Tourism Revenue as a Conservation Tool for Threatened Birds in Protected Areas

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Abstract

Many bird populations worldwide are at risk of extinction, and rely heavily on protected area networks for their continued conservation. Tourism to these areas contributes to conservation by generating revenue for management. Here we quantify the contribution of tourism revenue for bird species in the IUCN Red List, using a simple accounting method. Relevant data are available for 90 (16%) of the 562 critically endangered and endangered species. Contributions of tourism to bird conservation are highest, 10–64%, in South America, Africa, and their neighbouring islands. Critically endangered bird species rely on tourism more heavily than endangered species (p=0.02). Many protected areas could also enhance their management budgets by promoting birdwatching tourism specifically.

Introduction

Approximately 13% of extant bird species are threatened with extinction [1,2] and protected area (PA) networks are the mainstay of global efforts to conserve them [2,3,4]. These networks include: formal gazetted public national parks and reserves (e.g. IUCN Category II); internationally designated areas such as Biosphere Reserves; communal conservancies; and private reserves [5,6]. There are >120,000 public protected areas worldwide, covering ~13% of global terrestrial habitats [4]. Some bird species remain extant only as a result of reserves designated and managed specifically to conserve them [7,8].

Despite previous efforts, current protected area networks provide incomplete protection for global biodiversity, and species continue to decline in diversity and abundance [3,9]. Reversing these trends of decline requires a thorough understanding of species ecology, threatening processes, as well as the expansion and active management of global protected area networks [3,9,10,11]. These approaches require funds for conservation measures such as habitat restoration, control of invasive species, reintroductions of threatened species, and anti-poaching efforts [3,9,10,12,13]. Generally, funds for conserving biodiversity in protected areas worldwide remain inadequate to meet these needs [9,14].

Many protected area managers seeking to expand and diversify their funding portfolios consider tourism revenue to be an increasingly significant fiscal source for protected area management and conservation. Revenue is raised from entrance and activity charges, accommodation, concession and lease fees, and sales of tourist commodities [6,13,15,16–22]. Additional indirect contributions to conservation may occur through various social mechanisms. These include educating tourists and changing their behaviours; providing benefits to local communities to reduce dependence on natural resources [23–26]; and improving local awareness and attitudes towards conservation [12,24,25].

However, tourism can also create negative impacts in protected areas, affecting both the environment and species within them [16,27,28]. The scale, extent and severity of these impacts depend on the nature of the tourism activity. Previous studies have highlighted the variable impacts to birds from both motorised and non-motorised tourism activities [27,28]. So long as these impacts are managed effectively, tourism can deliver net benefits to species and ecosystems [6,15,20,29,30] but these are rarely quantified.

The relationship between tourism revenue to protected areas, and conservation of the threatened species which occur in them, has been demonstrated recently for mammals and frogs at the global scale [29,30], but not for any other taxa. Here, therefore, we examine firstly, the contributions of protected areas networks to conservation of threatened bird species; and secondly, the degree to which tourism revenue to protected areas contributes to the conservation of critically endangered and endangered bird species. We hypothesise that for threatened birds in developing countries, where government funding for conservation is scarce, tourism revenue plays a key role in conservation funding.

Methods

The degree to which individual threatened species depend on tourism revenues to protected areas can be quantified using simple accounting approaches, either for species populations [29] or species ranges [30]. Here we apply the population accounting approach [29], to all 562 bird species classified as critically endangered (CR) or endangered (EN) in the IUCN Red List of Threatened Species [31]. We use the widely adopted IUCN codes, CR and EN respectively, to refer to these threat classifications when reporting results [1,4,29,30]. For each species, this approach
calculates $T$, the proportion of global population protected by tourism, as $T = \left(\sum S_i / R_i \right) / G$ where $S_i$ are the sizes of subpopulations in parks, $R_i$ are proportions of parks revenue from tourism, and $G$ is the global population for the species concerned [29].

We compiled data on the population status and distributions for each of these 562 threatened bird species from the IUCN Red List and BirdLife International databases [32]. As in previous studies [1,4,10,29,30] we used these data sources and classifications as they provide a consistent and reliable measure of threat status at the global scale, despite their inherent limitations. In calculating $S_i$, we included only resident subpopulations [31,32] within each protected area. For migratory species, we included only those protected areas which are significant breeding sites. We included all protected areas which support known populations of critically endangered or endangered bird species, including those where tourism revenue, $R = 0$. We obtained data on $R$ from parks agency financial statements, annual reports and published compendia [21,22,29,30] for ~35 of the world’s 196 sovereign nations (Table S1). Such financial data for individual protected areas across global scales are rarely available or consistent. Therefore, we followed approaches used for mammals and frogs [29,30] and calculated $R$ at national scale, since protected area agencies routinely transfer funds between individual parks.

