

RECONSTRUCTION OF DOMESTIC FISHERIES CATCHES IN THE CHAGOS ARCHIPELAGO: 1950-2010¹

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ABSTRACT

The British Indian Ocean Territory (at the centre of which is the Chagos Archipelago) covers 640,000 km² in the central Indian Ocean, halfway between Indonesia and Madagascar. Most islands were used for copra farming from the late 1700s to about 1970 when the plantations were closed and the people moved to Mauritius and the Seychelles. At that time, the largest atoll, Diego Garcia, was turned into an American/British 'Joint Defense and Naval Support Facility'. In April 2010, the U.K. declared the entire EEZ of the Chagos Archipelago a 'no-take' marine reserve. This history is reflected in the catch history, with original Chagossian subsistence catch estimated at 90 t·year⁻¹ for the early 1950s, which declined to zero in 1972; and a recreational fishery by British and US military personnel, which started in 1973 and grew to 100 t·year⁻¹ in the 2000s. Thus, reconstructed domestic catches were likely around 12 times higher than reported data suggest for this time period. These catches, however, are relatively low compared to the large pelagic catches reported as taken by large-scale foreign fleets from these waters, which were reported as over 20,000 t in 2004/2005, and an unknown, but potentially significant illegal catch. These large pelagic catches taken from the same waters by either foreign vessels through licensed access agreements, or illegally, are not considered here. The transition in domestic fisheries from subsistence to recreational documented here will have implied a radical change in targets, from medium-sized reef fish and invertebrates to trophy-type fishes, i.e., larger reef fishes and reef-associated pelagic fish. The diversity of fish in the Chagos Archipelago is now in principle protected from fishing. Given the technology available to the current residents of the Chagos Archipelago, there is a good chance that the 'no-take' part of the Chagos marine reserve can be enforced against would-be illegal fishers.

INTRODUCTION

The British Indian Ocean Territory is 640,000 km², containing the Chagos Archipelago at its centre (Figure 1). The latter contains over 60,000 km² of shallow limestone, including 5 islanded atolls and a greater number of submerged banks and reefs. It was farmed for copra from the late 1700s. Two atolls ceased this activity in the 1930s, the remainder finally closing around 1970, having had persistent financial problems and declining product quality, and because of cold war politics requiring that one atoll, Diego Garcia, becoming a Naval Support Facility.

Occupation during plantation times was possible because of imported staple foods, the protein being produced locally, mainly through fishing and hunting for sea turtles and birds. The present military facility fishes recreationally, but food is generally imported. Diego Garcia's main island contains approximately half of the total landmass – there are about 54 other islands in the other atolls.

During the early days of the British Indian Ocean Territory there was no formal fisheries protection, and an unknown quantity of fish would have been taken; most islands had poachers' camps on them when fisheries protection or regulation began in the late 1990s. From then and until the creation of a large no-take MPA in 2010, fisheries (mostly for tuna) were licensed. All legal fishing ceased in late 2010.

