

Fisheries Centre

The University of British Columbia



Working Paper Series

Working Paper #2015 - 57

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Year: 2015

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RECONSTRUCTION OF MARINE FISHERIES CATCHES FOR FUJAIRAH (UAE) (1950-2010)

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ABSTRACT

Fujairah is one of the seven emirates which constitute the United Arab Emirates (UAE). However, unlike the rest of the UAE, Fujairah has a coastline only on the Gulf of Oman and none on the Persian Gulf. Total marine fisheries catches by Fujairah were estimated from 1950 to 2010, including small-scale commercial fisheries as well as subsistence and recreational catches, and major discards. Total reconstructed catches increased from just over 400 t-year⁻¹ in the 1950s to approximately 20,700 t-year⁻¹ in the 2000s. This estimated catch is 2.1 times the adjusted landings reported by the UAE authorities on behalf of Fujairah for the 1950-2010 time period. Artisanal (i.e., small-scale commercial) landings were reconstructed using information on catch per unit of effort (CPUE) from neighboring provinces of Oman, combined with fishing effort (i.e., number of boats) in Fujairah, as reported in fishery statistics issued by the UAE. Estimates of subsistence catches were obtained based on the number of foreign fishers residing in Fujairah who fish for their own consumption. Recreational catches were estimated based on the recreational fishing participation rate, and discards were obtained using the discard rate of the Omani artisanal fishery. The reconstruction suggested that catches, in Fujairah, are underestimated for the period 1950-2010 which is mostly due to unreported artisanal fishing, but also to the absence of the recreational and subsistence catches and discards from the fisheries statistics.

INTRODUCTION

Fujairah is part of the United Arab Emirates (UAE) but is located on the eastern coast of the country. Unlike the rest of the Emirates with a coastline on the Persian Gulf, Fujairah is the only of the seven emirates with a coast on the Gulf of Oman (www.fujmun.gov.ae). Fujairah has an area of 1,300 km² (www.citypopulation.de) and is mostly mountainous, with plains allowing farming while other Emirates are mostly desert-like. It is warm most of the year, with rainy winters. Fujairah had a population of 163,750 in 2010 (www.citypopulation.de).

Fujairah's economy is heavily based on government grants from Abu Dhabi. Thus, a decade ago, in order to develop its economy, Fujairah created a free trade zone, similar to the one of Dubai, allowing for full foreign ownership of facilities (www.robinsonlibrary.com).

Fujairah's fisheries

The Gulf of Oman is situated to the south of the Strait of Hormuz, and water from both the Arabian Sea to the south and the Persian Gulf to the north circulates past it (Pous *et al.* 2004).

The waters off Fujairah (Figure 1) within an EEZ of 4,370 km², are part of the Gulf of Oman, and are characterized by a rich fish fauna, some of which reef-associated, as well as abundant large pelagic species and small schooling species (Sheppard *et al.* 1992). Several fishing villages dot the coast of Fujairah, whose Ministry of Agriculture and Fisheries (MAF) is responsible of the management and monitoring of fishing activities (Pearson *et al.* 1998).

Fujairah's fisheries are artisanal with fishers deploying diverse types of gears (Table 1) that change according to the target species and seasonally (Pearson *et al.* 1998).

Tarrads use mainly traps, some nets and hook-and-line to catch pelagic and demersal species. In the winter and early spring, *tarrads* are also employed in beach seine fishing for sardines, which are sun-dried and transformed into fertilizer which is then exported. *Lanshs usually* fish in deeper waters than *tarrads* (Pearson *et al.* 1998).

While demersal fish species account for approximately 40% of the landings along the east coast of the UAE, migratory pelagic fish are the most valuable fish targeted along the Fujairahan coast in terms of unit value. Fishing occurs all year, with most landings occurring in winter and spring, and the lowest landings in summer (Pearson *et al.* 1998).

