conservation

Article

Valorisation of Madagascar's Wildlife Trade and Wildlife Tourism: What Are the Conservation Benefits?

Angus I. Carpenter [1,*] and Franco Andreone [2]

1 Institute of Science and Environment, University of Cumbria, Ambleside Campus, Rydal Road, Ambleside LA22 9BB, UK
2 Museo Regionale di Scienze Naturali, Via G. Giolitti, 36, I-10123 Torino, Italy; franco.andreone@regione.piemonte.it or franco.andreone@gmail.com
* Correspondence: angus.carpenter@cumbria.ac.uk or carpenter.angus@gmail.com

Abstract: Wildlife tourism and wildlife trade may appear juxtaposed, but are two, potentially aligning, income generators that could benefit conservation in developing countries. Utilising data sets collated from Madagascar's Ministère du Tourisme and CITES, respectively, for the period 2007 to 2018, this study estimated levels of income from wildlife tourism and wildlife trade for Madagascar. Between 2007 and 2018, tourism reported yearly incomes ranging from a low of USD 1.4 million up to a high of USD 15.7 million. However, it was unclear what percentage of this figure flowed to benefit local communities. Alternatively, using reported networks for the live wildlife trade, the estimated economic value reaching collectors and/or intermediaries in Madagascar was USD 72,299.80 for the period 2007 to 2018. Both revenue generators operated within different geographical areas, with tourism opportunities presenting themselves to communities adjacent to national parks, while wildlife trade networks were not restricted to protected areas and operated sporadically across Madagascar. Hence, the economic benefits reached different Malagasy participants across the country. The management of both activities needs great care to ensure that environmental impacts and sustainability are core measures on any such activities. Whilst this study shines a light on economic values and novel perspectives regarding these two trade types, it also highlights knowledge gaps, thus indicating where much greater research attentions are required to allow a better understanding of the specific benefits and risks from engaging with both trade types for local Malagasy people and their environments.

Keywords: community-based conservation; conservation; Madagascar; resource management; wildlife economics; wildlife trade; wildlife tourism; wildlife valorisation

check for updates

Citation: Carpenter, A.I.; Andreone, F. Valorisation of Madagascar's Wildlife Trade and Wildlife Tourism: What Are the Conservation Benefits? *Conservation* **2023**, *3*, 509–522. https://doi.org/10.3390/conservation3040033

Academic Editor: Guillermo Blanco

Received: 11 August 2023
Revised: 7 October 2023
Accepted: 1 November 2023
Published: 14 November 2023

1. Introduction

1.1. Socioeconomic Aspects of Wildlife Valorisation in Madagascar

A long-standing ambition in many societies has been to seek the alignment of conservation requirements and poverty alleviation to engender mutual benefits [1–4]. The paucity of reported successful case studies highlights the complexities, juxtapositions and contested notions of justice that surround such projects [5], especially regarding efforts to improve distributive justice concerned with benefits and burden sharing [6]. One of the most persistent issues is that lower income groups pay disproportionately higher costs for conservation, whereas the rich secure most of the benefits [7–9].

To varying degrees, conservation benefits have been derived globally from the sustainable exploitation of wildlife resources [3,9–11]. Conversely, it has also been stated that wildlife traded unsustainably was a major driver causing the decline in species globally [11,12]. However, in Madagascar, the impacts from harvesting wild flora and fauna were relatively poorly known, with both illegal [9,13,14] and unsustainable harvesting having been reported within and outside of protected areas [15]. A situation that was further compounded by the high numbers of new and yet to be described species, endemic to Madagascar, which were still being reported while others were to follow [16,17].

Historically, national parks (NPs) were established in Madagascar with the overriding aim to protect its unique biodiversity [18,19]. However, local communities in Madagascar often had little or no involvement in the establishment of NPs and other protected areas [20]. Yet local communities had received varying degrees of negative impact from their creation in many cases, as local communities were stopped from utilising these areas, and the natural resources within them, for subsistence or commerce [18,20–22]. Since 2003, during an expansion of almost 100 additional protected areas, the selection rationale also expanded to include cultural heritage, poverty alleviation and the sustainable use of natural resources [23]. However, local communities' knowledge on the legal processes and legislation governing protected areas and/or species protection was mostly very poor [24] and, therefore, they were unaware of the legal status and conservation protections afforded to species and habitats.

1.2. Wildlife Tourism Revenue

An alternative to extractive approaches for valorising wildlife would be to view it in-situ in applying wildlife tourism. The World Tourism Organization (UNWTO) defines ecotourism via five characteristic statements; for example, "All nature-based forms of tourism in which the main motivation of the tourists is the observation and appreciation of nature as well as the traditional cultures prevailing in natural areas". Each statement is broad and general in its meaning and applicability (UNWTO, no date). Variations across disciplines and sectors add further inconsistencies regarding clear and concise definitions for ecotourism, wildlife tourism and, furthermore, conservation tourism. However, tourism, across its varying formats, was often viewed as a sort of panacea to resolving potential conflicts between local peoples' needs and NP protection, by bringing tourists to see the wildlife in situ and having associated services develop around this premise [25,26]. Hence, wildlife tourism, in its broadest sense, has often been suggested as a non-extractive method for use in Madagascar [25,27,28]. However, it is evident that tourism requires careful management to ensure long-term sustainability, from broad-scale issues, such as operator responsibility (e.g., deleterious impacts from water supply demands to waste product disposal) [29], to fine-scale issues, such as negative impacts on species populations and animal welfare [30–32], to minimize the potential negative impacts on Madagascar's environments.

Several studies have estimated the economic value of tourism to a few protected areas and more generally for Madagascar. For example, at Mantadia NP, the economic values generated from tourism were estimated at USD 24–65 per individual visitor or USD 0.8–2.2 million per annum [25]. At Ranomafana NP, in 2002, it was estimated that a total of USD 29–31,246 was generated per annum with USD 15,836 going to the local communities, while lemurs were stated by visitors to be the wildlife attraction [33]. Similarly, over 600 tourists visiting different NPs in Madagascar also stated lemurs to be the main attraction, with chameleons ranked second [34]. Revenues estimated to be received by local communities at Masoala NP ranged from USD 700, in 1999, to USD 500, in 2001 [27]. A national-scale estimate of income generation via tourism was stated to be between USD 26 and 29 million, with approximately 17% of tourists to Madagascar visiting national parks [34].

1.3. Flora and Fauna Trade Revenues

In addition to their apparent lack of knowledge regarding NP and species conservation legislation [24], not all local communities were keen to engage in the live trade of wildlife for international markets (typically omitting bush meat, products and other derivatives, or domestic uses, such as medicinal plants) for several reasons. For example, individuals reported being repulsed by reptiles, while payment insecurity, fear of legal repercussions and traditional barriers to harvesting certain species were other reported concerns [35,36]. However, it has been argued that Malagasy communities should have the right to trade in their local wildlife resources [37]. Certainly, the international, live wildlife trade in Madagascar appeared to be flourishing. For example, relatively high levels of trade in flora and fauna from Madagascar have been reported in studies that meet international demands [36,38–44].

As to the value generated from the international wildlife trade in Malagasy flora and fauna, estimates vary greatly between product types and years. For example, Waeber and Wilmé [38] reported that illegal rosewood and ebony timber stockpiles due for export were valued at a minimum of USD 600 million, while trade conducted in 2013 alone, across all CITES listed flora and fauna, was estimated at between USD 346,246 and USD 646,226 [36]. Alternatively, various estimated values have been provided for specific taxonomic groups; such as chameleons generating over USD 14.5 million [43], amphibians traded between 2000 and 2006 reportedly generating USD 906,750 [42] or just *Mantella* poison frogs traded between 2001 and 2003 generating up to USD 246,372 [41]. Supply chain structures in Madagascar vary [45], though the three-actor level chain was most commonly used with collector and intermediary positions filled by Malagasy people [36,41]. However, the wildlife trade comes with potential hazards to an already challenging situation of protecting Madagascar's wildlife, such as the potential of over-harvesting, animal welfare issues, cartel formations, the possibility of introducing the amphibian disease chytridiomycosis into new locations, etc. [17,34].

This study draws together national-scale data sets on these two forms of income generation to investigate both the levels and dynamics of the income generated. Furthermore, it compares across both forms and discuss the potential benefits and costs to Madagascar for local communities. Such information greatly enhances discussions in Madagascar and internationally, which currently lack any such comparisons, regarding advancing management options and seeking the best outcomes for conservation and poverty alleviation. This paper presents: (1) numbers of tourists and levels of income generated over the period 2007–2018; (2) the numbers of ecotourists and income generated each year over the same period; (3) the CITES listed species of flora and fauna exported from Madagascar and the numbers exported in the period 2007–2018; (4) the income generated from the trade in wildlife exported from Madagascar.

