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Abstract

In addition to its main coast on the Mediterranean Sea, Israel has the very short coast on Red Sea, in the northern, inner part of the Gulf of Aqaba. The fisheries catch taken within the small Exclusive Economic Zones (EEZ) of Israel, in the Gulf of Aqaba is presented, based on catch estimates reconstructed from a variety of published papers, government and non-government sources for the years 1950–2010, and compared with the catch it 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. Israel's total catch in its Red Sea EEZ was less than 100 t·year⁻¹ in the early 1950s, increased until it reached its peak of around 300 t·year⁻¹ in the early 1980s, then decreased abruptly (when Israel signed a peace treaty with Egypt and left the Sinai Peninsula) to around 100 t·year⁻¹ in the late 2000s. Overall, the estimated reconstructed catch of Israel from 1950 to 2010 was 1.4 times what is reported in the FAO database after accounting for the fact that, from 1957 to the early 1970s, and Israeli vessels operated in Eritrean waters, but pooled their landing with those from the Israeli EEZ. This catch reconstruction with explicitly stated procedures and assumptions, accounting all the sectors comprehensively, should serve as a starting point to improve the quality of the data and for better management of resources.

Keywords

Time series • Fisheries • Catch • Catch composition • Mis-reported catch • Israel • Red Sea • Gulf of Aqaba

Introduction

Israel shares the north tip of the Gulf of Aqaba, Red Sea, with Jordan. It has small Exclusive Economic Zone of 29 km² (Fig. 8.1). This unique region harbors one of the world's northernmost coral reef ecosystems (Khalaf and Disi 1997; MoE 2002; Loya 2004) and is characterized as hypersaline, with waters averaging 42 psu (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 (Sheppard et al. 1992), but also increase its susceptibility to pollution, which, jointly

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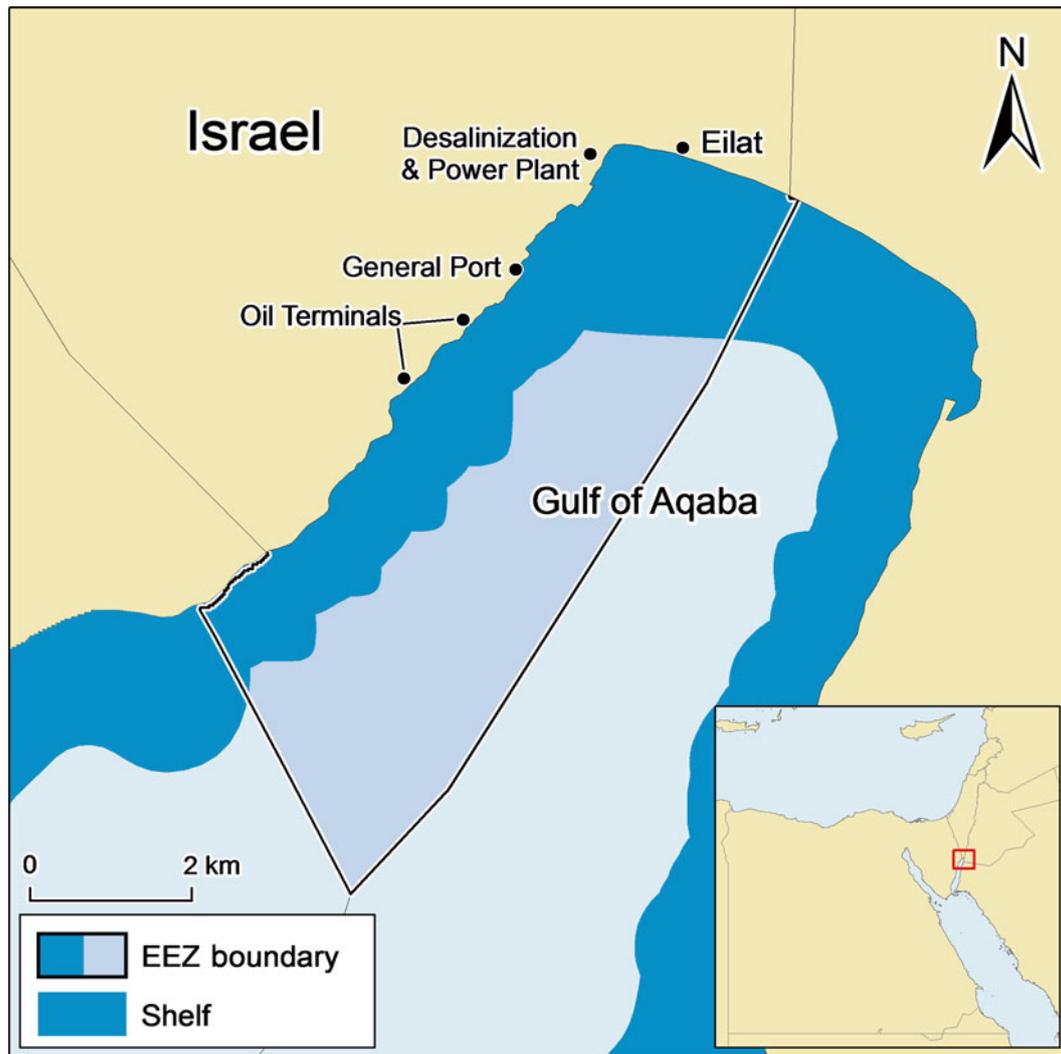


