2003). Rather, as for other countries and territories, it is necessary to ‘reconstruct’ historic catch trends to acquire an understanding of the evolution of these fisheries (Zeller et al. 2006, 2007). Thus, we present in this chapter an alternative catch estimates by reconstructing the Jordanian catch in the Red Sea from 1950 to 2010.

The fishery is divided into sectors and for each the total catch and its composition are presented. In order to have a good understanding of the ecosystem within which the fisheries are embedded, a brief description of the coral reef ecosystem of Jordan in the Gulf of Aqaba is given, followed by an introduction to the fisheries. Then the results are presented; the sources and methods used to estimate the catches are presented at the end.

Coral Reef Ecosystems

About 50 % of the Jordanian coast in the Gulf of Aqaba is covered by fringing coral reefs, with a high diversity of corals (about 180 species) and fishes (well over about 500 species). The live coral cover can be as high as 90 % and butterflyfishes have the highest abundance followed by parrotfishes (Kotb et al. 2008). The coral reef ecosystems on the Jordanian coast in the Gulf of Aqaba, along with those in the

Gulf of Suez (Riegl et al. 2012), are the northernmost reefs in the western Indo-Pacific (Khalaf and Disi 1997; MoE 2002). The main threats to the coral reefs of Jordan, besides fishing, are industrial development and tourism.

Some of the anthropogenic factors impacting the Jordanian coastal ecosystem over the past few decades include commercial fish farms, sewage outflow, and phos-



Fig. 7.2 The city of Aqaba, Jordan (Photo: Kht01, Wikipedia Commons)

Fig. 7.3 Diving in coral reef area is one of the most popular tourist activities along the Jordanian Red Sea coast (Photo: Marina Plaza Hotel)



phate emissions from nearby industrial terminals, which led to increasing levels of eutrophication (MoE 2002; Al Ouran 2005). Other stressors are oil spills (Kotb et al. 2008) and littering, especially plastics (Abu-Hilal and Al-Najjar 2009). As in many northern Red Sea countries, the development of tourism (Fig. 7.3) industry in Jordan has been rapid (Hawkins and Roberts 1994). These factors are having an adverse effect on the coral reefs. For example, in 1996, 70 % of the coral were reported to be alive, yet in 2002 the reef was comprised of only 30 % live coral in Jordan (MoE 2002). Khalaf and Kochzius (2002) found out, by comparing areas impacted by industrial development and undisturbed areas, that coastal industrial development disturbed coral reef ecosystems through dredging and pollution, which in turn affected the community structure of fishes; thus, e.g., fish abundance in disturbed areas was 50 % less than undisturbed areas, although species richness remained similar. They also found the disturbance affected different trophic levels of the ecosystem differently. Other impact of the stress on the ecosystem was shown by disease outbreaks (Al-Moghrabi 2001). Natural disturbances also affect the coral reefs of Jordan. The most recent example is the bleaching and mortality on reef flats in extreme low tide in 2007 (Kotb et al. 2008), which was thought to be aggravated by climate change. These unfavorable marine conditions, coupled with fishing (Tellawi 2001) are responsible for the increase of pressure on the ecosystem. The extent of the impact of these pressures needs to be studied and monitored. Some of the impacts are obvious, for example in 2006 half of all the Jordanian fishing boats were permanently anchored (IRIN 2006).

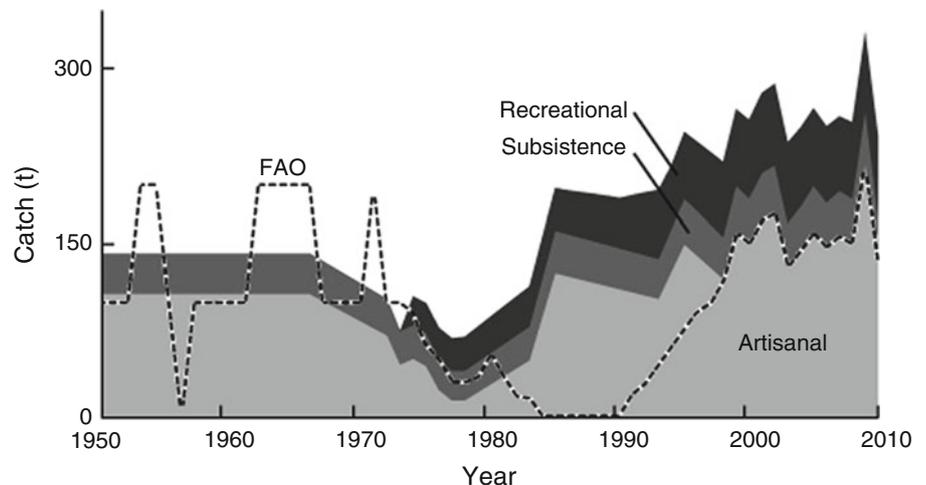
Jordan has been involved in active management of its marine ecosystem, with emphasis on sustainable development through planning and education, notably through the ‘On-ground Projects Programme’ implemented by The