2. Materials and Methods

Tourism data were obtained by request (collated October 2019) from the Ministère du Tourisme in Madagascar. The Ministry supplied data covering the period 2007–2018 that included the total number of overseas visitors (tourists) each year and estimated income from tourism for each year (Table 1). Wollenberg et al.'s [34] value of 17% (percentage of tourists who were ecotourists) was applied to the yearly tourist numbers to provide an estimate for the number of ecotourists visiting Madagascar each year (Table 1).

Table 1. The yearly number of tourists visiting Madagascar between 2007 and 2018 and the levels of income generated from those tourists, in USD as reported, in 2019, by Madagascar's Ministère du Tourisme.

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Number of tourists arriving on Madagascar *	344,348	375,010	162,687	19,052	225,055	255,942	196,375	222,374	244,321	293,185	255,460	291,299
Tourist income generation (USD millions)	313	45,965	1785	2111	26,249	27,981	39,042	64,962	58,538	748,297	668,262	
Number of ecotourists (17%; Wollenberg et al., 2011 [34])	58,539	63,752	27,657	3239	38,259	43,510	33,384	37,804	41,535	49,841	43,428	49,521

* denotes data source Ministère du Tourisme/PAF/ADEMA/RAVINALA AIR-PORTS/APMF (collated October 2019).

To estimate the income values generated from ecotourism, the yearly number of ecotourists (Table 1) was multiplied with published conversion values presented by both Wollenberg et al. [34] and Dixon and Pagiola [25], in each case the published values were adjusted for inflation in USD to 2019. Estimation 1 was calculated using Wollenberg et al.'s [34] conversion value with yearly ecotourist numbers. Estimation 2 used Dixon and Pagiola's [25] conversion values, who provided an upper and lower value.

Hence, there were two calculations performed and two sets of estimates, upper and lower values, presented.

CITES data were obtained from the CITES Trade database (https://trade.cites.org/). These data were collated on 23 December 2019 using the following criteria; export country = Madagascar, source = wild, purpose = commercial, terms = live. These criteria were applied while the 'Search by taxon' was left empty to collect trade data records across all CITES listed taxa groups, animals and plants, for the period 2007–2018. These data were downloaded in an Excel format for analysis and presentation.

Flora and fauna trade prices were extracted from published literature [36,41] and adjusted for inflation, in USD, for each year over the period. For plants, there were no trade structure price data available other than a single average export price [46]. The price structure reported for animals displayed a decrease in magnitude of the order of two from export to collector; hence, it has been assumed here that a similar price structure would be observed for plants. Thus, the average plant price has been reduced by two-fold to provide a general indicator of price at the collector level.

3. Results

3.1. Ecotourism Revenue Generation

The total number of tourists arriving in Madagascar for the period 2007 to 2018 was nearly 3 million people with, on average, over 240,000 people arriving each year (Table 1). Of this number of tourists, it was estimated that the number of ecotourists visiting each year was nearly 41,000 (Table 1). Over the total period 2007–2018, ecotourism generated a total income of nearly USD 189 million using Estimate 1, nearly USD 46 million using the Estimate 2 upper value and nearly USD 17 million with the Estimate 2 lower value. On average, across the period 2007–2018, a yearly income was reported ranging from a low of USD 1.4 million up to a high of USD 15.7 million (Figure 1).

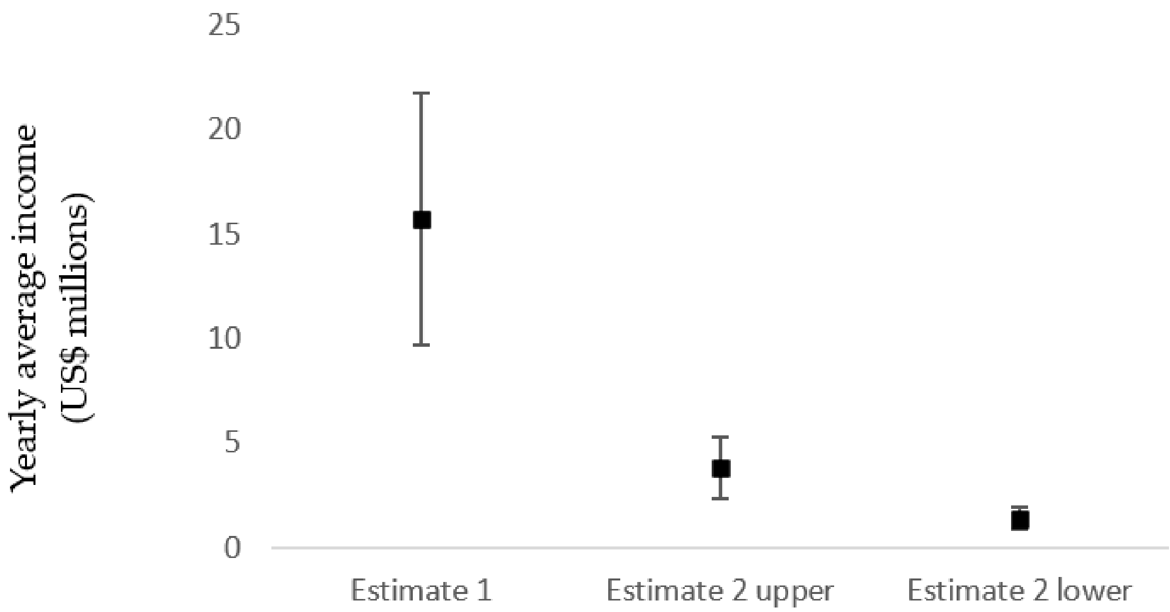

Figure 1. The average yearly level of income (+/− Std. Dev.) generated using the published conversion values of Wollenberg et al. [34] (Estimate 1) and Dixon and Pagiola, [25] (Estimate 2 upper and lower values) to estimate ecotourism income, based on the original source tourist data from the Ministère du Tourisme, Madagascar. All values are in USD at 2019 rates.

The highest level of income in any one year from ecotourists was in 2008 when it generated USD 24.6 million, while the lowest was in 2010 when USD 0.1 million was generated (Figure 2). Over 2007–2018, a linear regression analysis found no increase in ecotourism growth over the period ($y = 0.0741x + 15.235$; $R^2 = 0.002$) for Estimate 1. However, any long-term trend would be masked by the significant decrease in 2010. Applying a linear regression to a subset of the data, after the crash from 2011 to 2018, the income generated from ecotourism using Estimate 1 was generally increasing ($y = 0.613x + 13.454$; $R^2 = 0.4556$) back towards the high recorded in 2008 (Figure 2).

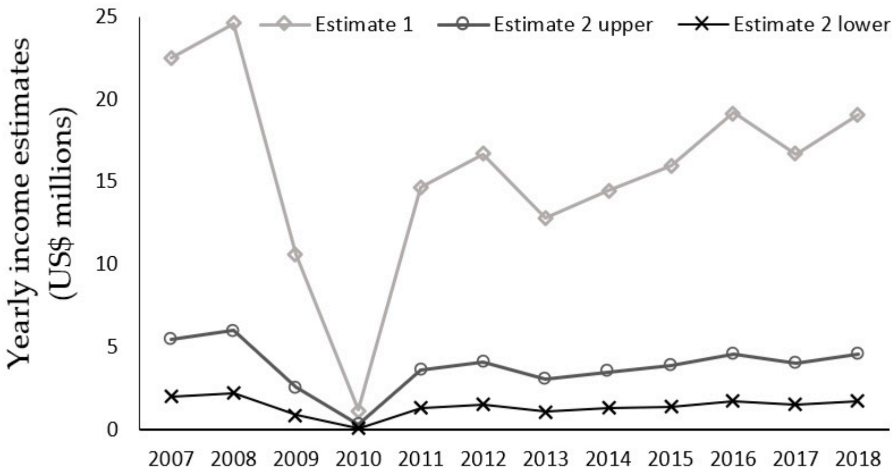

Figure 2. The trends in yearly estimated values (in USD) from ecotourism in Madagascar using the published conversion values of Wollenberg et al. [34] (Estimate 1) and Dixon and Pagiola, [25] (Estimate 2 upper and lower values). All values are in USD at 2019 rates.

3.2. Flora and Fauna Trade Revenues

Between 2007 and 2018, a total of 286,938 individual organisms were extracted from the wild and reported being exported from Madagascar with over 83% being animals and nearly 17% plants. The exported flora and fauna were from 52 known genera; 35 (67%) plant genera and 17 (33%) animal genera.

