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Biodiversity gains from efficient use of private sponsorship for flagship species conservation

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To address the global extinction crisis, both efficient use of existing conservation funding and new sources of funding are vital. Private sponsorship of charismatic 'flagship' species conservation represents an important source of new funding, but has been criticized as being inefficient. However, the ancillary benefits of privately sponsored flagship species conservation via actions benefiting other species have not been quantified, nor have the benefits of incorporating such sponsorship into objective prioritization protocols. Here, we use a comprehensive dataset of conservation actions for the 700 most threatened species in New Zealand to examine the potential biodiversity gains from national private flagship species sponsorship programmes. We find that private funding for flagship species can clearly result in additional species and phylogenetic diversity conserved, via conservation actions shared with other species. When private flagship species funding is incorporated into a prioritization protocol to preferentially sponsor shared actions, expected gains can be more than doubled. However, these gains are consistently smaller than expected gains in a hypothetical scenario where private funding could be optimally allocated among all threatened species. We recommend integrating private sponsorship of flagship species into objective prioritization protocols to sponsor efficient actions that maximize biodiversity gains, or wherever possible, encouraging private donations for broader biodiversity goals.

1. Introduction

Global conservation funding falls far short of what is required to halt the current extinction crisis [1]. To increase biodiversity that can be conserved within limited budgets, prioritization protocols have been developed that rank species using objective cost-effectiveness approaches [2–4]. However, conservation gains from using prioritization protocols are still constrained by available budgets. In order to ensure persistence of many species, increased conservation funding is essential.

One effective way of generating conservation funding is to solicit private sponsorship for conservation of charismatic species that serve as 'flagships' to potentially generate benefits for other species [5]. Public preferences for charismatic bird and mammal species [6,7] are reflected in greater willingness-to-pay for conservation focusing on these species [8]. Private funding for such species thus represents an additional pool of funds that is likely unavailable for use in objective cost-effectiveness approaches aimed at maximizing numbers of species conserved. The appeal of flagship species is frequently used by conservation agencies to generate private funding for conservation programmes. While most of these funds are spent on the flagship species themselves [7], conservation agencies can use flagship species to help achieve wider goals, such as conserving non-flagship species that share habitats or threats [9], or increasing awareness and engagement regarding conservation in general [5,10].

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Aside from the revenue-generating capacity of flagship species, the preferential funding of conservation actions for these species has been criticized as being subjective and inefficient compared with a cost-effectiveness approach [11,12], and for potentially leading to the neglect of non-charismatic species [13]. In addition, several studies have found that flagship species conservation programmes may have limited effectiveness in conserving other species [14,15], and that species such as large predators (which are often flagship species [6]) may have relatively low utility as 'umbrella' species for conserving biodiversity in general [16]. However, such studies have generally examined habitat overlaps rather than synergistic benefits of conservation actions that may be shared among species. Thus, the benefits of flagship species sponsorship require more detailed examination. More importantly, given constraints on conservation funding, strategies for maximizing ancillary benefits from private sponsorship of flagship species need to be identified.

We use a case study of flagship species sponsorship programmes in New Zealand (hereafter NZ) to quantify the potential biodiversity gains, measured as additional threatened species and estimated phylogenetic diversity conserved, from private sponsorship of flagship species, and to determine whether further gains can be achieved when sponsorship of flagship species is integrated with a cost-effectiveness approach. Specifically, we incorporate funding from national private sponsorship programmes for flagship species conservation into a prioritization protocol for NZ's 700 most threatened species, to answer the following questions: (i) what are the biodiversity gains from privately funded flagship species conservation programmes, compared with using the same funds in a strictly cost-effectiveness approach and (ii) what are the biodiversity gains when private funding of flagship species is combined with a cost-effectiveness approach to selectively fund flagship species conservation actions that maximally benefit other threatened species? Comprehensive data on locations and costs of specific conservation actions for threatened species allow us to quantitatively answer these questions for several flagship species sponsorship scenarios.