Regional Organization for the conservation of the Environment of the Red Sea and Gulf of Aden (PERSGA) in 2006. Also, Jordan has declared 30 % of its coast to be marine protected areas (Kotb et al. 2008). The results of these initiatives, however, will be revealed by long-term monitoring.

Fisheries

Due to the limited area available for fishing (Farid 1984), the fisheries of Jordan in the Gulf of Aqaba are generally small. In the past, Jordanian fishers operated beyond the inner Gulf of Aqaba, in the waters of neighboring countries, almost exclusively in Saudi Arabia (PERSGA 2002), as Jordanian fishers are rarely seen in Egyptian and Yemeni waters. The predominant gears utilized by Jordanian fishers are beach seines and gillnets, but trammel nets, hand lines, longlines, various traps, and (illegally) spear guns and explosives are also used. The main target species are snappers (Lutjanidae), groupers (Serranidae) and emperors (Lethrinidae), along with numerous incidental species (Khalaf and Disi 1997). The catch, which is not iced, is landed by boats ranging from 5.5 to 11 m (PERSGA 2002), and sold immediately to merchants in the port of Aqaba. The fisheries of Jordan can be categorized into three sectors; the first is the artisanal sector, with fishers who tend to work full time, and who may occasionally venture into the waters of neighboring countries. The second is the subsistence sector consisting of two components, one being the catch from small boats for direct consumption by family or neighbors, with a small part being sold or bartered, the other being that part of the catch of the artisanal fishery which is consumed by the crew, or given to family members and friends. The third fishery sector is recreational fishing, which is occasionally engaged in the weekends by the people who live on the coast. These three sectors are treated separately in the catch reconstruction.

Fig. 7.4 Total catch of the Jordanian fishery in the Gulf of Aqaba by sectors and the total catch Jordan reported to FAO from 1950 to 2010