Of the 238,961 individual animals traded, over 70% was in Reptilia, over 29% in Amphibia with minor amounts in Aves (0.3%) and Mammalia (0.002%). Reviewing the trade within the animal grouping at the genus level, the top five genera, which accounted for 97% of the trade in animals, were for amphibians of the genus *Mantella* (29%), while for reptiles we have *Phelsuma* (27%), *Furcifer* (25%), *Uroplatus* (13%) and *Brookesia* (3%) (Figure 3). Furthermore, within each genus just a handful of species accounted for the majority of its trade (Table 2). The top five species traded accounted for over 40.5% of the total number of animals exported; *Mantella betsileo* (brown mantella, n = 22,737, 9.5%), *Mantella baroni* (Baron's mantella, n = 21,110, 8.8%), *Furcifer pardalis* (panther chameleon, n = 19,029, 7.9%), *Phelsuma lineata* (lined day gecko, n = 17,939, 7.5%) and *Furcifer lateralis* (carpet chameleon, n = 15,908, 6.74%).

Of the 47,977 individual plants traded, four genera accounted for over 84% (n = 40,382) of the exported plants from Madagascar with these four genera being *Pachypodium*, nearly 48% (n = 22,967), *Euphorbia*, over 24% (n = 11,608), *Operculicarya*, nearly 9% (n = 4175) and *Angraecum*, over 3% (n = 1632) (Figure 4). Furthermore, within each genus just a handful of species accounted for most of the trade (Table 3). The top five plant species traded accounted for nearly 47% (n = 22,504) of the total number exported; *Pachypodium* spp. (n = 7532, 15.7%), *Pachypodium densiflorum* (n = 4232, 8.8%), *Pachypodium brevicaule* (n = 4219, 8.7%), *Operculicarya pachypus* (n = 3337, 6.9%) and *Euphorbia primulifolia* (n = 3184, 6.6%).

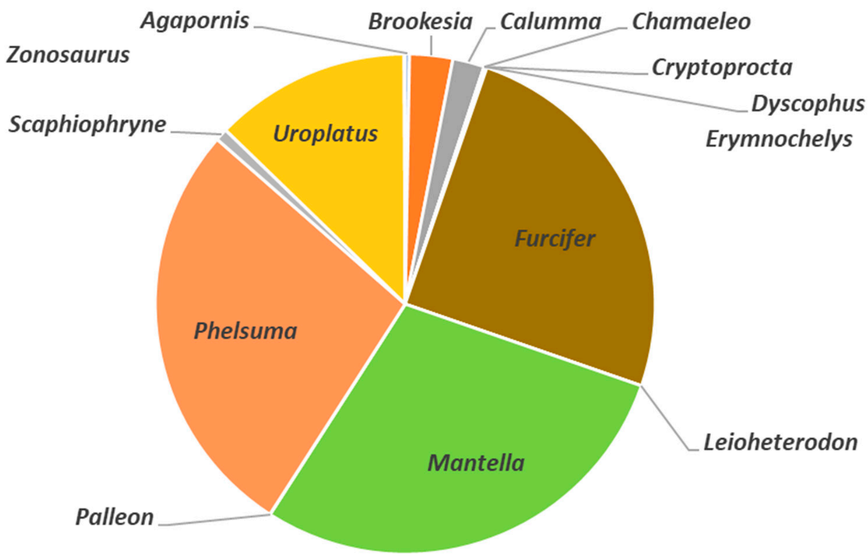

Figure 3. Each of the animal genera with species and numbers reported within the import data (two genera, *Eupleres* and *Fossa*, were reported in the import data set but with no data reported) exported from Madagascar between 2007 and 2018. It should be noted that *Chamaeleo* are not found in Madagascar and the reporting here is an artifact of data reporting within the CITES data set (Reprinted by permission of Princeton University Press).

Table 2. The top five traded genera within the animal groupings exported from Madagascar over the period 2007–2018, showing the total number traded within a genus and the four highest traded species within that genus and the percentage that species accounts for within the genus in trade. (Source: CITES).

Genus	Species	No.	%
	AMPHIBIANS		
Mantella		68,798	
	Mantella betsileo	22,737	33.0
	Mantella baroni	21,110	30.7
	Mantella nigricans	7306	10.6
	Mantella pulchra	5969	8.7
	REPTILES		
Phelsuma		65,329	
	Phelsuma lineata	17,939	27.5
	Phelsuma quadriocellata	15,534	23.8
	Phelsuma laticauda	14,124	21.6
	Phelsuma madagascariensis	10,563	16.2
Uroplatus		30,335	
	Uroplatus sikorae	10,059	33.2
	Uroplatus fimbriatus	6170	20.3
	Uroplatus phantasticus	5002	16.5
	Uroplatus ebenaui	4202	13.9
Brookesia		6686	
	Brookesia superciliaris	1927	28.8
	Brookesia stumpffi	1657	24.8
	Brookesia thieli	1326	19.8
	Brookesia therezieni	1169	17.5
Furcifer		59,722	
	Furcifer pardalis	19,029	31.9
	Furcifer lateralis	15,908	26.6
	Furcifer oustaleti	11,268	18.9
	Furcifer verrucosus	11,312	18.9

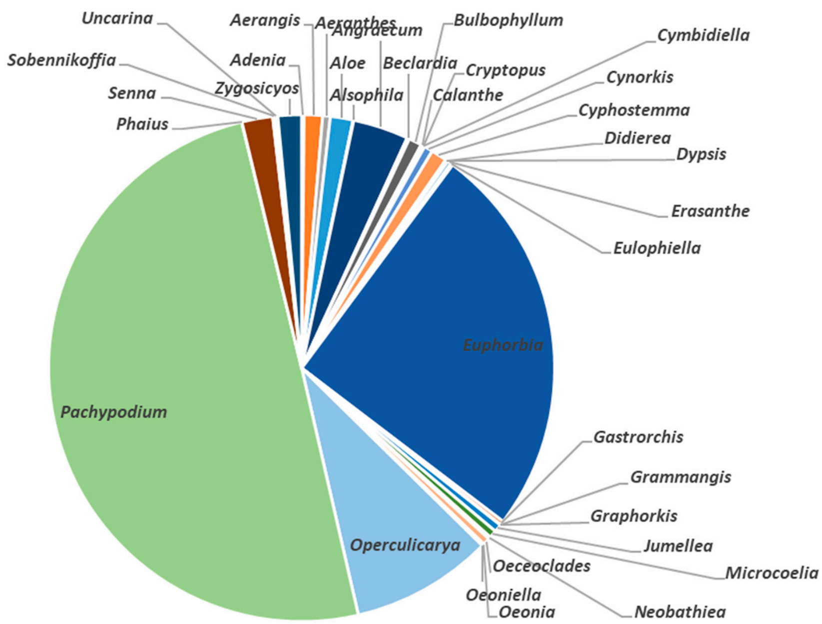

Figure 4. Each of the plant genera with species and numbers reported within the import data (one genera, *Alluaudia*, was reported in the import data set but with no data reported) exported from Madagascar between 2007 and 2018 (Reprinted by permission of Princeton University Press).

Table 3. The top four traded genera within the plant groupings exported from Madagascar over the period 2007–2018, showing the total number traded within a genus and the four highest traded species within that genus and the percentage that species accounts for in trade within the genus. (Source: CITES).

Genus	Species	No.	%
Pachypodium		22,967	
	Pachypodium spp.	7532	32.8
	Pachypodium brevicaule	4219	18.4
	Pachypodium densiflorum	4232	18.4
	Pachypodium eburneum	2352	10.2
Euphorbia		11,608	
	Euphorbia primulifolia	3184	27.4
	Euphorbia spp.	1222	10.5
	Euphorbia itremensis	1088	9.4
	Euphorbia guillauminiana	1029	8.9
Operculicarya		4175	
	Operculicarya pachypus	3337	79.9
	Operculicarya decaryi	430	10.3
	Operculicarya hyphaenoides	408	9.8
Angraecum		1632	
	Angraecum urschianum	113	6.9
	Angraecum breve	95	5.8
	Angraecum germinyanum	95	5.8
	Angraecum teretifolium	89	5.5

Consequently, using species-specific prices that were extracted from published scientific literature and adjusted for varying yearly levels of inflation, the calculation revealed an estimated total of USD 72,300 being generated from the trade between 2007 and 2018, and potentially made available to local communities (Table 4). The animal grouping contributed the majority (USD 54,728, nearly 76%) to the total value, with the plant grouping contributing USD 17,572 (over 24%). In the year 2016, both the animal and plant groupings recorded the highest levels of income (animals = USD 7944; plants = USD 4416), but both decreased rapidly post-2016. Trade remained static until 2013 (animals) and 2014 (plants), after which both groupings increased rapidly in the levels of trade (Figure 5).

