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State and Not-For-Profit delivery of species conservation. Cost utility analysis of multiple-species projects.

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**State and Not-For-Profit delivery of species conservation. Cost
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Abstract

Conservation of species is challenging, and there is continuing interest in finding more effective means to achieve conservation goals. State provision of conservation occurs in many countries, alongside a growing range of alternative providers including Not For Profit organisations and the private sector. Few studies have compared the effectiveness and efficiency of State provision against Not For Profit or private sector provision. This research assesses the effectiveness and cost-effectiveness of multiple-species projects in regard to the conservation of threatened and endangered species using a cost-utility analysis. Three State managed projects, three Not For Profit managed projects and one project managed by the State yet funded 'privately,' were evaluated. All of the Not For Profit managed projects were enclosed by predator-proof fences, while the other projects relied on natural barriers and/or intensive predator control methods. Results indicate that State managed multiple-species projects are both more effective and cost-effective than those projects managed by Not For Profits. While the Not For Profit managed projects are not so effective in improving national population totals, they are essential for ensuring regional biodiversity of threatened and endangered species. The objectives set by the projects appear to have a significant impact on their outputs. A number of recommendations are made for improving conservation efforts in the future. Most importantly, the development of a threatened and endangered species database to be contributed to by all conservation project providers. The importance of standardised reporting techniques is highlighted to allow comparisons both over time and between projects.

Keywords: State provision, Not For Profit, multiple-species, cost-utility analysis.

Introduction

Threatened species recovery is expensive, and State conservation managers are increasingly faced with a mounting list of tasks and often strictly limited budgets. In such circumstances it is important to ask if alternative conservation providers are more effective and efficient in meeting conservation needs. Evaluation is essential to answer that question. In the past, the majority of evaluation attention has been focused on developing, evaluating and prioritising single-species projects. Multiple-species projects however, are an area to which little attention has been paid by scientists and evaluators. As their popularity with conservation managers grows and there is pressure of limited finances, it is important that more research is carried out into the effectiveness of multiple species projects. The lure of these projects is the possibility of achieving economies of scope; the belief being that the cost per species is lower when managed this way than if managed as a series of single species projects. Nicholson and Possingham (2006) suggest it is likely that a multiple-species framework will be subject to many of the same limitations as a single-species project, yet the greatest benefit is the ability to measure conservation success in a way that is readily understood.

It is important to determine if conservation projects have been conducted in the most cost-effective way. In this paper we examine whether State managed and resourced multiple-species projects in New Zealand are more ‘successful’ than those managed and resourced by Not For Profits (also referred to as ‘trusts’), or projects managed by the State yet resourced by private business. This study is consistent with the call by Green and Clarkson (2006) for cost effectiveness analysis of conservation projects to be undertaken, and with the New Zealand Department of Conservation (DoC) 2007-2010 Statement of Intent which argues that to measure progress in protection and restoration DoC need to monitor change over time, to estimate the difference made by the actions of management agencies and estimate net achievement (Department of Conservation, 2007).

Evaluation of species conservation

Conservation management is becoming increasingly reliant on information from a number of disciplines. These include biology, conservation ecology, economics, political science and sociology (Hughey, Cullen, & Moran, 2003). Hughey et al. (2003) identified a number of examples where different methods for assessing conservation management have been used. These methods include expenditure analysis (Metrick & Weitzman, 1998), opportunity cost analysis (Main, Roka, & Noss, 1999), diminishing marginal productivity (Drechsler & Watzold, 2001), decision analysis (Guikema & Milke, 2002), and cost-effective indices (Macmillan, Harley, & Morrison, 1998; Moran, Pearce, & Wendelaar, 1996). However, these approaches cannot readily be used to assess both effectiveness and cost-effectiveness. There are three key approaches used for evaluating projects; cost-benefit analysis, cost-effectiveness analysis and cost-utility analysis. While the approaches are essentially economics-based, other disciplines such as those previously mentioned are used to collect the data required.

First, cost-benefit analysis (CBA) weighs up costs against the benefits of a project. This analysis relies on measurement applying monetary (and sometimes non-monetary) units to the costs and benefits. The second approach, cost-effectiveness analysis (CEA), is often used when the decision-maker has a limited budget. Biophysical data is required for each alternative being evaluated and the costs are generally measured in monetary units (Hughey et al., 2003). The final approach is cost-utility analysis (CUA). This approach measures output by way of 'utility' (change that occurs in a species status). The key advantage of CUA over CEA is it can cope with varying 'quality' outputs (so different species or projects may be compared). So long as conservation and management costs are efficiently recorded, this method imposes few data demands.