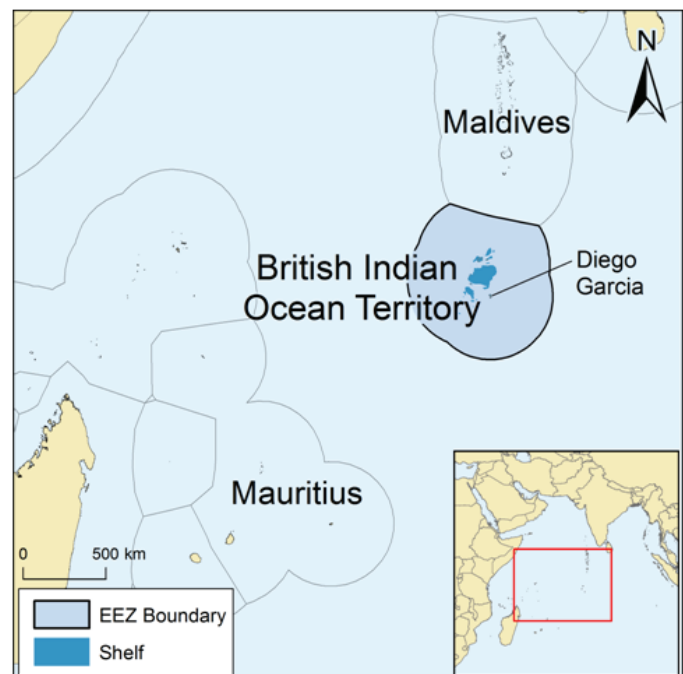


Figure 1. The Exclusive Economic Zone (EEZ) and shelf waters to 200 m depth for the British Indian Ocean Territory. Shown also is the location of Diego Garcia, currently a US/British military installation.

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METHODS

Subsistence fishing

Information on the human population in the Chagos Archipelago (excluding Diego Garcia's military installation as of 1972) was obtained from Wenban Smith (2012). Population data were interpolated for years between years of data to derive a population time series from 1950 to 1972 when all civilian residents were evacuated as part of the UK-US agreement (Table 1).

As this civilian population was directly associated with copra plantations in the Archipelago, and hence were largely employed on a cash basis, there was likely a smaller reliance on subsistence fishing compared to other nearby atoll societies, such as the Maldives. The companies were Mauritian or Seychellois, and supplied food staples to their workers. They fished for the protein. Thus, we assumed the Chagos civilian population had a *per capita* subsistence catch rate of half the estimated Maldives average *per capita* consumption rate of 161 kg·person⁻¹·year⁻¹ (Hemmings *et al.* 2014), i.e., 80 kg·person⁻¹·year⁻¹ (Table 1).

Recreational fishing

Recreational fishing occurs in the Chagos Archipelago only in relation to two opportunities: 1) the military personnel and civilian contractors working on the US military installation on the island of Diego Garcia; and 2) recreational yachts that stop off in the Chagos Archipelago during their transit of the Indian Ocean. As (2) consists of a relatively small number of boats with small crew and relatively short stays, we focused our estimation entirely on recreational fishing by personnel on Diego Garcia. Available data on the number of people stationed on Diego Garcia is difficult to obtain, as much relates to operational security by the US military and is thus not readily accessible. However, The CIA factbook states that in 2004 about 4,000 military personnel and civilian contractors were stationed on Diego Garcia.² GlobalSecurity.org suggests that normally the island is home to about 1,700 military personnel and 1,500 civilian contractors, i.e., around 3,200 personnel.³ The British Foreign & Commonwealth Office indicates that in 2012, the population of Diego Garcia amounted to 2,800 personnel.⁴

As construction of the military installation started in 1971 and major developments were completed by the early 1980s, we assumed zero military personnel or civilian contractors in 1971, increasing to 2,000 personnel by 1985 and remaining at that level to the year 2000. We then assumed an increase to 4,000 in 2001 lasting to 2009 (reflecting increased activities during the Iraq and Afghanistan wars), and a subsequent reduction to 2,800 in 2010 (Table 2).

Data made available by the British Indian Ocean Territory authority within the British Foreign & Commonwealth Office indicated the level of recreational catches for some years. We converted these into hypothetical *per capita* recreational catch rates and applied these to the assumed personnel levels on Diego Garcia to derive a total time series of estimated recreational catches from 1972 to 2010 (Table 2).

Table 1. Subsistence fisheries data for the Chagos Archipelago, excluding the military installation on Diego Garcia, showing derived total subsistence catch for the civilian human population from 1950 to 1972 when the remaining civilians were evacuated. A *per capita* subsistence catch rate of 80 kg·person⁻¹·year⁻¹ was assumed throughout the time period, based on half the subsistence catch rate in the Maldives (Hemmings *et al.* 2014). A dash (-) indicates data interpolation.