METHODS

Reported catches

Data for reported landings were available for the period 2000-2010 from the national statistical reports of the UAE Ministry of Environment and Water (www.uaestatistics.gov.ae). However, the catch amounts reported therein were reduced by 40%, based on the work of Emirates catch reconstruction Al-Abdulrazzak (2013) showing an over-reporting of the fisheries catches in the UAE. In order to determine the reported catches for the 1950-1999 period, we converted the reduced reported catch amount of the year 2000, i.e., 5,642 t, to a *per capita* catch amount applied to the regional population for that year, i.e., 94,545, and applied the *per capita* catch rate to the obtained population, all the way back to 1950. The resulting approximate reported landings estimates were then used as the 'reported baseline', to which we added unreported artisanal, subsistence, and recreational catches as well as major discards. To estimate unreported small-scale commercial catches, subsistence and recreational catches and discards, we used information from independent and government studies of the UAE (www.uaestatistics.gov.ae) and Oman (Omani Fisheries Statistic Department 2014), the catch reconstruction of the UAE (Al-Abdulrazzak 2013) and while following the general catch reconstruction approach outlined in Zeller *et al.* (2007).

Unreported artisanal catches

To reconstruct unreported small-scale commercial catches, we first identified the catch per unit effort (CPUE) in the Omani regions immediately adjoining Fujairah, from the official statistical reports of the Omani Ministry of Agriculture and Fisheries (Omani Fisheries Statistic Department 2014). Thus, we assumed similar effectiveness and efficiencies between these two neighboring fleets. We also identified the fishing effort in Fujairah, i.e., a number of boats equivalent to 685, for the year 2010 from the national fishing statistical reports of the UAE (www.uaestatistics.gov.ae). Fujairah is bordered by two coastal regions that are part of Oman, i.e., Musaundam in the north and El-Batina in the south, which have the same type of artisanal vessels and the same fishery as Fujairah. The CPUEs for the artisanal fishery in each of these two regions were identified and converted from the catch per boat per trip to catch per boat per year, and then averaged. This average CPUE was decreased from 54 t·boat⁻¹·year⁻¹ to 40 t·boat⁻¹·year⁻¹ in order to remain conservative. This revised CPUE was applied to the fishing effort of 2010 in Fujairah (Table 2). The resulting estimated total catch for 2010 was converted into a *per capita* rate that was applied to the local Fujairah's population for the 1950-2009 period. The unreported artisanal catches were then obtained through subtraction of the reported landings from the estimated total artisanal catches.

Recreational catches

Two types of recreational fishing were considered in this study, i.e., domestic recreational fishing, and recreational fishing by foreign tourists. Their catch was estimated separately then both estimates were added to obtain total recreational catch.

To estimate the domestic recreational catches, i.e., recreational catches by UAE citizens, we converted the total recreational catches for the UAE estimated by Al-Abdulrazzak (2013) to a *per capita* catch applied to

the whole population of the country for each year, beginning from 1960 (i.e., we assumed UAE citizen began fishing recreationally in 1960). This *per capita* was then multiplied by the regional population for each year for the period 1960-2010 (Table 3).

To estimate the recreational catches by foreign tourists, we identified the number of recreational fishing licenses obtained by tourists from 2006 to 2010 from the national official reports (www.uaestatistics.gov.ae) which are assumed to be 'fishing tourists'. The number of tourist fishing licenses was held constant between 2006 and 2010, at 1,311. We assumed that prior to 1960, there was no tourist fishing, and that the increase in foreign tourism was linear from 1961 to 2006. Then, we assumed that each fishing tourist stays an average of two weeks in Fujairah, corresponding to 5 days of fishing with a catch rate of 5 kg-fishing day⁻¹ (Table 4).

Subsistence catches

UAE citizens own domestic fishing vessels, but do not work on these boats. Foreign workers brought into the UAE to work as commercial fishers represent 0.0046% of the country's total population according to Al-Abdulrazzak (2013). We applied this percentage to estimate (foreign) fishers in Fujairah back to 1960 when this pattern of importing labour began. We then assumed that each fisher has been taking home an average of 5 kg of fish, per week for self- and family consumption.

Discards

According to Kelleher (2005), discard rates for Oman are about 1%. We used this to estimate discards of commercial fishing in Fujairah by applying it to the reconstructed artisanal catch of each year from 1950-2010.

Taxonomic disaggregation

The taxonomic disaggregation for both reported and estimated unreported catches was based on the official reports of the Omani government for the neighbouring regions to Fujairah (Omani Fisheries Statistic Department 2014). We calculated the average proportions of each taxon caught in Musandam and El Batina (Table 5), calculated the average of the proportion of each species in the catch (Table 5), and then multiplied the proportions by the annual catch of Fujairah. For subsistence catches and discards we used the same source as for the artisanal fishery. However, taxa were aggregated to the family level for both subsistence catches and for discards. For recreational catches, we identified the most commonly targeted fishes by recreational fishing in Fujairah according to Fishfishme Inc., which has one of the biggest online platforms allowing finding and booking charter trips around the world (www.fishfishme.com), we assumed their percentages according to their importance and popularity in the region (Table 6).