Table 4. The economic values (USD in 2019) across the three actor levels (Coll. = collector, Inter. = intermediary, Export. = exporter) generated from the reptile and amphibian wildlife trade in Madagascar for the period between 2007 to 2018.

Animals		2007	Price	Value	2008	Price	Value	2009	Price	Value	2010	Price	Value	2011	Price	Value	2012	Price	Value	2013	Price	Value	2014	Price	Value	2015	Price	Value	2016	Price	Value	2017	Price	Value	2018	Price	Value	Grand Total
Anura		7772			7348			8076			8000			6194			6191			6815			6395			3346			6070			4140			703			71,050
	Dyscophus		0.25	0		0.26	0		0.26	0		0.26	0		0.27	0		0.28	0		0.28	0		0.28	0		0.28	0		0.29	0	232	0.29	67.28	110	0.3	33	342
	Mantella *	7307	0.11	803.77	7177	0.11	789.47	7699	0.11	846.89	7698	0.11	846.78	6003	0.12	720.36	6028	0.12	723.36	6644	0.12	797.28	6347	0.12	761.64	3346	0.12	401.52	6070	0.12	728.4	3886	0.13	505.18	593	0.13	77.09	68,798
	Scaphiophryne	465	0.25	116.25	171	0.26	44.46	377	0.26	98.02	302	0.26	78.52	191	0.27	51.57	163	0.28	45.64	171	0.28	47.88	48	0.28	13.44		0.28	0		0.29	0	22	0.29	6.38		0.3	0	1910
Carnivora				0																												4						4
	Cryptoprocta			0						0			0			0			0			0			0			0			0	4		0			0	4
Psittaciformes				0																250			300												100			650
	Agapornis ^		0.3	0		0.31	0		0.31	0		0.31	0		0.32	0		0.33	0	250	0.33	82.5	300	0.34	102		0.34	0		0.34	0		0.35	0	100	0.36	36	650
Sauria		12,991		0	14,995			14,030			13,253			16,697			14,812			8937			11,677			14,923			24,873			17,351			2592			167,131
	Brookesia	267	0.25	66.75	267	0.26	69.42	396	0.26	102.96	348	0.26	90.48	564	0.27	152.28	386	0.28	108.08	298	0.28	83.44	212	0.28	59.36	922	0.28	258.16	1781	0.29	516.49	1010	0.29	292.9	235	0.3	70.5	6686
	Calumma		0.25	0		0.26	0		0.26	0		0.26	0		0.27	0		0.28	0		0.28	0	262	0.28	73.36	1326	0.28	371.28	2103	0.29	609.87	1152	0.29	334.08	28	0.3	8.4	4871
	Chamaeleo †		0.25	0		0.26	0		0.26	0		0.26	0		0.27	0		0.28	0		0.28	0		0.28	0		0.28	0	10	0.29	2.9		0.29	0		0.3	0	10
	Furcifer	4079	0.25	1019.75	4794	0.26	1246.44	4046	0.26	1051.96	4549	0.26	1182.74	6116	0.27	1651.32	6638	0.28	1858.64	4259	0.28	1192.52	5410	0.28	1514.8	4997	0.28	1399.16	8364	0.29	2425.56	5512	0.29	1598.48	958	0.3	287.4	59,722
	Palleon		0.25	0		0.26	0		0.26	0		0.26	0		0.27	0		0.28	0		0.28	0		0.28	0	6	0.28	1.68	15	0.29	4.35	11	0.29	3.19		0.3	0	32
	Phelsuma	4273	0.25	1068.25	4830	0.26	1255.8	5577	0.26	1450.02	5203	0.26	1352.78	7776	0.27	2099.52	6383	0.28	1787.24	3556	0.28	995.68	4539	0.28	1270.92	5617	0.28	1572.76	8942	0.29	2593.18	7328	0.29	2125.12	1305	0.3	391.5	65,329
	Uroplatus	4297	0.25	1074.25	5104	0.26	1327.04	3990	0.26	1037.4	3153	0.26	819.78	2241	0.27	605.07	1405	0.28	393.4	824	0.28	230.72	1254	0.28	351.12	2055	0.28	575.4	3633	0.29	1053.57	2338	0.29	678.02	41	0.3	12.3	30,335
	Zonosaurus	75	0.25	18.75		0.26	0	21	0.26	5.46		0.26	0		0.27	0		0.28	0		0.28	0		0.28	0		0.28	0	25	0.29	7.25		0.29	0	25	0.3	7.5	146
Serpentes				0	5						16																											21
	Leioheterodon		0.25	0	5	0.26	1.3		0.26	0	16	0.26	4.16		0.27	0		0.28	0		0.28	0		0.28	0		0.28	0		0.29	0		0.29	0		0.3	0	21
Testudines		14		0	3			10			2						16			8			15			16			10			11						105
	Erymnochelys	14	0.25	3.5	3	0.26	0.78	10	0.26	2.6	2	0.26	0.52		0.27	0	16	0.28	4.48	8	0.28	2.24	15	0.28	4.2	16	0.28	4.48	10	0.29	2.9	11	0.29	3.19		0.3	0	105
Animal total		20,777		4171.27	22,351		4734.71	22,116		4595.31	21,271		4375.76	22,891		5280.12	21,019		4920.84	16,010		3432.26	18,387		4150.84	18,285		4584.44	30,953		7944.47	21,506		5613.82	3395		923.69	238,961