**Results**

There are 190 CR and 372 EN bird species in the IUCN Red List of Threatened Species, 562 species in total. For 109 CR and 132 EN species, 57% and 35% respectively, there are no records of occurrence in any protected area worldwide. The distributions of the remaining 81 CR and 240 EN species intersect 520 protected areas in 77 countries. Of these, 17 CR and 11 EN species survive in only a single protected area. Four species survive only in Galapagos National Park in Ecuador; three on Norfolk Island in Australia; two in Junin National Reserve in Peru; and two in Alakai Wilderness Preserve in Hawaii, USA (Table S2). All remaining CR and EN bird species, 34% and 62% respectively, currently survive in at least two protected individual areas.

Worldwide, 413 protected areas conserve only a single CR or EN bird species, and 107 protected areas in 33 countries support two or more species (Table S3). Galapagos National Park supports eight CR and EN species; and Pedra Talhada Biological Reserve in Brazil, and Gough Island Nature Reserve in the southern Atlantic Ocean each support six (Table 1). This highlights the relatively high numbers of threatened bird species supported in island protected areas worldwide.

Tourism revenue contributions to protected area budgets, $R$, range from zero in some countries to 100% for a number of private reserves. North Island in the Seychelles, and Cerro Batípa Private Reserve in Panama, provides examples of the latter (Table S1). For most of the countries relevant to this analysis, $R$ at national scale ranges from 5–80%. For Australia, New Zealand and the USA, $R<10%$, and for Canada, $R=14%$. For the 19 South and Central American countries where data are available, $R>20%$ for five, 10% $<R<20%$ for five, and $R<10%$ for nine. Of the six continental African countries where population data $S_i$ are known for CR and EN bird species, data on $R$ are available for five, where $R$ ranges from between 36–81%. Globally, $R$ is higher on average for developing than developed nations.

Subpopulation data for threatened bird species in protected areas, $S_i$, are available for 55 CR and 85 EN species, comprising 216 subpopulations in all. Data for both $S$ and $R$ are available for 91 species in 131 subpopulations. For four species, data on $R$ are available for only some of the relevant protected areas. These species are the Seychelles Magpie-robin *Copsychus sechellarum*, Seychelles White-eye *Zosterops modestus*, Black-footed Albatross *Phoebastria nigripes*, and Sooty Albatross *Phoebastria immutabilis*. Calculations of $T$ for these species thus reflect only some of the known subpopulations.

For these 91 species, $T$ ranges from 0–64% (Table 2, Fig. 1). For nine species, $T=0$, as the protected areas in which these species occur do not receive income from tourism. For 41 species: 0% $< T <5%$; for 21 species, 5% $\leq T \leq 10%$; for 8 species, 10% $\leq T <20%$; and for 12 species, $T \geq 20%$ (Fig. 1). Mean $T$ is significantly greater for CR than EN bird species (arcsine square-root transformation, $\tau = 0.082$, d.f. = 89, $p = 0.92$). For two species, $T=50%$: the Seychelles Magpie-robin ($T=64%$) and the African Penguin ($T=50%$). It is not only small populations that rely on tourism revenue since there is no correlation between $T$ and global populations $G$ ($R^2 = 0.009$, d.f. = 89, $p = 0.397$) (Fig. 2). For example, the Seychelles Magpie-robin and African Penguin with $T \geq 50%$ have global population sizes $G$ of 100–500 and 50,000–100,000 respectively.

**Discussion**

Our findings as presented above fall into two major categories: firstly, on the degree of protection or otherwise for threatened bird species; and secondly, on the relative contributions of revenue from tourism. In the first category, we show that 57% of critically endangered and 35% of endangered bird species do not occur at all inside the current global protected area network, highlighting the global extinction risk facing many species. We also show that 14 individual protected areas each protect the last remaining populations for more than one critically endangered or endangered bird species (Table 1), and are hence of particular significance for bird conservation. Half of these protected areas are in South America, reflecting the high diversity and restricted ranges of neotropical avifauna. Three are on islands, particularly vulnerable to some threats but relatively protected from others [33], and sometimes amenable to direct conservation interventions, with a number of successful examples [34–36]. These findings confirm longstanding concerns over inadequate protection of bird species worldwide [9,10].

These findings are subject to limitations of available data on populations, distributions and threats to bird species. These limitations influence both the IUCN Red List classifications of species as critically endangered or endangered, and the reliability and completeness of numerical estimates for protected subpopulations, $S_i$. However, these limitations are unlikely to compromise our findings for several reasons. The first relates to the global scale of our assessment. A number of countries, and in some case subsidiary jurisdictions such as states and provinces, maintain their own legislation for protection of threatened species, which do not necessarily match the IUCN Red List either in the species included, the categories of threat status, or the threat classifications allocated. These differences, however, are not consistent. In some countries, national or subsidiary legislation may be more comprehensive, stringent or up to date than the IUCN Red Lists, but in other countries and jurisdictions the reverse applies, especially in developing nations. In this analysis, therefore, we relied on the IUCN Red List as the only standardised international database available.

