First Estimate of Unreported Catch in the French Îles Éparses, 1950-2010*

Frédéric Le Manach[1,2†] and Daniel Pauly[1]

[1] *Sea Around Us, Fisheries Centre, University of British Columbia, 2202 Main Mall, Vancouver V6T 1Z4, Canada*
[2] *Institut de Recherche pour le Développement, UMR212 Ecosystèmes Marins Exploités, Avenue Jean Monnet, CS 30171, 34203 Sète cedex, France*
[†] *Current address: BLOOM Association, 77 rue du Faubourg Saint-Denis, 75010 Paris, France*

fredericlemanach@bloomassociation.org; d.pauly@fisheries.ubc.ca

Abstract

In this report, we used the catch reconstruction approach developed by the *Sea Around Us* to estimate the total marine fisheries catch in the EEZs of the Îles Éparses. These islands being uninhabited, there are no records of such fisheries in the official fisheries data published by the Food and Agriculture Organization of the United Nations (FAO), and thus, our reconstruction is entirely comprised of unreported catches. Catches were estimated to around 2,800 tonnes between 1989 and 2010, essentially in the Glorieuses Archipelago. The small-scale artisanal *barques* from Mayotte represented 76.8% of the total, followed by the recreational and semi-industrial handline fisheries, with 14.0% and 6.7%, respectively. *Lutjanus bohar* represented 39.9% of the catch, followed by Serranidae, yellowfin tuna, other Scombridae and Carangidae, representing 21.5%, 7.0%, 7.3%, and 5.5% of the catch, respectively (the rest being composed of various species of groundfishes and pelagic fishes).

Introduction

The Îles Éparses (i.e., 'Scattered Islands') encompass a group of five small entities dispersed around Madagascar, in the Western Indian Ocean. Four of these islands, i.e., Europa, Bassas da India (an atoll), Juan de Nova, and the Glorieuses Archipelago (MPA since 2012; République Française 2012) are located in the Mozambique Channel, while Tromelin — which is jointly managed with Mauritius (Anon. 2010; Juppé 2012) — is located northeast of Madagascar (Figure 1). Overall, the Exclusive Economic Zone (EEZ; declared in 1978; République Française 1978) of these entities reaches over 640,000 km² (Anon. 2011), i.e., more than the surface of France's mainland. However, neighbouring countries claim all of these islands: all but Tromelin are claimed by Madagascar, and as well, by Mauritius; the Glorieuses Archipelago is claimed by Comoros and, until 2001, also by the Seychelles (République Française 2001).

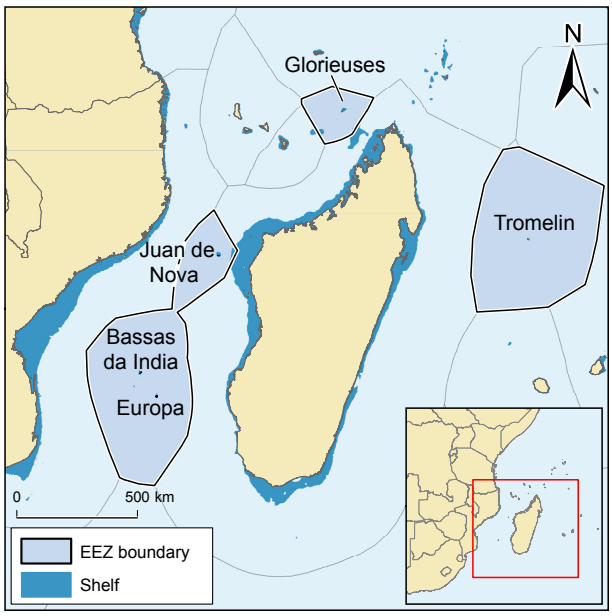

Figure 1. Map of the Îles Éparses showing the extent of their EEZs, as well as the -200 m isobaths (i.e., the 'shelf') in the region.

