The costs of single species programs and the budget constraint

Emma Moran [a], Ross Cullen [a*], Kenneth F.D. Hughey [b]

[a] *Commerce Division, PO Box 84, Lincoln University, New Zealand*

morane@xtra.co.nz, 64 3 768 5986

cullenr@lincoln.ac.nz, ph. 64 3 325 3807, Fax 64 3 325 3847

[b] *Environment, Society and Design Division, PO Box 84, Lincoln University, New Zealand*

hugheyk@lincoln.ac.nz, 64 3 325 2811

* corresponding author.

Abstract

Despite the scarcity of funding for species conservation programs, estimation of the cost of threatened species programs occurs in only a few countries. This paper examines the reasons for the lack of species program cost estimates and the likely impacts of this on conservation management. We report methodology used to estimate cost for eleven New Zealand species programs and their estimated costs over a ten year period. Differences between species in the costs of the programs and the breakdown of the costs are highlighted. The estimated costs are compared with expected levels of expenditure on each species to illustrate the existence of a budget constraint for threatened species. The likely effects of cost of species conservation exceeding expenditures on species conservation are examined. Annual cost data is used together with information on rate of conservation progress to estimate time and total cost for each species to reach 'Not Threatened' status.

Keywords

Threatened species, costs, expenditure, budget constraint

INTRODUCTION

In most countries the number of threatened species requiring direct management intervention is much greater than the number that can be managed with the funding made available (IUCN, 2000). In New Zealand, total annual funding of around NZ$40

million (1) allowed about 15 percent of the 2,400 native and endemic species listed as threatened to be specifically targeted for management (Department of Conservation, 2004). Although most of these species are included within New Zealand's extensive system of reserves, some require specific intervention. A goal of the New Zealand Biodiversity Strategy (2000) 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 over the past few decades that funding is insufficient to maintain the growing number of species known to be at risk of extinction (Bell, 1975; Williams, 1986; Towns and Williams, 1993; Hitchmough, 2002). Given the funding limits faced, the costs of managing individual species are clearly important, but in most countries little attention is placed on these costs.

The purpose of this paper is to investigate the future costs of New Zealand single species programs and to consider the possible impact of a budgeting constraint on threatened species management. Before proceeding some essential definitions are required: 'cost' is defined as the amount of money required in order to accomplish a particular purpose (Brown, 1993: 521); '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). 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 programs operating over the period 2003-2012. 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. Notwithstanding this uncertainty, the estimates of the varying costs of the 11 single species programs over

the ten 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 on outcomes of underfunding is speculated upon in considering how the budget constraint delays the recovery of those species already benefiting from management and, as a result, other threatened species that are still on the waiting list. Although the total costs of a program 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 a longer time horizon. To gain some idea of a program's 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 financial commitment that is needed in the long-term.

Lack of attention to costs

Beyond countries like the United States and Australia, accurate estimates of costs of programs 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 recognized by conservation managers or policy makers. Despite these reasons, information on the costs of programs is likely to be 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 effectiveness and efficiency in use of conservation resources. In threatened species management there has been some analysis of patterns of expenditure (for example Simon *et al.* 1995; Metrick and Weitzman, 1996; Restani and Marzluff, 2001), but only a handful of examples of research involving costs of individual species (for example Doerksen *et al.* 1998, Wilcove and Chen, 1998; Main *et al.* 1998; Fairburn *et al.* 2005).

METHODS

Department of Conservation (DoC) managers of single species programs were surveyed to gather cost estimates because, unlike the United States Fish and Wildlife Service, the DoC does not, as a rule, include estimates of costs in its recovery plans. A pilot survey was conducted of the managers for three single species programs 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). If a request for data on the future costs and expenditure for a particular species program was declined then an alternative program 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 programs for reptiles or freshwater fish were rejected. Furthermore, a disproportionate number of recovery programs exist for avian species. In general, the following set of criteria, in general order of importance, were used to select programs for this study:

1. Species programs for which there was a draft or published recovery plan.
2. Programs for species that are representative of different taxa.
3. Programs for species within each taxon that require different habitat types.
4. Programs for species that occur within one or two conservancies, rather than multiple conservancies.(2)
5. Programs for species that have a high threat classification, such as ‘Nationally Critically Endangered’, ‘Nationally Endangered’, or ‘Nationally Vulnerable’.
6. Programs for species that have a clear and undisputed taxonomy.