Furthermore, our assessment made no attempt to evaluate the accuracy of the threatened species classification used but focused simply on where threatened species occurred in protected areas and the degree to which these areas were funded through tourism. Similar global assessments using these data sets have recently been
completed for mammals and frogs [29,30] and these data are widely used for other global threatened species assessments [1,4,10]. This is less of a limitation for birds than for mammal and frog species [29,30], because in the case of birds, data from IUCN are supplemented by those from BirdLife International. For frogs [30], the shortcomings of subpopulation data forced the authors to rely on an alternative and less precise accounting metric, proportion of known range. For mammals [29], data on $S$ and $R$ were available jointly for only 90 of 1131 candidate species, which included vulnerable as well as critically endangered and endangered species. The calculations of $T$ presented here for threatened bird species are thus the most comprehensive yet available for any major taxonomic group.

For the future conservation of threatened bird species, two key issues emerge from this first section of our analyses. (a) The limitations in available data demonstrate the importance of

| Reserve Name                          | Country     | Total number of CR or EN bird species recorded in this reserve | Number of CR or EN species recorded only in this reserve |
|---------------------------------------|-------------|---------------------------------------------------------------|---------------------------------------------------------|
| Galapagos National Park               | Ecuador     | 8                                                             | 4                                                       |
| Pedra Talhada Biological Reserve      | Brazil      | 6                                                             | 0                                                       |
| Gough Island Nature Reserve           | Saint Helena| 6                                                             | 1                                                       |
| Munchique National Natural Park       | Colombia    | 5                                                             | 0                                                       |
| South East Island (Rangatira) Nature Reserve | New Zealand | 5                                                             | 1                                                       |
| Emas National Park                    | Brazil      | 4                                                             | 0                                                       |
| Frei Caneca Private Reserve           | Brazil      | 4                                                             | 0                                                       |
| Sooretama Biological Reserve          | Brazil      | 4                                                             | 0                                                       |
| Sierra Nevada de Santa Marta Biosophere Reserve | Colombia | 4                                                             | 1                                                       |
| French Southern and Antarctic Lands   | France      | 4                                                             | 0                                                       |
| Black River Gorges National Park      | Mauritius   | 4                                                             | 0                                                       |
| Fiordland National Park               | New Zealand | 4                                                             | 0                                                       |
| Mangere Island Nature Reserve         | New Zealand | 4                                                             | 0                                                       |
| Mt Canlaon Natural Park               | Philippines | 4                                                             | 0                                                       |

Figure 1. Proportions $T$ of CR and EN bird species with conservation funding from tourism.

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continuing research on bird species populations, distributions, ecology and threats. (b) The high proportions of threatened bird species (43%) which do not currently occur in any protected area worldwide demonstrates the importance of promoting biodiversity conservation across both public and private lands, even where expansion of the formal protected area network is not feasible. (c) Data on the joint distribution of critically endangered and endangered bird species, as highlighted here, could be used to direct conservation funding efficiently, thereby maximising overall threat reduction per unit expenditure.

Our second set of findings relates to the role of tourism revenue contributions to conservation of threatened bird species occurring at least in part within protected areas. Our results identify 41 species where at least 10% of each global population relies on tourism revenue. Naturally, these calculations are also subject to limitations in the scope, accuracy and reliability of financial data in the budgets of protected area agencies. Only a few countries produce and publish transparent, timely and externally audited annual financial statements for their protected area agencies that distinguish different revenue sources. Therefore, if anything, our findings underestimate the importance of tourism revenue for threatened birds in protected areas. When financial data become available for more protected area networks in more countries, a revised analysis would potentially identify a greater number of threatened species that are dependent on tourism revenues.

Despite these shortcomings in detailed data, our findings are broad and robust enough to demonstrate the important role of tourism in funding the conservation of threatened bird species. This reflects changing patterns in protected area funding more generally, over recent decades. Globally, government budget allocations are still the principal source of protected area management funds [13,21]. However, many protected area agencies increasingly rely on tourism revenues to supplement or replace government allocations (Table 2) [19]. Tourism thus contributes to the conservation of threatened bird species, especially in developing nations with high biodiversity.

The other side of this coin, however, is that threatened bird species protected in parks are now subject to risks associated with the volatility of global tourism markets in addition to those already imposed by direct disturbance impacts [12,28]. This is more of an issue for parks agencies in developing nations operating with less reliable government funding [13,21,37–40]. In addition, raising revenue from tourism to public protected areas may rely on charging user fees for visitors, and this is subject to equally volatile political and economic constraints [12,13,21]. In addition, for some countries, tourism revenues raised in protected areas not retained by the parks agencies at all. Such challenges are less problematic when tourism and conservation action occurs on private land, as has been demonstrated in southern Africa [16,41–44]. For threatened bird species, the contributions of private enterprise have been quantified for only a few cases, notably the Seychelles White-eye on North Island and the Resplendent Quetzal (Pharomachrus mocinno) in the Monteverde Cloud Forest Reserve [6,34].

