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Financing threatened species management: the costs of single species programmes and the budget constraint

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Summary

In New Zealand total annual funding allows 15 percent of the 2,400 threatened species to be targeted for management. Although management costs are crucial to a conservation organisation's ability to achieve its goals, estimates of costs are not usually included in applications for funding or the preparation of recovery plans. Cost is also not generally a factor in priority ranking systems and cost-effectiveness analysis is rarely conducted. Using the results of analysis of 11 single species programmes for 2003-2012, this paper investigates the costs of management. It also considers the impact of the budget constraint on outcomes, cost-effectiveness, and investment.

Keywords   threatened species, management, cost, budget constraint

Introduction

In most countries the number of threatened species requiring direct management intervention is much greater than that which can be managed with the funding made available. The World Conservation Union (IUCN, 2000) has advised that funding would have to be increased by ten to one hundred times its present level to be able to ensure the survival of the 11,000 species so far assessed globally as facing a high risk of extinction. In New Zealand, total annual funding of around NZ$40 million allows about 15 percent of the 2,400 native and endemic species listed as threatened to be specifically targeted for management (Department of Conservation, 2004).[1] Although most of these species are covered by New Zealand's extensive system of reserves, some require specific intervention, as can be seen by the success of the Chatham Island black robin programme (*Petroica traversi* Buller) (Merton, 1992). A goal of the New Zealand Biodiversity Strategy is to halt the decline in biodiversity by maintaining and restoring viable populations of all native species and subspecies across their natural range (DoC and MfE, 2000: 18). Yet it has been increasingly recognized that funding is insufficient to maintain the growing number of species known to be risk of extinction (for example: Bell, 1975; Williams, 1986; Towns and

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[1] In June 2005 the NZ$/US$ exchange rate was 0.71.

Williams, 1993).[2] It does not appear that this situation has changed significantly, despite additional funding being granted to implement the New Zealand Biodiversity Strategy. A suggested solution to the growing number of threatened species is ecosystem management but this is not an alternative to direct management of individual populations and species (Simberloff, 1998; Atkinson, 1999). Given the high demand, the costs of species programmes are crucial to a conservation organisation's ability to achieve its goals for threatened species management.

Beyond countries such as the United States and Australia, accurate estimates of costs of programmes are not, as a rule, included in either the preparation of recovery plans or applications for funding. Furthermore, cost does not generally appear as a factor in systems for determining a species' priority for management and analysis of the cost-effectiveness of management is rarely conducted. In New Zealand, the species priority ranking system that is used takes into account non-financial considerations, such as threat, vulnerability, and taxonomic distinctiveness, and funding decisions for threatened species management are made on an ad hoc, adversarial basis. Reasons for cost omissions may be that it requires the use of further resources, it is subject to risk and uncertainty, and it can create expectations of funding. A more basic reason may simply be that the importance of cost is not recognised by conservation managers or policy makers. Despite these reasons, information on the costs of programs is essential to the success of attempts to gain sufficient funding as it provides funding agencies with a more realistic understanding of the level of commitment required. Applications for funding that lack specific and detailed cost information can be more easily dismissed or underfunded, whereas applications that include such information must demand more serious attention. Cost estimates are also required for forecasting the effects of different policy goals, and for cost-effectiveness analyses. On a more fundamental level, such information is crucial for efforts to achieve greater efficiency in management. Up until now, the literature has tended to focus on the non-market value of threatened species (e.g. May, 1990; Polasky *et al.*, 1993; Humphries *et al.*, 1995; Sagoff, 1996; Pimentel *et al.*, 1997; Edwards and Abivardi, 1998; Bulte and van Kooten, 2000; and Alexander, 2000), the opportunity costs of habitat protection in terms of economic development (e.g. Montgomery *et al.*, 1994; Norton-Griffiths and Southey, 1995; Haight, 1995; Brown and Shogren, 1998; Lewandrowski *et al.*, 1999) and, to a lesser extent, on the costs of supplying reserves (e.g. Ruitenbeek, 1992; Ando *et al.*, 1998; Montgomery *et al.*, 1999; James et al., 1999 and 2001; Balmford *et al.*, 2000; and Drechsler and Wätzold, 2001). In threatened species management, there has been some analysis of patterns of expenditure (e.g. Simon *et al.*, 1995; Metrick and Weitzman, 1996; and Restani and Marzluff, 2001), but only a handful of examples of research involving costs (e.g. Doerksen *et al.*, 1998, Wilcove and Chen, 1998; Main *et al.*, 1998; Cullen *et al.*, 2005).

The purpose of this paper is to investigate the future costs of New Zealand single species programmes and to consider the possible impact of the budget constraint on

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[2] Although the range of biota assessed has been extended over the years, the number of New Zealand taxa classified as at risk of extinction has increased from twenty-eight species in 1981, to 171 species and subspecies in 1986, to 606 species and subspecies in 1993 to 2,373 species and subspecies in 2002 (Williams and Given, 1981; Bell, 1986; Veitch, 1992; Hitchmough, 2002).

threatened species management.[3] New Zealand was chosen because of the authors' familiarity with the management of threatened species, in comparison with other countries, and to highlight the importance of cost information in a situation where it is yet to be recognised. The paper is largely based on the results of cross-case analysis of data collected from a survey conducted in 2002 of 11 single species programmes for 2003 until 2012. Before the results are discussed, however, some reasons are outlined for why managers consider the task of estimating costs to be extremely complex and the results are, therefore, subject to significant uncertainty. Given this uncertainty, the estimates of the varying costs of the 11 single species programmes over the 10 year timeframe are presented. These costs are then compared with expected levels of expenditure to show the existence of a budget constraint for threatened species management. The effect of under-funding on outcomes is speculated upon to suggest how the budget constraint is delaying the recovery of those species benefiting from management and, as a result, other threatened species that are still on the waiting list. Although the total costs of a programme for a limited time horizon provide a picture of the funding that is needed in the short or medium term, they give little indication of the commitment that is needed over time. To gain some idea of a programmes' total cost over time, the average estimated costs of the outcomes of management for a species are examined. These costs are compared with average expected expenditure to indicate the extent to which a budget constraint may reduce the cost-effectiveness of threatened species management and so, ultimately, increase the level of investment that is needed in the long-term.

Methods

Unlike the United States Fish and Wildlife Service, the New Zealand Department of Conservation does not, as a rule, include estimates of costs in its preparation of recovery plans. The absence of readily available cost data meant that it was necessary to survey Department of Conservation managers of single species programmes. A pilot survey was conducted of the managers for three single species programmes to show whether the information could be easily gathered and whether it would be useful. Based on this experience, the Department supplied general species information, such as habitat area required by a species and the types of threats facing a species, and data on past expenditure and its associated outcomes. Future cost and expenditure data and its possible outcomes, however, were at the discretion of regional managers because it was not information held by the Department, and it was expected that it would be of limited value to the Department and not of interest to the general public (A. Ross, personal communication, August 12, 2002).[4] If a request for data on the future costs and expenditure for a particular species programme was

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[3] 'Cost' is defined as the amount of money that must be given in order to accomplish a particular purpose (Brown, 1993: 521). In contrast to cost, 'funding' is the amount of money set aside for a particular purpose, and 'expenditure' is the amount of money actually used for that purpose (Brown, 1993: 1042 and 886).

[4] A "back of an envelope" exercise in a species managers' workshop in 2001 used "guestimates" of the costs of achieving the recovery plan objectives for 73 threatened species to calculate the mean annual cost per species and the total cost for 403 species (P. Cromarty, personal communication, August 14, 2002).

declined then an alternative programme was chosen, preferably for a species from the same taxon. Although efforts were made to choose an equal number of species from each taxon, this was problematic because there are only seven native terrestrial mammal species and four native amphibian species in New Zealand. As well, all requests for future cost and expenditure data for the costs of programmes for reptiles or freshwater fish were rejected. Furthermore, a disproportionate number of recovery programmes exist for avian species. In general, the following set of criteria, in general order of importance, were used to select programmes for this study:

1. Species programmes for which there was a draft or published recovery plan.
2. Programmes for species that are representative of different taxa.
3. Programmes for species within each taxon that require different habitat types.
4. Programmes for species that occur within one or two conservancies, rather than multiple conservancies.[5]
5. Programmes for species that have a high threat classification, such as 'Nationally Critically Endangered', 'Nationally Endangered', or 'Nationally Vulnerable'.
6. Programmes for species that have a clear and undisputed taxonomy.
7. Species programmes that are of particular interest for research.