2. Methods

(a) Prioritization protocol

We incorporated private sponsorship of flagship species into a threatened species project prioritization protocol developed for the New Zealand Department of Conservation (NZ DOC) by Joseph *et al*. [4]. This protocol ranks potential recovery projects for 700 of the most threatened species in NZ based on their cost-effectiveness, and has been used by the NZ DOC to help prioritize budget allocations [17]. Species recovery projects were determined using information gathered from more than 100 experts in threatened species, and include the specific actions deemed necessary to ensure approximately 95% probability of each species' persistence over 50 years. Using this protocol allowed us to quantify the biodiversity gains that would be possible from the private sponsorship programmes and simulated budget scenarios of our case study.

The prioritization protocol begins with the ranked full set of 700 species, and sequentially removes the least cost-effective species until a set annual budget is reached. Cost-effectiveness is calculated using the following formula

$$E_i = \frac{W_i \times B_i \times S_i}{C_i}, \tag{2.1}$$

Table 1. Approximate annual donations from 'National Partnership' flagship species sponsorship programmes, and estimated annual budget necessary for full funding of conservation actions for those species, using actions to achieve long-term species persistence in the NZ Project Prioritization Protocol [4]. Note that the seven kiwi 'species' include three geographically isolated subspecies of *Apteryx australis* that are managed as separate species. ($NZD, New Zealand dollars.)

species	annual sponsorship from private sector partner ($NZD)	annual cost for full funding of conservation actions ($NZD)
kiwis (seven species; *Apteryx* spp.)	538 500	1 741 100
Kākāpō (*Strigops habroptilus*)	200 000	2 265 800
Whio (*Hymenolaimus malachorhynchos*)	500 000	1 867 000
Takahē (*Porphyrio hochstetteri*)	62 500	1 172 700
total	1301000	7046600

where E_i is the cost-effectiveness of the recovery project for species *i*; W_i is a metric of a species' evolutionary distinctiveness (to estimate its contribution to phylogenetic diversity of the species group); B_i is the project benefit to the species, defined as the difference between estimated probabilities that a species will be secure in 50 years with and without the project; S_i is the estimated probability of recovery project success and C_i is the total cost of all individual actions across all sites associated with the species project. For W_i, we used the phylogeny, threat and endemism (PTE) measure, which was the metric used by the NZ DOC for conservation prioritization (see [18] for details). Details regarding the estimation of other parameters are found in Joseph *et al*. [4]. Costs of shared actions (e.g. predator control that benefits several threatened species sharing a site) are shared among prioritized species recovery projects. For example, the cost of a shared conservation action between two prioritized species is reduced by 50% for each species. Private funding that covers the entire cost of flagship species actions can similarly benefit non-flagship species by covering the costs of any shared actions. This, in turn, can improve the cost-effectiveness of the affected non-flagship species, and as a result, potentially allow more species to be funded within a given budget.

(b) Flagship species

Among the 700 species used in the prioritization protocol, 10 species receive private, species-specific conservation funding from businesses, via 'National Partnerships' with the NZ DOC [19] (table 1). These species are a subset of 22 species that have subsequently been identified as 'national iconic' species by the NZ DOC, based on an independently run telephone survey of 3000 adult New Zealanders that was stratified and post-weighted according to census data, by age group, ethnicity and gender (NZ DOC 2011, unpublished data). It should be noted that additional initiatives to conserve threatened landscapes and species (including flagship species such as those in this case study) also exist in NZ [20,21]. We use the National Partnerships as realistic examples to examine the potential benefits of national-scale, species-specific private sponsorship programmes for flagship species.

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(c) Funding scenarios

To quantify the potential biodiversity gains that could be obtained from National Partnership funding as per table 1, we used five sponsorship scenarios. These included a baseline scenario using no private funding, plus four scenarios designed to make increasingly efficient use of the private funds.

(i) Baseline scenario

To determine the baseline threatened species and phylogenetic diversity that could be conserved without private flagship species sponsorship, we ran the prioritization protocol assuming that no flagship species received private funding, and that flagship species were considered alongside other threatened species in the prioritization protocol.