7. Species programs that are of particular interest for research.

The Species Managers Survey was eventually completed for 11 single species programs (listed in Table 1), which despite the use of selection criteria, covered almost all of the set of possible programs. 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 programs

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 *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 program is fully funded (3). A species' conservation status was used to quantify outcomes, rather than more common measures, such as a species' probability of survival over a certain timeframe based on population 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 seven 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.* 2005).

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 undertaken 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.

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. All estimates of costs, expenditure and changes in species' conservation status are discounted to their present value (PV) using the same constant exponential discount rate of six percent to allow incidences of each one occurring at different points in time to be directly compared across single species programs. The six discount rate reflects the public's preference for the conservation of a threatened species earlier rather than later and is based on the real cost of government borrowing in New Zealand (Cullen *et al.* 2001: 59).

RESULTS

The PV of estimated total costs of the 11 single species programs for 2003 until 2012 indicate that the costs of management are specific to each program (Figure 1). The results show that the variations in the costs of programs are striking: the PV of total costs for the ten year period covers a large range, from under $12,000 for the Stephens Island ground beetle program to over $9 million for the North Island kokako program. The large range in the PV of total costs means that the higher cost programs account for the majority of the costs of threatened species management over the timeframe: the six highest cost programs account for 92 percent of the costs over all 11 programs.

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 ten year period. Discounting reduces the costs of species programs, 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 programs studied.

Figure 1 Present Value of estimated total costs of NZ species programs 2003-2012

The PV of estimated total costs of a program 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. The estimated cost of a program 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 programs are categorized as follows: advocacy and/or public education, research, survey and monitoring, translocation, habitat restoration, protection from threats, control of threats, breeding program in the wild, and breeding program 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 2). 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 (Swanson,1994). 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

characterization 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 Figure 2.

Figure 2 Present Value of costs of objectives as a percentage of total cost 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 programs have survey and monitoring costs except for the program for Stephens Island ground beetle. The mohua, black stilt, and North Island kokako programs have survey and monitoring costs, but only mohua and black stilt programs have significant research costs (7). 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 cost of each program over the ten year period. The Stephens Island frog program and all five bird programs 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 program'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 program had a PV of total expenditure of $16,615,000 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. 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. By comparison, the South Island long-tailed bat program has a PV of total expenditure of $553,000 from 1995 until 2002 and a 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 programs for 2003 until 2012

Objective type	No. of programs	Average cost	Total cost
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	5	$2,758,000	$13,790,000
Captive breeding	5	$788,000	$3,940,000
Survey and monitoring	8	$422,000	$3,380,000
Research	7	$460,000	$3,220,000
Advocacy and education	5	$176,000	$880,000

With the exception of the Stephens Island ground beetle program, the programs can be divided into those for non-avian, which have costs for managing threats, and those for avian, which have costs for breeding programs either in addition to or instead of costs for the management of threats. 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 programs have costs for captive breeding programs, and black stilt and kakapo also have costs for breeding programs in the wild. Together, the average cost of breeding programs for each species over the ten year time period is about

$1,450,000, but this ranges from $29,000 for mohua to around $6,430,000 for black stilt. For mohua, black stilt, and North Island kokako, the costs for breeding programs are in addition to costs of controlling threats.

The cost structure for the 11 single species programs raises three points for consideration. First, most programs 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 programs, 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 programs 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 programs is NZ$18.6 million. The impact of the budget constraint on threatened species management is that a decision to implement a species program 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 program. Clearly, higher cost programs are far more likely to require more funding and so have higher opportunity costs than programs with lower costs. Decisions to implement higher cost programs will reduce the overall number of single species programs that can be established within a particular budget. Consequently, there needs to be a strong justification for higher cost programs at the expense of lower cost programs and an explicit understanding of the trade-offs involved. The varying costs of single species programs and the budget constraint will, therefore, have a significant impact on an organization's ability to achieve its goal for threatened species management.

Figure 3 Present Value of total cost and expected total expenditure 2003-2012

Programs 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 programs appears to be because funding tends to only become available when it can be spared from other programs that are given a higher priority. In contrast, programs 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 program 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 programs are expected to continue to be fully funded. For the programs 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 program. 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 programs of a PV of NZ$18.6 million is met (Figure 4). Fully funding these programs 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 additional funding is essential if any gains are to be made in the species' conservation status in subsequent years.

