

MISSING SECTORS FROM BAHRAIN'S REPORTED FISHERIES CATCHES: 1950-2010¹

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ABSTRACT

This study applies previously established catch reconstruction approaches to re-estimate total marine catches for Bahrain from 1950 to 2010. Utilizing all available quantitative and qualitative data from both peer-reviewed and grey literature, combined with conservative assumptions and interpolations, the catches for all Bahraini marine fisheries are estimated. When accounting for catches from discards, illegal fishing, recreational catches, and other missing small-scale sectors, these estimates suggest that data supplied to the FAO by Bahrain potentially underestimate catches by a factor of 5 since 1950. Incomplete and under-reported data can lead to mismanaged fish stocks which is particularly problematic in the case of Bahrain, which is small, and thus shares many stocks with other Gulf countries.

INTRODUCTION

Bahrain is the smallest of the Persian Gulf states and the only island country in the region (Figure 1). Archipelagic in nature, Bahrain consists of about 40 low lying islands, with the 55 km long and 18 km wide Bahrain Island being the largest; consequently, Bahrain has a rich maritime history that includes fishing (CBD 2012) and pearling, as evidenced by its 'Pearling Trail', a UNESCO World Heritage Site. Due to the wide range of seasonal variation in hydrological parameters in the Persian Gulf (Longhurst 2007), as well as the small area of Bahrain's Exclusive Economic Zone (EEZ), a significant number of fish species utilize Bahrain's waters on a seasonal basis. Consequently, Bahrain shares many of its fish fauna with other Gulf countries (Randall *et al.* 1978; Carpenter *et al.* 1997; also see FishBase [www.fishbase.org]).

Despite the historical presence of large-scale shrimp fishing, fisheries were of minor economic importance (prior to the discovery of oil in the 1960s) and now are valued mostly for their cultural contribution. Possibly because of the minuscule contribution of fisheries to the economy (0.4% of GDP), their management receives little attention, and regulations are not strongly enforced, and thus largely ineffective.

The main fishing gears used are shrimp trawls, gillnets, large wire traps (Arabic: *gargoor*) and hook-and-line. All commercial fishing is conducted as single-day trips. In the inshore areas, tidal weirs (Arabic: *hadrah*) are also used. Most of the catch is consumed locally, although some shrimp and crab are exported to neighbouring countries such as Saudi Arabia. A small number of seafood processing companies purchase surplus shrimp not destined for export. Bahrain's landings do not meet the fish demand of its over 1.3 million inhabitants, and therefore must be supplemented by imports.

Habitat destruction from coastal development, compounded with ill-enforced fisheries regulations, has led to a number of challenges for fisheries. Land reclamation is particularly problematic because fishermen are forced to fish further out and into Qatar's EEZ, leading to illegal catches and violent standoffs (Mahdi 2010). Other challenges include the deployment of banned gears such as driftnets

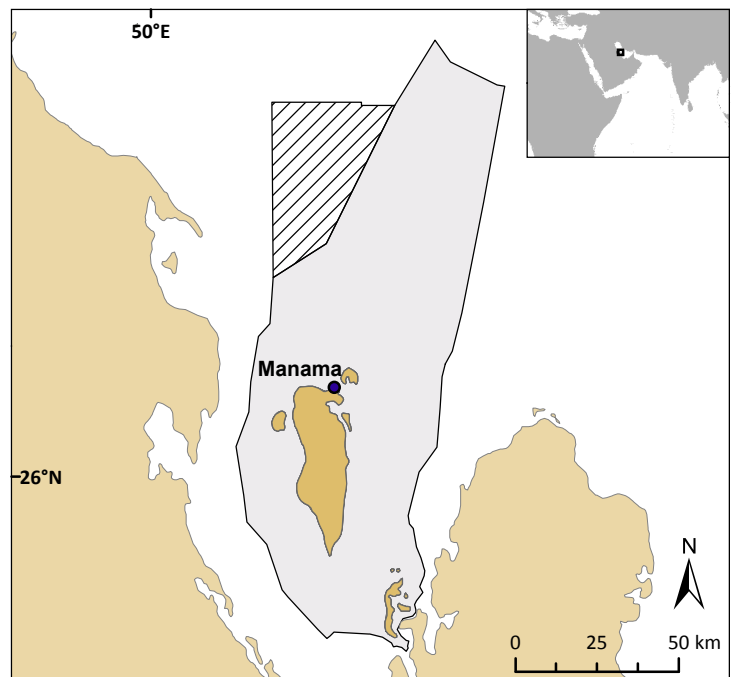


Figure 1. Map of Bahrain; showing the extent of its EEZ in grey; including the joint-regulation zone with Saudi Arabia (strippes area).