Tromelin was the first of the islands to be claimed by France in 1776 (Malick 1976), and by the end of the 19th century, all of them were under French rule (Anon. 2011). In 1960, the Îles Éparses became administered by the French island of La Réunion, located east of Madagascar (République Française 1960). In 2007, the Îles Éparses eventually became a district of the *Terres Australes et Antarctiques Françaises* ('Territory of the French Southern and Antarctic Lands'; République Française 2007), along with the islands of Kerguelen, St Paul & Amsterdam, and Crozet.[1]

The Îles Éparses have virtually always been uninhabited (or occupied for very short periods of time), but they host early-warning meteorological stations since 1950 (this region is under cyclonic threats part of the year), as well as a small but continuous military (and sometimes scientific) presence since 1973 (IUCN 2003; d'Aboville 2007).[2] This presence is used to exert sovereignty on these islands, as well as to deter illegal fishing from the coast (Anon. 2011).

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[1] Adélie Land on the Antarctic continent also belongs to the same district, with Article IV of the Antarctic Treaty suspending all territorial claims in Antarctica (Guyomard 2010).

[2] Note that there was a French guano industry occurring in Juan de Nova from the late 19th century until 1972 to supply the Seychellois market (d'Aboville 2007; IUCN 2003). A coconut plantation also exists on the Glorieuses Archipelago; it was planted in the late 19th century and exploited until 1958 by Seychellois mandated by the French government (Malick 1976).

Patrols are also carried out regularly in the Mozambique Chanel by the French Navy to prevent illegal activities in the French EEZs.

Thanks to their remoteness and their uninhabited status, the waters of the Îles Éparses are in an almost pristine state and host a very rich marine diversity (Le Corre and Safford 2001; Perillo 2008), compared, e.g., to its heavily populated and exploited Malagasy neighbour. An extensive mangrove of 700 ha (similar to the one found in Mayotte) is found on Europa (Barnaud 2011; Mangion *et al.* 2012), which largely motivated its classification as a RAMSAR site in 2011 (Barnaud 2011; RAMSAR 2014). There is also a much smaller mangrove on Juan de Nova, and minor seagrass meadows on two islands. Since 1975, all islands but Juan de Nova have benefited from a status of natural reserve (République Française 1975), which aims to protect the rich flora and fauna, including turtles, cetaceans, coral reefs, and seabirds (Anon. 2011; Quod *et al.* 2007). Moreover, recent legislation prohibits fishing activities within the 12 nm zone (10 nm around Geyser Bank; 24 nm for purse-seiners; République Française 2010a, 2013a).[3]

Unlike their surrounding waters, the terrestrial parts of these islands have faced a high pressure due to the introduction of various exotic species over time — including rats, cats, goats, chicken, and many plants — which have negatively impacted the indigenous species. Some of these invasive species have been entirely extirpated, while this is still in process for some others (IUCN 2003; Anon. 2011).

Given that these islands are uninhabited, there are no fisheries data currently estimated and transmitted to the Food and Agriculture Organization of the United Nations (FAO) and made publicly available *via* the FishStat fisheries database (FAO 2013). In this report, we apply to the Îles Éparses the reconstruction methods developed around principles in Pauly (1998), described in Zeller *et al.* (2007) and applied worldwide by the *Sea Around Us* (see e.g., Zeller and Pauly 2007; Zeller and Harper 2009; Harper and Zeller 2012; Harper *et al.* 2012). Due to the severe lack of catch data, this work of reconstruction was mostly based on Fermi solutions (von Baeyer 1993; Pauly 2010). We aimed to produce a first estimate of marine fisheries catch in these waters by reviewing the existing literature on the topic and estimating the total extraction of marine fish from 1950 to 2010.