Fig. 8.1 The shelf areas, Exclusive Economic Zone (EEZ) and major sites of Israel in the Gulf of Aqaba, Red Sea

with overfishing, affect the diversity and abundance of the fish stocks, as well as the health of the coral reefs (Tellawi 2001; Loya 2004). Eilat is the major settlement and is the focus of coastal tourism along the Israeli Red Sea coast (Fig. 8.2). As Israel has a relatively high income level, the coast is highly developed for tourism and the population of Eilat has increased dramatically in the last few decades (Loya 2004).

Although the Israeli fishery in the Gulf of Aqaba is small, it should not be ignored. Rather, like all fisheries, it needs to be properly documented and catches reported on regular basis. A reliable assessment of the fisheries in the inner Gulf of Aqaba cannot be done using only the catch data which Israel submit to the Food and Agriculture Organization (FAO) of the United Nations (Pauly and Zeller 2003). As for other countries and territories, it is necessary to ‘reconstruct’ historic catch trends to understand the evolution of Israel’s Red Sea fisheries (Zeller et al. 2006, 2007). Hence, in this chapter, we present an estimate of the Israeli catch in the

Gulf of Aqaba by reconstructing the catches from a variety of sources. A comprehensive account is given for each fishery sector. We first present a brief introduction of the ecosystem and the fisheries, then the catches and their composition are given. The sources and methods used for catch reconstruction are presented at the end of the chapter.

Coral Reef Ecosystem

Israel’s Red Sea coast is fringed with diverse and spectacular coral reefs (Fig. 8.3). These reefs are among the most northern of western Indo-Pacific coral reefs. The semi-enclosed nature of the Red Sea gives it unique characteristics resulting in high endemism (Ormond and Edwards 1987; Sheppard et al. 1992; Khalaf and Disi 1997; MoE 2002; Loya 2004). The coral reefs of the Gulf of Aqaba are among the best studied reefs in the world in general and in

Fig. 8.2 The Red Sea coast of Israel is a popular tourist destination (Photo: Sasi Horesh/Israel HaYom)



Fig. 8.3 A diverse coral reef in the Gulf of Aqaba, Israel (Photo: Daviddarom, Wikipedia Commons)



the Red Sea in particular, and over 50 % of the coral reef ecology papers published on the Red Sea deal with the Gulf of Aqaba, although it represents less than 2 % of the area of the Red Sea (Bahartan et al. 2010; Berumen et al. 2013). Nevertheless, there are many issues that remain understudied, and which need attention if an understanding of the ecology of the coral reefs of the region is to be attained (Loya et al. 2014); fishing is among the least studied issue in the region.