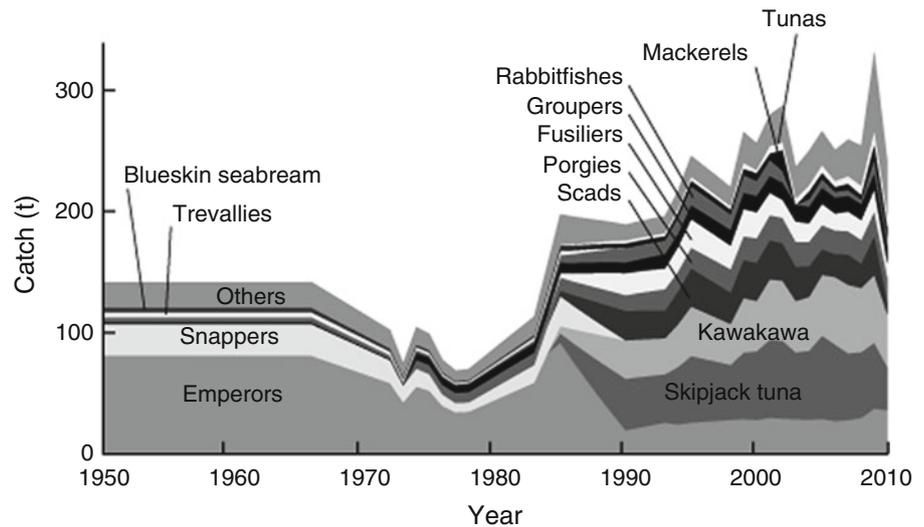


Fisheries Catches

Our results suggest that the catch in Jordanian waters ranged from slightly less than 150 t in 1950 to a maximum of 300 t in 2009 (Fig. 7.4). The total catch showed an increasing trend from its lowest values in the late 1970s until its peak in 2009. In contrast, the data supplied to FAO were lower than the reconstructed total catch for most of the period, except in the early period, where a total of 200 t was reported for a few years. These years correspond with the time the Jordanian fishers were fishing outside the Jordanian waters, i.e., overwhelmingly in Saudi Arabia. Since the origin of these catch was outside Jordan, we did not include them as Jordanian catch from Jordanian waters in our reconstruction. Instead, they were accounted in their main country of origin, Saudi Arabia (see Chap. 6). In the last few years, Jordanian fisheries hardly fish outside Jordanian waters. Similar to the reconstruction, the highest catch reported in the FAO database was for 2009. The FAO database has zero catches for some years. This is due to a lack of reporting by Jordan to FAO and does not mean that there were no fishery catches. Such data gaps can be very misleading in the assessment and management of fishery (Pitcher et al. 2002). From the late 1990s, the FAO data were equal to the total artisanal fishery, which is due to the subsistence and recreational not being reported at all.

When the reconstructed total catch of Jordan in Jordanian waters is divided into different sectors, the artisanal fishery contributes 62 %, followed by the subsistence fishery at 20 % and the recreational fishery at 18 % (Fig. 7.4). Jordan does not have an industrial fishery (PERSGA 2002). The artisanal fishery has the strongest influence on the pattern of the overall total. The subsistence fishery follows a pattern similar to that of the artisanal fishery because it was calculated mainly as a ratio of the artisanal fishery. The recreational fishery started in 1974 and its contribution became noticeable only in the later years.

Fig. 7.5 Composition of the total catch of Jordanian fisheries in the Gulf of Aqaba from 1950 to 2010



The total marine catch within Jordanian waters was found to be 1.7 times the catches reported to the FAO from 1950 to 2010. This can be attributed to two main reasons: non-reporting for some years, which translated as zeroes in the FAO database, and the fact that the subsistence and recreational fisheries are not included in the FAO database at all. The unreported catch accounted for 52 % of the reconstructed total catch. The reported catch (part of the reconstructed catch accounted in the FAO data) represented only 48 % of the total catch.

The total catch of Jordan in the Gulf of Aqaba is dominated by few taxa, although the total number of taxa in the catch is very high. The dominant taxon is emperors (Lethrinidae, 32 %), the distant second is skipjack tuna (*Katsuwonus pelamis*, 12 %), followed by kawakawa (*Euthynnus affinis*, 9 %) and snappers (Lutjanidae, 8 %). These four taxa jointly constitute 61 % of the total catch. Of the four taxa, emperors and snappers are coral-reef associated and their catch is visible from 1950, although their contributions decreased later. On the other hand, skipjack tuna and kawakawa appear only after 1980 (Fig. 7.5). This is a clear result of the shift of target species by the fishers from coral-reef associated fishes to pelagic in the mid-1980s. The composition of the total catch of Jordan in the Red Sea strongly resembles that of the artisanal fishery (Figs. 7.5 and 7.6a), because the artisanal fishery has the highest contribution to the total catch.

Looking at the fisheries separately, there are 21 identified taxonomic groups that made up the total artisanal fishery catch of Jordan in the inner Gulf of Aqaba (Fig. 7.6a). The most dominant taxon is emperors (Lethrinidae) at 29 %, followed by skipjack tuna (*Katsuwonus pelamis*) at 15 % and kawakawa (*Euthynnus affinis*) at 12 %. An explanation for the partial shift from coral reef to pelagic fish around 1985 is that in the early period, when Jordanian fishers used to ven-

ture out to neighboring countries, their target was coral-reef associated fishes. The gear and technology they used must have influenced their operation in the domestic waters as well, in Jordanian water, or the fishers who used to fish in Saudi waters would fish in Jordanian waters when they were not fishing in Saudi waters. However, later, when they were no longer allowed to fish in the waters of neighboring countries, the Jordanian fishers had to focus on local resources and target the more abundant resource – the pelagic fishes.

The catch composition of the subsistence fishery is similar to the artisanal fishery (Fig. 7.6b), as the same catch composition ratios were used. However, it does not show strong fluctuations like the artisanal fishery; it stays more or less stable. This is quite realistic for a subsistence fishery. As its name indicates, this is catch consumed by locals, is a source of food security, and it is usually less affected by external factors (e.g., market and politics) compared to the other fisheries. The catch composition of the recreational fishery has only three identified taxa (Fig. 7.6c).