Year	Human population ¹	Derived subsistence catch (t)
1950	1,141	91.3
1951	1,121	89.7
1952	1,158	92.6
1953	1,106	88.5
1954	1,142	91.4
1955	1,028	82.2
1956-1957	-	-
1958	985	71.6
1959-1961	-	-
1962	747	59.8
1963	-	-
1964	993	79.4
1965-1966	-	-
1967	797	63.8
1968	807	64.6
1969	577	46.2
1970	680	54.4
1971	630	50.4
1972	0	0.0

¹ Source: Wenban Smith (2012)

Table 2. Assumed and derived population (military personnel and civilian contractors), *per capita* recreational catch rates and total recreational catches on Diego Garcia, from first establishment of the military installation in 1972 to 2010. A dash (-) indicates data interpolation.

Year	Population	Catch rate (kg·person ⁻¹ ·year ⁻¹)	Catch (t)
1971	0	0.0	0.0
1972	-	14.5 ^a	2.1
1973-1984	-	-	-
1985	2,000	-	-
1986-1997	2,000	-	-
2000	2,000	-	47.5
2001	4,000	24.1 ^b	96.4
2002-2009	4,000	24.1	96.4
2010	2,800	24.1	67.5

^a Assumed *per capita* rate based on recreational catch of 28.9 t reported by the British Foreign & Commonwealth Office for latter years, here assumed to apply also as catch rate to 1972 ^b Based on recreational catch of 96.4 t reported by the British Foreign & Commonwealth Office.

² <https://www.cia.gov/library/publications/the-world-factbook/geos/io.html> [Accessed: November 12, 2012]

³ <http://www.globalsecurity.org/military/facility/diego-garcia.htm> [Accessed: November 12, 2012]

⁴ <http://www.fco.gov.uk/en/travel-and-living-abroad/travel-advice-by-country/country-profile/asia-oceania/british-indian-ocean-territory> [Accessed: November 12, 2012]

Subsistence and recreational catch composition

The taxonomic composition for the local subsistence catches as derived in Table 1 was assumed to consist of reef and reef-associated species, as it was assumed that little if any subsistence fishing opportunity in pelagic waters existed. Likely, a substantial portion of subsistence seafood was sourced by women and children engaging in reef gleaning (Chapman 1987; Des Rochers 1992; Lambeth *et al.* 2002; Malm 2009; Harper *et al.* 2013), hence our assumed catch composition reflects this activity, which is generally defined by a predominance of invertebrates (Table 3).

The taxonomic composition of the recreational catches was derived based on information in Zeller *et al.* (2005) which reconstructed recreational catches on Johnston Atoll in the Pacific, that also hosts US government installations with military personnel and civilian contractors (Table 3).

The reconstructed catch data were reconciled with data reported on behalf of the British Indian Ocean Territory (Chagos Archipelago) to the FAO, which consisted only of small tonnages of several species of scombrids and the miscellaneous category 'marine fishes nei'.

Foreign fishing

Foreign fishing in the waters of the Chagos Archipelago has occurred for a long time. These fisheries consist of mainly licensed fisheries for large pelagic species using industrial longline and purse seine gears, but also of un-monitored illegal fishing, e.g., by Sri Lankan vessels (Koldewey *et al.* 2010). Illegal catches were not estimated here, but could be significant and require urgent attention, estimation and public accounting by national and regional authorities (i.e., IOTC). Foreign, licensed large pelagic catches were deemed to be relatively well monitored and were all assumed to be reported landings. Information on catch levels by gear type are also presented in Koldewey *et al.* (2010), with clear indications that longline catches are dominated by Taiwanese and Japanese fleets, while purse seine catches are dominated by Spanish and French vessels. Here, we deem these catches to be reported as part of the FAO and IOTC datasets for the Western Indian Ocean area 51, and were not further considered. However, discarding by these gears, especially longline gears, can be significant, and also warrants closer attention and reporting by the national and regional management entities (i.e., IOTC).