RESULTS AND DISCUSSION

Total marine fisheries catches in Fujairah increased from around 400 t-year⁻¹ in the 1950s to approximately 21,000 t-year⁻¹ in the 2000s (Figure 2a). The estimated catch for the 2000s is 2.3 times the landings reported by the UAE authorities on behalf of Fujairah for the period 2000-2010, i.e., the only period with available fisheries reports for Fujairah (Figure 3).

Until the late 1990s, unreported catches were lower than the reported catches, but this has changed since then, mainly because of the increase of unreported artisanal fishing. Despite the importance of recreational fishing as an attraction for local and international tourists, the recreational catch amounts remain relatively low, as are discards.

The catch composition suggested that Scombridae, i.e., tuna are the most caught taxa in Fujairah, followed by Clupeidae, Carangidae and Engraulidae (Figure 2b).

This catch reconstruction for the period 1950 to 2010 combines the reported artisanal landings along with our best estimates of unreported small-scale, recreational and subsistence catches, as well as estimates of artisanal discards. Some of these estimates are very tentative, but they likely represent a more accurate picture of the total catch volume than omitting these components entirely (which is the default result of not reporting on existing, but unmonitored components).

ACKNOWLEDGEMENTS

We thank Dr. Leith A. Jawad for useful reports, and also acknowledge support from the *Sea Around Us*, a scientific initiative supported by The Pew Charitable Trusts and the Paul G. Allen Family Foundation.

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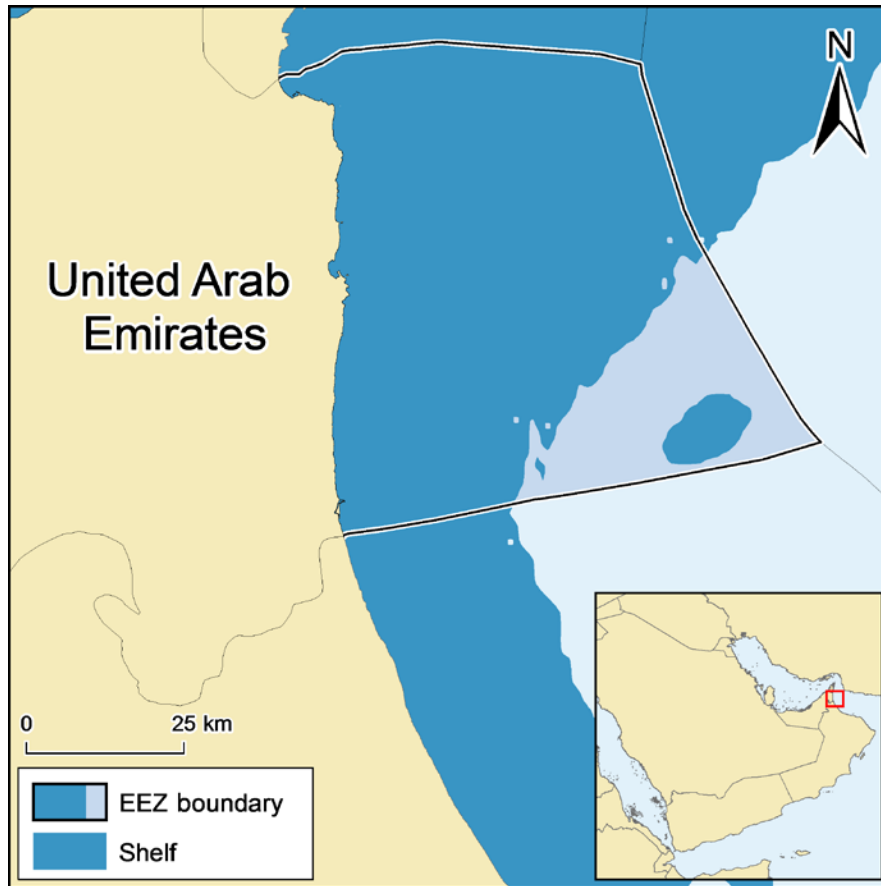


Figure 1. The Exclusive Economic Zone (EEZ) and shelf area (to 2000m depth) for Fujairah, United Arab Emirates