The Species Managers Survey was eventually completed for 11 single species programmes (listed in Table 1), which despite the use of selection criteria, covered almost all of the set of possible programmes. It also represented about 24 percent of the recovery plans developed at the time, even though some of these had yet to be implemented.

Table 1: 11 single species programmes

Taxon	Common name	Scientific name
Vascular plants	*Pittosporum patulum*	*Pittosporum patulum*
	climbing everlasting daisy	*Helichrysum dimorphum*
Terrestrial invertebrates	Stephens Island ground beetle	*Mecodema costellum costellum*
	flax snail	*Placostylus ambagiosus*
Amphibian	Stephens Island frog	*Leiopelma hamiltoni*
Terrestrial mammal	South Island long-tailed bat	*Chalinolobus tuberculata*
Avian species	black stilt	*Himantopus novaezelandiae*
	kakapo	*Strigops habroptilus*
	North Island kokako	*Callaeas cinerea wilsoni*
	mohua	*Mohoua ochrocephala*
	Campbell Island teal	*Anas nesiotis*

The outcomes of management for a species were evaluated using a continuum based on the New Zealand Threat Classification System (Molloy, Bell, Clout, de Lange, Gibbs, Given *et al*., 2002) (Appendix A). The Threat Classification System is used to

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[5] The Department of Conservation has a decentralized organizational structure that divides New Zealand into thirteen conservancies or management areas that are not necessarily aligned with natural species distributions.

assess the conservation status of a species according to its risk of extinction. It was developed by the Department of Conservation to complement the IUCN (World Conservation Union) Red List of Threatened Species but to also take into account New Zealand's relatively small land area, the period over which recent declines have occurred, and the high number of taxa with small population size and naturally restricted ranges (Molloy *et al.*, 2002). Under this classification system, a species is assessed using a range of status and trend criteria as being in one of seven threat categories (listed in decreasing order of risk): 'Nationally Critical', 'Nationally Endangered', 'Nationally Vulnerable', 'Serious Decline', 'Gradual Decline', 'Range Restricted', and 'Sparse'. In the survey, managers started with the species' existing classification and identified the species' possible conservation status category for each year of the time horizon using the NZ Threat Classification System. They then selected a number from within the range on the continuum for that category reflecting the extent to which the species was predicted to fit that category's criteria, assuming the programme is fully funded.[6] A species' conservation status was used to quantify outcomes, rather than more common measures, such as a species' probability of survival of a species based on species viability analysis, because managers were more familiar with the system and species' existing classification gave them a definitive starting point. Applying the classification system to a continuum allowed managers more flexibility in determining a species' status than the 7 categories, and through the use of a quadratic scale, change in the status of more endangered species was given a higher value (Cullen *et al.*, 2002).

The annual cost data used in this research were derived from the sum of the managers' estimates of the annual costs of the actions needed to be taken in order to achieve each objective developed for a species as stated in its recovery plan. The costs of managing the conservation estate, where the focus is on fire prevention and pest control, and other activities under taken by the Department were generally not included because the intention was to examine only the additional costs that are incurred as a direct result of the decision to manage a species[7]. New Zealand's established system of national parks and reserves means that habitat acquisition is generally not required specifically for the implementation of a single species programme, although the value of land would need to be calculated for comparisons to be made between this research and the costs of single species programmes internationally. New Zealand's system of national parks and reserves has been established for a number of purposes, and not specifically for species conservation, and so the opportunity costs of the land are not included in the annual costs. Estimating cost by objective is based on the approach used in recovery plans by the United States Fish and Wildlife Service. Species managers estimated costs for 2003 until 2012 to the nearest \$10,000 in constant December 2002 New Zealand dollars[8]. All estimates of costs, expenditure and changes in species' conservation status are discounted to their present value (PV) using the same constant exponential discount

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[6] The NZTCS was developed to complement the IUCN (World Conservation Union) Red List of Threatened Species but to also consider New Zealand's relatively small land area, the period over which recent declines have occurred, and the high number of taxa with small population size and naturally restricted ranges (Molloy *et al.*, 2002).

[7] It is important to note that the cost of the North Island kokako program is not directly comparable with the costs of programs for other threatened species because almost all management of North Island kokako occurs as part of ecosystem restoration projects (J. Hudson, personal communication, September 20, 2002).

[8] In December 2002 the NZ\$/US\$ exchange rate was 0.51.

rate of six percent to allow incidences of each one occurring at different points in time to be directly compared across single species programmes. The use of a positive discount rate also reflects the public's preference for the conservation of a threatened species earlier rather than later. The discount rate of six percent is based on the real cost of government borrowing in New Zealand (Cullen *et al.*, 2001: 59), which is lower than the public sector discount rate of ten percent used in New Zealand since the 1970s. The opportunity cost of capital was a key argument advanced in the 1970's in support of a ten percent discount rate. Increased availability of capital via international capital markets, however, has resulted in lower opportunity cost of capital in the USA (Lind, 1982) and most other countries, including New Zealand.

A descriptive approach that reflects the actual cost of investment was used to determine the discount rate in this research rather than a prescriptive approach, as is sometimes applied to intergenerational issues such as the conservation of biodiversity (Arrow, Cline, Mäler, Squitieri and Stiglitz, 1996), because species programmes tend to be for the short to medium term, and not the far distant future. Prescriptive approaches tend to advocate the use of interest rates that are below market value so as to avoid failures to recognize the value of long-term investments but, in this context, the use of more realistic interest rates can be an advantage.

The task of estimating costs

Before the results of the Species Managers Survey are presented and discussed, six main reasons became apparent in the survey as to why the task of estimating the costs of programmes is complex and subject to uncertainty. First, projects for particular populations of a threatened species may have multiple objectives or the programme may share resources with other programmes at certain sites (J. Hudson, personal communication, September 5, 2002). The costs of the North Island kokako programme are markedly different from other species programmes because much of the kokako programme occurs as ecosystem restoration projects and the costs are inextricably linked. Similar costs are not included for other programmes, even though the species in question benefit from the control of pests within the management of the conservation estate, because such activities would generally occur regardless of the decision to manage the species. Conversely, much of the actual cost of the Campbell Island teal programme is hidden, for example, by the use of New Zealand Navy transport ships for visits (P. McClelland, personal communication, September 17, 2002). Second, the costs of species programmes may be partly met by sponsorship from other public or private organisations. As well as not being directly comparable, part of the reported cost of the North Island kokako programme is funded by other agencies, such as Regional Councils and community groups, which are expected to take a greater share of costs in the future (J. Hudson, personal communication, September 20, 2002). Similarly, the kakapo programme is sponsored by Comalco New Zealand and the Royal Forest and Bird Protection Society. Third, programmes may benefit from voluntary community involvement. If any of these costs are not easily quantified then the task will be complicated.