(ii) Flagship sponsorship without considering synergies

To determine biodiversity gains from private sponsorship of flagship species conservation programmes as per table 1, without favouring actions that are shared with other threatened species, we randomly allocated funding to actions for each species according to its funding level in table 1, and set costs of any actions that happened to be shared with other species (e.g. predator control on the same site) to zero. Thus, species that shared these conservation actions received a windfall benefit. We ran 20 iterations of this scenario. This scenario represented the least efficient of the four scenarios using National Partnership funding.

(iii) Flagship species sponsorship to maximize synergies

To determine biodiversity gains from efficiently integrating private sponsorship of flagship species into a prioritization protocol, we allocated funding for the sponsored species as per table 1 to the conservation actions that maximize the ratio of shared costs with other species. For example, a recommended $10 000 predator fence that benefits a flagship species, which is also recommended for four other threatened species in the same habitat patch, would have a shared cost ratio of 4 : 1. For the seven kiwi (*Apteryx*) species/subspecies that were sponsored by the same programme, actions were chosen from among all kiwi species. This was assumed to be the most efficient use of National Partnership funding in table 1, while still spending the money on the species for which it was originally intended.

(iv) Maximizing flexibility by sponsoring actions from a larger suite of flagship species

To determine whether using a larger suite of flagship species could allow additional opportunities to efficiently allocate funding to maximize biodiversity gains (analogous to the potential fundraising gains from expanded 'flagship fleets' of species, cf. [22]), we expanded the flagship species list to include all 22 'national iconic' species. We also allowed the $1.3M National Partnership funding to be flexibly allocated among all 22 'national iconic' species, to the actions that maximized the ratio of shared costs with other species. This scenario does not allocate National Partnership funding to the species for which it was intended, but was assumed to be the most efficient allocation of these funds among any species considered to be a 'national iconic'.

(v) Private sponsorship of the most cost-effective species, regardless of flagship status

In our final, hypothetical scenario, we determined the potential biodiversity gains if the National Partnership private funding had been donated for general biodiversity goals (rather than toward individual species), and thus could be used to fund the most cost-effective species, regardless of flagship status. In this scenario, we added the $1.3M National Partnership funds in table 1 to the budget used in the baseline prioritization protocol of scenario 1, rather than using it to sponsor flagship species. This hypothetical scenario was considered to be the benchmark for the most efficient use of the $1.3M National Partnership funding, if it had not been tied to individual species.

For each scenario, we ran the prioritization protocol using a range of baseline conservation budgets from $5 to $50M New Zealand dollars (NZD) per annum, in increments of $5M. We used two measures to quantify biodiversity gains: the number of additional threatened species that could be prioritized for conservation at each budget increment, and the estimated additional phylogenetic diversity that could be gained by conserving these threatened species. These additional species could include both the National Partnership flagship species for which partial funding via sponsorship lowered total recovery project costs, and other species with improved cost-effectiveness owing to shared actions. Additional phylogenetic diversity conserved by funded species was estimated as the sum of PTE evolutionary distinctiveness values for all prioritized species. Although several other evolutionary distinctiveness measures are available [23,24], we used PTE because it was the metric used for conservation prioritization in NZ. The mean PTE value among all species was 1.7 ($\pm$1.7 s.d.). To determine how frequently partial funding via sponsorship would make the National Partnership species cost-effective enough to be fully funded in an objective prioritization protocol, we also examined the number of National Partnership species that would be funded across the range of budgets for each scenario.

To examine the biodiversity gains from additional, more optimistic sponsorship scenarios where all of the costs of flagship species are paid for by sponsors, we re-ran scenarios (iii)–(v) assuming that private sponsorship for the full costs of recovery programmes for National Partnership species was available (i.e. approx. $7.0M, table 1). For the sake of brevity, results from these analyses are presented in the electronic supplementary material.