Jordan has been plagued by numerous conflicts since 1950. This tumultuous history is mirrored in the state of the fisheries. Some of the fluctuations of its fisheries are attributed to lack of political stability in the region. The small coastal access to the Gulf of Aqaba attributed to one of the lowest total catch of all the countries bordering the Red Sea. Hence, there is little motivation for the country to collect detailed fisheries statistics, and assess and manage its fisheries. Most of the fisheries data appear to be collected by university researchers and sporadically by the fisheries administrations (Tellawi 2001). However, for effective policies to manage the fisheries to be developed and implemented, consistent time series data are essential (Caddy and Gulland 1983; PERSGA 2002; Tesfamichael 2012).

This study showed considerable discrepancies between the reconstructed catch and data supplied to the FAO by

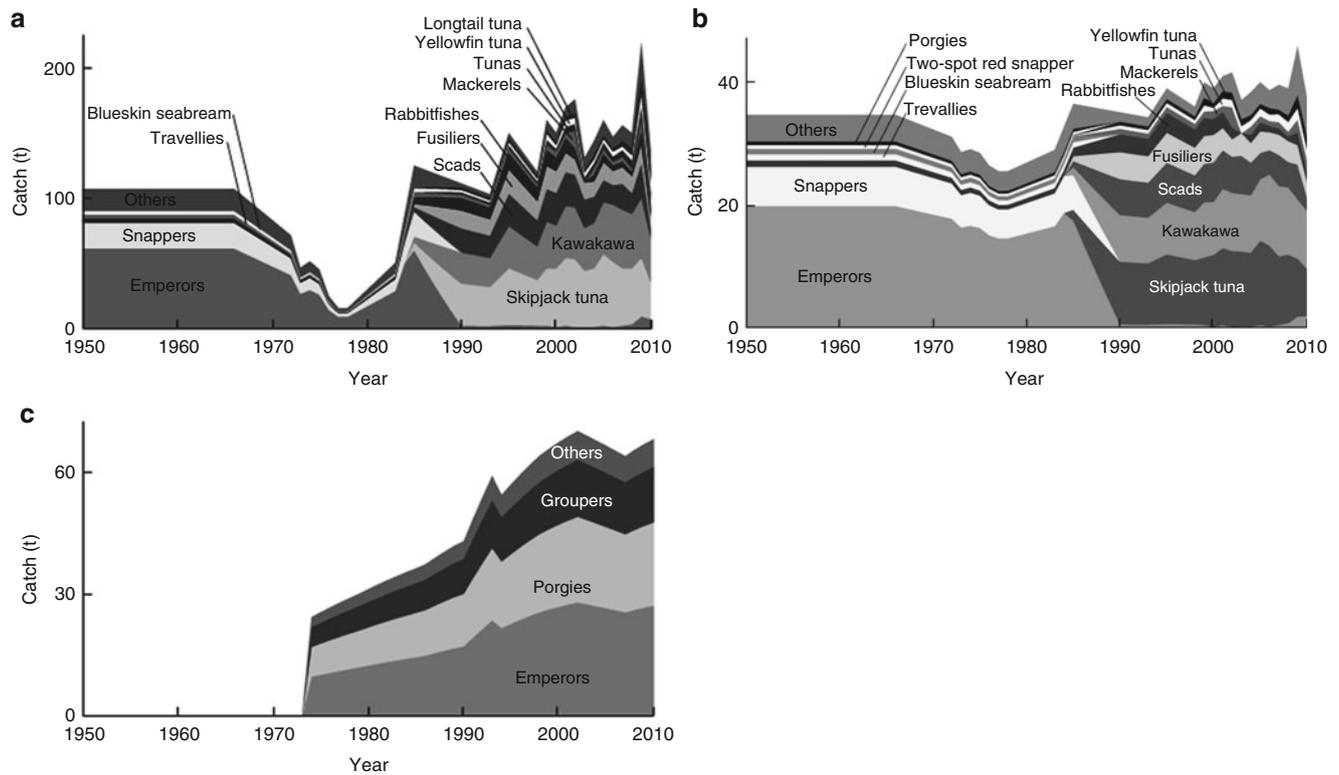


Fig. 7.6 Catch composition of (a) artisanal (b) subsistence and (c) recreational fisheries of Jordan in the Gulf of Aqaba from 1950 to 2010

Jordan. One source of discrepancy is the fact that the official data refer to a larger spatial area (FAO area 51) than is suitable for management. For the period after Jordanian fishing in Saudi Arabia ended, the reconstructed catch is 148 % of that reported to the FAO. We note that such ‘official’ underestimates are common (see contributions in Zeller and Haprer 2009).