The fourth reason for the task being complex is there may be a lack of knowledge about a species if existing management is limited, as it is for South Island long-tailed

bat (C. O'Donnell and J. Lyall, personal communication, March 20, 2003). Similarly, estimates of costs for the flax snail programme may be subject to a higher level of uncertainty than for the other programmes because flax snail is the only species of Northern giant land snails that is being actively managed by DoC (A. Booth, personal communication, September 10, 2002). Fifth, even when there is knowledge about a species, costs may depend upon a complex range of environmental factors that are often beyond the control of managers. The results for the mohua programme, and those for many other threatened species, are dependent upon the variable effects of factors relating to threats from predators (A. Roberts, personal communication, October 3, 2002). Finally, costs may change over time through the application of knowledge gained either from the use of adaptive management strategies or the management of other threatened species. A strategy using large-scale pest control in an experiment for the North Island kokako at Mapara and other sites showed that the total number of years for which there is control of pests was found to be the key factor in determining population size of kokako (Basse, Flux, and Innes, 2003) and management has since focused on this. Research into the control of stoats as part of the mohua programme has been used to benefit other threatened species, such as kaka (*Nestor meridionalis*) (C. O'Donnell and J. Lyall, personal communication, March 20, 2003). Innes, Hay, Flux, Bradfield, Speed, and Jansen (1999) noted that there is potential for adaptive management strategies in most species programmes, which would potentially reduce the costs of programmes over time. Uncertainty surrounding the results, however, could be addressed in further research by the use of a more detailed costing instrument (A. Roberts, personal communication, February 28, 2003).

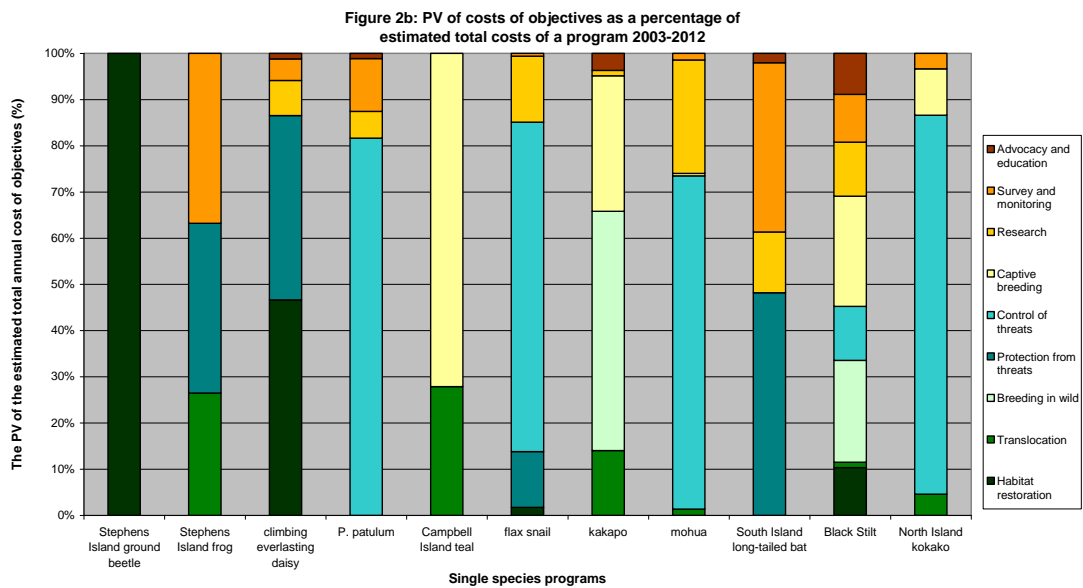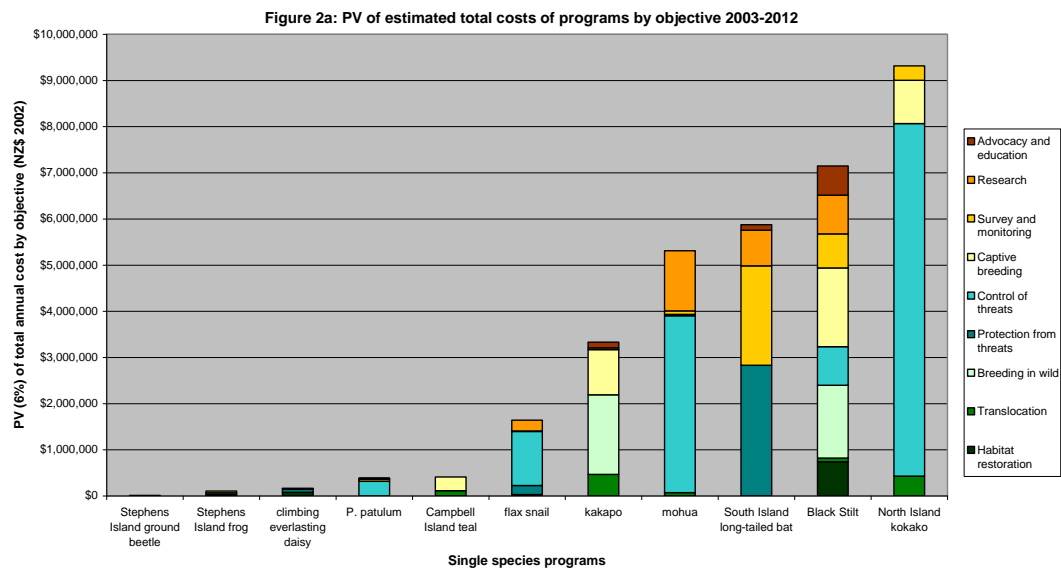## The costs of NZ single species programmes

The six reasons outlined mean that the results are subject to uncertainty but they also underline the key point that the costs are not uniform across species programmes. Although this point may appear to be self-evident, the consequences of the varying costs of programmes for threatened species management are so often ignored that it needs to be made. If a budget constraint exists then the opportunity costs in terms of the management of other threatened species will be disproportionate. In other words, a programme that has a high cost over time, either as a result of a high annual cost and/or a need for long-term management, may mean that it is necessary to forego the implementation of more than one lower cost programme. The PV of estimated total costs of the 11 single species programmes for 2003 until 2012 indicate that the costs of management are specific to each programme (Figure 1). The results show that the variations in the costs of programmes are marked: the PV of total costs for the 10 year period increases at a significant rate, from almost $12,000 for the Stephens Island ground beetle programme to over $9 million for the North Island kokako programme. The non-linear rate of increase in the PV of total costs means that the higher cost programmes account for the majority of the costs of threatened species management over the timeframe: the six highest cost programmes account for 92 percent of the costs over all 11 programmes. The variation in costs is also reflected in the difference between the median PV of total cost of just over $1.6 million and the average PV of total cost of around $3 million for the 10 year period. Discounting reduces the costs of species programmes, which may be of value when competing for funding, but it does not alter their ordinal ranking because the incidences of costs over time are similar for all of the 11 single species programmes studied. The highest

estimated annual costs are at the start of the ten-year timeframe for the 11 programmes: on average, 51 percent of the estimated total costs of programmes for the next 10 years will occur in the first 3 years. For the remainder of the timeframe, estimated annual costs are expected to decline to a lower plateau for eight programmes (less than 50 percent of the cost in 2003 for seven species); continue to decline for two programmes, and decline to lower cyclical costs for the last programme. Discounting the total costs of programmes over a longer timeframe may, however, significantly reduce the PV of the costs of programmes for species that require management over the long term, such as black stilt and kakapo, and bring them more into line with programmes for species such as the North Island kokako, which is estimated to have high costs over the short to medium term.