Notably, these issues concern the many stressors to the health of the coral reefs in the Gulf of Aqaba, due to natural environmental disturbances such as extreme low tides and above average water temperatures, which result in coral bleaching and mortality (Loya 2004). Another set of issues is

related to stresses from human activities, either direct (e.g., diving) or indirect, originating from terrestrial activities. These factors have degraded the health of coral reefs of Israel in the Gulf of Aqaba especially in the shallow, easily-accessible areas (Hawkins and Roberts 1994; Loya 2004). The coral reefs along the short Israeli coastline (around Eilat) are among the most frequently ‘dived’ reefs in the world, involving over 250,000 dives \cdot year $^{-1}$ (Zakai and Chadwick-Furman 2002). The impacts are mainly raising sediments during diving and direct breakage. Such perturbations have resulted in a high percentage of algal cover (up to 72 %) in shallow reefs off the coast of Eilat, while in the nearby area of Aqaba turf cover is only around 6 % (Bahartan et al. 2010). Also, studies in the Gulf of Aqaba showed that coral

recruits are negatively correlated to algal biomass (Stambler et al. 2008).

Israel has taken major management steps to improve the health of the coral reef ecosystems in its coastal waters. Some practical actions include the complete cessation of sewage pollution from the city of Eilat since 1995 and the 2008 closure of sea bream farms, which had been a major source of nutrient enrichment (Loya 2004; Stambler et al. 2008). Israel has declared the area of the shallow fringing reefs (ca 1.2 km long) in its Gulf of Aqaba as a nature reserve. In fact, it was the first nature reserve in Israel, declared as early as 1960 (Loya 2004).

Fisheries

In 1949, Israel conducted an experimental fishing expedition from the port of Eilat which confirmed the potential for a commercial fishery in the region, previously exploited only by poorly-documented traditional fisheries. Due to the limited area available for fishing (Farid 1984), Israel expanded its fishery beyond the inner Gulf of Aqaba, south to the coast of Eritrea beginning in 1957 and continued until the beginning of the 1970s when it stopped due to political instability in the region (Ben-Tuvia 1968; Giudicelli 1984). The predominant gears utilized by fishers in Israel are gill-nets, and trammel nets (Ben-Tuvia 1968). In the past, beach seines were used but they are now illegal. The few active fishing boats are 7–11 m long (Shapiro 2007). The fishing vessels used to fish in the Eritrean waters were larger trawlers with higher capacity than the boats used in Israeli Gulf of Aqaba waters (Ben-Yami 1964). The Gulf of Aqaba is not very suitable for trawl fishing as it has narrow shelf directly adjacent to very deep waters. The limited shallow waters are also covered with coral reefs and rocky bottoms. Thus all fishing is done by small scale fisheries using small boats and it occurs

in the northernmost coast, where the bottom is covered in seagrass rather than coral reefs.

The fisheries in the Israeli part of the Gulf of Aqaba can be divided into three sectors. The main sector is the artisanal fishery, which accounts for the majority of the catch. The artisanal fishers use mainly gill-nets and trammel nets as well as some traps. They rarely set their nets in or close to the coral reef areas to target reef fishes such as snappers, and groupers. More often, they target pelagic fishes such as mackerels and tunas or demersal fish such as goatfishes and rabbitfish (Sarig 1982; Shapiro 2008). The artisanal fishery was reduced from 12 licenced vessels in 2007 to only 5 currently. The second sector is the subsistence fishery, which includes small fishing operations where the catch is mainly for direct consumption, and not for sale. This type of fishery is declining in Israel as its society is becoming more affluent. However, we include in this group the catch by the artisanal fishery that is consumed by the crew or given to family and friends, which can be substantial (Snovsky and Shapiro 2004). The third sector is the recreational fishery, which is relatively recent and is a leisure activity. Recreational fishing has gained prominence as Israeli income increased (Zakai and Chadwick-Furman 2002), and is practiced both by the coastal communities in and around Eilat and by tourists visiting the area, who pay to go on fishing trips in the Gulf of Aqaba and target mostly tuna.