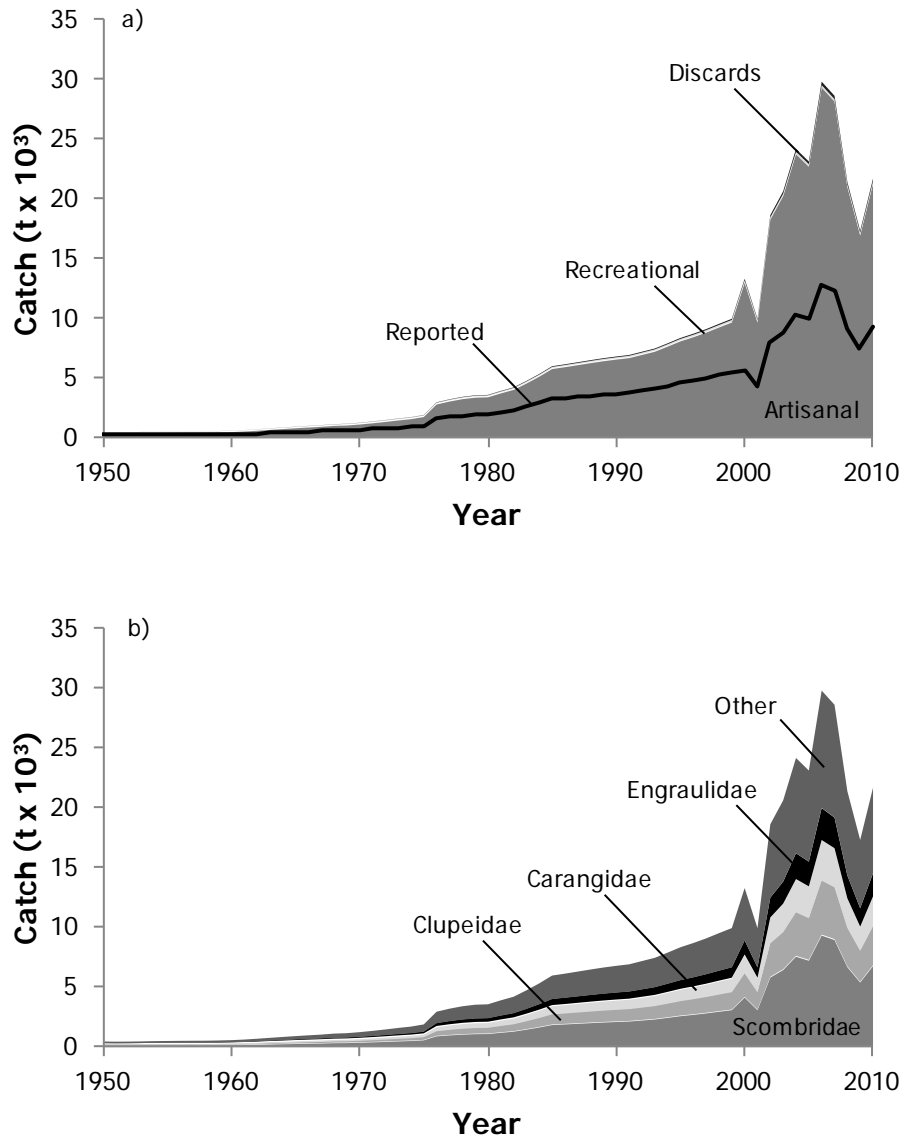


Figure 2. Reconstructed catches for the emirate of Fujairah (UAE) for 1950-2010, by a) fisheries sectors plus discards. Top dark line represents the discards and the middle lighter section is the recreational catches. Subsistence catches are included in the figure, but are too small to be visible. Landings as deemed reported by the UAE to FAO for Fujairah are overlaid as a line graph; and b) by major taxa. Note the 'others' category includes 42 additional taxonomic groups which are not included in the four families shown (see Appendix Table 2).

Table 1. Types of vessels, their gears and their targeted species in Fujairah.