Figure 4 Present Value of possible additional gains in conservation status if fully funded 2003-2012

The 11 programs 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 programs, 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 programs may include a disproportionate number of higher cost programs, such as that for kakapo, but they do not include the kiwi program, which receives more funding than any other program (C. Carter, personal communication, October 18, 2002). Managers' predictions of the outcomes that could be achieved if programs 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 programs over time

The PV of total cost for each of the 11 single species programs 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 program over time. As the task of estimating costs is subject to uncertainty and the objectives of a program are usually developed for a five to ten-year timeframe, any attempts to accurately estimate the annual costs of the programs 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 program and the commitment to management that is needed over the long-term. The PV of average cost for each of the 11 programs over the timeframe alters the relative positions of four of the species programs from their order by total cost and appears to be related to a species' taxon (Figure 5). Programs for Stephens Island frog, kakapo, and possibly South Island long-tailed bat have higher average costs when compared to other programs, and the average cost of the North Island kokako program is comparatively lower. The Stephens Island frog program, however, has a similar average cost to the four plant and invertebrate species. Average costs for the plant and invertebrate programs, excepting that for flax snail, are lower than for any other species programs. The annual costs for the flax snail program 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 program has a significantly lower PV of total cost per conservation status unit than the other four avian programs because much of the actual costs of the program has already occurred or is hidden. For example, the cost of feeding for the captive breeding program 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 programs are higher than for any other species, except for possibly South Island long-tailed bat.

Figure 5 Present Value of average costs of NZ single species programs 2003-2012

The average cost for the South Island long-tailed bat program is unknown because management of the species is not expected to improve its conservation status over the next ten years even if the program is fully funded. Research, survey and monitoring account for half of the future costs of the program, 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 programs 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 projected total costs of the 11 programs show how a species' initial conservation status and its rate of progress potentially influence the total costs of a program (Figure 6). All 11 species were classified as either 'Nationally Vulnerable', 'Nationally Endangered' or 'Nationally Critical' in 2002. The number of years that it would potentially take for each species to improve from its conservation status in 2002 to 'Not Threatened' is recorded above each result. The projected total costs for Stephens Island frog, mohua, black stilt and kakapo programs 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 program 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 programs. Stephens Island frog was more threatened than Campbell Island teal and less threatened than flax snail in 2002, but its program 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 program 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 program 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 programs (Figure 7). 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 programs because of differences in the timeframes needed for management of each species. The strongest effect is on programs that are likely to have extremely long timeframes. The PV of projected total cost for the mohua, black stilt and kakapo programs are reduced to less than the cost of the North Island kokako program 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 6 Projected total costs of NZ single species programs from 2003

Figure 7 The effect of a positive discount rate on projected total costs

DISCUSSION

Six main reasons became apparent from the Species Managers Survey as to why the task of estimating the costs of programs is complex and subject to uncertainty. First, projects for particular populations of a threatened species may have multiple objectives or the program may share resources with other programs at certain sites (J. Hudson, personal communication, September 5, 2002). The costs of the North Island kokako program are markedly different from other species programs because much of the kokako program occurs as ecosystem restoration projects and the costs are

inextricably linked. Similar costs are not included for other programs. Second, the costs of species programs may be partly met by sponsorship from other public or private organizations. As well as not being directly comparable, part of the reported cost of the North Island kokako program 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 program is sponsored by Comalco New Zealand and the Royal Forest and Bird Protection Society. Third, programs 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). 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 program, 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. Despite such limitations sufficient data was gathered to enable a substantive evaluation of the role of costs in managing endangered species.

Together, the varying costs of single species programs and the budget constraint have a significant influence on an organization's ability to achieve its management goal. Yet although basic estimates of the costs of single species programs 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. The results, illustrate that there are highly varying costs of single species programs. 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 programs.