Material and Methods

Small-scale fisheries

Recreational fishery

Virtually all recreational fisheries occur in Bassas da India's EEZ. This is an example of a highly organized unreported, illegal recreational fishery, with over a dozen South African and Mozambican charter companies offering "extreme adventure holiday [to] fish this mythical fishing destination" (www.bassadaindia.com). Boats filled with tourists (mostly from South Africa) are present in the zone at least half of the year, targeting all sorts of large species ranging from tuna and sharks, to Lutjanidae (snappers) and *Coryphaena hippurus* (dolphinfish) with spearguns, lines, flies, jigs, and other gears.[4] Note that some of these entirely unregulated practices — such as walking directly on the reefs (see vimeo.com/41090694), may result in severe damages to the habitats and the local wildlife, on top of the major impact on some fish stocks. In order to avoid fines by the French authorities, a known trick is to use paired boats: when the patrol arrives, tourists are transferred onto the empty boat, while the catch and the gears are kept on the other boat.[5] This way, the authorities cannot charge the charter companies with illegal fishing, as there are no proofs that the catch comes from these waters. However, it has to be noted that the French authorities recently improved their legislation to avoid such practices, by prohibiting the possession of fisheries products onboard boats within the no-fishing zone (10 nm around Geyser Bank, 12 nm elsewhere; République Française 2013b).

In order to produce a first estimate of this fishery, we considered that there were 20 boats doing each six trips per year (based on www.bassadaindia.com) for the year 2010, and that this number had increased from zero in 1989 to half of the 2010 level by 2005 (and interpolating in between; i.e., we assumed that this activity slowly expanded in its first years, and expanded more quickly in recent years). We also considered that 500 kg of fish were caught during each trip. We believe this is a conservative estimate, as one recreational fisher reported to have caught at least half a dozen 30–40 kg *Thunnus albacares* (yellowfin tuna), many *Carcharhinus longimanus* (oceanic whitetip shark) and *C. leucas* (Zambezi shark), "a few ignobilis kingfish [*Caranx ignobilis*]", "a number of black kingfish [*C. lugubris*][6]", "some decent sized snapper", "a number of big wahoo [*Acanthocybium solandri*], [...] the biggest estimated at over 30 kg", and "some other reef dwellers" (Milford 2006).

Based on this account, we considered that 50% of the catch was comprised of tunas (80% of yellowfin tuna and 20% of other species) and 20 % of selachimorpha (sharks; 80% of oceanic whitetip sharks and 20% of other species of sharks). The remaining 30% were equally distributed among Lutjanidae, Serranidae, Carangidae, Sphyraenidae, Coryphaenidae, and Istiophoridae.

[3] However, we know that Geyser Bank has been regularly fished by *barques* since at least 1997. Thus, unless there really is strict enforcement, these measures may not 'mostly protect' these waters.

[4] Some of these fish are released, but most are kept for consumption and we assumed 100 % mortality for all species except sharks, for which we assumed 30% survival (based on Diaz and Serafy 2005, Campana *et al.* 2009, and Butcher *et al.* 2014).

[5] The lead author heard this story several times during a trip to South Africa in 2012, while inquiring about a potential fishing trip to Bassas da India.

[6] Assumed to be the South African common name. Source: www.fishbase.org.

Holothurian fishery

Since 2011, another illegal fishery started to operate in the Îles Éparses' EEZ, from a base in Madagascar (Anon. 2013, 2014a; Pruffer 2013). What started as a small-scale fishery is increasing in organization and size with large (15+ m) mother ships deploying motorized *barques* and *pirogues* around the Glorieuses Archipelago (Geyser and other lagoons) and Juan de Nova (Anon. 2014a).[7] These fishers mostly target holothurians while scuba diving, although there is an ancillary catch of sharks (fins and tails kept for the Chinese market as well) and reef fish using lines and spearguns (Anon. 2014a).

Fishers likely started fishing these grounds in the early 2000s, i.e., when signs of over-exploitation of Malagasy holothurians started to be conspicuous (Le Manach *et al.* 2011, 2012, 2013). Noteworthy, it seems that part of this fishery is using boats owned by French expatriates who live in northwest Madagascar part of the year (and get Malagasy people to look after their boats the rest of the year). It happened several times that private sailboats were arrested by the French (or the Seychellois in their own EEZ) with Malagasy fishers and hundreds of holothurians on board, without the owner of the boat knowing that it was no longer moored in Madagascar (Pruffer 2013; G. Cripps, *pers. comm*. Blue Ventures Conservation).