Figure 1: PV of estimated total costs of single species programs 2003-2012
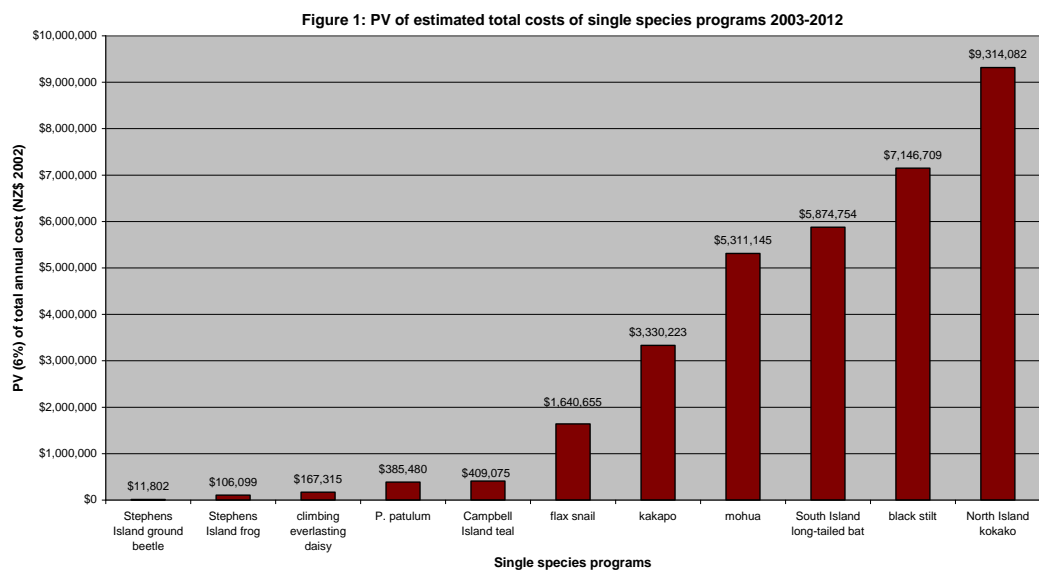
The PV of estimated total costs of a programme for 2003 until 2012 are derived from estimates of the annual costs of the actions that need to be taken to achieve the set of individual objectives developed for a species (Figure 2a). The estimated cost of a programme is, therefore, dependent upon both the set of objectives developed for a species and the estimated costs of achieving those objectives. The individual objectives for the 11 programmes are categorized as follows: advocacy and/or public education, research, survey and monitoring, translocation, habitat restoration, protection from threats, control of threats, breeding programme in the wild, and breeding programme in captivity. Using the typology, the PV of the estimated cost of the objectives for 2003 until 2012 is presented as a percentage of the PV of estimated total cost (Figure 2b). The types of objectives can be characterized as allocations of either the base resources required to sustain a species or management services needed to prevent their decline (Moran, Cullen and Hughey, in prep.). Habitat restoration and translocation indicates the supply of additional base resources to a species. The remaining types of objectives indicate services for the management of either indirect or direct threats and their characterisation depends upon the type of threat facing a species. For example, if the threat being controlled predates on the species in question then the objective indicates services for the management of direct threats, but if the threat is in competition with the species then this points towards services for managing indirect threats. Advocacy and education, research, and surveying and monitoring objectives indicate the creation of a management regime for a threatened species. The objectives are roughly ordered from the provision of

base resources at the bottom to the supply of management services at the top in Figures 2a and 2b.

Figure 2a: PV of estimated total costs of programs by objective 2003-2012

Figure 2b: PV of costs of objectives as a percentage of estimated total costs of a program 2003-2012

The results showed that the three most common objectives for which there are recorded costs for 2003 until 2012 are survey and monitoring, research, and translocation, but there is wide variation in the proportion of costs attributed to these different objectives. All of the non-avian programmes have survey and monitoring costs except for the programme for Stephens Island ground beetle. The mohua, black stilt, and North Island kokako programmes have survey and monitoring costs, but only mohua and black stilt programmes have significant research costs.[9] The costs for survey and monitoring, and research for South Island long-tailed bat, mohua, black stilt and Stephens Island frog account for over 20 percent of the PV of total

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[9] The cost of research for the kakapo program has a PV NZ$38,000, or about one percent of the program's PV of total costs for 2003 until 2012.

cost of each programme over the 10 year period. The Stephens Island frog programme and all five bird programmes have costs for translocation, ranging from a PV of $28,000 for Stephens Island frog to a PV of $467,000 for kakapo. The costs for advocacy and/or public education range from a PV of $2,000 for climbing everlasting daisy to a PV of $633,000 for black stilt, and are less than ten percent of any programme's PV of total cost for 2003 until 2012. The costs for survey and monitoring and research objectives appear to be affected by the level of existing knowledge about a species. The kakapo programme had a PV of total expenditure of $7,837,000 from 1989 to 2002 and it has a PV of total cost of $3,330,000 for 2003 until 2012, of which one percent is for survey and monitoring, or research objectives.[10] By comparison, the South Island long-tailed bat programme has a PV of total expenditure of $368,000 from 1995 until 2002 and has an estimated PV of total cost of $5,875,000 for 2003 until 2012, of which 50 percent is for survey and monitoring, and research. The conservation status of South Island long-tailed bat is unlikely to improve through management, however, until those objectives are accomplished (J. Lyall, personal communication, July 2002).

In total, the lowest cost objective over all 11 programs is habitat restoration (Table 2). Much of the costs of habitat restoration are, however, included in the management of the conservation estate generally, in the form of activities such as weed and pest control, and not the protection of threatened species. The program for Stephens Island ground beetle has only a cost for habitat restoration, which focuses on the placement of recycled wooden fence posts as refugia. The more intensive management objectives exhibit the highest costs: the control of particular threats, like possum control operations, and breeding programs in the wild, followed by breeding in captivity and then protection from threats, such as the use of predator proof fencing. Over 70 percent of the PV of total cost for *Pittosporum patulum*, flax snail, mohua and North Island kokako over the ten year time period will be for the control of threats. Part of the costs for the control of pests, however, may be covered by management of the conservation estate.

Table 2:   Costs of objectives across 11 programmes for 2003 until 2012

Objective type	Number of programmes	Average cost	Total cost[11]
Habitat restoration	4	$215,000	$860,000
Translocation	6	$198,000	$1,190,000
Breeding in wild	2	$1,650,000	$3,300,000
Protection from threats	4	$782,000	$3,130,000
Control of threats	4	$2,758,000	$13,790,000
Captive breeding	5	$788,000	$3,940,000
Survey and monitoring	7	$422,000	$3,380,000
Research	6	$460,000	$3,220,000
Advocacy and education	5	$176,000	$880,000

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[10] Unlike many other single species programs, the kakapo program has 100 percent of its annual cost funded, which means that expenditure is equal to cost.

[11] The total cost estimates are rounded to the nearest $10,000.

With the exception of the Stephens Island ground beetle programme, the programmes can be divided into those for non-avian, which have costs for managing threats, and those for avian, which have costs for breeding programmes either in addition to or instead of costs for the management of threats.[12] Stephens Island frog, climbing everlasting daisy, and South Island long-tailed bat have costs for protection from threats, *P. patulum* has a cost for the control of threats, and flax snail has costs for both types of objectives. The five avian programmes have costs for captive breeding programmes, and black stilt and kakapo also have costs for breeding programmes in the wild. Together, the average PV of total cost of breeding programmes for the 10 year time period is of $1,450,000, but this ranges from $29,000 for mohua to $6,431,000 for black stilt. For mohua, black stilt, and the North Island kokako, the costs for breeding programmes are in addition to costs of controlling threats. The cost structure for the 11 single species programmes raises three points for consideration. First, most programmes have costs for the creation of a management regime, such as survey and monitoring or research, but these costs appear to be affected by the level of existing knowledge about the species. Second, the costs of habitat restoration and the control of threats may not have been fully reported if they did not occur as a direct result of the decision to manage a species. Finally, intensive management objectives, such as control of threats and breeding programmes, are comparatively high cost and may be more commonly used for avian species for whatever reason. All of these points suggest areas for further research.

The budget constraint

As in most countries around the world, threatened species management in New Zealand operates under a budget constraint. Based on past patterns of expenditure and existing budgets, the PV of expected expenditure for the 11 single species programmes of NZ$15.1 million for 2003 until 2012, compared to the PV of estimated total costs of NZ$33.7 million over the same timeframe (Figure 3). The size of the gap between future cost and expenditure for the 11 species programmes is NZ$18.6 million. The impact of the budget constraint on threatened species management is that a decision to implement a species programme will have an opportunity cost in terms of the management of other species at risk of extinction. The extent of the opportunity cost, however, will depend on the programme. Clearly, higher cost programmes are far more likely to require more funding and so have higher opportunity costs than programmes with lower costs. Decisions to implement higher cost programmes will reduce the overall number of single species programmes that can be established within a particular budget. Consequently, there needs to be a strong justification for higher cost programmes at the expense of lower cost programmes and an explicit understanding of the trade-offs involved. The varying costs of single species programmes and the budget constraint will, therefore, have a significant impact on an organisation's ability to achieve its goal for threatened species management.