Fisheries Catches

The reconstructed total catch of Israel in the Gulf of Aqaba increased continuously from its low value of a little more than 60 t·year⁻¹ at the beginning of the 1950s to a peak of 346 t in 1980 (Fig. 8.4). Thereafter, it exhibited more fluctuations and remained at relatively lower values, except for a smaller peak in 1996. There are large discrepancies between

Fig. 8.4 Total catch of the Israeli fishery in the Gulf of Aqaba by sectors and the total catch Israel reported to FAO from 1950 to 2010

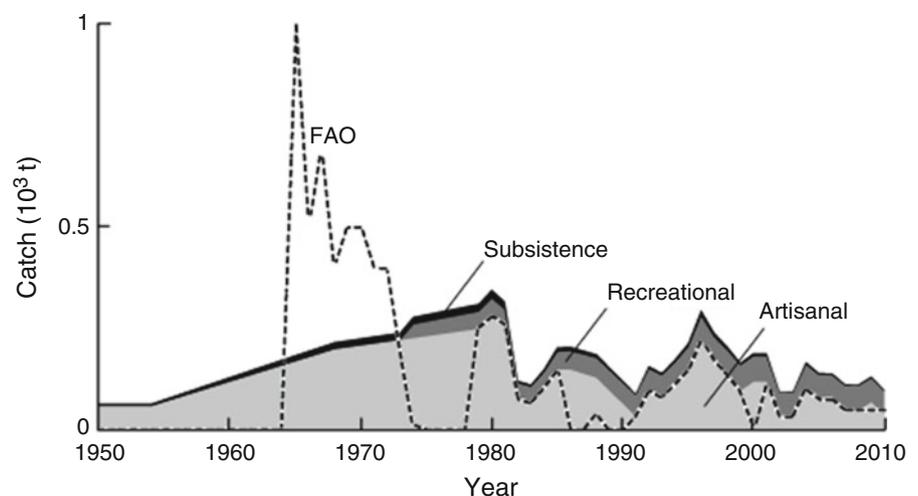
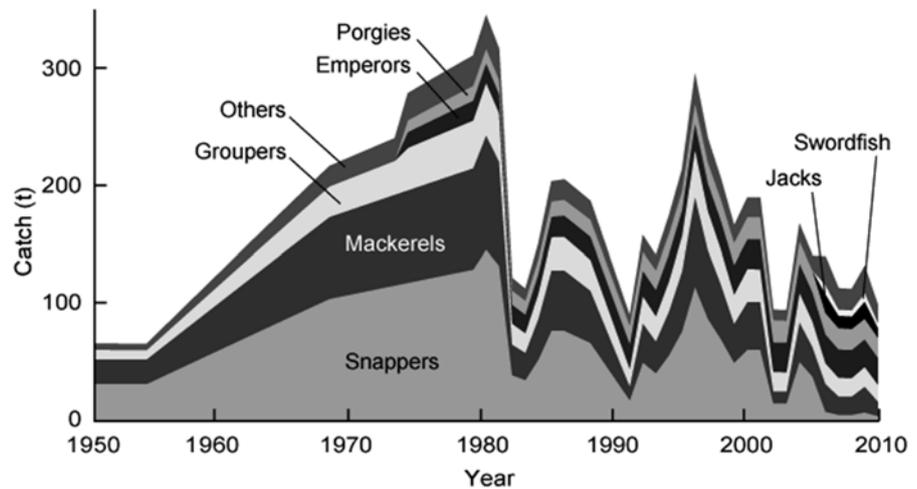


Fig. 8.5 Composition of the total catch of the Israeli fisheries in the Gulf of Aqaba from 1950 to 2010



the reconstructed catch and the data submitted to FAO by Israel, with the latter ranging from zero catches from 1950 to 1964 to a peak of 1,000 t in 1965. While the early catches of zero show the absence of reporting and do not mean there was no fishing, the high values include what Israel caught outside its EEZ, in the Eritrean EEZ, because FAO's catches are categorized by FAO's 'statistical area', and the entire Red Sea falls into one of these statistical areas (the Western Indian Ocean). However, our catch reconstruction focuses on the use catch data for ecosystem management, which makes it imperative to report the EEZ where the catch originated, preferably with a clear indication who caught the fish as well. Thus, the Israeli catches from Eritrean waters are reported in the catch reconstruction of Eritrea (see Chap. 4). Starting 1979, the FAO data matched with the artisanal catches, the only sector reported to FAO, except when the FAO values were zero, which again was due to lack of reporting.

