Motu Public Policy Seminar

Costs, Effectiveness, Evaluation of biodiversity projects

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Conservation requires hard choices

Global conservation expenditure US $6 billion annually $1996, but need $13b James et al. 2001.

'*We cannot preserve everything ... The laws of economics apply to diversity*' Weitzman 1992.

Failure to use economic analyses will result in less conservation gains than are potentially achievable.

Much effort focused on conservation planning – benefits

But costs of conservation/km^2 globally vary by 7 orders of magnitude Balmford et al. 2003.

Ando et al. 1998, cost reduced to one sixth if consider ecologic & economic factors when selecting habitat for 453 US species.

Projects

Projects aim to deliver:

- *reduction in threats to species, habitats, ecosystems*
- *increases in population number,*
- *increases in species' probability of survival.*

Markets for these outputs are rare – CBA tricky.

Decision makers need information:

- Costs of projects
- Effectiveness of projects
- Cost effectiveness

Emma Moran, The cost of single species programmes

Moran et al. 2008

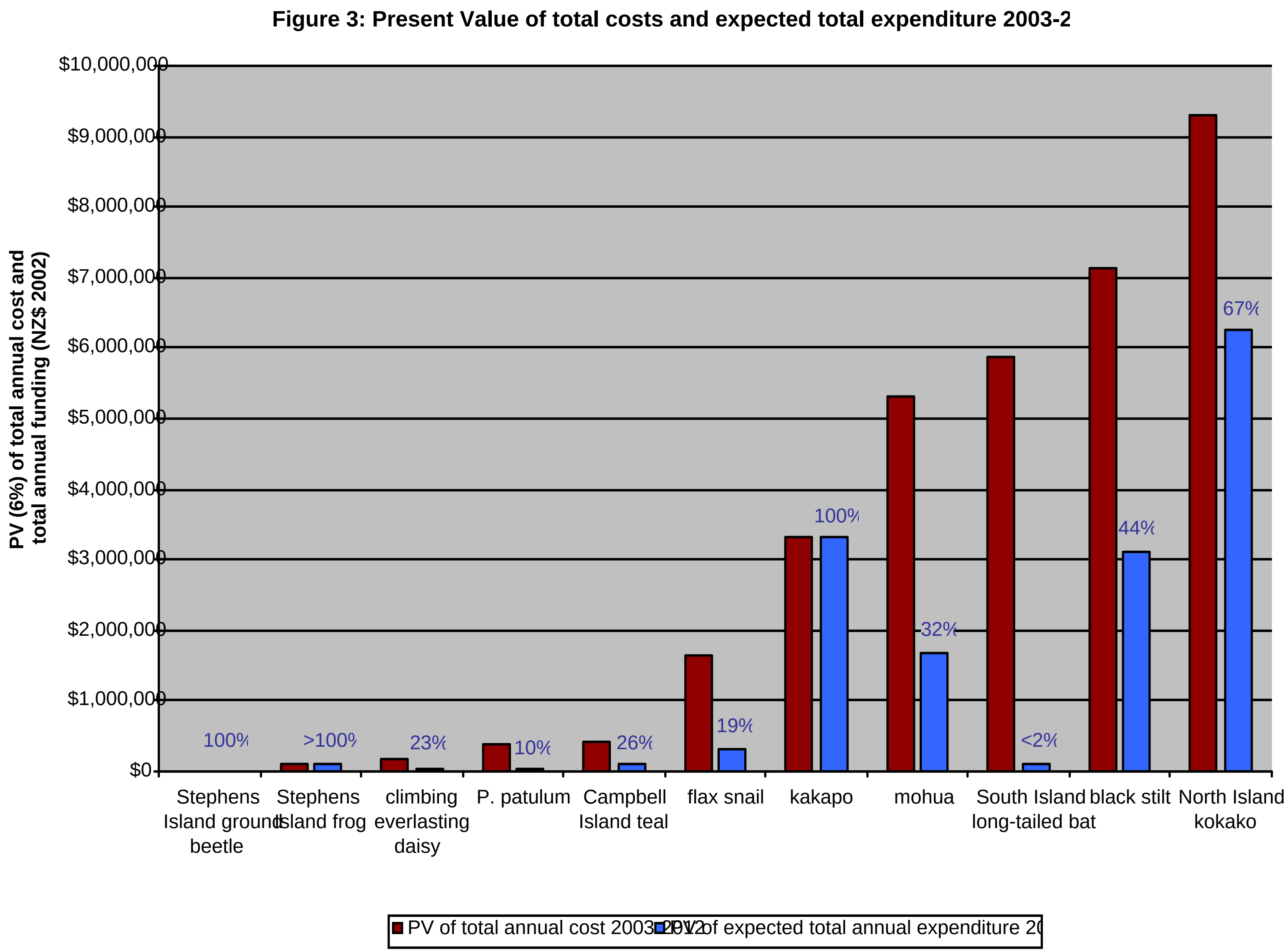
Selected eleven species & sought information on:

- Expected costs of management of each species to achieve the set of objectives in their Species Recovery Plan
- Expected expenditures on each species

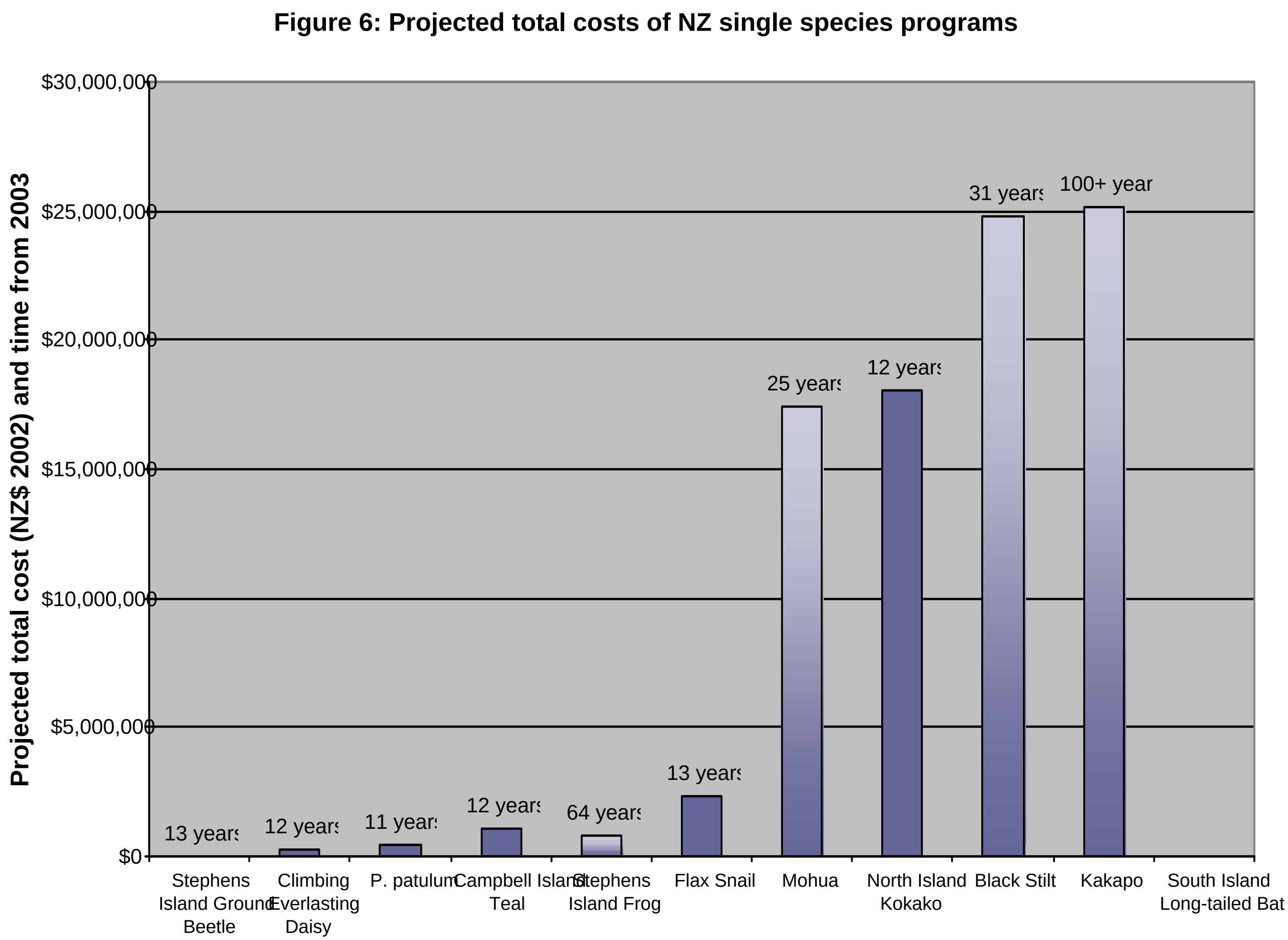
Calculated PV of total cost for each of the 11 single species programs for 2003 until 2012