The sharp decline of the Jordanian fisheries catch in the 1970s and 1980s may be due to political instability, but also may be a result of phosphate dust emissions (PERSGA 2006), compounded by harmful fishing practices. Jordan has substantial phosphate mines. Industrial pollution of the marine environment is a recurrent theme on the Jordanian side of the Gulf of Aqaba, and affects fishery catches (IRIN 2006). Tourism is an important contributor to the local economies (Al Ouran 2005), and it will be impacted if pollution and excess fishing continue to harm the reefs which form major fish habitats in the inner Gulf of Aqaba.

It will be beneficial to strike a balance between industrial development, fisheries and tourism for the inner Gulf of Aqaba which will permit the coexistence of these sectors, along with a revival of the natural habitats and their fauna and flora. Examples exist of such beneficial coexistence, one being Monterey Bay, in California, USA, which experienced

a tourism-led revival following its near destruction by a succession of out-of-control industries (Palumbi and Sotka 2010). This may serve as a model for the inner Gulf of Aqaba.

Sources and Methods

The total marine catches by Jordan within its EEZ in the Gulf of Aqaba were estimated for the period from 1950 to 2010. The required data were primarily obtained from government reports and the scientific literature. Since the fisheries of Jordan are dominated by artisanal fisheries, which use selective gear (PERSGA 2002), there is no discarded catch or, if it exists, it is negligible. Emphasis was given to ‘hard’ estimates of the catch of distinct fisheries, which were used as ‘anchor points’ (Zeller et al. 2006, 2007) between which estimates for missing years could be obtained by interpolation. The reconstructed catch derived here is proposed as an improvement over the data currently available. All our estimates are conservative and our assumptions explicitly stated. A brief account of the catch reconstruction procedure for each sector is presented below. A spatial distribution of the catch is given at www.seararoundus.org.

Artisanal Fishery

For some years, the Jordanian Red Sea fisheries data were obtained from peer-reviewed articles, government reports and grey literature. The catch estimates for years without sources were derived by interpolation between years with known catch. Also, the 1965 value was carried back to 1950, as the fishing fleet and environmental conditions have experienced few changes from 1950 to 1964 (Barrania 1979). After 1985, the fishery statistical reporting ceased and the catch values available were based on researchers from Jordanian universities (PERSGA 2002). These values match what are available in the FAO database for the later years. Thus, the FAO values were used from 1998 to 2010.

The landings in the Jordanian port of Aqaba prior to 1985 included both catches in Jordanian waters and catches from Saudi Arabian waters up to 300 km south of Aqaba. In 1985, access to these southern fishing grounds ceased, as did the collection of fisheries statistics by the government (PERSGA 2002). Until 1984, approximately half of the catch was obtained in Saudi Arabian waters (Barrania 1979) and thus only half of the reconstructed catch was applied to the Jordanian catch. The other half which was caught in Saudi waters was accounted in Saudi Arabia's catch reconstruction (see Chap. 6).

In addition to fishing in foreign waters, there are mentions of high spoilage rates due to low handling standards and insufficient amount of ice to preserve the catch. Estimated rates of spoilage ranged from 0.4 % to 54 % (Barrania 1979). The values from 1972 to 1978 included spoilage, whereas the data for the previous years did not. A conservative estimate of 19 %, calculated by taking the average spoilage values from 1972 to 1976, was added to the catch in all years prior to 1972.

Finally, the reconstructed catch was disaggregated into major taxa. There were two sources of catch composition data, one for the early period (Barrania 1979) and for the later period (1998–2010) from the FAO database. The Jordanian fishery in the Gulf of Aqaba had two distinct periods: before and after 1985. This coincides with the time the fishers were allowed to operate in the waters of neighboring countries (mainly in Saudi waters), or not. When they fished outside their waters, most of the local fishers were focused on inshore and coral reef fishes (Barrania 1979). Once they were prevented from fishing outside of Jordanian waters, in 1985, most of their catch focused on pelagic fishes (PERSGA 2002). Accordingly, the composition from 1950 to 1984 was calculated based on the data from Barrania (1979). Only local names were available in the report and their corresponding scientific and English common names were obtained from the matching names tables in Chap. 10,