Given that this fishery only started in 2011, i.e., after the end of the time-period studied here, reconstructed catches are not included in the present report. However, for future references, at least ten Malagasy fishing operations (with several boats involved in each) can be assumed to have ventured in the Glorieuses Archipelago and Juan de Nova to catch holothurians in 2013 and early 2014. To get an idea of the catches, one operation that was blocked by the French authorities had collected around one tonne (wet weight) of holothurians (for three small-scale and two semi-industrial boats and over 100 fishers; Anon. 2014a).

Reef fishery

From late 1989 to mid-1992, a semi-industrial exploitation of reef fish occurred around the Geyser Bank (Glorieuses Archipelago's EEZ) with the 12 m long YVALANN (see Doherty *et al.*, this volume). It quickly stopped due to plummeting catches of the main target species, *Lutjanus bohar* (two-spot red snapper; Maggiorani *et al.* 1994; Chabanet *et al.* 2002). Maggiorani *et al.* (1994) provided catch data as well as a taxonomic breakdown. Since this vessel used handlines, we considered that all of the bycatch was released in good condition; therefore, we did not estimate any dead discards.

Since 1997, fishers from Mayotte also started to travel further offshore to satisfy the local demand for reef fish and they reached the Glorieuses Archipelago's EEZ to target reef fish and some pelagic species (Wendling and Le Calvé 1999; Herfaut 2005; Thomassin and Andrefouet 2009; Fraisse 2010; Doherty *et al.*, this volume). These French fishers operate mostly illegally: fishing activities are forbidden within 10 nm of Geyser Bank and 12 nm of the other emerged land of the Glorieuses Archipelago (République Française 2010a), except for vessels that are deemed safe-enough to travel so far and which can apply for an exemption.[8] However, only one vessel was granted this authorization since 2009 (one longliner of 12+ meters), which did not declare any catch (making it illegal with regards to the exemption). As such, all other boats from Mayotte should be considered illegal. Most of this fishery occurs around Geyser Bank, but some *barques* (which mostly use longlines at night and other types of lines during the day) also travel further and operate around the main islands of the Archipelago.

During the first couple of years, it was reported that up to one tonne of fish could be caught per boat and per trip, but this yield quickly declined to only 200–300 kg by the mid-2000s (for longer trips; Thomassin and Andréfouët 2009).[9] Therefore, after a strong increase in the number of visits around Geyser bank, a decrease in the number of boats was observed due to this decreasing catch per trip (Quod 2007). Unofficial figures for 2012 suggest that at least 35 *barques* in Mayotte were equipped for fishing at Geyser and other offshore banks (Doherty *et al.*, this volume).

To reconstruct this sector, we considered that the number of *barques* slowly increased from zero in 1996 to 20 in 2000, and then more rapidly to 60 in 2005. We then considered that this number was halved by 2010, due to the decreasing catch. Regarding the catch, we considered that one tonne was caught by boat and by trip (one trip per month for each *barque* until 2005, and only 10 per year after 2009) during the first two years, and that this figure declined to 250 kg by boat and by trip after 2005. Regarding the taxonomic composition, we used the same as that of the YVALANN catch published by Maggiorani *et al.* (1994).

Other fisheries

Other very anecdotal small-scale fisheries may occur in the Îles Éparses' EEZ, such as the ones carried by sailboats in transit, military detachments, or even civilians staying at the islands' stations. However, regarding the latter two, it has to be noted that such activities are neither authorized by the hierarchy, nor by the *Terres Australes et*

[7] Such fishing operations have also been reported once in Bassas da India in 2013.