CUA was first used as a means of assessing health care activities (Drummond, Sculpher, Torrance, O'Brien, & Stoddart, 2005). This approach considers the quality of the health

outcome which may be produced by a particular procedure or programme, or forgone if it does not take place. CUA has been applied to a number of conservation projects. Cullen, Fairburn and Hughey (1999) adapted the method so that COPYs (Conservation Output Protection Years) could be measured and cost/COPY calculated. CUA is an effective method for evaluating programs or projects that are trying to achieve different results (for example assessing the cost-effectiveness of different management methods, or a range of species) and it may provide important information on the productivity of recovery projects (Cullen, Fairburn, & Hughey, 2001). This method of assessing the effectiveness and cost-effectiveness of projects was first applied to single-species projects and then in Cullen, Moran and Hughey (2005), to multiple-species projects. In the latter paper, CUA and COPY were used to compare the effectiveness of three offshore islands against three mainland islands. A potential weakness of CUA is that in this context it relies upon expert assessments and experts may have limited information to make an assessment, or alternatively may provide biased responses.

Methods

While every effort was made to apply the techniques used in Cullen et al. (2005), new methods were needed in order to obtain sufficient information to create robust results. Research assumptions that need to be noted are: all of the expenditure made by each project ultimately contributes to species recovery efforts and, only the impact of the project on threatened and endangered species is being assessed. Also it should be noted that the impact of the project on the national status of a species is assessed, as opposed to the impact on the regional or local population of a species.

The term ‘multiple-species project’ is used in this study as an umbrella term encompassing mainland islands, Operation Ark (multiple-species and multiple-site) and non-government wildlife/bird sanctuaries (which typically are also mainland islands). The common feature of

these projects is that they are designed for the conservation of a number of threatened or endangered species.

Creating mainland islands allows for areas of land to be subjected to intensive pest control and re-vegetation to provide a safe and natural habitat for those species at risk. Introduced pests (mainly mammalian predators) have played a substantial role in the decline of many native and endemic species in New Zealand (DoC and MfE 2000).

Extensive and continuous monitoring is needed to evaluate the effectiveness of the mainland island as well as the success of new methods of predator control. This cycle describes the management approach to many mainland islands (research by management). In addition to the monitoring of the mainland island sites, non-treatment sites nearby are often monitored to collate information about test versus non-test sites (Gundry, 2001).

In total, seven projects from across New Zealand were chosen for evaluation (Figure 1). These represent a range of multiple-species projects in terms of habitat, age of project and management approaches; however with the exception of one site, the projects are predominantly native forest habitats. Operation Ark includes Hurunui as one of its ten sites and the contribution of Hurunui is assessed both individually, and as part of Operation Ark. Table 1 illustrates the different characteristics of each project. In particular these sites reflect a division between State and Not For Profit management. The former are heavily reliant on the suppression of predator or competitor numbers, and the latter on fenced sanctuaries. State provided conservation is taxpayer funded, but Not For Profits have a range of funding sources. All projects have clearly defined goals and objectives. The extent of these goals and objectives ranges from the easily achievable within the foreseeable future to restoring the vegetation to its pre-human state.

Figure 1: Location of project sites. (Note: Operation Ark has a number of sites across the South Island)