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and the operation of unauthorized foreign vessels in Bahrain's EEZ. Bahrain also has a rapidly growing recreational fisheries sector (Uwate *et al.* 1994), which may be taking large quantities of commercially important species, but is unregulated and therefore unreported.

Species composition of landings has changed over time, masking the decline of traditionally exploited species such as orange-spotted grouper (*Epinephelus coioides*) and penaeid shrimps, which have been offset by increased catches of blue swimming crab (*Portunus pelagicus*), a species that was previously discarded, but is now being retained to meet demand from a growing immigrant community. Catches of more desirable species and shrimp have declined dramatically.

METHODS

This contribution follows the conceptual framework of the catch reconstruction as outlined by previous studies (Zeller *et al.* 2006; Zeller *et al.* 2007; Jacquet *et al.* 2010; Le Manach *et al.* 2012).

Using Google Earth, Al-Abdulrazzak and Pauly (2013), estimate 880 ± 57 *hadrah* were operating in Bahrain in 2005, generating an annual catch of $17,125 \pm 5,147$ t. These estimates are 8.7 times larger than what is reported to FAO for Bahrain in 2005. Since the number of *hadrah* is not known to have substantially fluctuated in the last five decades, the total reported catch from 2005 (1,960 t) was subtracted from all years, and the estimated catch (17,125 t) was added instead. From 1950-1964, reported landings were less than 1,960 t and therefore applying this method resulted in slightly lower overall catches (i.e., less than 17,125 t). Although it is known that *hadrah* catches have not fluctuated much in the last five decades, less information is known regarding the 1950s. Therefore, we kept the methodology the same for the entire time period, as it is not unreasonable to assume that catches may have been slightly lower in those early years. Species composition was estimated from data supplied by the Ministry of Fisheries in Bahrain (A.H. Al-Radhi, pers. comm., Directorate of Fisheries Resources).

To estimate discards by the shrimp trawlers, the shrimp to fish ratio of 1:15 reported by Abdulqader (2002) was applied to obtain the total by-catch. Abdulqader (2002) and Kelleher *et al.* (2005) estimate that Bahrain's discard rate was 24% in the 2000s. It was assumed that more discarding occurred at the start of the fishery, thus a conservative discard rate of 80% was applied from 1950-1979, followed by 50% from 1980-1999, and 24% from 2000-2010. A 3-year moving average was applied for smoothing and species composition ratios were applied from the Abdulqader (2002) study.

A number of sources reporting on the border disputes between Qatar and Bahrain highlight illegal fishing by Bahraini fishermen in Qatar's EEZ (e.g., Lessware and Mahdi 2010; Mahdi 2010; Khatri 2012). Here it is assumed that illegal fishing took place since the start of the border dispute in 1980, and that illegal fishing amounts to only 2% of commercial catch in the period from 1980 to 2010. Species composition were applied based on landed catch ratios.

Driftnets were banned in 1998 after complaints from trap fishermen that trawlers were operating in shallow water and cutting their floats (De Young 2006). Despite the ban, illegal driftnets for narrow-barred Spanish mackerel continue to be used (Uwate and Shams 1996, 1997; Abdulqader 2010) and pose a significant problem. It is conservatively assumed that since the 1998 ban, illegal catches by driftnets constitute 1% of total reported catch.

Uwate *et al.* (1994) conducted a survey of recreational fishermen and estimated that recreational catch amounts to 4% of commercial catch. It was assumed that this percentage was the same since the start of reporting and therefore was applied from 1950-2010. Because no data were available on species composition, species composition ratios from Kuwait were applied to the reconstructed recreational catch.

As in other Gulf countries, fishers are migrant labourers from Southeast Asia and Bahrain who make very little incomes, and therefore have a high incentive to fish for subsistence. From 1960-2010 foreign fishers made up 0.0046% of the population. It was assumed that fishers take $5 \text{ kg} \cdot \text{week}^{-1}$ for subsistence purposes, extrapolated from the start of the oil boom in 1960 until 2010. Because these take home catches are composed of less desirable species, subsistence catches were assigned species composition based on discarded species.

RESULTS AND DISCUSSION

For the period of FAO reporting, 1950-2010, estimated fisheries catches were almost 5 times what is reported by the FAO on behalf of Bahrain. Reconstructed catches for Bahrain totalled 1,877,300 t over the 1950-2010 period compared to 379,238 t reported by FAO.