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[12] Although none of the other species studied have formal breeding programs, such programs are not exclusive to avian. For example, the tuatara (*Sphenodon spp*) and the Middle Island tusked weta (*Motuweta isoweta*) both have breeding programs involving external organizations.

Figure 3: PV of estimated total costs versus PV of expected total expenditure 2003-2012
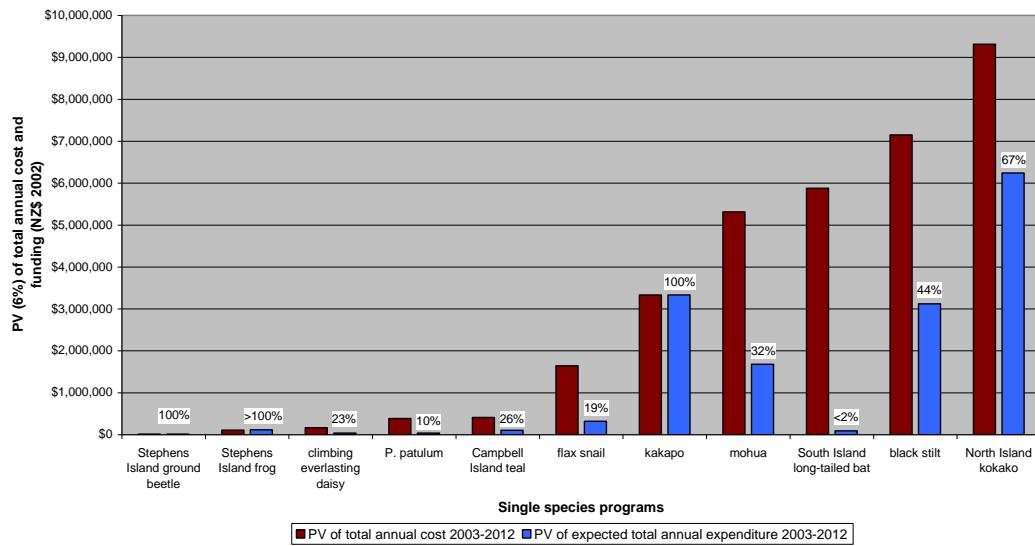
Programmes for Stephens Island ground beetle, climbing everlasting daisy, *P. patulum*, Campbell Island teal, and flax snail have a relatively low cost but are allocated minimal funding, sometimes on an irregular basis, or have to source funding from general budgets. The irregular basis of funding for such programmes appears to be because funding tends to only become available when it can be spared from other programmes that are given a higher priority. In contrast, programmes for mohua, South Island long-tailed bat, black stilt, and North Island kokako have a higher cost but are only allocated partial funding. In particular, the South Island long-tailed bat programme appears to be critically under funded: it expects to receive less than two percent of the cost of achieving the species' objectives. The Stephens Island frog and kakapo programmes are expected to continue to be fully funded.[13] For the programmes that receive minimal or partial funding, average future expenditure is expected to cover 28 percent of the costs. As a consequence, management of a species will be delayed, which puts the species at risk of further decline and may add to the total cost of the programme. The issue is similar to that which can exist in the health sector, where under-funding creates waiting lists for treatment, increasing the risk to the well-being of the patient and, ultimately, the total cost of healthcare.

The effect of under-funding on outcomes can be speculated upon by considering the additional gains in species' conservation status that could be achieved by 2012 if the gap between future cost and expenditure for the 11 species programmes of a PV of NZ$18.6 million is met (Figure 4). Fully funding these programmes could possibly improve the conservation status of *P. patulum* to 'Range Restricted'; climbing everlasting daisy and North Island kokako's conservation status to 'Gradual Decline'; flax snail and mohua to 'Serious Decline'; and the conservation status of black stilt from 'Critically Endangered' to 'Endangered'. It is not, however, expected to improve the conservation status of Campbell Island teal beyond that which the expected funding could achieve by 2012, or that of South Island long-tailed bat, and

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[13] Expected annual funding is higher than annual cost for the Stephens Island frog program because extra funding is to be allocated in case of disease (F. Begley, personal communication, November 7, 2002).

additional funding is essential if any gains are to be made in the species' conservation status in subsequent years.

Figure 4: PV of possible additional gains in species' conservation status if fully funded 2003-2012
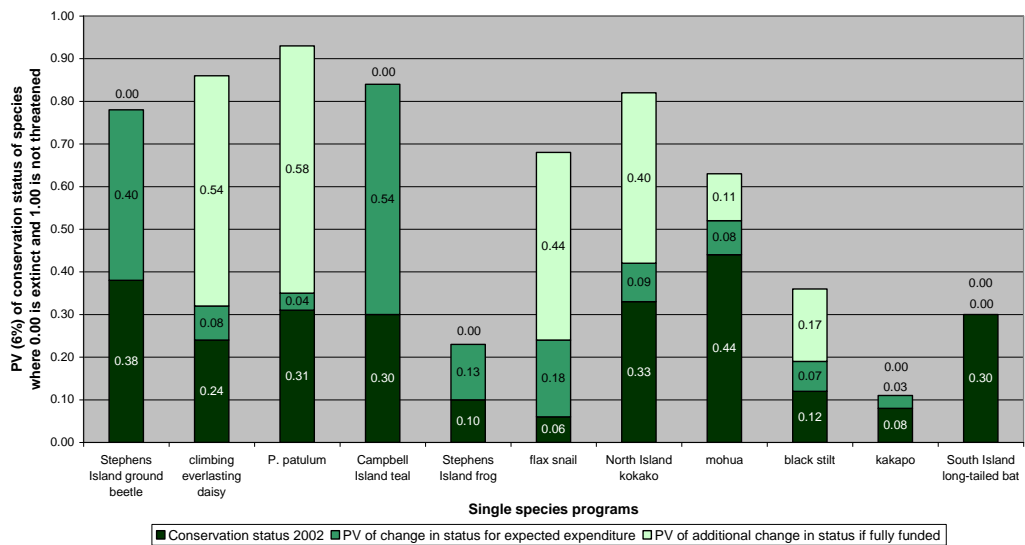
The 11 programmes directly represented less than two percent of the 603 New Zealand species classified as either 'Nationally Vulnerable', 'Nationally Endangered' or 'Nationally Critical' using the NZTCS (Hitchmough, 2002). Although this is a small proportion of New Zealand's threatened species, it can be argued that other species indirectly benefit from the programmes, which may create the potential for economies of scope. For example, management of *P. patulum*, climbing everlasting daisy, and South Island long-tailed bat would significantly reduce the management costs of other species, and kakapo, North Island kokako, mohua, and black stilt act as 'umbrella species'. The protection of large tracts of habitat for black stilt automatically protects wrybill (*Anarbynchus frontalis*), black-fronted tern (*Sterna albostriata*), and robust grasshopper (*Brachaspis robustus*). The effectiveness of an umbrella species as a 'short-cut' in threatened species management is, however, yet to be proved (Simberloff, 1998; Caro and O'Doherty, 1999; Andelman and Fagan, 2000). Not all of the 603 species classified as 'Nationally Vulnerable', 'Nationally Endangered' or 'Nationally Critical' require direct management. In many instances, ecosystem management will provide some benefit to species that are found within the ecosystem. It should also be noted that the 11 programmes may include a disproportionate number of higher cost programmes, such as that for kakapo, but they do not include the kiwi programme, which receives more funding than any other programme (C. Carter, personal communication, October 18, 2002). Managers' predictions of the outcomes that could be achieved if programmes are fully funded may be considered by some to be overly optimistic and further research is needed to check this against actual results.