[8] France is becoming rather worried about such fishery, as the target species (Lutjanidae) are known to be highly sensitive to fishing. The state of the resource is supposed to be assessed as part of the Regional 10th European Development Fund allocated to local French authorities (Mayotte's *Conseil Général* and *Terres Australes et Antarctiques Françaises*) in order to implement a "sustainable use of natural resources in Mayotte and the Îles Éparses" (especially in the perimeter of the two *Parc Naturel Marins* of Mayotte and the Glorieuses Archipelago).

[9] These illegal fishers will often stay at sea for several days when fishing around offshore banks and risk dangerous sea conditions as well as explosions (Anon. 2014b), in order to remain profitable (Herfaut 2005; Guézel *et al.* 2009; Fraisse 2010). Some of these illegal fishers operating within the 12 nm are sometimes caught by the French authorities (Anon. 2014c, b).

Antarctiques Françaises. Although this may occur from time to time, their catch is therefore likely very low. Due to the elusive nature of these fisheries, no estimates were made here.

Large pelagics industrial fishery

The Îles Éparses are located in the second largest tuna fishing ground in the world (FAO 2012), and as such, are attractive to large-scale industrial vessels interested in pursuing this resource. Catches of these fleets were not reconstructed as part of this report. Rather, they were considered to have been reported to the Indian Ocean Tuna Commission (IOTC), and were dealt with as part of the global reconstruction of large pelagics catches (Le Manach *et al.* in press). However, we present here a brief summary of these fisheries.

French fleet

French purse-seiners (flagged in France mainland, Mayotte, or La Réunion) and longliners (flagged in La Réunion) are active in the Îles Éparses' EEZ (Laurent-Monpetit *et al.* 2012; www.taaf.fr/Navires-autorises-293). In order to access fishing grounds of the *Terres Australes et Antarctiques Françaises*, owners of these French vessels must annually apply for a licence, pay a specific fee to contribute to the observation and surveillance program of the *Terres Australes et Antarctiques Françaises* since 2010 (République Française 2010b, 2013c), and finally, pay fishing rights since 2013 (none until then; République Française 2013d). Since 2008, these vessels must follow the *Terres Australes et Antarctiques Françaises* regulations (République Française 2008, 2010c, 2013a, 2014),[10] and take on fisheries observers (on average 10–15% of trips are monitored).

Foreign fleets

Spanish seiners are also authorized to fish in the Îles Éparses' EEZs as part of a bilateral agreement with France. These vessels are either flagged in Spain or in the Seychelles (see Le Manach *et al.*, this volume; www.taaf.fr/Navires-autorises-293).

In 1993, there were also licenses delivered to 28 Taiwanese longliners for a trial period of one year (René *et al.* 1998). It seems that very few industrial vessels have ventured into the Îles Éparses' EEZs over the past couple of decades to fish illegally,[11] as they are generally afraid of the increasing French military presence and are thus more inclined to fish in areas further north (known to be more productive and less tightly monitored; e.g., Kenya, Somalia).

Results

Overall, catches in the Îles Éparses' EEZs are estimated to have totalled over 2,800 tonnes between 1989 and 2010 (Figure 2A; mostly in the Glorieuses Archipelago with 84% of the total, Bassas da India representing only 16%). The small-scale artisanal *barques* from Mayotte represented 76.8% of the total (followed by the recreational and semi-industrial handline fisheries, with 14.0% and 6.7%, respectively; Figure 2A).

Regarding the taxonomic breakdown, *Lutjanus bohar* made up 39.9% of the catch, followed by Serranidae, yellowfin