3. Results

Randomly allocating the $1.3M private conservation funding among actions for each of the 10 National Partnership species according to their funding levels in table 1 (scenario (ii)), allowed gains of up to five additional threatened species over the baseline scenario of no additional investment (mean species gained across all budgets = 1.4, mean PTE gained = 0.12; figures 1 and 2). Allocating this funding to the actions for National Partnership species that maximized benefits to other species (scenario (iii)) resulted in gains of up to six species beyond the baseline scenario (mean species gained across budgets = 2.8, mean PTE gained = 2.8). Allocating this funding to efficient actions from a larger suite of 22 flagship species (scenario (iv)) also resulted in gains of up to six species, and generally greater biodiversity gains across budgets (mean species gained across budgets = 3.3, mean increase in PTE = 3.5). Scenario (v), the hypothetical scenario where the $1.3M National Partnership funding was donated for general biodiversity goals and could be applied directly to the prioritization protocol rather than to flagship species, resulted in the greatest biodiversity gains. Up to 13 additional species were prioritized for conservation in this scenario compared with the baseline scenario (mean species gained across budgets = 7.1), and a there was a marked increase in phylogenetic diversity conserved across budgets (mean PTE gained = 11.0).

In a small number of cases, sponsoring flagship species resulted in inefficient outcomes, with fewer species

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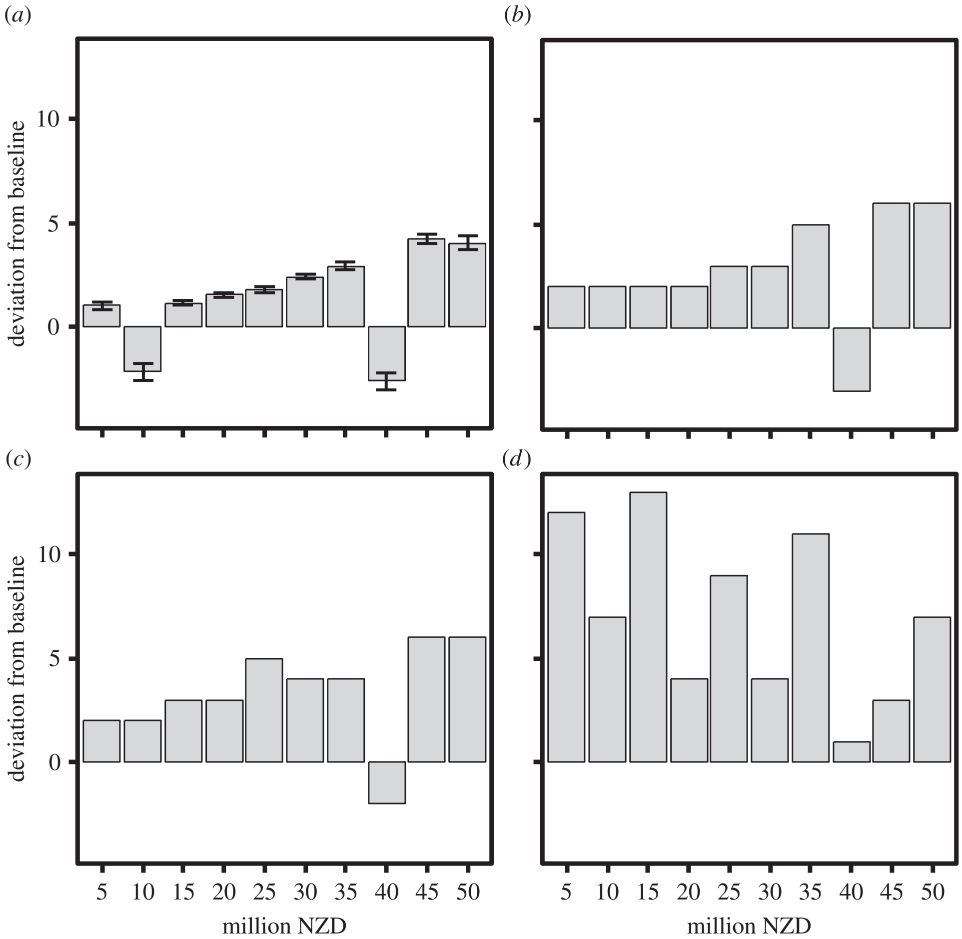