The broad accounting approach taken here simply quantifies the degree to which tourism to protected areas contributes to funding conservation of threatened bird species. A number of more detailed or sophisticated approaches may also be feasible. 1. Differentiation by land tenure, distinguishing public, communal and private lands. 2. An accounting approach which calculates net contributions [45], allowing for negative environmental impacts [27,28] as well as positive conservation measures, and distinguishing high-impact park-based mass tourism from low-impact park-based nature tourism. 3. A more detailed approach which relies on ecological modelling rather than purely on accounting. 4. A narrower focus, on the bird-watching or avitourism subsector specifically, as below.

Birdwatching is a significant and expanding subsector of the tourism industry. Avitourists travel either to see particular bird species, especially those that are rare or threatened; or to visit areas with high endemism and high diversity of bird species [46–52]. As shown here, many threatened bird species currently occur only outside protected areas, and this includes species attractive to birdwatchers. Specialist avitourism may thus create further incentives to expand the protected area network, or improve bird conservation on lands outside that network. In particular, this includes Important Bird Areas, designated in part due to the presence of threatened bird species. The role of avitourism in

Figure 2. Relation between $T$ and $G$, natural log scales, for CR and EN bird species ($n=91$).
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| Scientific Name                  | Common Name           | IUCN | Global population (G) | Number* of protected subpopulations with known S, R | Number of individuals protected through tourism (SR) | Percentage of global population protected through tourism (%) |
|---------------------------------|-----------------------|------|-----------------------|----------------------------------------------------|------------------------------------------------------|-------------------------------------------------------------|
| Copsychus sechellarum           | Seychelles Magpie-robin | EN   | 178                   | 2                                                  | 114                                                  | 64.0                                                        |
| Spheniscus demersus             | African Penguin       | EN   | 52000                 | 6                                                  | 26040                                                | 50.1                                                        |
| Zosterops modestus              | Seychelles White-eye  | EN   | 450                   | 3                                                  | 178                                                  | 39.6                                                        |
| Sephanoides fernandensis        | Juan Fernandez Firecrown | CR  | 3000                  | 1                                                  | 1137                                                 | 37.9                                                        |
| Malacoctonus alius              | Uluguru Bush-shrike   | CR   | 2400                  | 1                                                  | 881                                                  | 36.7                                                        |
| Mirus trifasciatus              | Floreana Mockingbird  | CR   | 100                   | 1                                                  | 28                                                   | 28.0                                                        |
| Camarhynchus pauper             | Medium Tree-finch     | CR   | 1660                  | 1                                                  | 460                                                  | 27.7                                                        |
| Phoebastria irrorata            | Waved Albatross       | CR   | 34700                 | 1                                                  | 9612                                                 | 27.7                                                        |
| Mirus melanotis                 | San Cristobal Mockingbird | EN  | 8000                  | 1                                                  | 2216                                                 | 27.7                                                        |
| Camarhynchus heliobates         | Mangrove Finch        | CR   | 160                   | 2                                                  | 44                                                   | 27.5                                                        |
| Spheniscus mendiculus           | Galapagos Penguin     | EN   | 1800                  | 1                                                  | 474                                                  | 26.3                                                        |
| Artisornis moreasi              | Long-billed Tailorbird | CR  | 250                   | 1                                                  | 55                                                   | 22.0                                                        |
| Buteo ridgwayi                  | Ridgway’s Hawk        | CR   | 240                   | 1                                                  | 38                                                   | 15.8                                                        |
| Pololiptila clementsia           | Iquitos Gnatcatcher   | CR   | 250                   | 1                                                  | 39                                                   | 15.6                                                        |
| Laterallus tuerosi              | Junin Rail            | EN   | 2500                  | 1                                                  | 388                                                  | 15.5                                                        |
| Podiceps taczanowiskii          | Junin Grebe           | CR   | 304                   | 1                                                  | 47                                                   | 15.5                                                        |
| Hylomypha macrocerca            | Scissor-tailed Hummingbird | EN  | 20000                 | 1                                                  | 2480                                                 | 12.4                                                        |
| Pterodroma phaeopygia           | Galapagos Petrel      | CR   | 10000                 | 4                                                  | 1219                                                 | 12.2                                                        |
| Terpsiphone corvina             | Seychelles Paradise-flycatcher | CR  | 278                   | 2                                                  | 30                                                   | 10.8                                                        |
| Zosterops albogularis           | White-chested White-eye | CR   | 50                    | 1                                                  | 5                                                    | 10.0                                                        |
| Grus americana                  | Whooping Crane        | EN   | 382                   | 1                                                  | 36                                                   | 9.4                                                         |
| Manorina melanotis              | Black-eared Miner     | EN   | 1000                  | 1                                                  | 94                                                   | 9.4                                                         |
| Papasula abbotti                | Abbott’s Booby        | EN   | 6000                  | 1                                                  | 564                                                  | 9.4                                                         |
| Zosterops tenuirostris          | Slender-billed White-eye | EN  | 2000                  | 1                                                  | 188                                                  | 9.4                                                         |
| Ara ambiguus                    | Great Green Macaw     | EN   | 3700                  | 3                                                  | 334                                                  | 9.0                                                         |