FishBase (Froese and Pauly 2012) and Dr. Dori Edelist (University of Haifa, Israel, pers. comm.). The report by Barrania (1979) had catch composition estimates for only eight of the taxa, while the rest were put under 'others'. However, local names for some of the components of the 'others' were available, and we assumed a value of 0.3 % for each of the taxa for which we were able to find the corresponding scientific names in our sources; only the rest were categorized under 'others'. The FAO catch composition was used from 1998 to 2010. From 1990 to 1997, the values of 1998 were used. From 1985 to 1989, we interpolated the catch composition to allow a relatively smoother transition of the fishery from inshore coral reef to pelagic. Although there is evidence that the fishery switched its target fishes from reef-associated to pelagic, it is unrealistic to assume the shift happened within a year, as there are capital investment and technical issues that need to be considered. We allowed 5 years for the shift to occur.

Subsistence Fishery

The catch of the subsistence fishery consists of two components, the first is the catch of small boats mainly for direct consumption by the fishers' families and communities. A small portion of their catch may be sold or bartered. These catches are not reported at all. The second component of the subsistence catch is part of the catch of the larger boats that is consumed by the crew and given to family and friends. For the small boats it was calculated based on a survey (Barrania 1979), where it was estimated that a total of about 12 boats made day trips and caught 6–10 kg (average 8 kg·day⁻¹). We assumed the total number of fishing days per year to be 250 and thus could compute the total catch to be 24 t·year⁻¹. For the bigger boats, we assumed that 10 % of their catch was consumed by crew and/or given to family members. The percentages used to calculate the artisanal fishery catch composition were used to calculate the composition of subsistence catch composition as well, because they employ similar gears.

Recreational Fishery

A recreational fishery exists in the Jordanian Gulf of Aqaba and it is growing fast (FAO 2003). However, data on its size and catches do not exist. The recreational fishery catch was estimated using the population of Aqaba, the main coastal settlement on the Jordanian coast, taken from www.populstat.info and Wikipedia (2012). Data were not available for the whole time series, and interpolation was used to fill the

gaps. The recreational fishery was assumed to start in 1974, after the war between Israel and Arab countries in 1973, referred to as '6th of October War', so zero was assigned from 1950 to 1973. From 1974 onward, it was calculated using a participation ratio of 0.08, based on the regional value of 0.12 (Cisneros-Montemayor and Sumaila 2010). Note the participation ratios in Cisneros-Montemayor and Sumaila (2010) are given for the whole countries in percentages. In our calculations, we used population size of only Aqaba, the main coastal settlement because the coastal people are the ones to be involved more in recreational fishing than people far from the coast. The participation ratio was adjusted for the population size of Aqaba using the ratio of Aqaba population to the total Jordanian population from 1974 to 2010, which was 1.5 % (i.e., the total population is 65 times that of Aqaba). Hence the participation ratio for Jordan in total (0.12 %) was multiplied by 65, making the participation percentage only for Aqaba to be 8 %. In addition, we assumed that recreational fishers go fishing a total of 15 days · year⁻¹. As for the catch rate, we assumed a rate of 1 kg · day⁻¹ for 1974 and 0.5 kg · day⁻¹ for 2010. The rate was interpolated between those 2 years. Finally, the annual recreational fishery estimate was calculated as a product of population, participation ratio, number of days per year, and catch rate. The catch composition of recreational fishery was adapted from Saudi Arabia's recreational fishery in the Red Sea, where emperors accounted for 40 %, sea breams 30 %, groupers 20 % and 'others' 10 % (see Chap. 6).

Comparing Reconstructed Catches with FAO Statistics

The reconstructed catches, i.e., what were caught in the EEZ's of Jordan and excluding what were caught in other countries' EEZs, were compared to the data for Jordan in the FAO database. Since the subsistence and recreational fisheries were not reported at all, only the reconstructed artisanal catches were compared to the FAO data. In order to be able to compare taxon by taxon, the FAO data, when only totals were given, were divided into the components using the ratios in the reconstructed catches. For any taxon, if the amount in the reconstruction was higher than its value in the FAO database, the difference is assigned as 'unreported catch'; if it is the opposite, then it is 'over-reported catch'. The part of the reconstructed catch that is accounted in the FAO data is referred as 'reported catch' in our result.

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