Figure 1. Deviations from the baseline number of species conserved at each budget, for four flagship species sponsorship scenarios: (*a*) allocating private funds to actions for 'National Partnership' flagship species as per table 1 without favouring actions shared with other species (with error bars representing 95% CIs); (*b*) efficiently allocating private funds to actions for National Partnership species as per table 1 to maximize synergies with other species; (*c*) efficiently allocating private funds to actions from a larger suite of 22 flagship species; and (*d*) allocating private funds directly to the prioritization protocol to sponsor the most cost-effective species, regardless of flagship status.

prioritized for conservation than the baseline scenario. This occurred because partial funding via sponsorship of flagship species reduced the cost of some expensive flagship species to the point that they were cost-effective enough to be fully funded using baseline funding, displacing less-expensive species from the funded ranks. For example, with a baseline budget of $40M, partial funding via sponsorship for the kākāpō (*Strigops habroptilus*) allowed it to be ranked as cost-effective enough to be prioritized for full conservation funding. This species was ranked highly because of its high evolutionary distinctiveness (PTE value = 5, the 11th highest PTE value) and high project benefit (0.95, the highest possible benefit value), and despite the fact that its annual cost when partially funded (approx. $1.9M) was still approximately 19 times higher than the mean annual cost of other retained species, and the highest of all funded species at this budget. The addition of this expensive flagship species restricted the available funding for lower-ranked species, such that the baseline scenario (in which kākāpō remained unfunded) was actually more efficient from the standpoint of both species numbers and total PTE conserved.

The relatively low cost-effectiveness of projects for several flagship species is reflected in the fact that partial funding via sponsorship for National Partnership species as per table 1 was not sufficient to allow all of these species to be ranked high enough to be prioritized for full funding in the prioritization protocol (electronic supplementary material, figure S1). Indeed, even with the maximum baseline annual budget of $50M, only six of 10 National Partnership species were prioritized for full funding. Two National Partnership species, the whio (*Hymenolaimus malacorhynchos*) and takahē (*Porphyrio hochstetteri*), were not prioritized in any of our budget scenarios.

(a) Assuming private sponsorship expands to cover the full costs of National Partnership species

Biodiversity gains assuming sufficient private funding to cover the full annual costs of conserving National Partnership species (i.e. approx. $7.0M; table 1) followed similar patterns to the $1.3M partial funding scenarios. Fully funding the National Partnership species actions resulted in up to 26 additional species being conserved (mean species gained = 15.4; mean PTE gained = 20.4; electronic supplementary material, figures S2 and S3). This was the only scenario we tested in which all 10 National Partnership species were conserved (electronic supplementary material, figure S4). Using the approximately $7.0M funding to cover the most efficient actions for a larger suite of flagship species resulted in gains of up to 29 species (mean species gained = 21.2; mean PTE gained = 23.5). Applying this funding directly to the prioritization protocol in the hypothetical scenario