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 program 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 programs for some species and a complete lack of funding for those still on the waiting list. A decision to implement a higher cost program will reduce the overall number of single species programs, and so, there needs to be a strong justification for the implementation of higher cost programs and an understanding of the trade-offs involved. As in the health sector, insufficient funding delays a species' program, putting it at risk of further decline, and potentially increases the total cost of management. It also reduces the cost-effectiveness of programs and increases the level of financial commitment that is ultimately required to manage a species over time. Yet without cost information, measured as present values of costs of programs over time, these effects cannot be quantified.

Fundamentally, however, the thesis of this paper is not whether programs should be fully funded or whether some programs should be allocated funding ahead of others. It is that information on costs and possible outcomes should be sought and understood, and that it is to a conservation organisation's advantage to do so. The likelihood of achieving improvements in effectiveness and efficiency, and the increased ability to gain additional funding provide a strong incentive for conservation organizations to generate such information. Perhaps part of the problem is that organisations tend to set laudable but potentially unrealistic conservation goals. Achieving these goals may have far greater costs than is envisaged and can be provided for by funding agencies and society, and as a result, there may be wariness about estimating costs and possible outcomes on the side of the conservation organisation. Yet with better information and an increased understanding this situation could be resolved.

ACKNOWLEDGEMENTS

We thank the New Zealand Department of Conservation species managers who took the time to answer our survey. Without their co-operation this research would not have been possible. This research was funded by the Ryoichi Sasakawa Young Leaders' Scholarship and Lincoln University, New Zealand.

References

Brown, L. 1993. The new shorter Oxford English dictionary on historical principles. Clarendon Press, Oxford.

Bell, B.D., 1986. The conservation status of New Zealand wildlife. N.Z. Wildlife Service Occasional Publication, No.12.

Cullen, R., Fairburn, G.A., Hughey, K.F.D., 2001. Measuring the productivity of threatened species programs. Ecological Economics. 39(1): 53-66.

Cullen, R., Moran, E.M., and Hughey, K.F.D., 2005. Measuring the success and cost effectiveness of New Zealand multiple species projects to conservation of threatened species. Ecological Economics, 53: 311-323.

Department of Conservation (DoC). 2004. Annual report: for the year ended 30 June 200*4*. Department of Conservation, Wellington.

Department of Conservation (DoC), and Ministry for the Environment (MfE) 2000. The New Zealand Biodiversity Strategy: our chance to turn the tide; whakakohukihukitia te tai roroku ki te tai oranga. Department of Conservation and Ministry for the Environment, Wellington.

Doerksen, H., Leff, C.S., and Simon, B.M. 1998. Policy goals for endangered species recovery. Society and Natural Resources. 11: 365-373.

Fairburn, G., Hughey, K.F.D., and Cullen, R., 2004. Cost effectiveness of endangered species management: the Kokako (Calleas cinerea) in New Zealand. New Zealand Journal of Ecology. 28(1): 83-91.

Hitchmough, R. 2002. New Zealand Threat Classification System lists 2002. Threatened Species Occasional Publication, 23. Department of Conservation, Wellington.

Main, M.B., Roka, F.M., and Noss, R.F. 1998. Evaluating costs of conservation. Conservation Biology. 13(6):1262-1272.

Metrick, A. and Weitzman, M.L. 1996. Patterns of behavior in endangered species preservation. Land Economics. 72(1): 1-15.

Molloy, J., Bell, B.D., Clout, M., de Lange, P., Gibbs, G., Given, D., Norton, D., Smith, N., and Stephens, T. 2002. Classifying species according to threat of extinction: a system for New Zealand. Threatened Species Occasional Publication, 22. Department of Conservation, Wellington.

Restani, M., and Marzluff, J.M. 2001. Avian conservation under the Endangered Species Act: expenditures versus recovery priorities. Conservation Biology. 15(5): 1292-1300.

Simon, B.M., Leff, C.S., and Doerksen, H. 1995. Allocating scarce resources for endangered species recovery. Journal of Policy Analysis and Management. 14 (3): 415-432.

Swanson, T.M., 1994. The economics of extinction revisited and revised: a generalised framework for the analysis of the problems of endangered species and biodiversity losses. Oxford Economic Papers. 46: 800-821.

Towns, D.R., and Williams, M. 1993. Single species conservation in New Zealand: towards a redefined conceptual approach. Journal of the Royal Society of New Zealand. 23(2): 61-78.

Wilcove, D.S., and Chen, L.Y. 1998. Management costs for endangered species. Conservation Biology. 12 (6):1405-1407.