| Pardalotus quadragintus         | Forty-spotted Pardalote | EN  | 3800                  | 2                                                  | 339                                                  | 8.9                                                         |
| Caratua haematurophygia         | Philippine Cockatoo   | CR   | 2700                  | 2                                                  | 239                                                  | 8.9                                                         |
| Acroros narcondam              | Narcondam Hornbill    | EN   | 340                   | 1                                                  | 27                                                   | 7.9                                                         |
| Threskiornis bernieri           | Madagascar Sacred Ibis | EN   | 3250                  | 1                                                  | 254                                                  | 7.8                                                         |
| Myiotheretes permix             | Santa Marta Bush-tyrant | EN  | 2500                  | 1                                                  | 190                                                  | 7.6                                                         |
| Anas layanensis                 | Laysan Duck           | CR   | 1100                  | 2                                                  | 82                                                   | 7.5                                                         |
| Acrocephalus familiaris         | Millerbird            | CR   | 1000                  | 1                                                  | 74                                                   | 7.4                                                         |
| Myadestes palmeri               | Puiaohi               | CR   | 500                   | 1                                                  | 37                                                   | 7.4                                                         |
| Oreomyctis bairdi               | Akkiki                | CR   | 1840                  | 1                                                  | 136                                                  | 7.4                                                         |
| Crax blumenbachii               | Red-billed Curassow   | EN   | 250                   | 3                                                  | 16                                                   | 6.4                                                         |
| Aratinga brevipes               | Socorro Paraheet      | EN   | 300                   | 1                                                  | 18                                                   | 6.0                                                         |
| Mimus grayseni                  | Socorro Mockingbird   | CR   | 420                   | 1                                                  | 25                                                   | 6.0                                                         |
| Anas wyvilliana                 | Hawaiian Duck         | EN   | 2525                  | 1                                                  | 148                                                  | 5.9                                                         |
| Leptoptilos dubius              | Greater Adjutant      | EN   | 1000                  | 2                                                  | 52                                                   | 5.2                                                         |
| Petroica traversi               | Black Robin           | EN   | 250                   | 2                                                  | 13                                                   | 5.2                                                         |
| Phoebastria nigipes             | Black-footed Albatross | EN  | 130000                | 3                                                  | 6700                                                  | 5.2                                                         |
| Strigops habroptila             | Kakapo                | CR   | 124                   | 2                                                  | 6                                                    | 4.8                                                         |
| Pterodroma axillaris            | Chatham Petrel        | EN   | 1100                  | 1                                                  | 53                                                   | 4.8                                                         |
| Pterodroma magnetae             | Magenta Petrel        | CR   | 150                   | 2                                                  | 7                                                    | 4.7                                                         |
| Psephotus chrysopterygius       | Golden-shouldered Parrot | EN  | 2000                  | 2                                                  | 87                                                   | 4.4                                                         |
| Eudyptes sclateri               | Erect-crested Penguin | EN   | 170000                | 2                                                  | 7392                                                  | 4.3                                                         |
| Scientific Name          | Common Name          | IUCN | Global population (G) | Number* of protected subpopulations with known $S, R$ | Number of individuals protected through tourism ($SR$) | Percentage of global population protected through tourism ($T$) |
|--------------------------|----------------------|------|------------------------|------------------------------------------------------|------------------------------------------------------|---------------------------------------------------------------|
| Anas nesiotsis           | Campbell Islands Teal | CR   | 250                    | 3                                                   | 10                                                   | 4.0                                                           |
| Fregata andrewsi         | Christmas Frigatebird | CR   | 4800                   | 1                                                   | 188                                                  | 3.9                                                           |
| Heteroglaux blewitti     | Forest Owlet          | CR   | 250                    | 1                                                   | 8                                                    | 3.2                                                           |
| Pyrrhura grisepectus     | Grey-breasted Parakeet| CR   | 250                    | 1                                                   | 8                                                    | 3.2                                                           |
| Odontophorus striphium   | Gorgeted Wood-quail   | EN   | 4300                   | 1                                                   | 137                                                  | 3.2                                                           |
| Porphyrio hochstetteri   | Takahe                | EN   | 220                    | 2                                                   | 7                                                    | 3.2                                                           |
| Thinornis novaeseelandiae| Shore Plover          | EN   | 220                    | 1                                                   | 6                                                    | 2.7                                                           |
| Cyanoramphus malherbi    | Malherbe's Parakeet   | CR   | 663                    | 3                                                   | 18                                                   | 2.7                                                           |
| Rollandia micropera      | Titicaca Grebe        | EN   | 3000                   | 2                                                   | 81                                                   | 2.7                                                           |
| Phoebetria fusca         | Sooty Albatross       | EN   | 42000                  | 1                                                   | 1133                                                 | 2.7                                                           |
| Carpodectes antoniae     | Yellow-billed Cotinga | EN   | 794                    | 1                                                   | 20                                                   | 2.5                                                           |