The costs of single species programmes over time

The PV of total cost for each of the 11 single species programmes for 2003 until 2012 provides a picture of the funding that is needed in the short to medium term, but it gives little indication of the total cost of a programme over time. As the task of

estimating costs is subject to uncertainty and the objectives of a programme are usually developed for a five to ten-year timeframe, any attempts to accurately estimate the annual costs of the programmes beyond 2012 would be unrealistic. An alternative approach is to calculate the average cost of one outcome unit, which in this case is a unit improvement in a species' conservation status for 2003 until 2012. Average cost gives a rough idea of the cost-effectiveness of a programme and the commitment to management that is needed over the long-term. The PV of average cost for each of the 11 programmes over the timeframe alters the relative positions of four of the species programmes from their order by total cost and appears to be related to a species' taxon (Figure 5). Programmes for Stephens Island frog, kakapo, and possibly South Island long-tailed bat have higher average costs when compared to other programmes, and the average cost of the North Island kokako programme is comparatively lower. The Stephens Island frog programme, however, has a similar average cost to the four plant and invertebrate species. Average costs for the plant and invertebrate programmes, excepting that for flax snail, are lower than for any other species programmes. The annual costs for the flax snail programme may also be somewhat overstated because they cover eighteen Endangered and Critically Endangered sub-species, some of which are undescribed, but the conservation status of the species is only assessed for the twelve Critically Endangered sub-species (A. Booth, personal communication, September 10, 2002). The Campbell Island teal programme has a significantly lower PV of total cost per conservation status unit than the other four avian programmes because much of the actual costs of the programme has already occurred or is hidden. For example, the cost of feeding for the captive breeding programme is included in the overheads for the Mt Bruce National Wildlife Centre, and the cost of maintaining wild populations is covered by the Southland Conservancy's quarantine budget (P. McClelland, personal communication, September 17, 2002). The average costs for the remaining avian programmes are higher than for any other species, except for possibly South Island long-tailed bat.

Figure 5: PV of average cost of species programs 2003-2012
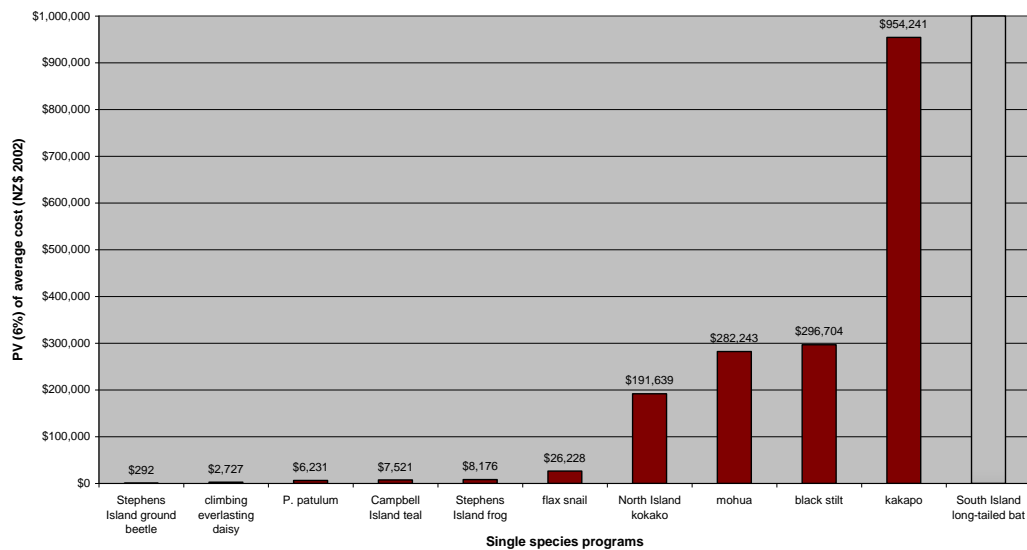
The average cost for the South Island long-tailed bat programme is unknown because management of the species is not expected to improve its conservation status over the next 10 years even if the programme is fully funded. Research, survey and

monitoring account for half of the future costs of the programme, but will not necessarily bring about any direct improvement, even though they are essential for its management. Bats are the only land mammal species native to New Zealand and their management is expected to be effective at the sites that are managed, which is similar to the management of forest avian, such as mohua and kokako (J. Lyall, personal communication, December 2002). Past expenditure on the preparation of a recovery plan for climbing everlasting daisy did not improve the species' conservation status because no extra funding was allocated for its implementation (N. Head, personal communication, September 19, 2002). Similarly, past expenditure for *P. patulum* enabled a full survey of historical sites to determine the best example of habitat for protection but it was insufficient to allow for any mitigation of threats (N. Head, personal communication, September 12, 2002). Such intermediate outputs of single species programmes have only an instrumental value for the species in question and usually need to be carried out together with direct interventions for them to be translated into final outcomes. Managers' observations suggest that past patterns of expenditure and expectations of future funding for different taxa could influence estimates of costs and the development of objectives, which suggests these as additional areas for further research.

The PV of average costs compared to the PV of average expenditure indicates that the cost of most of the programmes that receive minimal or partial funding could be significantly reduced if they were fully funded (Figures 6a and 6b). The cost of the programmes for climbing everlasting daisy, *P. Patulum*, North Island kokako, mohua and black stilt may decrease if the programmes are fully funded. The cost of the Campbell Island teal and flax snail programmes may marginally increase if the programmes are fully funded, but the value of a possibly more rapid recovery of flax snail populations is likely to outweigh the additional cost. The estimated cost of the 11 programmes in 2003 ranged from NZ$5,000 for Stephens Island ground beetle to NZ$1.53 million for the North Island kokako. Together, the total cost of the programmes in 2003 would have been around NZ$6 million, which is about 15 percent of total expenditure on management of protected species and island habitats of $40 million for the 2003/04 financial year (DoC, 2002). In contrast, managers expected the programmes to be allocated NZ$2.86 million in 2003, or about half of the funding that is required to meet recovery plan objectives. It is apparent that without extra funding, the NZ Department of Conservation will be unable to achieve the NZ Biodiversity Strategy goal of halting the decline in New Zealand's native and endemic biodiversity by 2020 (DoC and MfE, 2000: 18). The Department has recently noted that 92 percent of the approximately 800 native and endemic species classified as 'Threatened' do not receive enough help (Department of Conservation, 2004).