The artisanal sector had the highest contribution to the reconstructed total catch of the Israeli fishery in the Gulf of Aqaba, contributing 76 %. The second was the recreational fishery with 18 %; the subsistence fishery (6 %) was last (Fig. 8.4). Artisanal and subsistence fisheries operated for the entire period, 1950–2010, while the recreational fishery began only in 1974, it shares a good proportion of the total catch at the present.

Overall, the reconstructed catch was 1.4 times the catches reported to FAO. If the years where Israel was fishing in Eritrean waters, from 1958 to 1968, are excluded from the analysis, the reconstructed catch is 1.8 times the catches reported to FAO. The unreported catch accounts for 62 % of the reconstructed catch. The reported catch (part of the reconstructed catch accounted in the FAO data) represented only 38 %.

The catch composition of the total catch reflected more or less that of the artisanal fishery. The contribution of snappers (Lutjanidae) was reduced from 47 % in the artisanal fishery

to 38 % in the total catch and that of mackerels (tuna-like) fishes was also reduced from 32 % to 26 %. The contributions of these taxa were reduced by an increased contribution of the recreational fishery, but they still were the dominant taxa in the total catches (Fig. 8.5).

When we look at the sectors separately, the catch composition of the artisanal fishery was dominated by snappers (Lutjanidae) accounting for 47 % of the reconstructed total catch. The second most important group was pelagic species mackerels (Scombridae), with a contribution of 32 % and groupers (Serranidae) was third with 12 % (Fig. 8.6a). These three groups accounted for more than 90 % of the reconstructed total catch. The diversity of the total catch was higher in the later years with some taxa, mainly pelagic, that were not dominant in the early years were represented with a higher percentage in the later years. The catch composition of the subsistence fishery was the same as that of the artisanal fishery (Fig. 8.6b), because the catch composition ratios used in the artisanal fishery were used for the subsistence fishery as well.

The total recreational catch estimate for Israel in the Gulf of Aqaba was generally low, a maximum of 63 t · year⁻¹ in the early 2000s. It increased continuously until it reached its peak and then declined slowly (Fig. 8.6c). As compared to the Israeli recreational fishery in Mediterranean, where the catch of recreational fishery was comparable to the that of the artisanal fishery (Edelist et al. 2013), our estimate for the Gulf of Aqaba was very conservative; only 24 % of the artisanal catch. The composition of the recreational fishery was dominated by three taxa.

Some of the fluctuations of the fisheries are attributed to political instability in the region. The magnitude of the fishery being small, it does not get a lot of attention from the government to assess and manage the resource, especially compared to the resources allocated to coral reef conservation in Eilat. For effective policies to manage the fisheries to be developed and implemented, consistent time series data