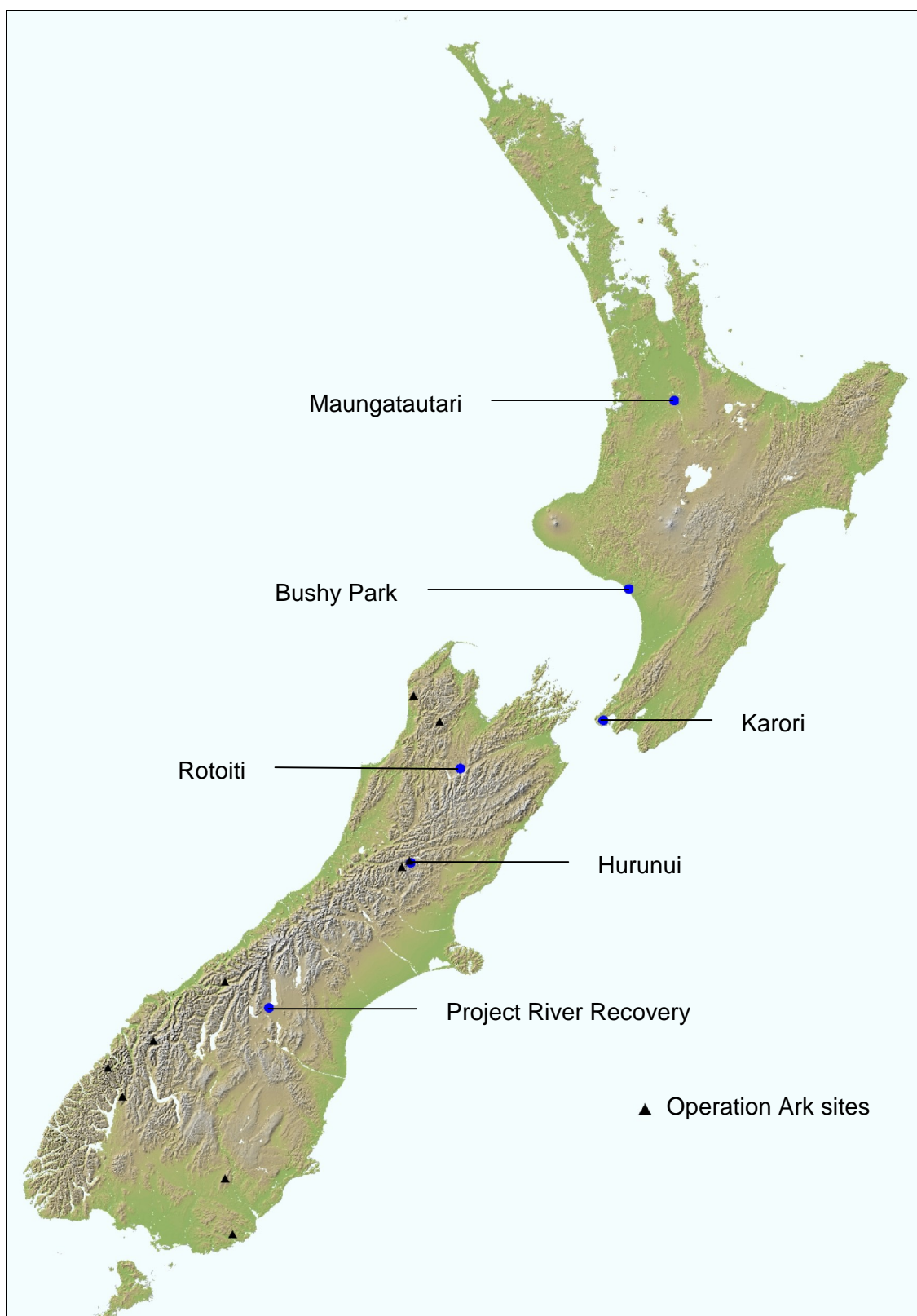


Table 1: Characteristics of the multiple-species projects.

Project	Bushy Park	Karori	Maungatautari	Hurunui	Project River Recovery	Rotoiti	Operation Ark
Size	98 ha	252 ha	3,363 ha	12,000 ha	>33,000 ha	5,000 ha	208,579 ha
Location	Wanganui	Urban Wellington	Cambridge	North Canterbury	Twizel/ Mackenzie Basin	Nelson Lakes National Park	South Island – 10 different sites
Established	1994	1997	2003	1995	1991	1995	2004
Ecosystem type	Northern rata-mixed podocarp rainforest	Native forest	Forested volcanic cone	Beech forest	Braided rivers	Beech forest	Predominately Beech forest
Managed	Bushy Park Trust	Karori Wildlife Sanctuary Trust (Inc.)	Maungatautari Ecological Island Trust	DoC	DoC	DoC	DoC
Funded	Bushy Park Trust membership, Save the Kiwi Foundation, Sponsor a Kiwi	Karori Wildlife Sanctuary Trust membership, sponsors, grants	Maungatautari Ecological Island Trust membership, grants	DoC	Meridian Energy	DoC	DoC
Fenced/ natural	4.7 km perimeter fence, 750m secondary fence	8.7 km perimeter fence	47 km perimeter fence	Natural	Predominately natural	Natural	Natural
Cost of predator proof fence (Scofield, Cullen, & Wang, 2008)	\$50,000 (\$10,638 per km)	\$2,200,000 (\$252,874 per km)	\$14,000,000 (\$297,872 per km)				
Number of T+E species Present	3	18	5	6	33	6	5
Number of T+E species producing COPY	2	8	1	2	5	0	3

Data collection and evaluation

The initial methods used for data collection followed Cullen et al. (2005) and enables comparisons to be made to that study. An important requirement of the CUA technique is the use of an appropriate scale for measuring the conservation status of species. The DoC Threat Classification System (Hitchmough, Bull, & Cromarty, 2007) is somewhat linked to the IUCN (2001) red list, yet also allows for unique characteristics of conservation in New Zealand such as; the small habitat area of some species, the small carrying capacity of those habitats and the naturally low population numbers of some species (Cullen et al., 2005). Categories on the Threat Classification System were combined with a cardinal scale to create a continuum to describe species status (Table 2).

Table 2: Conservation status continuum (adapted from Cullen et al. (2005)).

Abbreviation	Threat category	Range on continuum
NT	Not threatened	0.99-1.00
S	At risk-sparse	0.95-0.98
RR	At risk-range restricted	0.87-0.94
GD	Chronically threatened-gradual decline	0.76-0.86
SD	Chronically threatened-serious decline	0.62-0.75
NV	Acutely threatened-nationally vulnerable	0.45-0.61
NE	Acutely threatened-nationally critical	0.24-0.44
E	Extinct	0.00

Structured interviews held at project managers' work places were used as the initial means of data collection. These managers work with the species and process data concerning their projects on a daily basis and can potentially provide faster and more detailed explanations of dynamics in their ecosystem than can be gathered from reports, texts or even modelling systems (Ferraro & Pattanayak, 2006). A poor response to requests for data was received, with the most common reasons for this being time and budget constraints. To obtain further data a new methodology was developed. Raw data was collected from annual reports, newsletter, updates posted on the various Trusts' websites and bird population estimates from

Heather & Robertson (2005), along with the opinions of experts or Recovery Team Leaders for each species in question. While this process consumed more time than simply meeting with an individual, the data that was collected has the added strength that it is published material.