The 11 programs directly represented less than 2% of the 603 NZ species classified as either ‘Nationally Vulnerable’, ‘Nationally Endangered’ or ‘Nationally Critical’ using the NZTCS.

PV of Total Costs and Expenditures 2003-2012



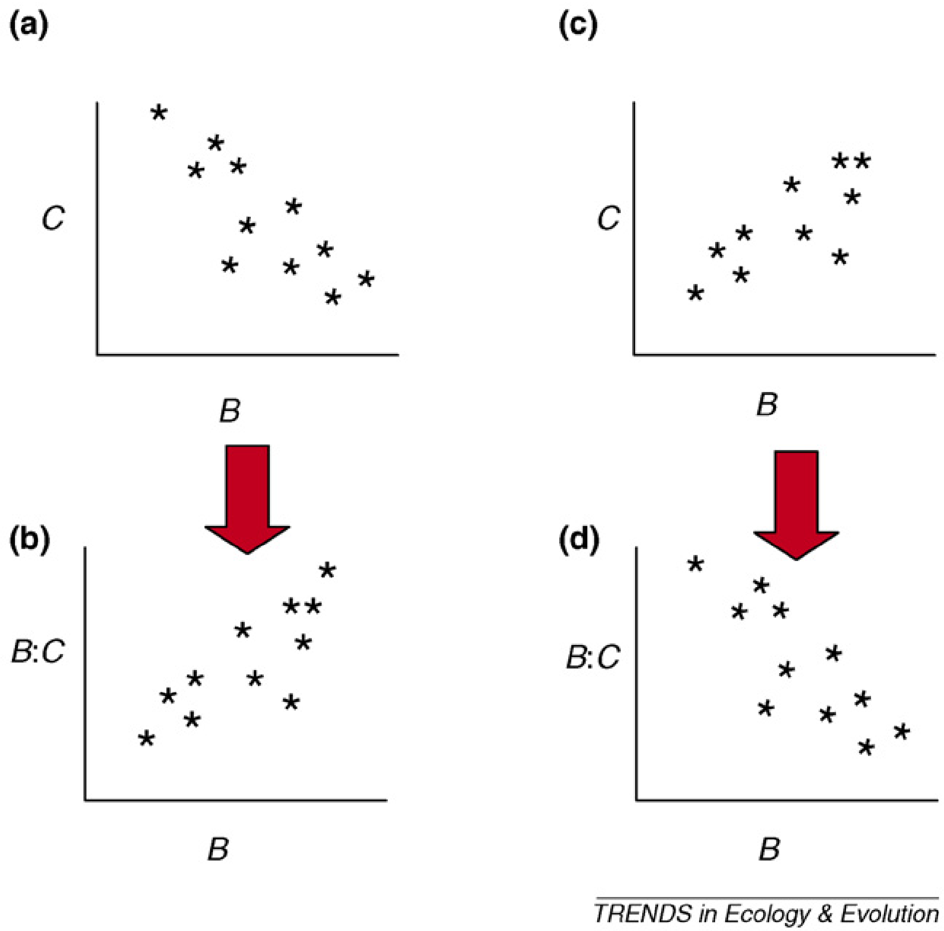
Projected total costs single species programs