Plants		2007	Price	Value	2008	Price	Value	2009	Price	Value	2010	Price	Value	2011	Price	Value	2012	Price	Value	2013	Price	Value	2014	Price	Value	2015	Price	value	2016	Price	Value	2017	Price	Value	Grand Total
Arecales			32.93			34.2			34.07			34.63			35.73			36.47			37			37.6			37.64			38.12			38.93		
	Dypsis	3	0.33	0.99		0.34	0		0.34	0		0.35	0		0.36	0		0.37	0		0.37	0		0.38	0		0.38	0		0.38	0		0.39	0	3
Caryophyllales			0.33	0		0.34	0		0.34	0		0.35	0		0.36	0		0.37	0		0.37	0		0.38	0		0.38	0		0.38	0		0.39	0	
	Alluaudia		0.33	0		0.34	0		0.34	0		0.35	0		0.36	0		0.37	0		0.37	0		0.38	0		0.38	0		0.38	0		0.39	0	
	Didierea		0.33	0		0.34	0		0.34	0	50	0.35	17.5		0.36	0		0.37	0		0.37	0	3	0.38	1.14		0.38	0	20	0.38	7.6		0.39	0	73
Cyatheales			0.33	0		0.34	0		0.34	0		0.35	0		0.36	0		0.37	0		0.37	0		0.38	0		0.38	0		0.38	0		0.39	0	
	Alsophila	20	0.33	6.6		0.34	0		0.34	0		0.35	0		0.36	0		0.37	0		0.37	0		0.38	0		0.38	0		0.38	0		0.39	0	20
Euphorbiales			0.33	0		0.34	0		0.34	0		0.35	0		0.36	0		0.37	0		0.37	0		0.38	0		0.38	0		0.38	0		0.39	0	
	Euphorbia	1381	0.33	455.73	1033	0.34	351.22	620	0.34	210.8	370	0.35	129.5	895	0.36	322.2	1600	0.37	592	710	0.37	262.7	1104	0.38	419.52	1411	0.38	536.18	1974	0.38	750.12	510	0.39	198.9	11,608
Fabales			0.33	0		0.34	0		0.34	0		0.35	0		0.36	0		0.37	0		0.37	0		0.38	0		0.38	0		0.38	0		0.39	0	
	Senna		0.33	0		0.34	0		0.34	0		0.35	0		0.36	0		0.37	0		0.37	0	55	0.38	20.9	502	0.38	190.76	350	0.38	133		0.39	0	907
Gentianales			0.33	0		0.34	0		0.34	0		0.35	0		0.36	0		0.37	0		0.37	0		0.38	0		0.38	0		0.38	0		0.39	0	
	Pachypodium	2798	0.33	923.34	2434	0.34	827.56	530	0.34	180.2	945	0.35	330.75	1876	0.36	675.36	2598	0.37	961.26	1425	0.37	527.25	1156	0.38	439.28	3175	0.38	1206.5	5470	0.38	2078.6	560	0.39	218.4	22,967
Liliales			0.33	0		0.34	0		0.34	0		0.35	0		0.36	0		0.37	0		0.37	0		0.38	0		0.38	0		0.38	0		0.39	0	
	Aloe	390	0.33	128.7	130	0.34	44.2		0.34	0		0.35	0	100	0.36	36	50	0.37	18.5		0.37	0		0.38	0		0.38	0		0.38	0		0.39	0	670
Orchidales			0.33	0		0.34	0		0.34	0		0.35	0		0.36	0		0.37	0		0.37	0		0.38	0		0.38	0		0.38	0		0.39	0	
	Aerangis	75	0.33	24.75	35	0.34	11.9	20	0.34	6.8		0.35	0		0.36	0		0.37	0	30	0.37	11.1		0.38	0	138	0.38	52.44	143	0.38	54.34	100	0.39	39	541
	Aeranthes	30	0.33	9.9	55	0.34	18.7		0.34	0		0.35	0		0.36	0		0.37	0	20	0.37	7.4		0.38	0	51	0.38	19.38	30	0.38	11.4	38	0.39	14.82	224
	Angraecum	93	0.33	30.69	185	0.34	62.9		0.34	0		0.35	0		0.36	0		0.37	0	80	0.37	29.6		0.38	0	460	0.38	174.8	558	0.38	212.04	256	0.39	99.84	1632
	Beclardia	13	0.33	4.29		0.34	0		0.34	0		0.35	0		0.36	0		0.37	0	10	0.37	3.7		0.38	0	22	0.38	8.36	18	0.38	6.84	7	0.39	2.73	70
	Bulbophyllum	10	0.33	3.3	40	0.34	13.6		0.34	0		0.35	0		0.36	0		0.37	0	30	0.37	11.1		0.38	0	73	0.38	27.74	143	0.38	54.34	88	0.39	34.32	384
	Calanthe		0.33	0	20	0.34	6.8		0.34	0		0.35	0		0.36	0		0.37	0	10	0.37	3.7		0.38	0	15	0.38	5.7	18	0.38	6.84		0.39	0	63
	Cryptopus		0.33	0		0.34	0		0.34	0		0.35	0		0.36	0		0.37	0		0.37	0		0.38	0		0.38	0	3	0.38	1.14		0.39	0	3
	Cymbidiella	11	0.33	3.63	15	0.34	5.1		0.34	0		0.35	0		0.36	0		0.37	0	5	0.37	1.85		0.38	0	4	0.38	1.52	12	0.38	4.56	1	0.39	0.39	48
	Cynorkis	9	0.33	2.97	45	0.34	15.3		0.34	0		0.35	0		0.36	0		0.37	0	60	0.37	22.2		0.38	0	40	0.38	15.2	94	0.38	35.72	9	0.39	3.51	257
	Erasanthe	33	0.33	10.89	30	0.34	10.2		0.34	0		0.35	0		0.36	0		0.37	0		0.37	0		0.38	0	16	0.38	6.08	23	0.38	8.74	12	0.39	4.68	114
	Eulophiella	3	0.33	0.99		0.34	0		0.34	0		0.35	0		0.36	0		0.37	0	5	0.37	1.85		0.38	0	3	0.38	1.14	35	0.38	13.3	13	0.39	5.07	59
	Gastrorchis	2	0.33	0.66		0.34	0		0.34	0		0.35	0		0.36	0		0.37	0	25	0.37	9.25		0.38	0	24	0.38	9.12	36	0.38	13.68	25	0.39	9.75	112
	Grammangis	9	0.33	2.97		0.34	0		0.34	0		0.35	0		0.36	0		0.37	0		0.37	0		0.38	0	2	0.38	0.76	6	0.38	2.28	1	0.39	0.39	18
	Graphorkis	2	0.33	0.66		0.34	0		0.34	0		0.35	0		0.36	0		0.37	0		0.37	0		0.38	0		0.38	0		0.38	0		0.39	0	2
	Jumellea	3	0.33	0.99	30	0.34	10.2		0.34	0		0.35	0		0.36	0		0.37	0	35	0.37	12.95		0.38	0	45	0.38	17.1	66	0.38	25.08	50	0.39	19.5	229
	Microcoelia		0.33	0	20	0.34	6.8		0.34	0		0.35	0		0.36	0		0.37	0	60	0.37	22.2		0.38	0	40	0.38	15.2	60	0.38	22.8	45	0.39	17.55	225
	Neobathiea	2	0.33	0.66		0.34	0		0.34	0		0.35	0		0.36	0		0.37	0		0.37	0		0.38	0	36	0.38	13.68	16	0.38	6.08	11	0.39	4.29	65
	Oeceoclades	150	0.33	49.5		0.34	0		0.34	0	30	0.35	10.5		0.36	0		0.37	0		0.37	0		0.38	0	3	0.38	1.14	23	0.38	8.74	4	0.39	1.56	210
	Oeonia	3	0.33	0.99		0.34	0		0.34	0		0.35	0		0.36	0		0.37	0		0.37	0		0.38	0	33	0.38	12.54	17	0.38	6.46	3	0.39	1.17	56
	Oeoniella	6	0.33	1.98		0.34	0		0.34	0		0.35	0		0.36	0		0.37	0		0.37	0		0.38	0		0.38	0	1	0.38	0.38		0.39	0	7
	Phaius		0.33	0		0.34	0		0.34	0		0.35	0		0.36	0		0.37	0		0.37	0		0.38	0	3	0.38	1.14	3	0.38	1.14	1	0.39	0.39	7
	Sobennikoffia	40	0.33	13.2		0.34	0	15	0.34	5.1		0.35	0		0.36	0		0.37	0		0.37	0		0.38	0		0.38	0	12	0.38	4.56	2	0.39	0.78	69
	(blank)	230	0.33	75.9	103	0.34	35.02	124	0.34	42.16	204	0.35	71.4	239	0.36	86.04		0.37	0	305	0.37	112.85		0.38	0	641	0.38	243.58		0.38	0	2	0.39	0.78	1848
Rhamnales			0.33	0		0.34	0		0.34	0		0.35	0		0.36	0		0.37	0		0.37	0		0.38	0		0.38	0		0.38	0		0.39	0	
	Cyphostemma		0.33	0		0.34	0		0.34	0		0.35	0		0.36	0	33	0.37	12.21	120	0.37	44.4	21	0.38	7.98	155	0.38	58.9	125	0.38	47.5	10	0.39	3.9	464
Sapindales			0.33	0		0.34	0		0.34	0		0.35	0		0.36	0		0.37	0		0.37	0		0.38	0		0.38	0		0.38	0		0.39	0	
	Operculicarya		0.33	0		0.34	0		0.34	0	50	0.35	17.5	231	0.36	83.16	511	0.37	189.07	84	0.37	31.08	229	0.38	87.02	545	0.38	207.1	2031	0.38	771.78	494	0.39	192.66	4175
Scrophulariales			0.33	0		0.34	0		0.34	0		0.35	0		0.36	0		0.37	0		0.37	0		0.38	0		0.38	0		0.38	0		0.39	0	
	Uncarina		0.33	0		0.34	0		0.34	0		0.35	0		0.36	0		0.37	0		0.37	0	1	0.38	0.38	80	0.38	30.4		0.38	0		0.39	0	81
Violales			0.33	0		0.34	0		0.34	0		0.35	0		0.36	0		0.37	0		0.37	0		0.38	0		0.38	0		0.38	0		0.39	0	
	Adenia		0.33	0		0.34	0		0.34	0		0.35	0		0.36	0		0.37	0		0.37	0	1	0.38	0.38		0.38	0	70	0.38	26.6		0.39	0	71
	Zygosicyos		0.33	0		0.34	0		0.34	0		0.35	0	5	0.36	1.8	20	0.37	7.4	179	0.37	66.23	45	0.38	17.1	163	0.38	61.94	263	0.38	99.94	20	0.39	7.8	695
Plant total		5316		1754.28	4175		1419.5	1309		445.06	1649		577.15	3346		1204.56	4812		1780.44	3193		1181.41	2615		993.7	7680		2918.4	11,620		4415.6	2262		882.18	47,977

† denotes dedicated chameleon prices extracted from Carpenter et al. [45] adjusted for inflation in USD; * denotes dedicated *Mantella* prices extracted from Rabemananjara et al. [41] adjusted for inflation in Malagasy Ariary value before conversion to USD. ^ denotes Agapornis prices from Reuter et al. [47]. All remaining prices were extracted from Robinson et al. [36] adjusted for yearly inflation levels in USD.