A standardised approach was used to calculate expenditure for each of the seven projects. In order to maintain comparability between DoC and privately managed projects, organisation overheads have been included. In some cases, expenditure data was not available for the duration of the projects (likely due to poor record keeping in the past). In these instances the project life has been taken from the first year of available data. The annual expenditure values for each conservation project were all converted into \$2007 (second quarter) using Statistics New Zealand's CPI indices and the Reserve Bank's CPI Inflation Calculator (<http://www.rbnz.govt.nz/inflationcalculator/showcalculator.do>). Comparison of results with Cullen et al. (2005) occurred after dollar values from that study were converted to \$2007.

The DoC managed projects are located on state owned land and legislation means the land is unable to be used for other activities; hence no opportunity costs may be attributed to these projects (Cullen et al., 2005). While there may be the possibility of including opportunity costs for the trust managed conservation projects, this has not been explored further and hence has not been included in the cost calculations.

The unit of measurement for this analysis is COPY. The conservation status values for each species 'with' and 'without' the projects are crucial to the calculation of the COPY values. The contribution of a particular project to the conservation status of a threatened species found at its site is measured using the following method:

$$\text{COPY}_i = \sum_t (Si_{tw} - Si_{tw/o})$$

where: Si_{tw} = species i conservation status in year t with management w

$Si_{tw/o}$ = species i conservation status in year t without management w/o

For multiple species projects, the numbers of COPY calculated for each species are added together to give the total output from the particular conservation project.

$$\text{Total Output} = \sum_i \text{COPY}_i$$

A second measure of the success of the conservation project is the distance between a species ‘with project’ and ‘without project’ status score in the final year of the study period (Cullen et al., 2005). This term is referred to as Gain.

$$\text{Gain}_i = (Si_{fw} - Si_{fw/o})$$

where: Si_{fw} = species i conservation status in year f with management w
 $Si_{fw/o}$ = species i conservation status in year f without management w/o
 f = final year of study period

Because these projects run over several years, present values of COPY are calculated. A zero discount rate was used when calculating the initial numbers of COPY, however these were then discounted using rates of 3%, 6% and 10%. The 6% discount rate was used for analysis purposes as it approximates the cost of borrowing by the New Zealand Government. The discounted present value of costs for each project was divided by the discounted present value of each project’s COPY in order to calculate a metric (cost/COPY), which could be compared between projects. As the age of the projects available varied between 3 and 16 years, annualised costs were calculated so fair comparisons could be made. Annualised costs spread the present value (using 6% discount rate) of costs across the project’s life, creating a value that includes capital and interest. These costs were divided by the number of hectares each conservation project protected to create another metric for comparison (cost/hectare).

Results

A range of values were calculated for each of the conservation projects.

Table 3 shows the conservation status for each of the threatened and endangered species that produced COPY, as well as an estimate of the percentage of each species population present in 2007. Of the twenty different species which recorded a positive COPY, only three have changed classification status between the 2002 and 2005 Classification System Lists as noted by (Hitchmough et al., 2007). The little spotted kiwi improved between the two publications, while the orange-fronted parakeet and wrybill plover both worsened. It is important to note that the species listed in Table 3 are not the only threatened and endangered species present for each project, however they are the only ones which have produced COPY during the study period.

Of the seven projects, the Hurunui Mainland Island has produced the greatest COPY (2.44), while two other DoC managed projects (Operation Ark and Project River Recovery) followed with 0.89 and 0.62 respectively (Table 3). The high COPY produced by Operation Ark reflects the large COPY produced for orange-fronted parakeets by the Hurunui site. Karori was the only Not For Profit managed site which generated a noticeable amount of COPY. With the exception of Operation Ark, each of these sites producing significant amounts of COPY has operated for 10 years or more.

Gain is also reported in Table 3. While the top four scoring projects are the same as those for COPY, the order is quite different. Operation Ark, with only 3 years of data, ranked highest on Gain (0.16) closely followed by Karori. Hurunui and Project River Recovery both scored a Gain of 0.1. The final year Gain for Karori is likely to have been bolstered by recent relocations of a number of threatened and endangered species into the Sanctuary.

Table 3: Gain and COPY calculated for each project.