Why are conservation costs important for planning?
Naidoo et al. 2006

- Conservation investments can be based on B: C
- Spatial distributions of B and C differ
- Costs of conservation projects typically vary by 2-4 orders of magnitude
- Species richness & endemism scores rarely vary by more than one order of magnitude
- Spatial correlations of B and C can differ
- Ignoring costs can lead to faulty decisions

Spatial correlation of B and C and B: C ratios Naidoo et al. 2006



Possibilities for effectiveness assessment

‘No objective independent or dependent variable’ (Abbitt and Scott, 2001)

‘No data on biological outcomes’ (Kiesecker *et al*, 2007)

‘BACIP is ideal way to test effectiveness of conservation’ (Stewart-Oaten *et al*, 1986)

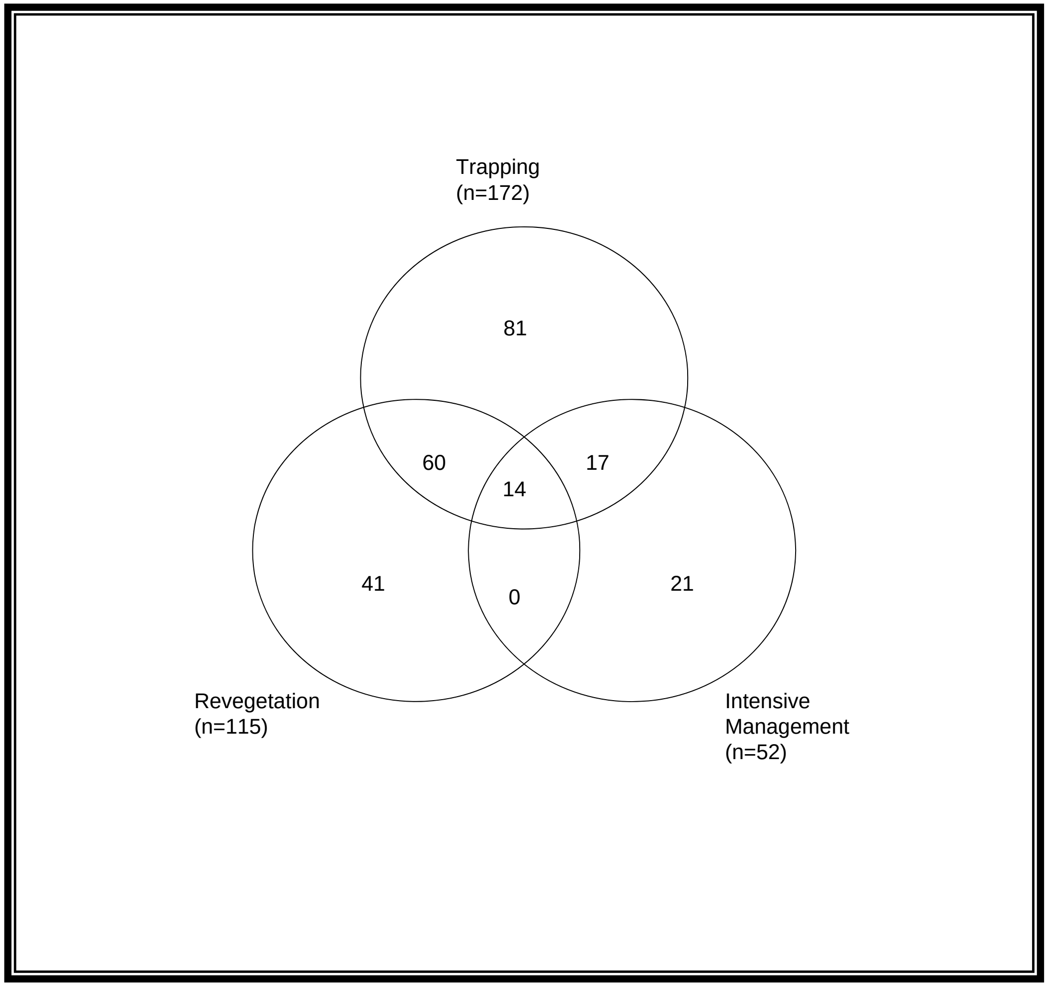
Innovative approaches to assessment needed