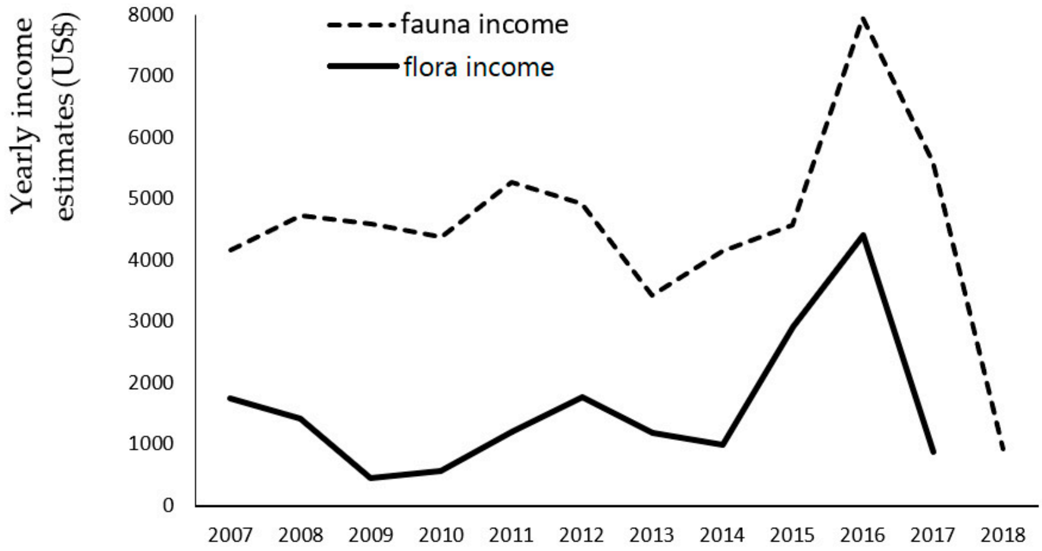

Figure 5. Yearly income estimates from the live trade in CITES listed animals and plants exported from Madagascar between 2007 and 2018 (Source: CITES Database).

Comparing the estimated levels of income generated from both ecotourism and wildlife trade in Madagascar, a much greater level of income generation was garnered from wildlife tourism (Figure 6). Wildlife tourism reported a yearly income estimated in the millions of US dollars, while estimates of income generation from the wildlife trade were recorded in thousands of US dollars (Figure 6). However, the wildlife trade displayed a positive increase in trade ($y = 305.23x + 4657.4$, $R^2 = 0.224$) (excluding 2018; as it has been reported that observed drops in trade in the latest year of reporting were more likely due to an artifact of countries' failure to meet CITES reporting timelines than a true drop in any trade—see [45]).

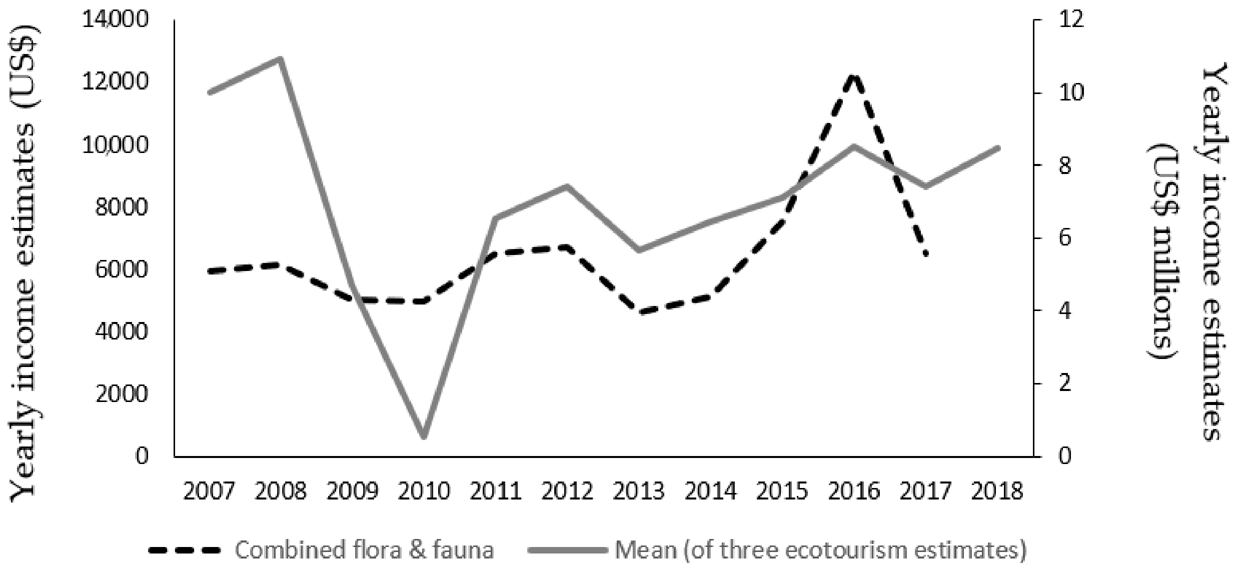

Figure 6. Yearly income estimates from both the combined live trade in CITES listed animals and plants exported from Madagascar and the mean estimated income from ecotourism to Madagascar between 2007 and 2018.

4. Discussion

Over the whole time period for which data exist (2007–2018), the international live trade in herpetofauna from Madagascar generated estimated revenues totalling up to USD 401,470 that were reaching local Malagasy people. Taking just the upper estimate, for the reptile- and amphibian-focused wildlife tourism, it was valued at over USD 51 million while the general figure was estimated at USD 17–46 million. However, these revenue estimates from tourism were much greater than the income estimate calculated from the wildlife trade. However, actually how much does flow to the local people was unknown. For comparison, in just 2018, Madagascar's top income generators ranged from; firstly, coffee, tea and spices (valued at USD 1 billion; on its own, vanilla was worth USD 855.4 million and cloves USD 149 million) to tenth place, mineral fuels, including oil (valued at USD 51.5 million) [48]. The vast differences highlighted here between top income generators and the trade in wildlife potentially offer some justification for the government of Madagascar's apparent lack of attention and focus to issues raised by this trade type. It can sometimes be forgotten by conservationists that Madagascar's government are often dealing with perceived greater priorities and with minimal resources.

However, it should also be remembered that this study is presenting wildlife trade data only for CITES listed species. There would also be much trade in non-CITES listed species happening in parallel to these data presented here. Therefore, the monetary values presented should be viewed as minimum values. It is known that illegal trade in wildlife exists, but, obviously, due to its very nature, this is not recorded or monitored and so not represented here, despite contributing to local economies. Furthermore, whilst CITES listed species do have non-detrimental findings (NDFs—albeit NDFs remain highly questionable in terms of the population data used and the robustness of outputs) that allow quotas to be assigned to a species limiting the number of individuals they are traded in, this is not the case for non-CITES listed species. Thus, questions over the sustainability of trade in all species of flora and fauna remain. However, presenting both flora and fauna data together within this study does allow for a more complete 'picture' of the wildlife trade in Madagascar, whilst highlighting that many questions remain unanswered over the sustainability and management of its wildlife.

The wildlife trade appears to exhibit greater resilience to extreme political unrest, such as that witnessed in Madagascar in 2009 when political unrest ended in a coup d'état. Conversely, the tourism sector was greatly impacted by this period of unrest, as observed in Figures 2 and 6 when tourism income records extreme lows in 2010. During the period of unrest, the incumbent president's position was challenged through national, unofficial strikes, public protest marches, which led to many confrontational flash points (such as the public clashing with the army and civilians being shot, some dying) and industries shutting down, which included travel, civil servant positions, etc.

Regarding tourism with a herpetological focus, whilst over two magnitudes of difference higher than income levels generated from the international live trade, this income and any benefits were orientated towards local communities located adjacent to the NPs. Conversely, the live trade was more likely to involve individuals who were geographically dispersed and not associated to any national park. Therefore, the two alternative sources of revenue generation are possibly complementary to each other in that they could potentially engage with different sets of local people. Therefore, they should not be viewed as single, exclusive forms of income generation, but rather sources that can operate side by side, as long as it is sustainably conducted. Thus, both avenues to the valorisation of wildlife raise not only the levels of revenue generated but also the opportunities to engage in revenue generation for a wide spectrum of local communities. However, one has to be careful of the wider dynamics involved. For example, one hotel northeast of Mahajunga, Anjajavy, attempted to train individuals from the adjacent, remote, village to work in the hotel (author, pers obs.). However, due to the multiple juxtapositions between the individuals and the western-facing hotel, the training of local people to work within the hotel and, thus, provide local benefits had very mixed results. This resulted in the hotel ceasing to try to utilize staff from the local village due to several reasons, but instead recruiting individuals with more western 'standards' exposure from major towns and importing them to work at the hotel but living in the local village. These new recruits were from different tribes with very different social/behavioural mannerisms, outlooks and more western experiences.