Project and Species	Conservation status		Estimated % of total Population in project	Gain (2007)	COPY
	2002	2005			
Bushy Park				0.01	0.04
NI Brown Kiwi (<i>Apteryx mantelli</i>)	SD	SD	<1	0.01	0.03
NI Saddleback (<i>Philesturnus carunculatus rufusater</i>)	RR	RR	1	0	0.01
Karori				0.14	0.5
Northern Tuatara (<i>Sphenodon punctatus</i>)	S	S	1	0.01	0.02
Brown teal (<i>Anas chlorotis</i>)	NE	NE	<1	0.02	0.17
Little Spotted Kiwi (<i>Apteryx owenii</i>)	SD	RR	7	0.01	0.06
NI Kaka (<i>Nestor meridionalis septentrionalis</i>)	NE	NE	1	0.01	0.04
Maud Island Frog (<i>Leiopelma pakeka</i>)	NE	NE	<1	0.06	0.12
NI Saddleback (<i>Philesturnus carunculatus rufusater</i>)	RR	RR	<1	0	0.01
Stitchbird (<i>Notiomystis cincta</i>)	RR	NE	1	0.02	0.06
Cook Strait Giant Weta (<i>Deinacrida rugosa</i>)		RR	1	0.01	0.02
Maungatautari				0.02	0.03
Takahe (<i>Porphyrio hochstetteri</i>)	NC	NC	<1	0.02	0.03
Hurunui				0.1	2.44
Yellowhead (<i>Mohoua ochrocephala</i>)	NE	NE	<1	0.05	0.4
Orange-fronted Parakeet (<i>Cyanorhamphus malherbi</i>)	NE	NC	100	0.05	2.04
Project River Recovery				0.1	0.62
Black Stilt (<i>Himantopus novaezelandiae</i>)	NC	NC	100	0.03	0.24
Wrybill Plover (<i>Anarhynchus frontalis</i>)	SD	NV	10	0.04	0.25
Robust Grasshopper (<i>Brachaspis robustus</i>)	NE	NE	100	0.01	0.04
Pygmy Clubrush (<i>Isolepis basilaris</i>)	SD	SD	10	0.01	0.04
Dwarf Woodrush (<i>Luzula celata</i>)	SD	SD	40	0.01	0.05
Rotoiti				0.00	0.00
COPY was not produced for any species					
Operation Ark				0.16	0.89
Yellowhead (<i>Mohoua ochrocephala</i>)	NE	NE	90	0.05	0.15
Blue duck (<i>Hymenolaimus malachorhynchus</i>)	NE	NE	4	0.06	0.09
Orange-fronted Parakeet (<i>Cyanorhamphus malherbi</i>)	NE	NC	100	0.05	0.65
Long-tailed bat (<i>Chalinolobus tuberculata</i>)	NE	NE	unknown	not enough data	
Short-tailed bat (<i>Mystacina tuberculata tuberculata</i>)	NE	NE	unknown	not enough data	

Table 4 reports present value (PV) of the total costs and PV of COPY for each of the projects using four discount rates. As there are differing project lengths (resulting from differing start years and data availability), annualised costs have been calculated in Table 5. Many of the projects' expenditure varied annually so the values for annualised costs provide a way to compare typical expenditure for each project. There was a range of approximately \$2 million (\$2,310,230-\$244,889) for annualised costs, with the costs for Operation Ark almost twice those of the next largest, Karori.

Table 4: Costs and cost effectiveness of projects.

Project	Discount rates (%)			
	0	3	6	10
<i>Bushy Park</i>				
Present value of costs	\$ 2,640,705	\$ 2,205,503	\$ 1,861,660	\$ 1,508,660
PV of COPY	0.04	0.03	0.03	0.02
PV of costs per PV of COPY	\$ 66,017,619	\$ 69,311,644	\$ 73,022,745	\$ 78,702,242
<i>Karori</i>				
Present value of costs	\$ 14,785,968	\$ 11,968,214	\$ 9,811,842	\$ 7,670,546
PV of COPY	0.42	0.32	0.24	0.17
PV of costs per PV of COPY	\$ 35,204,686	\$ 37,915,480	\$ 40,954,149	\$ 45,582,070
<i>Maungatautari</i>				
Present value of costs	\$ 3,020,073	\$ 2,850,651	\$ 2,697,437	\$ 2,514,948
PV of COPY	0.03	0.03	0.02	0.02
PV of costs per PV of COPY	\$ 100,669,104	\$ 105,888,888	\$ 111,289,287	\$ 118,778,556
<i>Hurunui</i>				
Present value of costs	\$ 3,271,711	\$ 2,700,849	\$ 2,259,495	\$ 1,816,097
PV of COPY	2.44	2.06	1.76	1.46
PV of costs per PV of COPY	\$ 1,340,865	\$ 1,312,902	\$ 1,283,434	\$ 1,242,912
<i>Rotoiti</i>				
Present value of costs	\$ 4,347,519	\$ 3,892,489	\$ 3,516,638	\$ 3,109,963
PV of COPY	0	0	0	0
PV of costs per PV of COPY	undefined	undefined	undefined	undefined
<i>Project River Recovery</i>				
Present value of costs	\$ 8,129,885	\$ 6,662,995	\$ 5,592,078	\$ 4,572,420
PV of COPY	0.62	0.45	0.33	0.22
PV of costs per PV of COPY	\$ 13,112,718	\$ 14,961,611	\$ 17,151,343	\$ 20,657,049
<i>Operation Ark</i>				
Present value of costs	\$ 6,554,258	\$ 6,357,371	\$ 6,175,287	\$ 5,952,942
PV of COPY	0.92	0.89	0.87	0.84
PV of costs per PV of COPY	\$ 7,124,193	\$ 7,123,242	\$ 7,124,209	\$ 7,128,213

The annualised costs for each project were divided by the number of hectares in each site to find how much is spent per unit area. This shows a reverse of the two extremes recorded for annualised costs. Bushy Park was the second most expensive project, while the large area managed by Operation Ark resulted in it being the lowest cost per hectare. The Not For Profit managed and variously funded conservation projects were all higher cost per hectare than the other four projects. Project River Recovery however, is DoC managed yet privately funded and was the second lowest cost/hectare project.