| Mergus octosetaceus      | Brazilian Merganser   | CR   | 250                    | 1                                                   | 6                                                    | 2.4                                                           |
| Penelope albipennis      | White-winged Guan     | CR   | 250                    | 3                                                   | 6                                                    | 2.4                                                           |
| Megadytes antipodes      | Yellow-eyed Penguin   | EN   | 4800                   | 3                                                   | 110                                                  | 2.3                                                           |
| Geothlypis beldingi      | Belding's Yellowthroat| CR   | 1500                   | 1                                                   | 30                                                   | 2.0                                                           |
| Tareornis inexpectata    | Cuban Sparrow         | EN   | 700                    | 1                                                   | 13                                                   | 1.9                                                           |
| Conothraupis mesoleuca   | Cone-billed Tanager   | CR   | 250                    | 1                                                   | 4                                                    | 1.6                                                           |
| Callaeas cinerus         | Kokako                | EN   | 1538                   | 1                                                   | 24                                                   | 1.6                                                           |
| Pipile jacutinga         | Black-fronted Piping-guan | EN  | 10000                  | 1                                                   | 156                                                  | 1.6                                                           |
| Ardea humbloti           | Madagascar Heron      | EN   | 1500                   | 1                                                   | 22                                                   | 1.5                                                           |
| Ardeola idae             | Madagascar Pond-heron | EN   | 6000                   | 1                                                   | 85                                                   | 1.4                                                           |
| Amazona vinacea          | Vinaceous Amazon      | EN   | 2500                   | 3                                                   | 30                                                   | 1.2                                                           |
| Penelope perspicax       | Cauca Guan            | EN   | 1235                   | 2                                                   | 14                                                   | 1.1                                                           |
| Apteryx mantelli         | Northern Brown Kiwi   | EN   | 25000                  | 3                                                   | 202                                                  | 0.8                                                           |
| Amazona rhodocorytha     | Red-browed Amazon     | EN   | 2500                   | 1                                                   | 19                                                   | 0.8                                                           |
| Eleutherus candicans     | White-winged Nightjar | EN   | 2400                   | 1                                                   | 18                                                   | 0.8                                                           |
| Pedionomus torquatus     | Plains-wanderer       | EN   | 8000                   | 2                                                   | 50                                                   | 0.6                                                           |
| Phytotoma raimondii      | Peruvian Plantcutter  | EN   | 1000                   | 1                                                   | 6                                                    | 0.6                                                           |
| Curaeus forbesi          | Forbes's Blackbird    | EN   | 2500                   | 1                                                   | 12                                                   | 0.5                                                           |
| Haliaeetus vociferoides  | Madagascar Fish-eagle | CR   | 250                    | 1                                                   | 1                                                    | 0.4                                                           |
| Eutriorchis astur        | Madagascar Serpent-eagle | EN  | 250                    | 1                                                   | 1                                                    | 0.4                                                           |
| Cistothorus apalinari    | Apolinar's Wren       | EN   | 1300                   | 1                                                   | 4                                                    | 0.3                                                           |
| Anodorhynchus hyacinthinus| Hyacinth Macaw        | EN   | 6500                   | 1                                                   | 18                                                   | 0.3                                                           |
| Brotoergis pyrhoptera    | Grey-cheeked Parakeet | EN   | 15000                  | 2                                                   | 22                                                   | 0.1                                                           |
| Anas bernieri            | Madagascar Teal       | EN   | 2500                   | 1                                                   | 2                                                    | 0.1                                                           |
| Terenura sharpei         | Yellow-rumped Antwren | EN   | 10000                  | 1                                                   | 8                                                    | 0.1                                                           |
| Ara rubrogenys           | Red-fronted Macaw     | EN   | 4000                   | 1                                                   | 1                                                    | 0.0                                                           |
| Diomedea sanfordi        | Northern Royal Albatross | EN  | 17000                  | 1                                                   | 2                                                    | 0.0                                                           |
| Thalassarche melanophys  | Black-browed Albatross| EN   | 12200000               | 2                                                   | 77                                                   | 0.0                                                           |
| Eleoscytalopus psychopompus | Bahia Tapaculo       | CR   | 250                    | 1                                                   | 0                                                    | 0.0                                                           |
| Zosterops chloronothus   | Mauritius Olive White-eye | CR  | 296                    | 1                                                   | 0                                                    | 0.0                                                           |
| Foudia rubra             | Mauritius Fody        | EN   | 328                    | 1                                                   | 0                                                    | 0.0                                                           |
| Nesoenas mayeri          | Pink Pigeon           | EN   | 395                    | 1                                                   | 0                                                    | 0.0                                                           |
| Ptilococula eugens       | Mauritius Parakeet    | EN   | 300                    | 1                                                   | 0                                                    | 0.0                                                           |
| Trichocichla rufa        | Long-legged Thicketbird| EN   | 250                    | 3                                                   | 0                                                    | 0.0                                                           |