Williams, M.J., 1986. Native bird management, Forest and Bird. 17 (November) 7-9.

World Conservation Union (IUCN) Species Survival Commission 2000. 2000 IUCN Red List of threatened species: confirming the global extinction crisis. www.iucn.org/redlist/2000/news.html

Endnotes

1. The April 2007 NZ$/AU$ exchange rate was 0.88 and NZ$/US$ rate 0.74.

2. 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.

3. 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).

Figure 1: Present Value of estimated total costs of NZ species programs 2003-2012

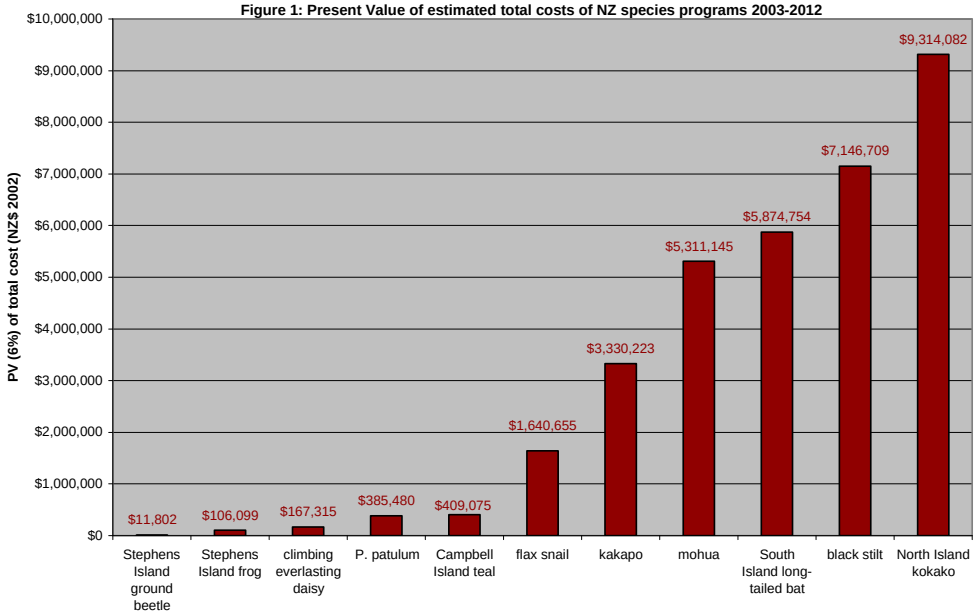

Figure 2: Present Value of costs of objectives as a percentage of total cost 2003-2012