Catch data as reported by FAO on behalf of Bahrain suggest a steady increase in catches from 800 t in 1950 to a peak of 16,359 t in 2009, before a slight decrease in 2010. In contrast, reconstructed time series data suggest a fluctuating increase in catches throughout, with a sharp peak of 50,600 t in 1996. Catches declined until 2001 and then increased up to 2010.

The catch of recreational fisheries is likely underestimated, for two reasons. First, the study of Uwate *et al.* (1994), which formed the basis of the estimates presented here, is likely outdated at present. Bahrain's population has strongly increased in recent years leading us to predict that participation has also greatly increased. Second, the study, which was conducted by people working for Bahrain's Fisheries Directorate, was only carried out in selected ports, not all ports that service recreational fisheries. Other sources (e.g., Uwate and Shams 1996; De Young 2006) highlight the significance of recreational catches in Bahrain, but without providing tonnage. However, the study estimates catches to be only 4% of all commercial catches. Ultimately, this value was chosen in order to remain conservative.

Discards, as reconstructed here, were substantial, and on average accounted for 28% of total estimated catches each year (Figure 2a; Appendix Table A1). Bahrain's by-catch to trawled shrimp ratio of 15:1 is nearly 3 times the global average and highlights the need for concern regarding the ecological and economic impacts of this wasteful practice (Alverson and Hughes 1996; Kelleher *et al.* 2005).

The four main taxa caught by Bahrain are Siganidae (15.7%), *Portunus pelagicus* (15.5%), Clupeidae (7.4%), and *Pelates quadrilineatus* (4.7%) (Figure 2b; Appendix Table A2). Juveniles of commercially important species make up the majority of by-catch and *hadrah* catches, which may lead to growth overfishing.

This reconstruction supports growing concern over the status of Bahrain's fisheries. Although catches appear to be increasing, it is more likely that the declines are masked by previously discarded species being retained. Masked declines, coupled with shared stocks, unsustainable fishing practices through illegal driftnets and high discard rates all point to stocks that are overfished. In addition, Bahrain's population has essentially doubled in the last decade, from 638,000 in 2000 to 1.3 million in 2010, placing enormous pressure on the country's natural resources.

In addition, this reconstruction indicates poor data coverage for Bahrain's officially reported catch series. The reconstruction undertaken here accounts for missing sectors, including discards, illegal and recreational catches, and offers a more complete accounting for *hadrah* catches. Thus, the reconstructed time series better reflects the catches extracted from Bahrain's marine ecosystems. Although there is some uncertainty surrounding the estimates, assumptions in this report are conservative throughout and illustrate more likely historical trends and patterns.

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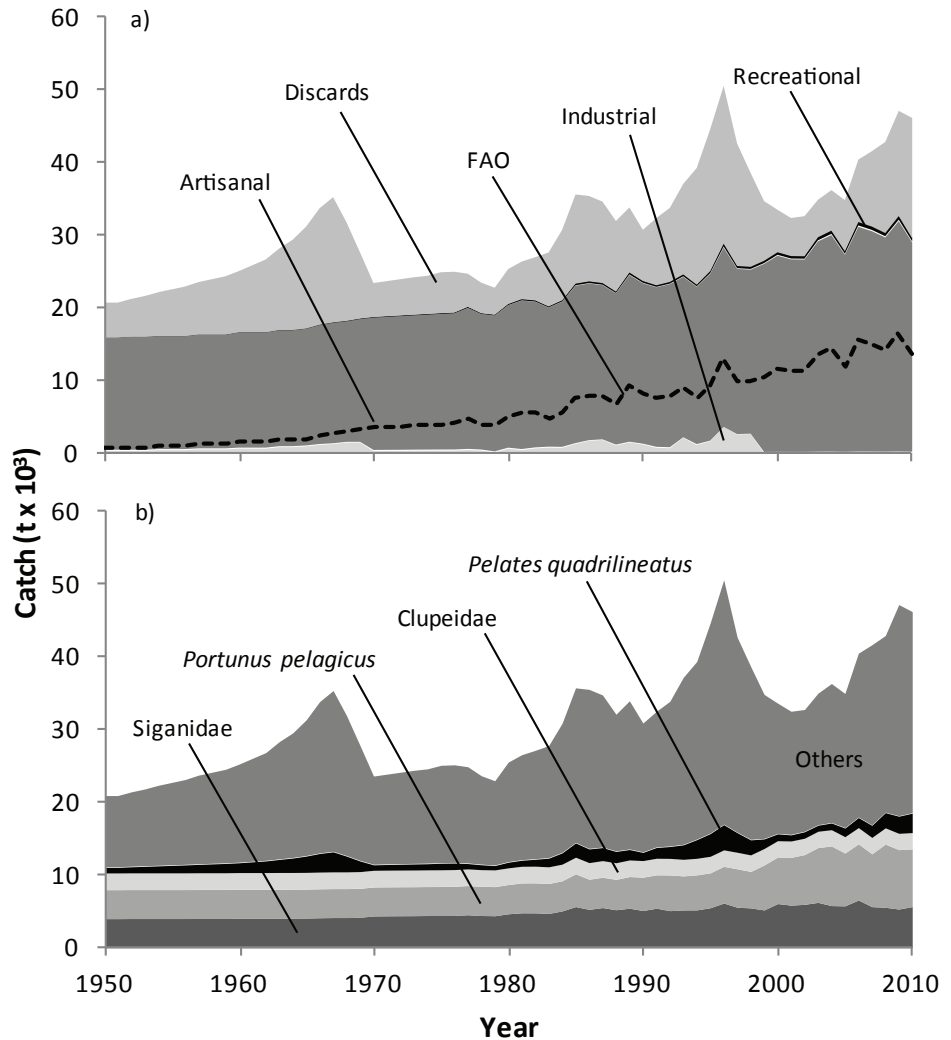