*Other subpopulations lacking data on $S$ and $R$ may also exist. doi:10.1371/journal.pone.0062598.t002
contributing to bird conservation through mechanisms such as Important Bird Areas merits further attention.

In conclusion, despite the dependence of tourism revenues on market conditions, and the risk associated with such dependence, we demonstrate that tourism revenue to protected areas makes a significant contribution to the conservation of threatened bird species, comparable to that for threatened mammals and frogs [29,30]. While government funding remains a critical source of funding for many protected areas and conservation globally, we propose that this could be increased by promoting tourism on both public and private lands. Specialist niche tourism markets such as avitourism may provide further incentives to promote sustainable conservation tourism, particularly in those habitats identified as Important Bird Areas.

Supporting Information

Table S1 Proportional contributions of tourism to protected area budgets by country. All figures in local currencies at publication date of source.

(DOCX)

References

1. Hoffmann M, Hilton-Taylor C, Angulo A, Bohm M, Brooks TM, et al. (2010) The impact of conservation on the status of the world’s vertebrates. Science 330: 1503-1509.

2. Hilton-Taylor C, Pollock G, Chanson J, Butchart SM, Oldfield T, et al. (2009) Status of the world’s species. In: Viet J-C, Hilton-Taylor C, Stuart SN, editors. Wildlife in a changing world. An analysis of the 2008 IUCN Red List of Threatened Species. IUCN. Gland. pp 15–42.

3. Rodrigues ASL, Andelman SJ, Bakarr MI, Boitani L, Brooks TM, et al. (2004) Effectiveness of the global protected area network in representing species diversity. Nature 428: 640-643.

4. Butchart SHM, Scharlemann JPW, Evans MM, Quader S, Arico S, et al. (2012) Protecting important sites for biodiversity contributes to meeting global conservation targets. PLoS ONE 7: e32529.

5. Langholz JA, Krug W (2004) New forms of biodiversity governance: Non-state actors and the private protected area plan. Journal of International Wildlife Law and Policy 7: 9-29.

6. Buckley RC (2010) Conservation Tourism. Wallingford: CAB International. pp. 145–175.

7. Department of Conservation New Zealand (DOC) (2011) Kākāpō. Available: http://www.doc.govt.nz/conervation/native-animals/birds/land-birds/kakapo/docs-work/. Accessed 2011 Aug.

8. Department of Conservation New Zealand (DOC) (2011) Black Robin. Available: http://www.doc.govt.nz/conervation/native-animals/birds/land-birds/black-robin/docs-work/. Accessed 2011 Aug.

9. Rodrigues ASL, Aćakaya HR, Andelman SJ, Bakarr MI, Boitani L, et al. (2004) Global gap analysis: Priority regions for expanding the global protected area network. BioScience 54: 1092-1100.

10. Bersonford AE, Buchanan GM, Donald PF, Butchart SHM, Fishpool LCD, et al. (2011) Poor overlap between the distribution of protected areas and globally threatened birds in Africa. Animal Conservation 14: 99-107.

11. Lockwood M (2010) Good governance for terrestrial protected areas: A framework, principles and performance outcomes. J Environ Manage 91: 754-766.

12. Eagles PFJ, McCool SF, Haynes CD (2002) Sustainable tourism in protected areas. Guidelines for planning and management. Gland: IUCN. 191 p.

13. Emerton L, Bishop J, Thomas L (2006) Sustainable financing of protected areas: A global review of challenges and options. Gland: IUCN. 109 p.

14. McCarthy DP, Donald PF, Scharlemann JPW, Buchanan GM, Balmford A, et al. (2012) Financial costs of meeting global biodiversity conservation targets: Current spending and unmet needs. Science 334: 1092-1100.

15. Buckley RC (2009) Parks and tourism. PLoS Biology 7(6): e1000143.

16. Castley JG (2010) Southern and Eastern Africa. In: Buckley RC, Conservation tourism. Wallingford: CAB International. pp. 145-157.

17. Buckley RC (2011) Tourism and environment. Ann Rev Enviro Resources 36: 397-416.

18. Bookbinder MP, Dinnenstein E, Rijal A, Cauley H, Rajouria A (1998) Ecotourism’s support of biodiversity conservation. Conserv Biol 12: 1399-1404.

19. Buckley RC (2003) Day to play in parks. J Sust Tour 11: 56–73.

20. Table S2 Remaining global populations for critically endangered (CR) and endangered (EN) bird species surviving in only a single PA.

(DOCX)

21. Mansourian S, Dudley N (2008) Public funds to protected areas. Gland: WWF.

22. Boarnnick A, Fernandez-Baca J, Galindo J, Negret H (2010) Financial sustainability of protected areas in Latin America and the Caribbean: Investment policy guideline. United Nations Development Programme (UNDP) and The Nature Conservancy (TNC). 162 p.

23. Minopoulou G, Bignani JN (2006) The Okavango Delta: The value of tourism. South African Journal of Economic and Management Sciences 9: 113–127.

24. Sekhar NU (2003) Local people’s attitudes towards conservation and wildlife tourism around Srikakulam Tiger Reserve, India. J Environ Manage 69: 339-347.