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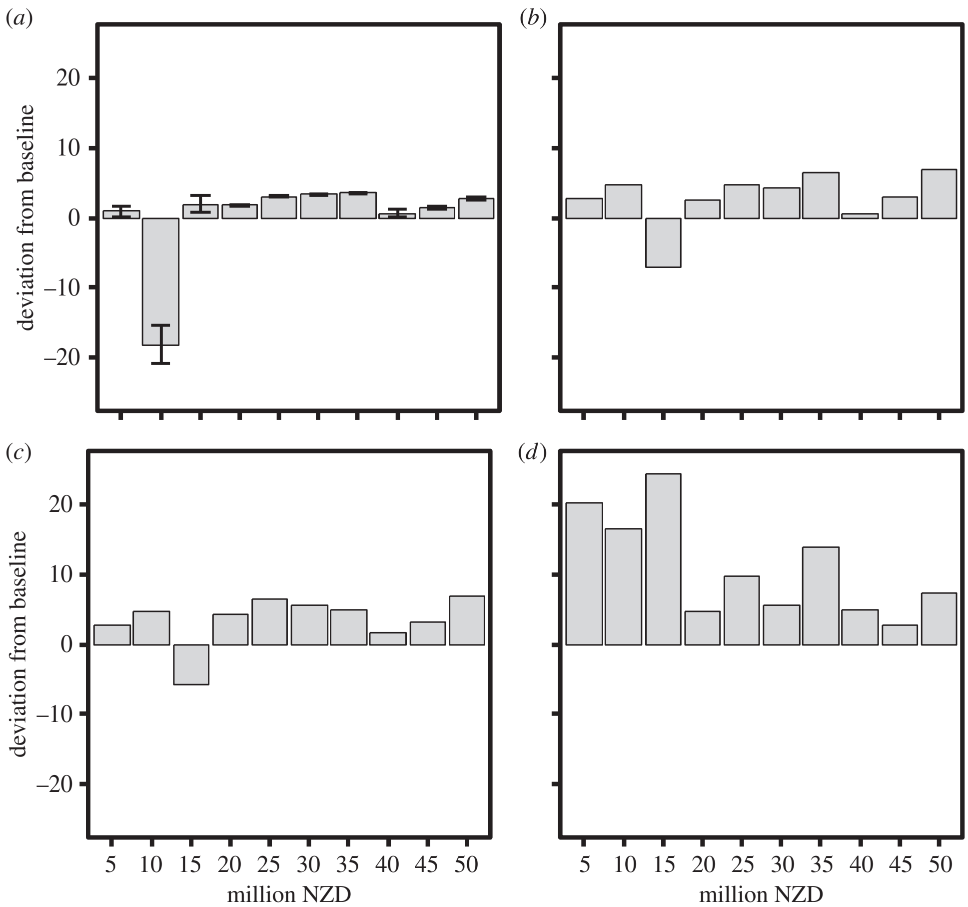

Figure 2. Deviations from the baseline phylogenetic diversity (estimated using the sum of PTE values) conserved at each budget, for four flagship species sponsorship scenarios: (*a*) allocating private funds to actions for 'National Partnership' flagship species as per table 1 without favouring actions shared with other species (with error bars representing 95% CIs); (*b*) efficiently allocating private funds to actions for National Partnership species as per table 1 to maximize synergies with other species; (*c*) efficiently allocating private funds to actions from a larger suite of 22 flagship species; and (*d*) allocating private funds directly to the prioritization protocol to sponsor the most cost-effective species regardless of flagship status.

where funding was not tied to individual species (scenario (v)), again led to the greatest gains, with up to 61 additional species funded (mean species gained = 33.1; mean PTE gained = 52.1).

4. Discussion

Conservation programmes focusing on flagship species have been criticized as being subjective and inefficient [12,13], potentially creating self-reinforcing increases in species-specific research and public information that lead to the neglect of other species [25]. Prioritization protocols based on cost-effectiveness are designed to avoid such inefficiencies by objectively ranking species according to criteria designed to maximize biodiversity gains [2,4,26]. However, by appealing to social preferences rather than objective criteria, flagship species conservation programmes may be able to access private donations that are inaccessible to programmes using objective prioritization protocols. Several studies have shown a greater public affiliation for certain species and higher willingness to pay for conservation projects for these species [6,27]. Indeed, this is reflected in the threatened species benefitting from species-specific 'national partnerships' in NZ (table 1): all are relatively large birds. While it has been suggested that cost-effectiveness and maximizing biodiversity gains be used instead of flagship species as a marketing technique to solicit private donations [28], many people and organizations may still prefer to donate resources to flagship species conservation.

In our case study, using a comprehensive dataset of conservation actions for the 700 most threatened species in NZ, we showed that incorporating additional private funding for flagship species into conservation scenarios can clearly result in consistent biodiversity gains over baseline scenarios, via shared conservation actions. Such gains are likely where private conservation initiatives are directed at flagship species sharing habitats and threats with other species that would not otherwise be subject to conservation actions [29]. We also showed that when private sponsorship of flagship species is efficiently incorporated into a prioritization protocol to preferentially fund actions shared with additional species, these gains could be more than doubled. Thus, the two approaches of funding flagship species and cost-effective funding allocation can be complementary.