Yet they were expected to be both located within the local village and welcomed by those living there. The impacts were extremely wide-ranging and both negative and positive.

Despite the short-term economic benefits, the long-term conservation impacts resulting from the existing scope and scale of the consumptive use of wildlife was increasingly being questioned [1,11]. However, the potential negative impacts following unsustainable exploitation were not limited to extractive use of Madagascar's flora and fauna. For example, broad themed issues arising from ecotourism operators' environmental responsibility such as the demand for water supplies or waste product disposal can have large scale, deleterious impacts on the environment [29]. Alternatively, irresponsible ecotourism can result in smaller-scale negative impacts on both the conservation and welfare of wild animals, including reptiles [31,32]. For example, tourists being brought into regular and close proximity of free-ranging wildlife can negatively impact a range of species-specific behaviours, such as breeding [49] or foraging [50]. Furthermore, the direct physical contact with wildlife taken from the wild and being brought into captivity to show off to tourists can also result in the unintentional transfer of zoonotic diseases [34] and the potential death of individual animals or affect species' populations, including potentially threatened species. These types of negative impacts are often difficult to detect [31], while the cultural backgrounds of tourists and local Malagasy will have different attitudes and societal expectations that further complicate such decision-making [32].

Both trade types reported here, whilst generating income, raise questions over their sustainability, both from direct and indirect effects. However, it is imperative that Madagascar's authorities seek to implement much more robust and detailed reporting of the structures operating within both trade types. For example, taxes are collected from both trade types and there are potential benefits to government, local communities and conservation from implementing better monitoring. However, presently, there is a lack of knowledge and openness as to both the supply chain networks and financial flows operating within the country. Hence, to allow both fuller evaluation and greater management of these income-generation types, much greater effort needs to be focused on reporting on and managing both supply chain networks and financial flows. This would permit adjustment of higher financial flows away from wildlife exporters/foreign businesses and more towards government and local communities; importantly raising the benefits gained by local communities from maintaining local wildlife and habitats. Considering local communities are a conservation concern in places, this could be managed to benefit both local people and conservation.

No previous study has sought to estimate and compare such complex scenarios, especially for a country that has such a high conservation profile and in need of such evidence upon which to make more robust and sustainable management decisions for the national good. Ultimately, there are positives and negatives associated with both the live trade in wildlife and ecotourism. However, it will be the long-term sustainability with minimum environmental impacts that follow both activities that managers will need to ensure going forward. These will be multi-dimensional, ranging across species and ecosystems to human dimensions, and spanning both temporal and spatial scales. Hence, balancing social demands with environmental capacity to minimise impacts and maintain sustainability should be the goal of government and managers alike.

5. Conclusions

There have been no comprehensive reviews undertaken previously on the value of these two sectors for the potential conservation benefits they offer. This study was the first that sought to contrast and compare the extent of each trade type in Madagascar. It provides a comprehensive baseline from which to further investigate these areas, but also highlights the vast differences in income generated from both. However, it also highlights the need to better understand the flow of these revenue streams to better improve their benefits to both poverty alleviation and conservation. Certainly, without a much improved understanding of the flow and divisions of income, from the country level down to the local family, studies such as this one lack the detail and nuances to best advise on the changes required. This study has highlighted the levels of incomes involved, detailed the trade networks involved, highlighted the wild flora and fauna being traded and highlighted broadscale issues. It is now incumbent on others to take the fundamentals reported in this study and add the detail to allow sensitive, adaptive management proposals that benefit both poverty alleviation and conservation equally.

Author Contributions: Conceptualization, A.I.C.; methodology, A.I.C.; formal analysis, A.I.C.; investigation, A.I.C.; data curation, A.I.C.; writing—original draft preparation, A.I.C.; writing—review and editing, A.I.C. and F.A.; visualization, A.I.C. and F.A.; project administration, A.I.C. and F.A. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Data Availability Statement: CITES species trade data were openly and freely available from the CITES Trade Database.

Acknowledgments: AIC thanks the University of Cumbria for administrative, technical support and the donations in kind towards producing this study.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. IPBES. *Global Assessment Report on Biodiversity and Ecosystem Services of the 733 Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*; IPBES Secretariat: Bonn, Germany, 2019.
2. Low, B.R.; Costanza, E.; Ostrom, J.; Wilson, S.C. Human-ecosystem interactions: A dynamic integrated model. *Ecol. Econ.* **1999**, *31*, 227–242. [CrossRef]
3. Milner-Gulland, E.; Mace, R. *Conservation of Biological Resources*; Blackwell Science: Oxford, UK, 1998.
4. Brown, D. Participatory biodiversity conservation rethinking the strategy in the low potential areas of tropical Africa. In *Natural Resource Perspectives*; Overseas Development Institute: London, UK, 1998; Volume 44.
5. Martin, A.; McGuire, S.; Sullivan, S. Global environmental justice and biodiversity conservation. *Geogr. J.* **2013**, *179*, 122–131. [CrossRef]
6. Walker, G. *Environmental Justice: Concepts, Evidence and Politics*; Routledge: London, UK, 2012.
7. Chan, K.; Satterfield, T. Justice, equity and biodiversity. In *The Encyclopedia of Biodiversity*; Levin, S., Daily, G.C., Colwell, R.K., Eds.; Elsevier: Oxford, UK, 2007; pp. 1–9.
8. Casse, T.; Milhøj, A.; Ranaivoson, S.; Randriamanarivo, J.R. Causes of deforestation in southwestern Madagascar: What do we know? *For. Policy Econ.* **2004**, *6*, 33–48. [CrossRef]
9. Golden, C.D.; Bonds, M.H.; Brashares, J.S.; Rasolofoniaina, B.J.R.; Kremen, C. Economic Valuation of Subsistence Harvest of Wildlife in Madagascar. *Conserv. Biol.* **2014**, *28*, 234–243. [CrossRef] [PubMed]
10. Norman, D. Man and tegu lizards in eastern Paraguay. *Biol. Conserv.* **1987**, *41*, 39–56. [CrossRef]
11. IPBES; Pascual, U.; Balvanera, P.; Christie, M.; Baptiste, B.; González-Jiménez, D.; Anderson, C.B.; Athayde, S.; Barton, D.N.; Chaplin-Kramer, R.; et al. (Eds.) *Summary for Policymakers of the Methodological Assessment Report on the Diverse Values and Valuation of Nature of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*; IPBES Secretariat: Bonn, Germany, 2022. [CrossRef]
12. Gibbons, J.W.; Scott, D.E.; Ryan, T.J.; Buhlmann, K.A.; Tuberville, T.D.; Metts, B.S.; Greene, J.L.; Mills, T.; Leiden, Y.; Poppy, S.; et al. The Global Decline of Reptiles, Déjà Vu Amphibians. *BioScience* **2000**, *50*, 653–666. [CrossRef]
13. Reuter, K.E.; LaFleur, M.; Clarke, T.A. Illegal lemur trade grows in Madagascar. *Nature* **2017**, *541*, 157. [CrossRef]
14. Patel, E.R. Logging of rare Rosewood and Palisander (Dalbergia spp.) within Marojejy National Park, Madagascar. *Madag. Conserv. Dev.* **2007**, *2*, 11–16.
15. Jenkins, R.K.B.; Tognelli, M.F.; Bowles, P.; Cox, N.; Brown, J.L.; Chan, L.; Andreone, F.; Andriamazava, A.; Andriantsimanarilafy, R.R.; Anjeriniaina, M.; et al. Extinction Risks and the Conservation of Madagascar's Reptiles. *PLoS ONE* **2014**, *9*, 100173. [CrossRef]
16. Glaw, F.; Vences, M. Current counts of species diversity and endemism of Malagasy amphibians and reptiles. In *Diversité et Endémisme à Madagascar*; Lourenço, W.R., Goodman, S.M., Eds.; Mémoires de la Société de Biogéographie: Paris, France, 2000; pp. 243–248.
17. Goodman, S.M. (Ed.) *The New Natural History of Madagascar*; Princeton University Press: Princeton, NJ, USA, 2022.
18. Rabesahala Horning, N. Madagascar's biodiversity conservation challenge: From local- to national-level dynamics. *Environ. Sci.* **2008**, *5*, 109–128. [CrossRef]
19. Ferraro, P.J. The local costs of establishing protected areas in low-income nations: Ranomafana National Park, Madagascar. *Ecol. Econ.* **2002**, *43*, 261–275. [CrossRef]