Gear	Targeted species	Type of vessel
Nets (drifts and set)	Pelagic and demersal fish	Small outboard-powered (<i>tarrads</i>)
Traps (<i>gargurs</i>)		
Hook-and-line		
Beach seine		
<i>Lanshs</i> (seines)	Pelagic fish, mostly sardines	Large diesel-powered (<i>dhow</i> s)

Table 2. Key data used to estimate the unreported artisanal fishery of Fujairah

Key data	Value
CPUE in Musandam (t.boat ⁻¹)	64.75
CPUE in Al Batina (t.boat ⁻¹)	43.64
Mean CPUE applied to Fujairah (t.boat ⁻¹)	40.00
Boat in Fujairah in 2010	685.00

Table 3. Data used to estimate domestic and foreign recreational catches (in tonnes) in Fujairah. Values in brackets indicate estimated populations in the years with missing data

Years	Total UAE Population (A)	Regional population (B)	Recreational domestic national catches (C)	Recreational Domestic catches (D) D=C/A* B	Fishing tourists in Fujairah	Recreational catches by foreign tourists
1960	90,000	(4,823)	11	0.60	(0)	0.0
1961	98,000	(5,252)	12	0.66	(29)	0.7
1962	109,000	(5,841)	14	0.73	(57)	1.4
1963	122,000	(6,538)	15	0.81	(86)	2.1
1964	134,000	(7,181)	17	0.90	(114)	2.9
1965	146,000	(7,824)	18	0.98	(143)	3.6
1966	157,000	(8,414)	20	1.05	(171)	4.3
1967	167,000	(8,950)	21	1.12	(200)	5.0
1968	181,000	9,700	23	1.21	(228)	5.7
1969	201,000	10,000	25	1.25	(257)	6.4
1970	232,000	(10,770)	29	1.34	(285)	7.1
1971	272,000	(11,722)	34	1.47	(314)	7.8
1972	322,000	(12,805)	40	1.60	(342)	8.6
1973	383,000	(13,957)	48	1.74	(371)	9.3
1974	453,000	15,000	57	1.87	(399)	10.0
1975	533,000	16,655	67	2.08	(428)	10.7
1976	623,000	26,500	78	3.31	(456)	11.4
1977	724,000	(28,837)	90	3.60	(485)	12.1
1978	827,000	(30,702)	103	3.84	(513)	12.8
1979	926,000	(31,872)	116	3.98	(542)	13.5
1980	1,015,000	32,189	127	4.02	(570)	14.3
1981	1,091,000	(35,231)	136	4.40	(599)	15.0
1982	1,156,000	38,000	144	4.75	(627)	15.7
1983	1,215,000	(42,983)	152	5.37	(656)	16.4
1984	1,277,000	(48,374)	160	6.05	(684)	17.1
1985	1,347,000	54,400	168	6.80	(713)	17.8
1986	1,427,000	(55,879)	178	6.98	(741)	18.5
1987	1,515,000	(57,464)	189	7.18	(770)	19.2
1988	1,609,000	(59,054)	201	7.38	(798)	20.0
1989	1,707,000	(60,555)	213	7.57	(827)	20.7
1990	1,806,000	(61,850)	226	7.73	(855)	21.4
1991	1,908,000	63,000	238	7.87	(884)	22.1
1992	2,013,000	(65,502)	251	8.18	(912)	22.8
1993	2,121,000	68,000	265	8.49	(941)	23.5
1994	2,232,000	(72,018)	279	8.99	(969)	24.2
1995	2,346,000	76,180	293	9.52	(998)	24.9
1996	2,471,000	(79,424)	309	9.92	(1,026)	25.7
1997	2,609,000	83,000	326	10.37	(1,055)	26.4
1998	2,753,000	(87,059)	344	10.87	(1,083)	27.1
1999	2,894,000	(90,969)	362	11.36	(1,112)	27.8
2000	3,026,000	(94,545)	379	11.83	(1,140)	28.5
2001	3,132,000	(97,263)	393	12.21	(1,169)	29.2
2002	3,224,000	(99,508)	406	12.54	(1,197)	29.9
2003	3,369,000	(103,345)	424	13.02	(1,226)	30.6
2004	3,659,000	(111,547)	457	13.92	(1,254)	31.4
2005	4,149,000	125,698	508	15.39	(1,283)	32.1
2006	4,876,000	(132,667)	582	15.83	1,311	32.8
2007	5,797,000	(139,826)	675	16.27	1,311	32.8
2008	6,799,000	143,000	775	16.29	1,311	32.8
2009	7,718,000	152,000	866	17.05	1,311	32.8
2010	8,442,000	163,751	937	18.18	1,311	32.8

Table 5. Composition of fisheries catches from Musandam and Al Batina, Oman (%) based on statistical reports of the Omani Fisheries Statistic Department (2014)