Table 5: Summary of annualised costs for each project (n= number of years of data).

Project	Area (ha)	Annualised costs	Annualised costs/ha	Cost/COPY
Bushy Park (n=10)	98	\$ 252,940	\$ 2,581.02	\$ 73,022,745
Karori (n=12)	252	\$ 1,170,327	\$ 4,644.15	\$ 40,954,149
Maungatautari (n=5)	3363	\$ 641,893	\$ 190.87	\$ 111,289,287
Hurunui (n=12)	12000	\$ 269,506	\$ 22.46	\$ 1,283,434
Rotoiti (n=10)	5000	\$ 477,799	\$ 95.56	undefined
Project River Recovery (n=16)	33000	\$ 553,348	\$ 16.77	\$ 17,151,343
Operation Ark (n=3)	208579	\$ 2,310,230	\$ 11.08	\$ 7,124,209

The cost per COPY ratios show that DoC managed sites are more cost effective than the Not For Profit managed conservation projects (except for Rotoiti which did not produce any COPY). The Not For Profit managed projects have substantially greater cost/COPY ratios. Hurunui scored the best, producing one COPY for \$1,283,434 while the least effective was Maungatautari which cost \$111,289,287. Operation Ark is the second most cost-effective COPY producing project, with significantly lower costs than many of the projects which have been operating for a longer time.

Finally, results from this study were compared with the results in Cullen et al. (2005) and are reported in Table 6. Only three sites (all State managed) are common to each study; Hurunui, Rotoiti and Project River Recovery. Rotoiti did not produce any COPY in either study, and while the annualised costs increased marginally during the different time period, the costs per hectare are one quarter of those in the previous study. This large change may be due to the increase in project size between studies (825ha to 5000ha). Unlike Rotoiti, the other two sites have increased COPY between the studies, although the Gain decreased. The Gain for Hurunui was half of the value in 2002 while the COPY produced almost doubled (Table 6). The amount of money spent per hectare has decreased slightly, possibly reflecting the increased understanding of effective predator control techniques. Despite these noticeable improvements the annualised costs have increased and there has only been marginal change in

the cost of producing COPY. Project River Recovery's annualised costs decreased very slightly between studies, possibly reflecting the period of time it has been operating (16 years). The costs per hectare ratio also fell, to over a third of the initial study (Table 6). As with Rotoiti, it is likely this can be attributed to the fact the area managed by Project River Recovery tripled during this period.

Table 6: Comparison of values calculated by Cullen et al. (2005) and this study. (A 6% discount rate has been applied).

Project	2002 Cullen et al. (2005)	2007 This study
<i>Hurunui</i>		
Area managed (ha)	12,000	12,000
Gain	0.2	0.1
COPY	1.28	2.44
Present value of costs	\$973,960	\$2,259,495
Annualised costs	\$180,100	\$269,506
Cost/hectare	\$15.01	\$22.46
Cost/COPY	\$964,659	\$1,283,434
<i>Project River Recovery</i>		
Area managed (ha)	11,000	33,000
Gain	0.12	0.1
COPY	0.45	0.62
Present value of costs	\$4,617,816	\$5,592,078
Annualised costs	\$585,507	\$553,348
Cost/hectare	\$53.23	\$16.77
Cost/COPY	\$16,430,099	\$17,151,343
<i>Rotoiti</i>		
Area managed (ha)	825	5,000
Gain	0	0
COPY	0	0
Present value of costs	\$1,639,909	\$5,592,078
Annualised costs	\$333,492	\$477,799
Cost/hectare	\$404.23	\$95.56
Cost/COPY	undefined	undefined

Discussion

Table 1 shows there are marked differences between the projects; from those producing zero COPY to 2.44 COPY. Reasons for these differences may include the proportion of the total species population found in each project, the threat classification of species (how at risk they are), the duration of the project and the ease with which species can be protected and

relocated. COPY is calculated by assessing the impact of a project on the national population of each species. When calculated like this, the outputs are likely to be much smaller than if their impact on the regional population was being assessed. For example; Hurunui and Project River Recovery score high COPY values as they are the only areas of New Zealand where particular species are found. Hurunui has the largest and most significant population of orange-fronted parakeet while Project River Recovery has the only breeding populations of black stilt and robust grasshopper. On the other hand, Maungatautari is home to two takahe. These two non-breeding birds reflect only a small percentage of the national population of approximately 250 (Heather & Robertson, 2005), however they are the only takahe in the Waikato region and so are regionally significant. This raises the question; where should conservation efforts be focused – on protecting the overall population by potentially confining species to ‘safe’ locations (such as offshore islands), or risking a lower total population through keeping species where they have naturally existed in the past.