Mauritian fishers are also known to fish on banks within the EEZ of the Chagos Archipelago, at least until concerns about Somali piracy developed. Catches taken by Mauritian fishers within these waters have been estimated elsewhere (Boistol *et al.* 2011). These catches amount to a few hundred tonnes per year (Boistol *et al.* 2011), and were not detailed here.

Table 3. Assumed and derived taxonomic composition of subsistence and recreational fisheries catches in the Chagos Archipelago. Subsistence catches relate to the civilian population associated with copra plantations between 1950 and 1972, while recreational catches relate to military personnel and civilian contractors associated with the US military installation on Diego Garcia (from 1972 to 2010).

Taxon	Subsistence (%)	Recreational (%) ¹
Carangidae	15	25
Scombridae	-	25
Lutjanidae	10	10
Lethrinidae	10	-
Serranidae	15	20
Cephalopods	15	0
Molluscs	15	0
Crustaceans	15	0
Others	5	20

¹ Composition modified from Zeller *et al.* (2005).

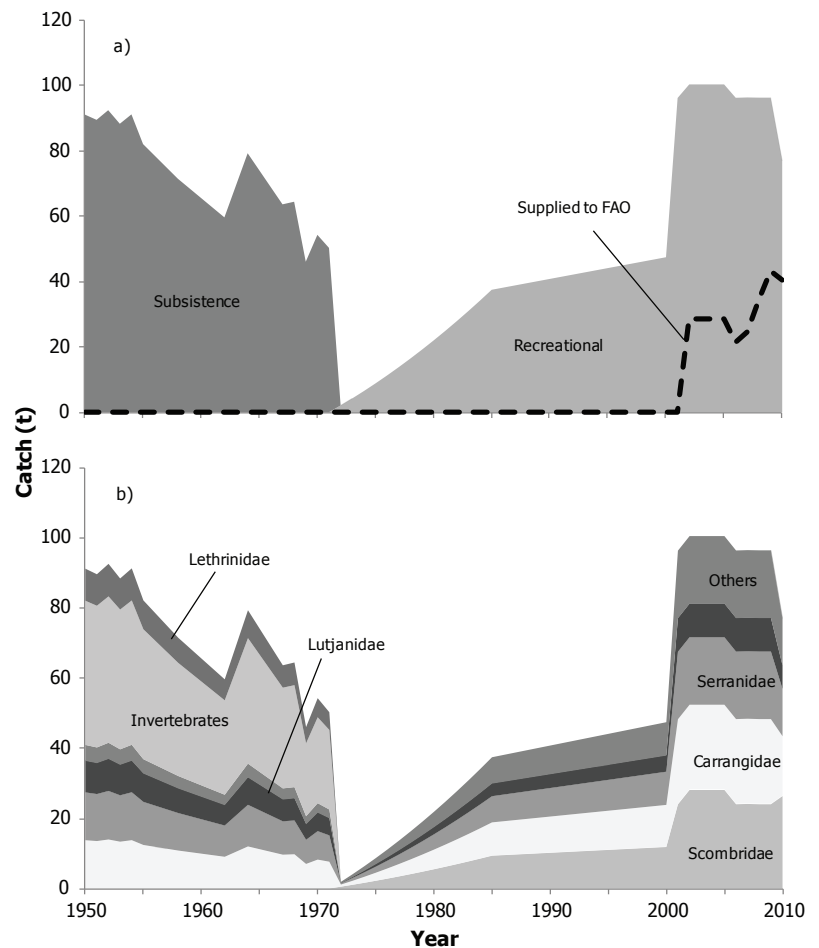


Figure 2. Reconstructed total domestic catches for the Chagos Archipelago/British Indian Ocean Territory, showing (a) estimated subsistence and recreational catches as stacked area graph, with reported data according to FAO overlaid as a line graph; and (b) total reconstructed catches by taxon.