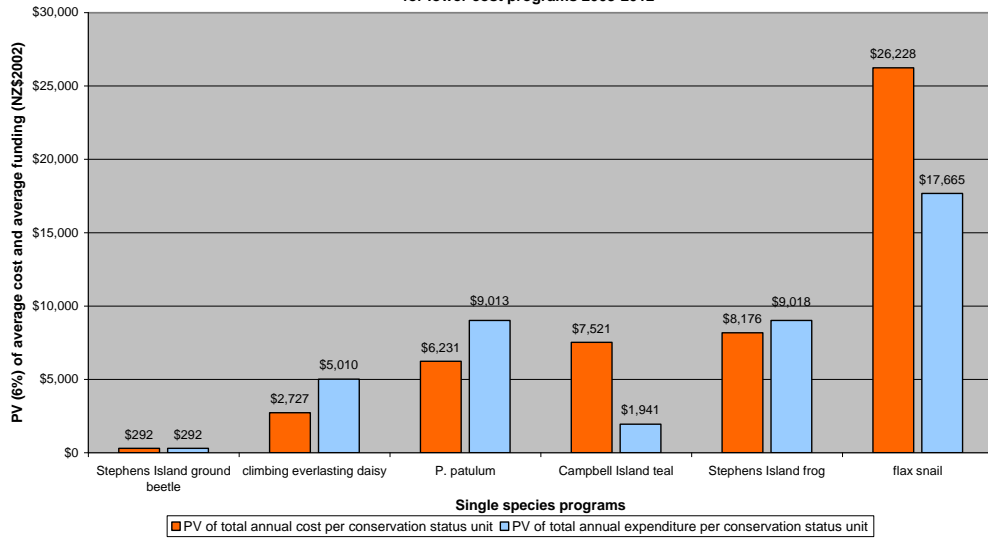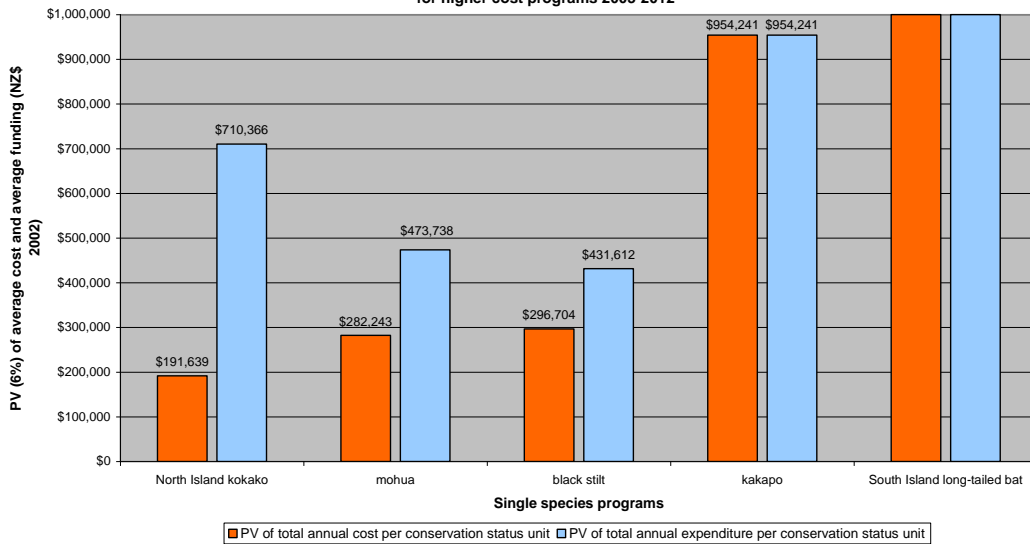**Figure 6a: PV of average estimated cost versus PV of average expected expenditure for lower cost programs 2003-2012**

Figure 6b: PV of average estimated cost versus PV of average expected expenditure for higher cost programs 2003-2012

The projected total costs of the 11 programmes show how a species' initial conservation status and its rate of progress potentially influence the total costs of a programme (Figure 7). All of 11 species were classified as either 'Nationally Vulnerable', 'Nationally Endangered' or 'Nationally Critical' in 2002. The number of years that it would theoretically take for each species to improve from its conservation status in 2002 to 'Not Threatened' are recorded above each result. The projected total costs for Stephens Island frog, mohua, black stilt and kakapo programmes are shaded from dark to light to reflect increasing uncertainty in the medium to long-term. The projected total cost of the South Island long-tailed bat programme is not presented because the recovery rate of the species for 2003 until 2012 is unknown. The effect of differences in the timeframes can be seen by comparing the projected total costs for different single species programmes. Stephens Island frog was more threatened than Campbell Island teal and less threatened than flax snail in 2002, but its programme has a similar projected total cost because it has lower estimated annual costs and a lower predicted rate of recovery. North Island

kokako was more threatened than mohua in 2002 but its associated programme has a similar projected total cost, even though its estimated annual costs are higher, because it has a higher predicted recovery rate. Black stilt and kakapo were both Critically Endangered in 2002 and have similar projected total costs, even though estimated annual costs for the black stilt programme are higher, because black stilt has a higher predicted rate of recovery than that for kakapo. If the PV of projected total costs is discounted using a positive discount rate then the effect is to reduce the projected total costs of the programmes (Figure 8). The higher the discount rate that is used, the greater the reduction in the total costs over time will be. The effect, however, is relatively uneven across the 11 programmes because of differences in the timeframes needed for management of each species. The strongest effect is on programmes that are likely to have extremely long timeframes. The PV of projected total cost for the mohua, black stilt and kakapo programmes are reduced to less than the cost of the North Island kokako programme because they occur over a longer time horizon. Despite this, existing budgets in recovery plans for threatened species either in New Zealand or overseas do not tend to discount management costs.

Figure 7: Projected total costs of programs from 2003 assuming full funding
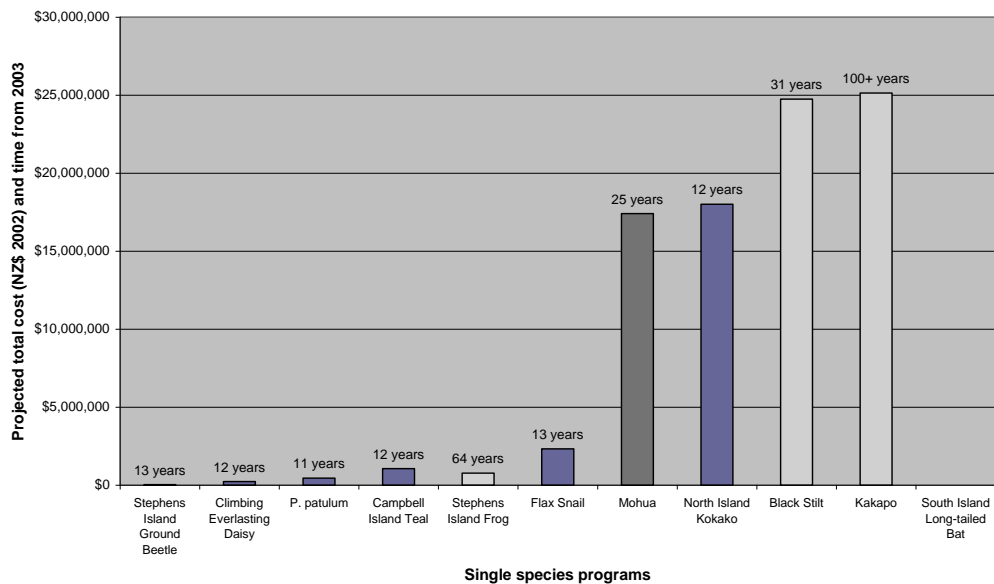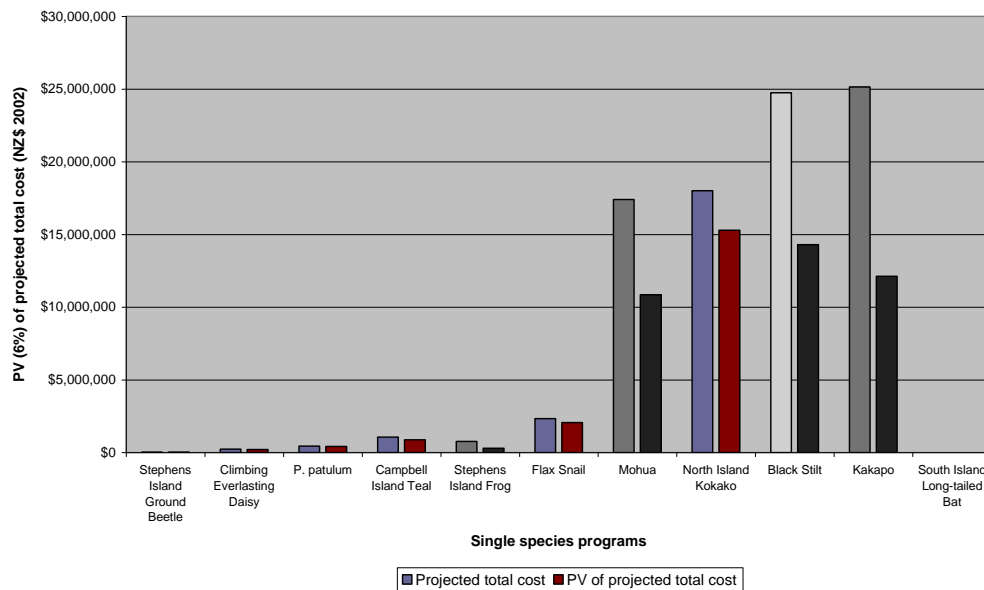
Figure 8: The effect of discounting on projected total costs