Figure 2. Total reconstructed catch for Bahrain by a) sector (with comparison to FAO data), and b) major taxa, 1950-2010. Note that subsistence catches were included on the sector graph (a) but are not visible (too small).

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Appendix Table A1. FAO landings vs. total reconstructed catch (t) for Bahrain, 1950-2010, as well as catch by sector.

Year	FAO landings	Total reconstructed catch	Industrial	Artisanal	Subsistence	Recreational	Discards
1950	800	20,800	400	15,600	0	32	4,800
1951	800	20,800	400	15,600	0	32	4,800
1952	900	21,300	400	15,700	0	36	5,200
1953	900	21,700	400	15,700	0	36	5,600
1954	1,000	22,200	500	15,700	0	40	6,000
1955	1,000	22,600	500	15,700	0	40	6,400
1956	1,000	23,000	500	15,700	0	40	6,800
1957	1,200	23,600	600	15,800	0	48	7,200
1958	1,200	24,000	600	15,800	0	48	7,600
1959	1,200	24,400	600	15,800	0	48	8,000
1960	1,500	25,100	700	16,000	2	60	8,400
1961	1,500	25,900	700	16,000	2	60	9,200
1962	1,500	26,700	700	16,000	2	60	10,000
1963	1,800	28,200	900	16,100	2	72	11,200
1964	1,800	29,400	900	16,100	2	72	12,400
1965	2,000	31,200	1,000	16,200	2	80	14,000
1966	2,500	33,800	1,200	16,500	2	100	16,000
1967	2,800	35,300	1,300	16,700	2	112	17,200
1968	3,000	31,800	1,500	16,700	2	120	13,500
1969	3,300	27,700	1,500	17,000	2	132	9,100
1970	3,500	23,500	380	18,300	3	140	4,700
1971	3,600	23,800	390	18,400	3	144	4,800
1972	3,700	24,000	400	18,500	3	148	5,000
1973	3,800	24,300	420	18,500	3	152	5,200
1974	3,900	24,500	430	18,600	3	156	5,300
1975	4,000	25,000	440	18,700	3	160	5,600
1976	4,084	25,000	440	18,800	3	163	5,600
1977	4,837	24,800	530	19,500	4	193	4,600
1978	4,000	23,500	440	18,700	4	160	4,200
1979	3,801	22,800	180	18,800	4	152	3,700
1980	5,115	25,400	690	19,700	4	205	4,800
1981	5,747	26,400	500	20,500	4	230	5,200
1982	5,594	27,000	730	20,100	5	224	5,900
1983	4,812	27,700	830	19,200	5	192	7,400
1984	5,599	30,800	810	20,100	5	224	9,700
1985	7,763	35,700	1,330	21,800	5	311	12,300
1986	8,057	35,400	1,730	21,700	5	322	11,700
1987	7,842	34,700	1,840	21,300	5	314	11,200
1988	6,736	32,000	1,120	20,900	6	269	9,700
1989	9,207	33,900	1,520	23,000	6	368	8,900
1990	8,105	30,800	1,250	22,200	6	324	7,000
1991	7,553	32,400	810	22,100	6	302	9,200
1992	7,983	33,800	760	22,600	6	319	10,200
1993	8,958	37,100	2,130	22,200	6	358	12,400
1994	7,628	39,300	1,190	21,800	7	305	16,000
1995	9,389	44,600	1,660	23,100	7	376	19,500
1996	12,940	50,600	3,570	24,800	7	518	21,700
1997	10,050	42,600	2,570	22,800	7	402	16,800
1998	9,849	38,600	2,630	22,700	7	394	12,900
1999	10,620	34,700	110	26,000	8	425	8,200
2000	11,718	33,500	120	27,100	8	469	5,800
2001	11,230	32,400	110	26,600	8	449	5,200
2002	11,204	32,700	110	26,600	9	448	5,500
2003	13,638	34,900	140	29,100	9	546	5,200
2004	14,489	36,200	140	29,900	10	580	5,600
2005	11,854	34,900	120	27,300	11	474	7,000
2006	15,595	40,400	160	31,100	11	624	8,600
2007	15,015	41,600	150	30,500	12	601	10,400
2008	14,175	42,900	140	29,600	13	567	12,500
2009	16,359	47,100	160	31,900	14	654	14,500
2010	13,491	46,200	130	28,900	15	540	16,600