RESULTS AND DISCUSSION

The catch reconstruction of what can be termed ‘domestic’ catches by Chagos Archipelago fisheries in the EEZ or EEZ-equivalent waters of the British Indian Ocean Territory (Figure 1) suggested that over 3,400 t were caught between 1950 and 2010, exclusively by subsistence and recreational fisheries. This contrasts with 286 t being reported by the UK on behalf of the British Indian Ocean Territory to the global community via FAO for the same time period (Figure 2a). Thus, total reconstructed domestic catches were likely around 12 times higher than reported data suggest for this time period.

These catches, however, are low compared to the large pelagic catches reported as taken by large-scale fleets from these waters, which were reported as, for example, over 20,000 t in 2004/2005, and an unknown, but potentially significant illegal catch (Koldewey *et al.* 2010). These large pelagic catches taken from the same waters by foreign vessels through licensed access agreements, or illegally, are not considered here.⁵

The present reconstruction clearly illustrates the fundamental shift from subsistence fishing by the former civilian employees associated with past plantation activities during the first two decades of the present time period, to exclusively recreational fishing by the military and civilian personnel on the only remaining inhabited island (Diego Garcia) over the more recent four decades. Subsistence catches were highest (around 90 t·year⁻¹) at the start of the time period (early 1950s) when the largest number of employees still resided on the plantations (Figure 2a). Subsistence catches declined thereafter to 50-60 t·year⁻¹ (Figure 2a), in line with the declining population associated with the demise of plantations in the Territory and in preparation of the de-population as part of the UK-US agreement to establish a military installation on Diego Garcia.

With the arrival of military engineers and associated personnel, followed later by civilian contractors stationed on Diego Garcia, fishing emerged as a recreational activity for residents. This suggested a gradual increase in recreational catches from around 20 t·year⁻¹ in the early 1980s to over 40 t·year⁻¹ by the 1990s (Figure 2a). Based on the assumption that the number of personnel stationed on Diego Garcia increased substantially with the terrorist events of 2001 and the subsequent wars in Afghanistan and Iraq, we also estimated that recreational catches likely increased to around 90 t·year⁻¹, before declining slightly at the end of the time period due to an assumed draw-down of personnel with the approaching end of US military engagements in Afghanistan and Iraq (Figure 2a).

Taxonomically, the reconstruction suggested that besides readily caught reef fishes such as serranids, lutjanids, lethrinids and reef-associated pelagic (e.g., carangids), invertebrates dominated early subsistence catches, mainly cephalopods, molluscs and crustaceans (Figure 2b). The taxonomic composition of catches changed with recreational fishing, which likely focused more on pelagic species (i.e., reef-associated scombrids and carangids), which are known as challenging species to land on recreational rod-and-reel gears (Figure 2b).

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⁵ *Sea Around Us* is reconstructing global large pelagic catches through a separate process, and the information on this topic derived through the present research, including the information on tuna catches in BIOT presented by Koldewey *et al.* (2010) will be incorporated in this separate process.

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Appendix Table A1. FAO landings vs. reconstructed total catch (in tonnes), and catch by sector, for Chagos Archipelago, 1950-2010.