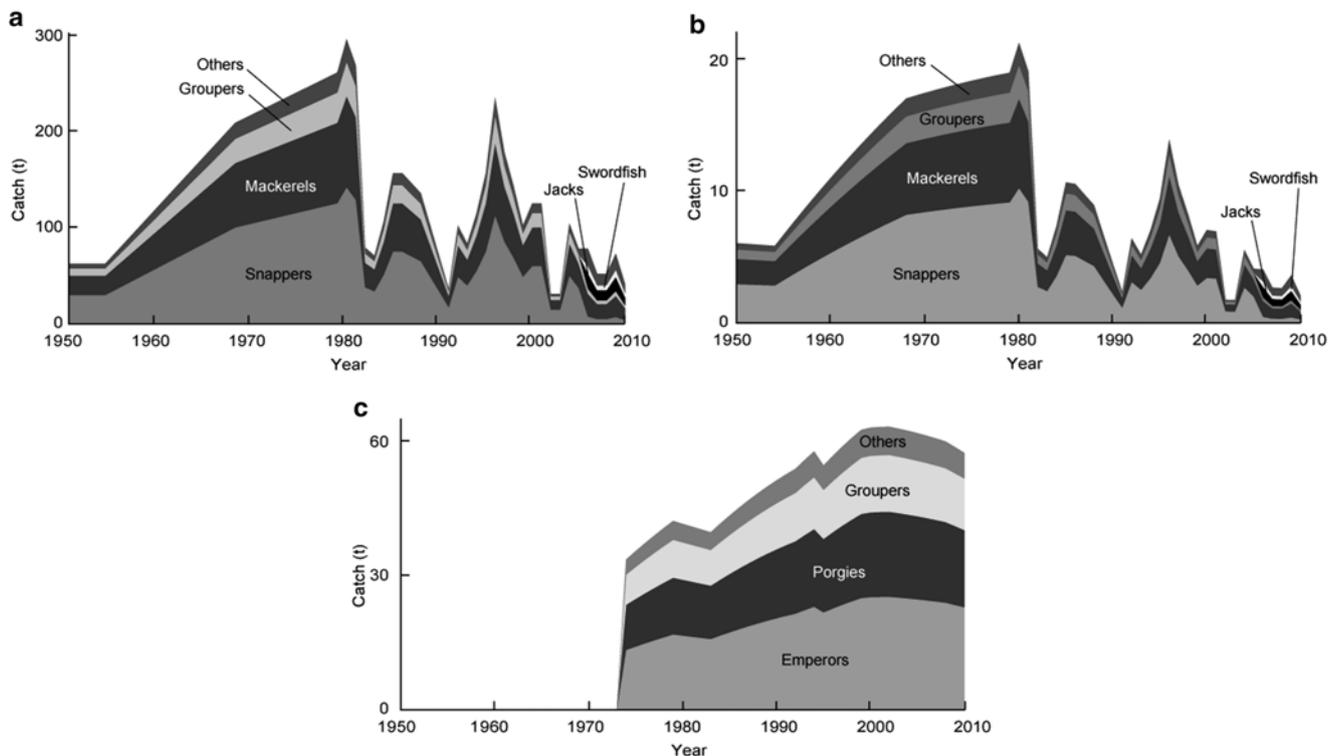


Fig. 8.6 Catch composition of (a) artisanal (b) subsistence and (c) recreational fisheries of Israel in the Gulf of Aqaba from 1950 to 2010

are essential (Caddy and Gulland 1983; Tesfamichael 2012). This study showed differences between the reconstructed catch and data supplied to the FAO by the Israeli Ministry of Agriculture. One source of discrepancy is the fact that the ‘official data’ is for a larger spatial area (an FAO area) than what we are trying to reconstruct (an EEZ), and therefore do not necessarily refer to Israeli waters, but also to waters further south, in Eritrea. However, even for the period after fishing in the southern Red Sea waters ended, the reconstructed catch is 65 % higher than what Israel reported to the FAO; such ‘official’ underestimates are common (Zeller and Haprer 2009).

Sources and Methods

The total marine catches of Israel 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 fishery is dominated by artisanal fisheries, which use selective gear, 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. A spatial distribution of the catch is given at www.seararoundus.org.