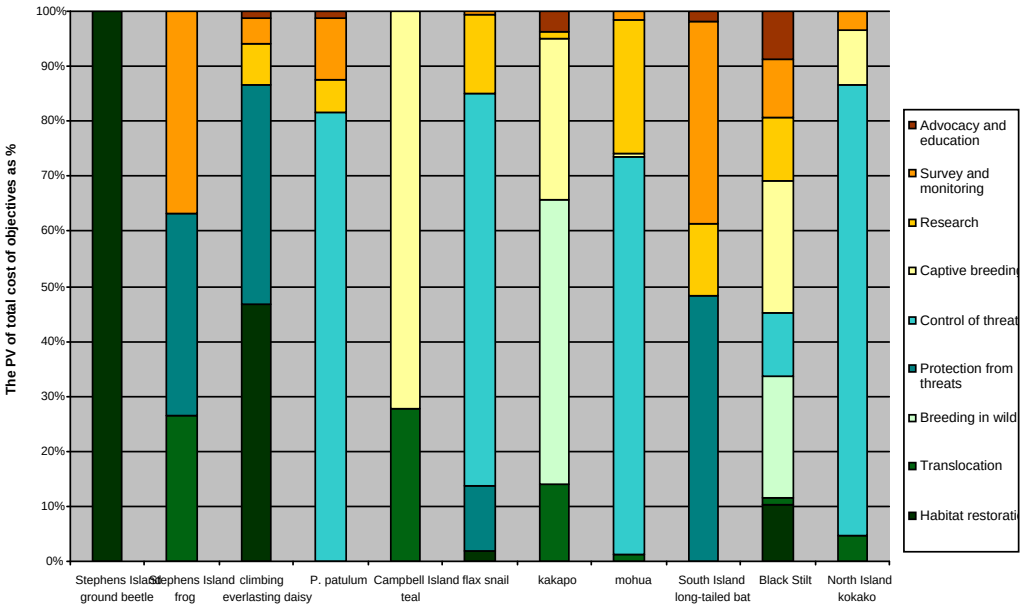

Figure 3: Present Value of total costs and expected total expenditure 2003-2012

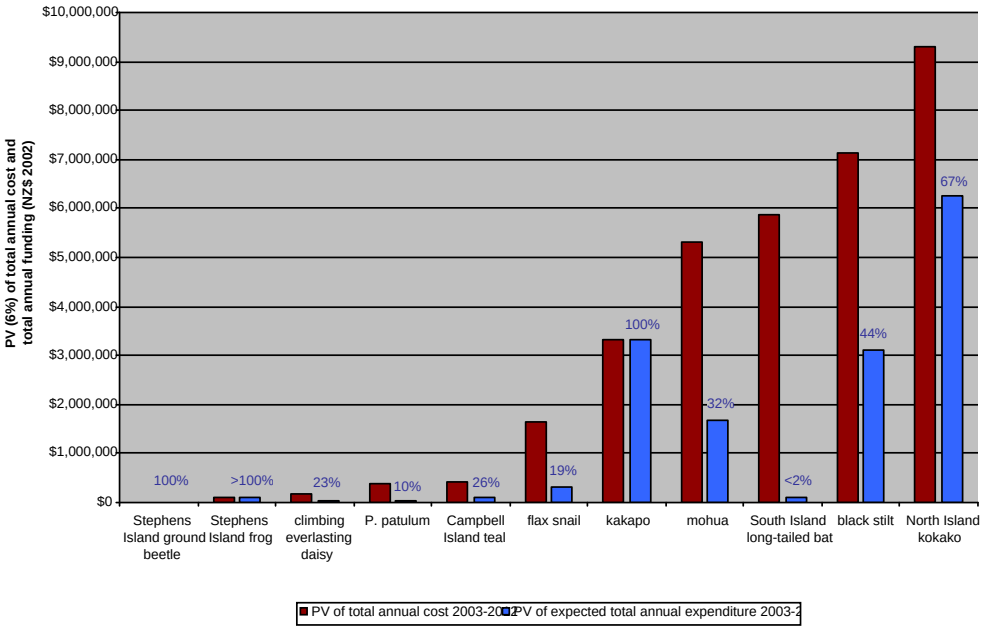

Figure 4: Present Value of possible additional gains in conservation status if fully funded 2003-2012