Year	FAO landings	Reconstructed total catch	Recreational	Subsistence
1950	-	91	-	91
1951	-	90	-	90
1952	-	93	-	93
1953	-	88	-	88
1954	-	91	-	91
1955	-	82	-	82
1956	-	79	-	79
1957	-	75	-	75
1958	-	72	-	72
1959	-	69	-	69
1960	-	66	-	66
1961	-	63	-	63
1962	-	60	-	60
1963	-	70	-	70
1964	-	79	-	79
1965	-	74	-	74
1966	-	69	-	69
1967	-	64	-	64
1968	-	65	-	65
1969	-	46	-	46
1970	0.25	54	-	54
1971	0.25	50	-	50
1972	0.25	2	2	-
1973	0.25	4	4	-
1974	0.25	6	6	-
1975	0.25	9	9	-
1976	0.25	11	11	-
1977	0.25	14	14	-
1978	0.25	16	16	-
1979	0.25	19	19	-
1980	0.25	22	22	-
1981	0.25	25	25	-
1982	0.25	28	28	-
1983	0.25	31	31	-
1984	0.25	34	34	-
1985	0.25	38	38	-
1986	0.25	38	38	-
1987	0.25	39	39	-
1988	0.25	40	40	-
1989	0.25	40	40	-
1990	0.25	41	41	-
1991	0.25	42	42	-
1992	0.25	42	42	-
1993	0.25	43	43	-
1994	0.25	44	44	-
1995	0.25	44	44	-
1996	0.25	45	45	-
1997	0.25	46	46	-
1998	0.25	46	46	-
1999	0.25	47	47	-
2000	0.25	48	48	-
2001	0.25	96	96	-
2002	28.50	101	101	-
2003	28.50	101	101	-
2004	28.50	101	101	-
2005	28.50	101	101	-
2006	21.50	96	96	-
2007	24.50	97	97	-
2008	34.75	96	96	-
2009	43.25	96	96	-
2010	40.50	77	77	-

Appendix Table A2. Reconstructed total catch (in tonnes) by all taxonomic group for Chagos Archipelago, 1950-2010.

Year	Carangidae	Lethrinidae	Lutjanidae	Marine fishes nei	Scombridae	Serranidae	Invertebrates
1950	14	9	9	5	-	14	41
1951	13	9	9	4	-	13	40
1952	14	9	9	5	-	14	42
1953	13	9	9	4	-	13	40
1954	14	9	9	5	-	14	41
1955	12	8	8	4	-	12	37
1956	12	8	8	4	-	12	35
1957	11	8	8	4	-	11	34
1958	11	7	7	4	-	11	32
1959	10	7	7	3	-	10	31
1960	10	7	7	3	-	10	30
1961	9	6	6	3	-	9	28
1962	9	6	6	3	-	9	27
1963	10	7	7	3	-	10	31
1964	12	8	8	4	-	12	36
1965	11	7	7	4	-	11	33
1966	10	7	7	3	-	10	31
1967	10	6	6	3	-	10	29
1968	10	6	6	3	-	10	29
1969	7	5	5	2	-	7	21
1970	8	5	5	3	-	8	24
1971	8	5	5	3	-	8	23
1972	1	-	-	-	1	-	-
1973	1	-	-	1	1	1	-
1974	2	-	1	1	2	1	-
1975	2	-	1	2	2	2	-
1976	3	-	1	2	3	2	-
1977	3	-	1	3	3	3	-
1978	4	-	2	3	4	3	-
1979	5	-	2	4	5	4	-
1980	6	-	2	4	6	4	-
1981	6	-	2	5	6	5	-
1982	7	-	3	6	7	6	-
1983	8	-	3	6	8	6	-
1984	9	-	3	7	9	7	-
1985	9	-	4	8	9	8	-
1986	10	-	4	8	10	8	-
1987	10	-	4	8	10	8	-
1988	10	-	4	8	10	8	-
1989	10	-	4	8	10	8	-
1990	10	-	4	8	10	8	-
1991	10	-	4	8	10	8	-
1992	11	-	4	8	11	8	-
1993	11	-	4	9	11	9	-
1994	11	-	4	9	11	9	-
1995	11	-	4	9	11	9	-
1996	11	-	4	9	11	9	-
1997	11	-	5	9	11	9	-
1998	12	-	5	9	12	9	-
1999	12	-	5	9	12	9	-
2000	12	-	5	10	12	10	-
2001	24	-	10	19	24	19	-
2002	24	-	10	19	28	19	-
2003	24	-	10	19	28	19	-
2004	24	-	10	19	28	19	-
2005	24	-	10	19	28	19	-
2006	24	-	10	19	24	19	-
2007	24	-	10	19	24	19	-
2008	24	-	10	19	24	19	-
2009	24	-	10	19	24	19	-
2010	17	-	7	14	27	14	-