The allocation of expenditure appears to impact the cost-effectiveness of projects. The Not For Profit managed and funded conservation projects were consistently amongst the least cost-effective based on annualised costs, costs/hectare and costs/COPY (Table 5). The most obvious difference between the Not For Profit and DoC managed sites is the presence of predator-proof boundary fences on the former. These fences are relatively expensive (Table 1) averaging a cost of \$187,128 per km across the three included in this study. Approximately one quarter of the mainland conservation projects listed on the Sanctuaries of New Zealand website (www.sanctuariesnz.org) have built or are in the process of building predator-proof boundary fences. While some of these projects may be supported by DoC, the majority are managed by community groups or trusts. Alternatively, some Not For Profit managed projects take advantage of natural barriers such as peninsulas to minimise the cost involved in managing boundaries from reinvasion by predators and pests. The effectiveness of projects

such as Hurunui, Project River Recovery and Operation Ark suggest that expensive fences may not be essential for a successful conservation project. The money invested in fences could have been used instead to fund efficient trapping lines throughout the project area, and around the boundary of the property. Maungatautari is an example of this could have occurred as it is effectively a mountain surrounded by farmland. The absence of forest and adequate habitat for predators on surrounding property, mean the invasion rates may naturally be minimised to an extent that the placement of trapping lines and bait stations are sufficient to protect populations from reinvasion.

While some Not For Profit sites may have produced very little COPY, the geographically dispersed presence of species adds more 'safe' locations. In cases where there are only a few populations of species this is important and should be considered, as it reduces the risk of population wipe-out by environmental or biological factors, whereas if there are already multiple populations of the species around New Zealand then there may be very little conservation benefit.

There appears to be a relationship between the number of threatened and endangered species present and the amount of COPY produced for the Not For Profit managed sites. Not For Profit managed projects seem to be more effective when they have a large number of species (such as Karori) whereas the most effective DoC managed projects had fewer threatened and endangered species present (Hurunui and Operation Ark). This may reflect the differing objectives and financial constraints of the projects. DoC projects generally have a limited budget and so managers have to prioritise where that money is spent. Not For Profit projects are guided by their own objectives and have more discretion over the funds they can apply to projects. Additionally, they are able to apply for grants and support from DoC to aid species relocations.

Karori was the only Not For Profit managed project which produced substantial COPY or Gain. A clear factor distinguishing Karori from the other two Not For Profits projects is the number of years it has been actively managing species. Karori's fence was completed in 1999 while Bushy Park and Maungatautari's were completed in 2005 and 2006 respectively. The DoC managed projects produced higher COPY than Karori, likely as a result of not being hindered by the building of a predator proof fence, as well as focusing on species already present rather than relocations.

The present value of costs in Table 5 show the total expenditure by each project over the period studied. It might be expected that the longest running project would accumulate the greatest expenditure. This was true for two of the three highest costing projects (Karori and Project River Recovery), however the 'youngest' project (Operation Ark) ranked second highest. The total area of each project greatly affects these values, possibly more so than the project's age. The area managed by Operation Ark is six times greater than that for Project River Recovery and over 800 times Karori's managed area.

Two of the Not For Profit projects with predator proof fences have lower total expenditure than the majority of DoC projects (Table 4). This may reflect how the cost of the fences have been spread across their estimated life (approximately 25 years (Scofield et al., 2008)) through depreciation, alternatively this may also be attributed to the small area they manage. When the age of the projects is taken into consideration and annualised costs are calculated, the most expensive projects are the Not For Profit projects (Table 5). They manage small areas, and have expensive perimeter fences. The State projects manage much larger areas and do not have perimeter fences.

Operation Ark is the second ranking project in terms of cost per unit of COPY and area. It is also distinct from the other projects in that it manages 10 different sites around the South Island rather than only one protected area. By focusing on the existing habitat sites of

identified species, Operation Ark has minimised the cost involved in creating ‘replica’ or suitable ecosystems to relocate the species to.

As with many conservation projects, the multiple-species projects studied predominately protect birds, in particular ‘flagship’ or charismatic species (Metrick & Weitzman, 1998). While it is tempting to focus on these species, there is an opportunity for many, if not all of the projects studied to introduce more species other than birds. These projects are predominantly (and relatively) predator and pest free and have well-established vegetation providing ideal habitat for invertebrates and lizards.

One of the study’s objectives was to determine if the sites previously assessed in Cullen et al. (2005) have improved their effectiveness and cost-effectiveness since 2002. Kerkvliet & Langpap (2007) suggest that it may take at least six years in order to see the full effect of investment in a threatened species project. There has been a further six years of operation until this study providing a sufficient time period to test that proposition. The three sites common to both studies were analysed to assess if they had become more effective or cost-effective over time.

There are many factors which may have contributed to changes in effectiveness including staff/management turnover resulting in loss of knowledge about the project, development in understanding/technology leading to improved trapping rates for example, changes in funding, and biological factors such as disease potentially harming a species. Additional project-specific factors which should be considered when making the comparisons are: Project River Recovery changed its objectives for the 2006-2012 Strategic Plan. While the changes to the focus of the project may not be significant, it may have some impact in allocation of resources. Rotoiti has increased its management area from 825 hectares to 5,000 hectares. Rotoiti staff suggested their productivity has increased substantially with this increase in area as they have had little change in funding to reflect the increase (P. Gasson,

personal communication, 14 December 2007). Hurunui was incorporated into Operation Ark and is managed very much as part of this programme rather than as a mainland island. Some management aspects have been maintained, however on a much smaller scale.