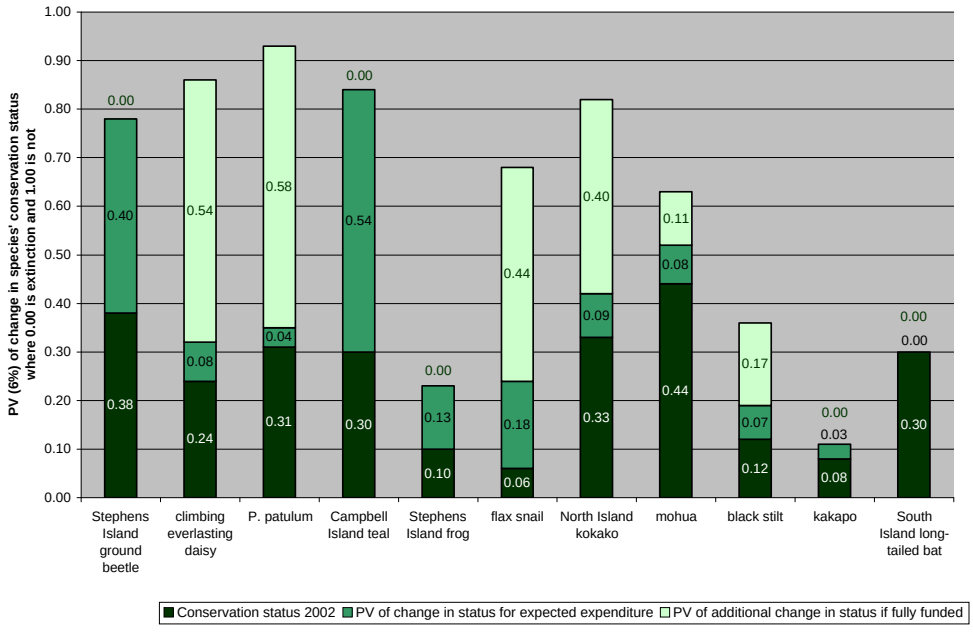

Figure 5: Present Value of average costs of NZ single species programs 2003-2012

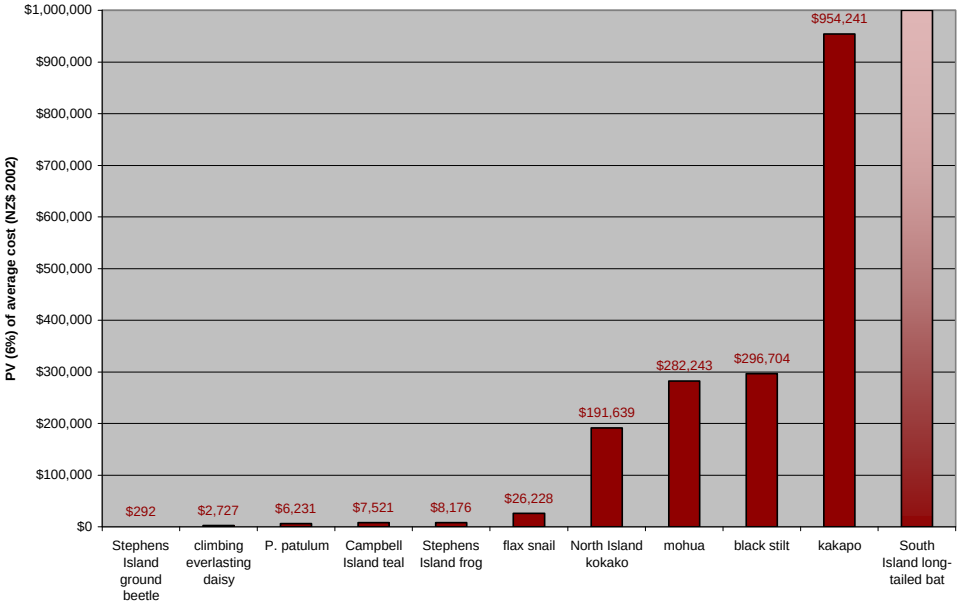

Figure 6: Projected total costs of NZ single species programs from 2003

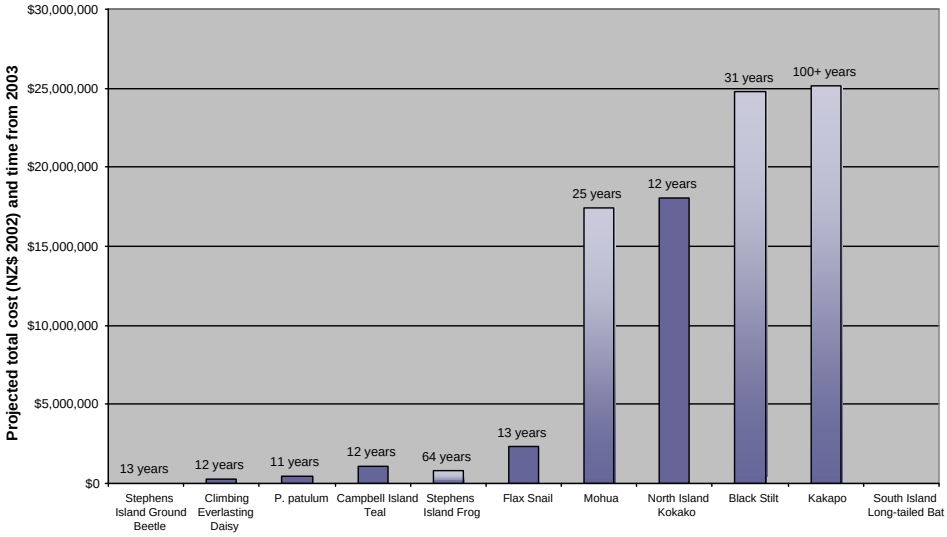

Figure 7: The effect of a positive discount rate on projected total costs