25. Walter MJ, Goodwin HJ (2001) Local attitudes towards conservation and tourism around Komodo National Park, Indonesia. Environ Conserv 28: 160–166.

26. Mhiwa JE (2003) The socio-economic and environmental impacts of tourism development on the Okavango Delta, north-western Botswana. J Arid Environ 54: 447–467.

27. Buckley RC (2004) Environmental Impacts of Ecotourism. Wallingford: CAB International. 389 p.

28. Steven R, Pickering G, Cauley JG (2011) A review of the impacts of nature based recreation on birds. J Environ Manage 92: 2287–2294.

29. Buckley RC, Castley JG, Pegas FdeV, Mossaz AC, Steven R (2012) A population accounting approach to assess tourism contributions to conservation of IUCN-Redlisted mammal species. PLoS ONE 7(9): e44134. doi: 10.1371/journal.pone.0044134.

30. Morrison C, Simpkins CA, Castley JG, Buckley RC (2012) Tourism and the conservation of critically endangered frogs. PLoS ONE 7(9): e35757.

31. IUCN (2011) The IUCN Red List of Threatened Species. Available: http://www.iucnredlist.org/. Accessed 2011 March.

32. BirdLife International (2011) IUCN Red List for birds. Available: http://www.birdlife.org. Accessed September 2011.

33. Whithaker RJ (1995) Disturbed island ecology. TREE 10: 421–425.

34. Rocamora G, Skerrett A (2001) Seychelles. In: Fishpool L, Evand I editors. Important Bird Area in Africa and associated islands. Cambridge: Birdlife International. pp 751–768.

35. Shah N (2001) Eradicating of alien predators in the Seychelles: An example of conservation action on tropical islands. Biodivers Conserv 10: 1219–1229.

36. Department of Conservation New Zealand (DOC) (2011) Offshore islands and conservation. Mangere Island. Available: http://www.doc.govt.nz/conservation/land-and-freshwater/offshore-islands/mangere-and-rangitira-islands/mangere-island/. Accessed 2011 Aug.

37. Benitez SP (2001) Visitor use fees and concession systems in protected areas: Galápagos National Park Case Study. Ecotourism Program Technical Report Series Number 3. Arlington: The Nature Conservancy. 19 p.

38. Shariff R, McNair M (2008) Modelling international tourism demand and uncertainty in Maldives and Seychelles: A portfolio approach. Mathematics and Computers in Simulation 78: 459–468.

39. Smeral E (2010) Impacts of the world recession and economic crisis on tourism: Forecasts and potential risks. Journal of Travel Research 49: 31–38.

40. Balbaford A, Bersonford J, Green J, Naidoo R, Walpole M, et al. (2009) A global perspective on trends in nature-based tourism. PLoS Biol 7: 1-6.

41. Cousens JA, Sadler JP, Evans J (2008) Exploring the role of private wildlife ranching as a conservation tool in South Africa: Stakeholder Perspectives. Ecology and Society 13: 43.

42. Castley G, Knight M, Gordon J (2009) Making Conservation Work: Innovative Approaches to Meeting Conservation and Socio-economic Objectives (an

Author Contributions

Conceived and designed the experiments: JGC RB. Performed the experiments: RS JGC. Analyzed the data: RS JGC. Contributed reagents/materials/analysis tools: JGC RB. Wrote the paper: RS JGC RB.

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Example from the Addo Elephant National Park, South Africa. In: Suich H, Child B, Spenceley A (eds) Evolution and Innovation in Wildlife Conservation: Parks and Game Ranches to Transfrontier Conservation Areas. SASUSG, IUCN, London: Earthscan. pp. 307–324.

43. Buckley R (2010) Safaris can help conservation. Nature 467: 1047.

44. Buckley R, Pablo HN (2012) Tourism ban won’t help Indian tigers. Nature 489: 33.

45. Buckley R (2012) Sustainable tourism: research and reality. Annals of Tourism Research 39: 528–546.

46. Biggs D, Turpie J, Fabricius JC, Spenceley A (2011) The value of avitourism for conservation and job creation – an analysis from South Africa. Conservation and Society 9: 80–90.

47. Pahakka L, Salo M, Saaksjarvi IE (2011) Bird diversity, birdwatching tourism and conservation in Peru: A geographic analysis. PLoS ONE 6, e26786.

48. Verissimo D, Fraser I, Groombridge J, Bristol R, MacMillan DC (2009) Birds as tourism flagship species: a case study of tropical islands. Animal Conservation 12: 549–558.

49. Booth JE, Gaston KJ, Evans KL, Armsworth PR (2011) The value of species rarity in biodiversity recreation: A birdwatching example. Biol Conserv 144: 2728–2732.

50. Hvenegaard GT (2002) Birder specialization differences in conservation involvement, demographics, and motivations. Human Dimensions of Wildlife 7: 21–36.

51. Şekercioğlu CH (2002) Impacts of birdwatching on human and avian communities. Environ Cons 29: 282–289.

52. Connell J (2009) Birdwatching, twitching and tourism: Towards an Australian perspective. Aust Geogr 40: 203–217.