Species	Musandam	Al Batina	Mean
Large Pelagics			
Yellowfin tuna	0.7	3.3	4.0
Longtail tuna	20.0	9.6	29.6
Kawakawa	3.8	2.7	6.5
Striped bonito	0.0	0.1	0.1
Frigate tuna	0.7	0.2	0.9
Skipjack	0.0	0.1	0.1
Other tuna	0.5	0.1	0.6
Kingfish	3.5	3.4	6.9
Queenfish	4.5	1.7	6.2
Barracuda	3.4	5.1	8.4
Cobia	0.1	0.3	0.3
Sailfish	0.1	0.8	0.9
Large Jacks	6.0	3.2	9.2
Other	0.6	0.3	0.9
Small Pelagics			
Sardine	5.4	25.4	30.8
Indian Mackerel	6.8	7.3	14.1
Anchovy	11.8	6.3	18.0
Small Jacks	4.5	3.0	7.4
Mullet	0.6	0.3	0.9
Needlefish	1.4	0.4	1.8
Other	0.5	1.2	1.6
Demersal			
Emperor	5.5	3.3	8.8
Seabream	1.9	1.5	3.5
Grouper	4.0	2.4	6.4
Crocker	0.0	0.2	0.2
Sweetlips	1.2	0.8	1.9
Snapper	2.5	0.9	3.4
Jobfish	0.1	1.0	1.1
Rabbitfish	0.3	0.3	0.5
Catfish	0.4	0.4	0.8
Ribbonfish	0.3	0.3	0.7
Other	3.6	3.5	7.1
Sharks & Rays			
Sharks	4.0	2.8	6.8
Rays	0.4	1.8	2.2
Crustaceans			
Cuttlefish	0.3	3.7	4.1
Other	0.8	2.5	3.2

Table 6. Assumed catch composition of the recreational fishery of Fujairah (adapted from Table 5)

Scientific name	Common name	%
<i>Istiompax indica</i>	Black marlin	5
<i>Kajikia audax</i>	Striped marlin	5
<i>Istiophorus platypterus</i>	Sailfish	5
<i>Coryphaena hippurus</i>	Dorado	20
<i>Thunnus albacares</i>	Yellowfin tuna	20
<i>Seriola dumerili</i>	Amberjack	10
<i>Sphyrnaena barracuda</i>	Baracuda	10
Lutjanidae	Red snapper	10
Istiophoridae	Other marlins	5
Others	Marine fishes nei	10

Appendix Table A1. Time series of reported fisheries landings for Fujairah vs. total reconstructed catch (in tonnes), as well as catch by sector and discards.

Year	Reported landings	Reconstructed total catch	Artisanal	Subsistence	Recreational	Discards
1950	224	402	398	-	-	4
1951	217	390	386	-	-	4
1952	221	397	393	-	-	4
1953	230	413	409	-	-	4
1954	243	436	432	-	-	4
1955	249	447	443	-	-	4
1956	256	460	455	-	-	5
1957	259	466	461	-	-	5
1958	262	471	466	-	-	5
1959	272	489	484	-	-	5
1960	288	518	512	0.06	1	5
1961	313	566	557	0.06	4	6
1962	349	634	621	0.07	6	6
1963	390	711	694	0.08	9	7
1964	429	783	763	0.09	12	8
1965	467	855	831	0.09	15	8
1966	502	920	893	0.10	18	9
1967	534	981	950	0.11	21	10
1968	579	1,065	1,030	0.12	24	11
1969	597	1,100	1,062	0.12	27	11
1970	643	1,186	1,144	0.13	30	12
1971	700	1,291	1,245	0.14	33	13
1972	764	1,409	1,359	0.15	36	14
1973	833	1,536	1,482	0.17	39	15
1974	895	1,650	1,592	0.18	42	16
1975	994	1,831	1,768	0.20	45	18
1976	1,582	2,892	2,814	0.32	49	29
1977	1,721	3,145	3,061	0.34	52	31
1978	1,832	3,348	3,259	0.37	55	33
1979	1,902	3,477	3,384	0.38	58	34
1980	1,921	3,513	3,417	0.38	61	35
1981	2,103	3,844	3,741	0.42	64	38
1982	2,268	4,143	4,034	0.45	67	41
1983	2,565	4,681	4,563	0.51	71	46
1984	2,887	5,263	5,136	0.58	74	52
1985	3,247	5,913	5,776	0.65	78	59
1986	3,335	6,074	5,932	0.67	81	60
1987	3,429	6,247	6,100	0.69	84	62
1988	3,524	6,420	6,269	0.71	87	64
1989	3,614	6,585	6,429	0.72	90	65
1990	3,691	6,727	6,566	0.74	93	67
1991	3,760	6,853	6,688	0.75	96	68
1992	3,909	7,125	6,954	0.78	99	71
1993	4,058	7,396	7,219	0.81	103	73
1994	4,298	7,830	7,646	0.86	106	78
1995	4,546	8,279	8,087	0.91	109	82
1996	4,740	8,631	8,432	0.95	113	85
1997	4,953	9,017	8,811	0.99	116	89
1998	5,196	9,457	9,243	1.04	119	94
1999	5,429	9,879	9,658	1.09	123	98
2000	5,642	13,225	12,967	1.13	126	131
2001	4,198	9,875	9,647	1.16	129	98
2002	7,937	18,557	18,240	1.19	132	184
2003	8,792	20,546	20,206	1.24	136	203
2004	10,318	24,091	23,712	1.33	139	239
2005	9,864	23,042	22,669	1.50	144	228
2006	12,740	29,722	29,279	1.59	147	294
2007	12,230	28,539	28,107	1.67	147	283
2008	9,122	21,323	20,963	1.71	147	211
2009	7,363	17,242	16,921	1.82	148	171
2010	9,242	21,604	21,239	1.96	149	214