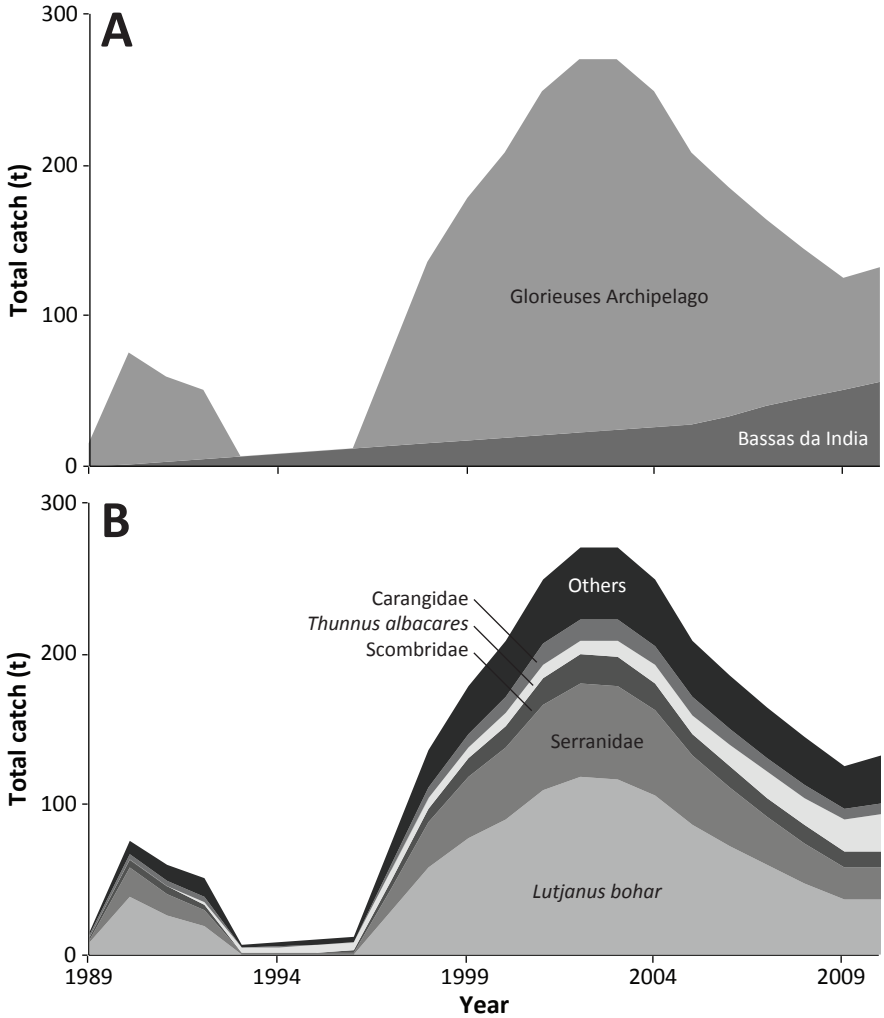

Figure 2. Annual reconstructed catch (t), by A) EEZ and B) taxa. See Appendix Table A1 and Appendix Table A2, respectively, for details.

[10] Regulations established by the *Terres Australes et Antarctiques Françaises* are updated every year in accordance with the best available scientific data and national or regional regulations (e.g., IOTC's recommendations and resolutions).

[11] Note, however, that this concept of 'illegal' fishing does not apply for the period prior to 1978, as no EEZ existed (République Française 1978).

tuna, other Scombridae and Carangidae, representing 21.5%, 7.0%, 7.3%, and 5.5% of the catch, respectively. The rest of the catch was composed of various species including sharks, other Lutjanidae, Sphyraenidae, and undetermined groundfishes and pelagic fishes (Figure 2B).

Discussion

In this report, we provide a first estimate of total marine fisheries catch in the Îles Éparses' EEZs from 1950 to 2010. While the overwhelming majority of the catch is that of the large pelagics industrial fleets (consisting of longliners active since the early 1950s and purse-seiners active since the early 1980s; not included in this report), more recent fisheries are increasingly targeting vulnerable, nearshore species such as holothurians and reef species of fish in an entirely uncontrolled and unmonitored fashion. Signs of over-exploitation are already visible for some of these stocks (e.g., the ones targeted by the *barques* fishery in the Glorieuses Archipelago and associated banks), with important decreases reported in catch per unit of effort.