Concluding comments

Together, the varying costs of single species programmes and the budget constraint have a significant influence on an organisation's ability to achieve its management goal. Yet although basic estimates of the costs of single species programmes can be calculated, they often remain unquantified. The task can be complex, particularly if there is limited knowledge about a species, and as a result, cost estimates are subject to a great deal of uncertainty. Given the importance of cost information, however, this does not provide sufficient justification for such an exercise not to be undertaken. Estimating the costs of programmes is, in itself, likely to be useful because it requires systematic consideration of the plan of actions to be undertaken and how these are linked to the objectives and goal of a programme. The information produced is essential for successful applications for funding, forecasting the effects of different policy goals, and conducting cost-effectiveness analysis of programmes. To deal with uncertainty, a range of costs based on a worst case scenario and a best case scenario, rather than single cost estimates, could be estimated for each program and used in decision making. The approach used in this research did not include land acquisition costs or an opportunity cost for land because of New Zealand's existing system of reserves. If these costs are incorporated into analysis then comparisons could be made between the costs of species management in New Zealand and other counties. The results, however, illustrated there are highly varying costs of single species programmes. It also showed that there are significant differences in the proportion of costs for specific recovery plan objectives, such as research, habitat restoration, and translocation, between programmes.

In New Zealand, as in many other countries, the management of threatened species is limited by a budget constraint. The impact of the budget constraint is that a decision to implement a programme for one species will have an opportunity cost in terms of the management of other species at risk. This impact is apparent both in the

persistent underfunding of programmes for some species and a complete lack of funding for those still on the waiting list. A decision to implement a higher cost programme will reduce the overall number of single species programmes, and so, there needs to be a strong justification for the implementation of higher cost programmes and an understanding of the trade-offs involved. As in the health sector, insufficient funding delays a species' programme, putting it at risk of further decline, and potentially increases the total cost of management. It also reduces the cost-effectiveness of programmes and increases the level of investment that is ultimately required to manage a species over time. Yet without cost information, these effects cannot be quantified. On a final note, the total costs of programmes over time can be significantly reduced by discounting them back to their present value using a market interest rate. The possibilities of improvements in effectiveness and efficiency provide a strong incentive for conservation organisations and agencies to estimate the costs of their programmes.

Acknowledgements

Appendix A

Continuum   **New Zealand Threat Classification System**[14]

0.99 − 1.00   **Not Threatened**
A taxon that does not fit any of the threatened or at risk categories. This includes any that may have declined historically but are now considered secure due to widespread distribution, abundance, and stable or increasing populations.

0.95 − 0.98   **At Risk – Sparse**
A taxon is not currently in decline, but whose population characteristics mean a new threat could rapidly deplete their population(s). It has very small, widely scattered populations and is either naturally sparse or has become sparse as a result of human activities.

0.87 − 0.94   **At Risk – Range Restricted**
A taxon is not currently in decline, but whose population characteristics mean a new threat could rapidly deplete their population(s). It occurs either in a small geographic area (e.g. Three Kings Islands), is restricted to a particular habitat (e.g. geothermal areas) or requires very specific substrates (e.g. ultramafic rock). It is either naturally restricted or has become restricted as a result of human activities. The area of occupancy is less than $100km^2$ for a terrestrial and a freshwater taxon and less than $1,000$ km^2 for a marine taxon.

0.76 − 0.86   **Chronically Threatened – Gradual Decline**
Moderate-large population and small-moderate decline
A taxon fits at least one status criterion and the trend criterion:
Status criteria
1.   Total population size is > 5,000 mature individuals.
2.   There are > 15 sub-populations *and either*:
     a.   500 mature individuals in the largest sub-population, *or*
     b.   Total area of occupancy is > 100 ha ($1km^2$).
Trend criterion
A predicted decline of 5-30% in total population in the next 10 years due to existing threats *and* the decline is predicted to continue beyond the next 10 years.

0.62 − 0.75   **Chronically Threatened – Serious Decline**
A. Moderate-large population *and* moderate-large predicted decline
A taxon fits one status criterion *and* the trend criterion:
Status criteria
1.   Total population size is > 5,000 mature individuals.
2.   There are ≤ 15 sub-populations *and either*:

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[14] 'Nationally Vulnerable', 'Nationally Endangered', and 'Nationally Critical' categories equate with the IUCN categories of Vulnerable', 'Endangered', and 'Critically Endangered': the criteria measure similar population features as those in the IUCN Red List criteria but the numerical limits and timeframes are designed to suit the New Zealand context (Molloy *et al.*, 2002: 13).

a. 500 mature individuals in the largest sub-population, *or*
b. Total area of occupancy is > 100 ha (1km^2).

Trend criterion

Predicted decline of 30-60% in total population in the next 10 years due to existing threats.

B. Small-moderate population *and* small-moderate predicted decline

A taxon fits one status criterion *and* the trend criterion:

Status criteria

1. Total population size is < 5,000 mature individuals.
2. There are ≤ 15 sub-populations *and either*:
    a. 500 mature individuals in the largest sub-population, *or*
    b. Total area of occupancy is ≤ 100 ha (1km^2).

Trend criterion

Predicted decline of 5-30% in total population in the next 10 years due to existing threats.

0.45 – 0.61   **Acutely Threatened – Nationally Vulnerable**

Small-moderate population *and* moderate recent predicted decline

A taxon fits at least one status criterion *and* one trend criterion:

Status criteria

1. Total population size is 1,000 - 5,000 mature individuals.
2. There are ≤ 15 sub-populations *and either*:
    a. 300-500 mature individuals in the largest sub-population, *or*
    b. Total area of occupancy is 10 - 100 ha (0.1 - 1km^2).

Trend criteria

A decline of 30-60% in total population or habitat area in the last 100 years *and* the total population *or* habitat is still in decline.

1. A predicted decline of 30-60% in total population in the next 10 years due to existing threats.

0.24 – 0.44   **Acutely Threatened – Nationally Endangered**

A. Small population *and* moderate-high recent predicted decline

A taxon fits at least one status criterion *and* one trend criterion:

Status criteria

1. Total population size is 250-1,000 mature individuals.
2. There are ≤ 5 sub-populations *and either*:
    a. 300 mature individuals in the largest sub-population, *or*
    b. Total area of occupancy is ≤ 10 ha (0.1km^2).

Trend criteria

1. A decline of ≥ 30% in total population *or* habitat area in the last 100 years.
2. A predicted decline of ≥ 30% in the next 10 years due to existing threats.

B. Small-moderate population and high recent or predicted decline

A taxon fits one status criterion *and* one trend criterion:

Status criteria

1. Total population size is 1,000 - 5,000 mature individuals.
2. There are ≤ 15 sub-populations *and either*:
    a. 300 - 500 mature individuals in the largest sub-population, *or*
    b. Total area of occupancy is 10 - 100 ha (0.1 - 1km^2).

Trend criteria

1. A decline of ≥ 60% in total population *or* habitat area in the last 100 years.

2. A predicted decline of ≥ 60% in the next 10 years due to existing threats.

0.01 − 0.23   **Acutely Threatened – Nationally Critical**
Very small population *or* a very high predicted decline
A taxon meets any of the following three criteria:
1. Total population size is ≤ 250 mature individuals.
2. Human influences have resulted in ≤ 2 sub-populations *and either*:
   a. 200 mature individuals in the largest sub-population, *or*
   b. Total area of occupancy is ≤ 1ha (0.01km^2);
3. A predicted decline of ≥ 80% in total population in the next 10 years due to existing threats.

0.00   **Extinct**
A taxon where there is no reasonable doubt, after repeated surveys in known or expected habitats at appropriate times (diurnal, seasonal and annual) and throughout the taxon's historic range, that the last individual has died. A taxon that is extinct in the wild but occur in captivity or cultivation are as Nationally Critical and are qualified with the letters EW (Extinct in the Wild).

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