Appendix Table A2. Total reconstructed catch (t) by major taxa (at family level) for Fujairah, 1950-2010. 'Others' includes 42 additional taxa (20 additional families and a miscellaneous group).

Year	Scombridae	Clupeidae	Carangidae	Engraulidae	Other
1950	126	62	46	36	132
1951	122	60	44	35	128
1952	125	61	45	36	130
1953	130	64	47	37	135
1954	137	67	50	39	143
1955	140	69	51	40	147
1956	144	71	52	41	151
1957	146	72	53	42	153
1958	148	72	54	42	154
1959	153	75	56	44	160
1960	163	80	59	47	170
1961	177	87	65	51	187
1962	198	96	72	57	210
1963	222	108	81	63	236
1964	245	119	89	70	261
1965	267	129	97	76	286
1966	287	139	105	81	309
1967	306	148	112	87	330
1968	332	160	121	94	358
1969	342	165	125	97	371
1970	369	178	135	104	400
1971	402	193	147	113	435
1972	438	211	160	124	475
1973	478	230	175	135	518
1974	513	247	188	145	557
1975	570	275	208	161	617
1976	902	437	329	256	967
1977	981	476	358	279	1,051
1978	1,045	506	381	297	1,118
1979	1,085	526	396	308	1,162
1980	1,096	531	400	311	1,175
1981	1,200	581	438	341	1,284
1982	1,293	627	472	368	1,384
1983	1,462	709	533	416	1,561
1984	1,644	798	599	468	1,754
1985	1,848	897	674	526	1,968
1986	1,898	922	692	541	2,022
1987	1,952	948	712	556	2,080
1988	2,006	974	731	571	2,138
1989	2,057	999	750	586	2,193
1990	2,101	1,020	766	598	2,241
1991	2,141	1,039	781	609	2,283
1992	2,226	1,080	812	634	2,373
1993	2,310	1,122	842	658	2,463
1994	2,447	1,188	892	697	2,607
1995	2,587	1,256	943	737	2,756
1996	2,697	1,310	983	768	2,872
1997	2,818	1,369	1,027	803	3,000
1998	2,956	1,436	1,077	842	3,146
1999	3,088	1,500	1,125	880	3,285
2000	4,138	2,014	1,507	1,181	4,384
2001	3,086	1,499	1,125	879	3,286
2002	5,812	2,833	2,115	1,662	6,135
2003	6,436	3,139	2,342	1,841	6,788
2004	7,548	3,683	2,747	2,160	7,952
2005	7,219	3,521	2,627	2,065	7,610
2006	9,316	4,548	3,389	2,667	9,802
2007	8,944	4,366	3,254	2,561	9,414
2008	6,678	3,256	2,431	1,910	7,048
2009	5,397	2,629	1,965	1,542	5,709
2010	6,766	3,299	2,463	1,935	7,140