20. Shyamsundar, P.; Kramer, R. Biodiversity conservation—At what cost? A study of households in the vicinity of Madagascar's Mantadia National Park. *Ambio* **1997**, *26*, 180–184.
21. Nicoll, M.E.; Langrand, O. *Madagascar: Revue de la Conservation et des Aires Protégées*; WWF: Gland, Switzerland, 1989.
22. Durbin, J.; Ralambo, J.A. The role of local people in the successful maintenance of protected areas in Madagascar. *Environ. Conserv.* **1994**, *21*, 115–120. [CrossRef]
23. Gardner, C.J.; Nicoll, M.E.; Mbohoahy, T.; Oleson, K.L.L.; Ratsifandrihamanana, A.N.; Ratsirarson, J.; de Roland, L.-A.R.; Virah-Sawmy, M.; Zafindrasilivonona, B.; Davies, Z.G. Protected areas for conservation and poverty alleviation: Experiences from Madagascar. *J. Appl. Ecol.* **2013**, *50*, 1289–1294. [CrossRef]
24. Keane, A.; Ramarolahy, A.A.; Jones, J.P.G.; Milner-Gulland, E.J. Evidence for the effects of environmental engagement and education on knowledge of wildlife laws in Madagascar. *Conserv. Lett.* **2011**, *4*, 55–63. [CrossRef]
25. Dixon, J.A.; Pagiola, S. *Ecotourism: Incentives for Conservation Success*; Environment Department, World Bank: Washington, DC, USA, 2001.
26. Buckley, R. *Conservation Tourism*; CABI: Cambridge, UK, 2010.
27. Ormsby, A.; Mannle, K. Ecotourism benefits and the role of local guides at Masoala National Park, Madagascar. *J. Sustain. Tour.* **2006**, *14*, 271–287. [CrossRef]
28. Neudert, R.; Ganzhorn, J.U.; Wathold, F. Global benefits and local costs—The dilemma of tropical forest conservation: A review of the situation in Madagascar. *Environ. Conserv.* **2017**, *44*, 82–96. [CrossRef]
29. Kasim, A. Towards a wider adoption of environmental responsibility in the hotel sector. *Int. J. Hosp. Tour. Adm.* **2007**, *8*, 25–49. [CrossRef]
30. Platt, J.R. Ring-Tailed Lemurs Threatened by Illegal Pet Trade. *Scientific American*. 7 August 2015. Available online: https://blogs.scientificamerican.com/extinction-countdown/ring-tailed-lemurs-pet-trade/ (accessed on 1 December 2019).
31. Moorhouse, T.P.; Dahlsjö, C.A.; Baker, S.E.; D'Cruze, N.C.; Macdonald, D.W. The customer isn't always right—Conservation and animal welfare implications of the increasing demand for wildlife tourism. *PLoS ONE* **2015**, *10*, e0138939. [CrossRef]
32. Moorhouse, T.; D'Cruze, N.C.; Macdonald, D.W. Unethical use of wildlife in tourism: What's the problem, who is responsible, and what can be done? *J. Sustain. Tour.* **2017**, *25*, 505–516. [CrossRef]
33. Peters, J. Sharing national park entrance fees: Forging new partnerships in Madagascar. *Soc. Nat. Resour.* **1998**, *11*, 517–530. [CrossRef]
34. Wollenberg, K.C.; Jenkins, R.K.; Randrianavelona, R.; Rampilamanana, R.; Ralisata, M.; Ramanandraibe, A.; Ravoahangimalala, O.R.; Vences, M. On the shoulders of lemurs: Pinpointing the ecotouristic potential of Madagascar's unique herpetofauna. *J. Ecotourism* **2011**, *10*, 101–117. [CrossRef]
35. Brady, L.D.; Griffiths, R.A. *Status Assessment of Chameleons in Madagascar*; IUCN Species Survival Commission, IUCN: Cambridge, UK, 1999.
36. Robinson, J.E.; Fraser, I.M.; John, F.A.V.S.; Randrianantoandro, J.C.; Andriantsimanarilafy, R.R.; Razafimanahaka, J.H.; Griffiths, R.A.; Roberts, D.L. Wildlife supply chains in Madagascar from local collection to global export. *Biol. Conserv.* **2018**, *226*, 144–152. [CrossRef]
37. Ganzhorn, J.; Manjoazy, T.; Paplow, O.; Randrianavelona, R.; Razafimanahaka, J.; Ronto, W.; Walker, R. Rights to trade for species conservation: Exploring the issue of the radiated tortoise in Madagascar. *Environ. Conserv.* **2015**, *42*, 291–293. [CrossRef]
38. Waeber, P.O.; Wilmé, L. Madagascar rich and intransparent. *Madag. Conserv. Dev.* **2013**, *8*, 52–54. [CrossRef]
39. Morgan, J.; Chng, S. Rising internet-based trade in the Critically Endangered ploughshare tortoise Astrochelys yniphora in Indonesia highlights need for improved enforcement of CITES. *Oryx* **2018**, *52*, 744–750. [CrossRef]
40. Innes, J.L. Madagascar rosewood, illegal logging and the tropical timber trade. *Madag. Conserv. Dev.* **2010**, *5*, 6–10. [CrossRef]
41. Rabemananjara, F.C.E.; Raminosoa, N.R.; Ramilijaona, O.R.; Rakotondravony, D.; Andreone, F.; Bora, P.; Carpenter, A.I.; Glaw, F.; Razafindrabe, T.; Vallan, D.; et al. Malagasy poison frogs in the pet trade: A survey of levels of exploitation of species in the genus Mantella. In *Conservation Strategy for the Amphibians of Madagascar Proceedings*; Andreone, F., Ed.; Monografie del Museo Regionale di Scienze Natural di Torino: Turin, Italy, 2008; pp. 277–300.
42. Carpenter, A.I.; Robson, O. Madagascan amphibians as a wildlife resource and their potential as a conservation tool: Species and numbers exported, revenue generation and bio-economic models to explore conservation benefits. In *Conservation Strategy for the Amphibians of Madagascar Proceedings*; Andreone, F., Ed.; Monografie del Museo Regionale di Scienze Natural di Torino: Turin, Italy, 2008; pp. 357–376.
43. Carpenter, A.I.; Rowcliffe, M.; Watkinson, A.R. The dynamics of the global trade in chameleons. *Biol. Conserv.* **2004**, *120*, 295–305. [CrossRef]
44. Carpenter, A.I.; Andreone, F.; Moore, R.D.; Griffiths, R.A. A review of the global trade in amphibians: The types of trade, levels and dynamics in CITES listed species. *Oryx* **2014**, *48*, 565–574. [CrossRef]
45. Carpenter, A.I.; Robson, O.; Rowcliffe, M.; Watkinson, A.R. The impacts of international and national governance on a traded resource: A case study of Madagascar and its chameleon trade. *Biol. Conserv.* **2005**, *123*, 279–287. [CrossRef]
46. Vaglica, V.; Sajeva, M.; McGough, H.N.; Hutchison, D.; Russo, C.; Gordon, A.D.; Ramarosandratana, A.V.; Stuppy, W.; Smith, M.J. Monitoring internet trade to inform species conservation actions. *Endanger. Species Res.* **2017**, *32*, 223–235. [CrossRef]
47. Reuter, K.E.; Clarke, T.A.; LaFleur, M.; Rodriguez, L.; Hanitriniaina, S.; Schaefer, M.S. Trade of parrots in urban areas of Madagascar. *Madag. Conserv. Dev.* **2017**, *12*, 41–48. [CrossRef]

48. World's Top Exports. Madagascar's Top 10 Exports. 2019. Available online: http://www.worldstopexports.com/madagascars-top-10-exports/ (accessed on 15 October 2019).
49. Jacobson, S.K.; Lopez, A.F. Biological impacts of ecotourism: Tourists and nesting turtles in Tortuguero National Park, Costa Rica. *Wildl. Soc. Bull.* **1994**, *22*, 414–419.
50. Meissner, A.M.; Christiansen, F.; Martinez, E.; Pawley, M.D.; Orams, M.B.; Stockin, K.A. Behavioural effects of tourism on oceanic common dolphins, Delphinus sp., in New Zealand: The effects of markov analysis variations and current tour operator compliance with regulations. *PLoS ONE* **2015**, *10*, e0116962. [CrossRef] [PubMed]