Appendix Table A2. Total reconstructed catch (t) for Bahrain by major taxa, 1950-2010.

Year	<i>Siganidae</i>	<i>Portunus pelagicus</i>	<i>Clupeidae</i>	<i>Pelates quadrilineatus</i>	Others ^a
1950	4,000	3,940	2,270	768	9,800
1951	4,000	3,940	2,270	768	9,800
1952	4,010	3,940	2,270	832	10,200
1953	4,010	3,940	2,270	896	10,600
1954	4,010	3,940	2,270	960	11,000
1955	4,010	3,940	2,270	1,024	11,400
1956	4,010	3,940	2,270	1,088	11,700
1957	4,020	3,940	2,270	1,152	12,200
1958	4,020	3,940	2,270	1,216	12,600
1959	4,020	3,940	2,270	1,280	12,900
1960	4,050	3,940	2,270	1,344	13,500
1961	4,050	3,940	2,270	1,472	14,200
1962	4,050	3,940	2,270	1,600	14,900
1963	4,060	3,940	2,270	1,792	16,200
1964	4,060	3,940	2,270	1,984	17,200
1965	4,080	3,940	2,270	2,240	18,700
1966	4,120	3,940	2,270	2,560	20,900
1967	4,140	3,940	2,270	2,752	22,200
1968	4,140	3,940	2,270	2,164	19,300
1969	4,190	3,940	2,270	1,453	15,800
1970	4,360	3,940	2,270	749	12,200
1971	4,380	3,940	2,270	775	12,400
1972	4,390	3,940	2,270	800	12,600
1973	4,400	3,940	2,270	826	12,800
1974	4,420	3,940	2,270	841	13,000
1975	4,430	3,940	2,270	903	13,400
1976	4,440	3,970	2,270	900	13,500
1977	4,530	3,970	2,270	732	13,300
1978	4,430	3,970	2,270	673	12,200
1979	4,390	3,970	2,270	596	11,600
1980	4,660	3,980	2,270	772	13,700
1981	4,790	4,070	2,270	828	14,500
1982	4,790	4,090	2,270	950	14,900
1983	4,710	4,070	2,270	1,188	15,400
1984	5,050	4,100	2,270	1,547	17,800
1985	5,640	4,460	2,270	1,961	21,300
1986	5,270	4,100	2,270	1,878	21,900
1987	5,510	4,130	2,270	1,791	21,000
1988	5,210	4,130	2,270	1,553	18,800
1989	5,420	4,310	2,270	1,431	20,400
1990	5,110	4,530	2,270	1,127	17,800
1991	5,420	4,540	2,270	1,479	18,700
1992	5,090	4,860	2,270	1,628	20,000
1993	5,180	4,630	2,270	1,991	23,000
1994	5,190	4,760	2,270	2,566	24,500
1995	5,490	4,750	2,270	3,120	29,000
1996	6,130	4,990	2,270	3,468	33,700
1997	5,550	5,230	2,270	2,690	26,900
1998	5,470	4,960	2,270	2,066	23,800
1999	5,180	6,120	2,270	1,315	19,900
2000	6,060	6,320	2,270	935	18,000
2001	5,840	6,500	2,270	839	17,000
2002	5,950	6,770	2,270	882	16,800
2003	6,220	7,460	2,270	826	18,100
2004	5,780	8,110	2,270	924	19,200
2005	5,740	7,190	2,270	1,182	18,500
2006	6,540	7,640	2,270	1,378	22,600
2007	5,640	7,190	2,270	1,664	24,800
2008	5,550	8,600	2,270	2,087	24,400
2009	5,310	8,080	2,270	2,357	29,100
2010	5,640	7,850	2,270	2,665	27,700

^a Others category includes 62 additional taxonomic groups.