Artisanal Fishery

Fishery catch data were obtained from ‘*Bamidgeh*’, a publication of the Israeli Department of Agriculture for some years between 1954 and 1985, after which we used reports from ‘*The Fisheries and Aquaculture of Israel*’. The 1954 total catch estimate, from Cohen (1957), was carried back to 1950 as the gear and fishing grounds appear to have remained similar during those years. The following sources were used for 1968 (Ben-Tuvia 1968), 1979 and 1980 (Sarig 1982), 1986 (Sarig 1987), 1988 (Anonymous 1992), 2003 (Snovsky and Shapiro 2004), 2004 (Shapiro 2005), 2005 (Shapiro 2006), 2006 (Shapiro 2007) and 2007 (Shapiro 2008). For periods where data were missing, FAO data were used selectively. The FAO data for Israel have some inconsistency, mainly reports of zero catches for some periods; however, we were able to get non-zero estimates from national sources. On the other hand, for some periods, the catch values reported in the FAO database matched the sources from the Israeli fishery administration. It is safe to conclude that Israel reported its fishery catch in the Red Sea accurately to FAO,

for some periods, vis-à-vis its national reports. Thus, we used FAO data from 1981 to 1985 because the FAO data and other sources for neighboring years (1979, 1980 and 1986) were the same. Similarly, FAO data were used from 1991 to 2002 and 2008. FAO data were not used for 1955–1967, 1969–1978, 1987, 1989–1990, where FAO data contained numerous zero catches. Instead the catches were estimated using interpolation. For 2009 and 2010, data from Israeli Department of Fisheries Statistical Yearbooks, DoFSY (Dr. Dori Edelist, pers. comm.) were used; these values differed from the FAO dataset.

The composition of the catch, predominantly comprised of snappers was obtained from Sarig (1982) and was used from 1950 to 2005. However, since 2006, the catch composition changed, as pelagic species started to become abundant in the catch. Thus, for 2006–2010, catch composition data obtained from DoFSY (Dr. Dori Edelist, pers. comm.) were used. Israel fished in Eritrean waters starting in 1958 (Ben-Tuvia 1968; Sarig 1969). Since these catches originated from Eritrean waters, they are reported in the Eritrea catch reconstruction (see Chap. 4 for details on this fishery).

Subsistence Fishery

Israel publishes its annual fishery statistics for its fishery in the Gulf of Aqaba, and that is also what is reported to FAO, at least for most years. The reports clearly state that the data do not include part of the catch that is consumed by the crew and catch given to families and friends (Snovsky and Shapiro 2004). This constitutes the subsistence fishery in our report. The subsistence catch in the Israeli Gulf of Aqaba fishery was estimated as a percentage of the artisanal catches. Based on interviews with fishers (Dr. Dori Edelist, pers. comm.), 5 % of the total catch of artisanal fishers is consumed by the crew or given freely to family and friends, which was used as an anchor point for 2010. As observed in other Red Sea countries, the ratio is generally higher for earlier years (see other chapters in this volume). We assumed 10 % in 1950. The ratio was interpolated from 1950 to 2010. The composition of the subsistence fishery was adapted from that of the artisanal fishery.

Recreational Fishery

The recreational fishery of Israel in the Gulf of Aqaba was calculated based on the population of its largest coastal city, Eilat on the Red Sea coast. The recreational fishery was assumed to start in 1974, after the 1973 war. A participation ratio of 0.12 was used in the calculations (Cisneros-Montemayor and Sumaila 2010) and the number of days fished per year was assumed to be 20; these data were applied

to the population of Eilat, which had an average of a little less than 1 % of the total Israeli population from 1974 to 2010. We assumed 1 % and multiplied the participation ratio by 100. The catch rate per day was assumed to be $1 \text{ kg} \cdot \text{day}^{-1}$ for 1974 and $0.5 \text{ kg} \cdot \text{day}^{-1}$ in 2010. Catch rates were interpolated for the intervening years. The catch composition of the 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 of Israel in its Red Sea EEZ were compared to the catch data reported for Israel 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. Large quantities of brush-tooth lizardfish (*Saurida undosquamis*) and narrow-barred Spanish mackerel (*Scomberomorus commerson*) catches were reported in the FAO data, mainly from 1965 to 1972, which were higher than the reconstructed catch. This is the period when Israel fished in Eritrean waters, and thus they were excluded from the taxon-to-taxon comparison as they were deemed to be caught outside the Israeli EEZ. For other taxa, if the amount in the reconstruction was higher than its value in the FAO database, the difference was assigned as 'unreported catch'; if it was the opposite, then it was considered '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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