However, biodiversity gains from private sponsorship of flagship species were relatively small compared with the hypothetical scenario where private sponsorship money was not tied to individual species, and could be used directly in a prioritization protocol to fund actions for the most cost-effective species. On average, across all budgets, using the money directly in prioritization more than doubled the species gained and more than tripled the additional phylogenetic diversity conserved relative to even the most efficient scenario where private funding was used on flagship species (figures 1 and 2). While private funding for flagship species has clear

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benefits for other threatened species, constraining this funding to flagship species is suboptimal for conserving biodiversity.

In addition, partial funding via private sponsorship for flagship species did not guarantee that these species would become cost-effective enough to merit prioritization for full funding in an objective protocol. In some cases where partial funding for expensive flagship species allowed them to be ranked as cost-effective enough to fund, these species drew sufficient funding that biodiversity conserved within budget constraints was lower than that of the baseline scenario. This is exemplified by the high cost of the partially funded kākāpō recovery programme leading to lower-than-baseline biodiversity conserved with a $40M baseline budget. Although such cases allowing an externally driven inefficiency to create further inefficiency were uncommon, they argue for some caution in spending public money to complete partially funded private conservation projects, if the money could be more efficiently used on other projects.

Although the biodiversity gains from sponsorship of flagship species were relatively small compared with using the money in a prioritization protocol based on cost-effectiveness, making even one additional species safe from extinction would not be a trivial conservation outcome. Our realistic case study suggests that additional species can be conserved, even by partly funding conservation of flagship species. We speculate that this ancillary benefit could be an effective tool to solicit donations, especially if funds are used efficiently, such that donors could claim they are helping to conserve both a flagship species in particular and biodiversity in general. The public appeal of flagship species campaigns may also provide additional benefits such as marketing opportunities to expand the scope of programmes or promote biodiversity conservation in general [10,30,31].

(a) Conclusions and recommendations

Even among birds, which are one of the best understood and most charismatic taxonomic groups, conservation funding is several times lower than what is necessary to ensure survival of all threatened species [1]. To slow the loss of biodiversity, both efficient use of current funds and generation of new funds will be crucial. Private funding that capitalizes on the human appeal of charismatic flagship species will likely remain an important means of generating conservation funding. Indeed, private funding is already a large component of some threatened species conservation programmes [32]. As we have shown, private sponsorship of flagship species conservation actions can lead to additional biodiversity gains. Crucially, flagship species can also be used to encourage conservation awareness and funding [9,10], and generate further biodiversity gains.

To maximize biodiversity gains from private funding of flagship species, we recommend the following strategies: (i) use objective criteria for baseline funding of threatened species conservation, and use private funding for flagship species conservation as efficiently as possible to maximize shared benefits with other species. If private donors are made aware of the ancillary gains from their flagship species sponsorship, this may encourage further donations or new partners. (ii) Encourage donations to a broader suite of flagship species, to maximize possibilities for efficient sponsorship through shared actions with other species. As noted by Verissimo *et al.* [22], using a relatively large 'flagship fleet' can potentially appeal to a larger pool of donors. Our results show that a 'flagship fleet' can also allow additional flexibility to increase the efficiency of allocating conservation funding. If donors wish to sponsor an individual species, they can be encouraged to sponsor species whose conservation actions result in the greatest additional biodiversity gains. If donors are willing to sponsor a 'flagship fleet' of species, the money can be used to fund the specific actions with the greatest additional biodiversity gains. (iii) Explore the possibility of encouraging private funding for general biodiversity goals. Although private funding for flagship species can help to conserve biodiversity in general, it can only supplement, not replace, funding based on objective criteria. If such supplemental funding can be used in the most efficient manner possible, the greatest biodiversity gains can be achieved.

Data accessibility. The data and code for the NZ Prioritization Protocol have been deposited in the Dryad Digital Repository (http://dx.doi.org/10.5061/dryad.3qn55).

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Authors' contributions. J.R.B. conceived of the study, designed the study, conducted the analyses and drafted the manuscript. R.M. assisted in study design and data collection, and edited the manuscript. H.P.P. assisted in study design, coordinated the study, and edited the manuscript.

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