While all sites have lowered their expenditure per hectare, and two have increased the COPY produced, none of the projects have increased their cost-effectiveness in improving the conservation status of the species present. This may indicate that it may be easy to initially produce high COPY, but maintaining or improving this in the long run is potentially difficult and expensive. The objectives set by each project appear to drive the success of the projects in producing COPY. Those which have a goal of improving research and education efforts were less successful in producing COPY (Rotoiti), whereas projects which are specifically focused on the protection of key species, i.e., specific and measurable conservation outcomes, concentrate their expenditure directly on the species and hence produce COPY (Hurunui and Operation Ark).

Conclusions

There are four main sets of findings from this research. They relate to conservation effectiveness and associated management implications, the techniques involved in evaluation, the potential to internationalise evaluation, and to monitoring and data collection needs.

The study found that two of three State provided multiple-species projects are more cost-effective than a State managed and privately funded project, and three Not For Profit projects. State provided projects manage large areas at low cost per hectare and provide habitat for large percentage of threatened species' populations. In contrast Not For Profit projects managed smaller areas, made large investments in fences and provided habitat for small percentage of species' populations, which often had been reintroduced to the region. In order for Not For Profit projects to make a difference to overall species conservation they need to either have a significant percentage of the national population, or be one of a few locations

where the species may be found. Not For Profit managed conservation projects major contributions to date are in ensuring species biodiversity on regional scales, providing educational and recreational opportunities, and raising the profiles of particular species.

Green and Clarkson (2006) state that among the priorities for New Zealand conservation is to increase actions for priority threatened species, and increased, better-focused and more efficient pest control. Operation Ark has proven that intense, focused funding and management approaches can be successful in improving the conservation status of species in the short-run. These additional projects should be allocated money in addition to present conservation funding (Norton, 2000). Operation Ark funding provides national level supplements to the money already allocated by regional offices. In periodic ‘mast’ years¹ the conservancies need to find money from other projects to meet extra predator control needs. This approach has been successful in the short-run, but its long run success is unclear.

For conservation projects to improve their effectiveness and cost effectiveness they must evaluate their techniques and results, then adjust their management approach in response to their findings. Project River Recovery writes a strategic plan every seven years, reviewing the past period as well as making suggestions and setting objectives for the forthcoming period. Adopting a similar approach in other conservation projects would force them to review their relative success formally rather than relying solely on managers’ opinions. As well as refining objectives and management approaches, these reports should include total or estimated numbers of all threatened and endangered species present as well the methods used to calculate these numbers so their accuracy may be readily assessed.

The CUA approach used by Cullen et al. (2005) can be replicated, but it can also be modified to provide alternative means of data collection. The Cullen et al. (2005) techniques proved to

¹ In beech (*Nothofagus* spp.) forests of the South Island of New Zealand seeding only occurs occasionally and is referred to as ‘masting’. In a ‘mast’ year the massive seed drop results in a build up of introduced herbivores (primarily mice (*Mus musculus*)). This eruption is then followed by an eruption in introduced predators (mainly stoats (*Mustela erminea*)). These predators then prey heavily on hole nesting bird species.

be relatively simple and effective only if full co-operation of project managers was available, and this seems to be an increasingly difficult challenge. The modifications developed and tested here mean that if needed, very little or no cooperation by managers is required. Such evaluation may be more time consuming, but can still provide a standardised evaluation method using data which has been sourced from audited annual accounts or published reports.

Cullen et al. (2005) suggest that because the conservation status continuum used to calculate COPY is based on the DoC Threat Classification System Lists (which in turn are linked to the IUCN classification system), this evaluation approach could be applied to conservation projects internationally. Haddock, Tzanopoulous, Mitchley and Fraser (2007) used this approach to develop a similar CUA methodology to evaluate habitat conservation. The new data collection methods will assist international application of this evaluation approach.

There is often little ‘reliable’, readily available, and up-to-date population data for threatened and endangered species. There are multiple records of species at different locations, but very little about national trends and totals. The development of a national database containing information such as national, regional and project populations would become a highly useful resource, for researchers, conservation managers and others, nationwide. Ideally these databases would be developed in conjunction with managers of the conservation projects.

While many projects publish strategic plans, annual reports, audited accounts, and newsletters, they do not report the same data nor have a standardised reporting template. While it may not be realistic to expect similar reports from Not For Profit and State conservation projects, a standard reporting structure would allow simple, comparable and relevant results to be relayed.

A search for greater effectiveness and improved cost effectiveness in biodiversity conservation should not overlook State provision. Alternative provision may be less effective

and higher cost ways of delivering conservation outcomes. Evaluation is essential to assess conservation performance and CUA provides a relatively straight forward low cost way to accomplish that. Information is essential to complete evaluations, and to effective decision-making. The introduction of standardised reporting formats and national databases would enhance information availability, support evaluation and decision-making as well as underpin more effective and efficient conservation performance.

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