While our estimates are based on assumptions and are thus perfectible, we do point out the necessity to dedicate increasing efforts towards improving the monitoring and control of these fisheries. This should include the most recent one for holothurians (not reconstructed here), in order to ensure that the exploitation of the marine resources in the biodiversity sanctuary that are the Îles Éparses remains sustainable (if legal), e.g., by restricting fishing activities to areas where stocks are assessed and monitored.

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Appendix Table A1. Total reconstructed catch (t) by EEZ, 1989–2010.

Year	Bassas da India	Glorieuses Archipelago
1989	-	15.6
1990	1.8	73.7
1991	3.5	55.4
1992	5.3	45.7
1993	7.1	-
1994	8.8	-
1995	10.6	-
1996	12.3	-
1997	14.1	60.0
1998	15.9	120.0
1999	17.6	160.7
2000	19.4	188.6
2001	21.2	228.0
2002	22.9	246.9
2003	24.7	245.1
2004	26.4	222.9
2005	28.2	180.0
2006	33.8	150.9
2007	39.5	123.8
2008	45.1	98.4
2009	50.8	75.0
2010	56.4	75.0

Appendix Table A2. Total reconstructed catch desaggregated by taxa, 1950–2010.

Year	Carangidae	*Carcharhinus longimanus*	Selachimorpha	Groundfishes	Lutjanidae	*Lutjanus bohar*	Pelagic fishes	Scombridae	Serranidae	Sphyraenidae	*Thunnus albacares*
1989	2.1	-	-	1.3	-	8.6	-	1.7	1.9	-	-
1990	3.1	0.2	0.1	8.4	0.1	38.5	0.1	5.1	19.0	0.1	0.8
1991	2.7	0.4	0.1	8.8	0.2	25.5	0.2	4.6	14.7	0.2	1.5
1992	3.0	0.6	0.2	11.7	0.3	18.2	0.3	2.4	11.6	0.3	2.3
1993	0.5	0.8	0.2	-	0.5	-	0.5	0.8	0.5	0.5	3.0
1994	0.6	1.1	0.3	-	0.6	-	0.6	0.9	0.6	0.6	3.8
1995	0.7	1.3	0.3	-	0.7	-	0.7	1.1	0.7	0.7	4.5
1996	0.8	1.5	0.4	-	0.8	-	0.8	1.3	0.8	0.8	5.3
1997	4.1	1.7	0.4	9.5	0.9	28.6	0.9	5.5	15.6	0.9	6.0
1998	7.5	1.9	0.5	19.0	1.0	57.3	1.0	9.6	30.3	1.0	6.8
1999	9.8	2.1	0.5	25.5	1.1	76.7	1.1	12.5	40.4	1.1	7.5
2000	11.4	2.3	0.6	29.9	1.2	90.0	1.2	14.5	47.3	1.2	8.3
2001	13.6	2.5	0.6	36.1	1.4	108.8	1.4	17.3	57.0	1.4	9.0
2002	14.8	2.7	0.7	39.1	1.5	117.8	1.5	18.8	61.8	1.5	9.8
2003	14.8	2.9	0.7	38.9	1.6	117.0	1.6	18.8	61.5	1.6	10.5
2004	13.7	3.2	0.8	35.3	1.7	106.3	1.7	17.6	56.1	1.7	11.3
2005	11.5	3.4	0.8	28.5	1.8	85.9	1.8	14.9	45.8	1.8	12.0
2006	10.3	4.0	1.0	23.9	2.2	72.0	2.2	13.6	39.0	2.2	14.4
2007	9.2	4.7	1.2	19.6	2.5	59.1	2.5	12.4	32.8	2.5	16.8
2008	8.2	5.4	1.3	15.6	2.9	47.0	2.9	11.3	26.9	2.9	19.2
2009	7.3	6.0	1.5	11.9	3.2	35.8	3.2	10.4	21.6	3.2	21.6
2010	7.6	6.7	1.7	11.9	3.6	35.8	3.6	11.0	21.9	3.6	24.0