Panel data, regression to test treatment effectiveness
Busch and Cullen 2009

- Yellow-eyed penguin conservation program
  - Stationary, observable species
  - Nest counts across 48 sites, 15 years
  - Three conservation measures used at different sites at different times:
    - Trapping
    - Revegetation
    - Intensive Management

Photo credit: DOC

Number of site-years receiving each combination of treatments



What works?

Econometric analysis of panel data

$$\ln \lambda_{it} = \beta_0 + X'_{it}\,\beta_1 + \beta_2 \ln \delta_{it-1} + \beta_3 y_t + \varepsilon_{it}$$

- $\lambda_{it}=n_t/n_{t-1}$ – change in nests at site *i* between year *t-1* and year *t*
- X – conservation measures taken
- δ – nest density
- y – year dummy

Assumption: use of a particular conservation measure is exogenous to intrinsic probability of its success; $E(X_{it}\varepsilon_{it})=0$.

- Nest density and IM significant (columns b-h)
- Test three year lags (column d)
- YEP are predated by Hooker's sealion at 2 sites (column e)
- Fire negatively impacted YEP 1 site year (column f)
- Site characteristics, interactions, etc

Panel data regression

	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
Observations	519	506	506	506	506	506	506	506	506
Intercept	0.0007 (0.07)	0.02013* (1.89)	0.0478 (1.51)	0.0516* (1.65)	0.0475 (1.50)	0.0837 (1.43)	0.0471 (1.48)	0.0485 (1.30)	0.1476*** (3.91)
Trapping	0.0091 (0.50)	0.0096 (0.54)	0.0151 (0.89)	-0.0055 (-0.31)	0.0116 (0.68)	0.0134 (0.68)	0.0027 (0.13)	0.0225 (1.15)	0.0013 (0.04)
Revegetation	-0.0140 (-0.69)	-0.0041 (-0.21)	-0.0107 (-0.57)	0.0164 (0.82)	-0.0050 (-0.26)	-0.0061 (-0.30)	-0.0039 (-0.14)	-0.0135 (-0.65)	-0.0047 (-0.12)
Intensive management	0.0185 (0.69)	0.0582** (2.13)	0.0523** (2.03)	0.0478* (1.72)	0.0847*** (2.64)	0.0828** (2.46)	0.0361 (0.76)	0.0741** (2.22)	0.0807 (0.79)
Log density	no	-0.1104*** (-5.12)	-0.0998*** (-4.82)	-0.1002*** (-4.84)	-0.1009*** (-4.89)	-0.1211*** (-5.25)	-0.1022*** (-4.86)	-0.1055*** (-4.99)	-0.5376*** (-12.93)
Year dummies	no	no	yes	yes	yes	yes	yes	yes	yes
Three year lag	no	no	no	yes	no	no	no	no	no
Sea lion	-	-	-	-	-0.0813* (-1.69)	-0.0867* (-1.68)	-0.0335 (-0.567)	-	-0.0944 (-1.46)
Fire	-	-	-	-	-	-0.4391** (-2.59)	-	-	-

Cost Effectiveness

- Only IM is effective, but cost per additional nest obtained via IM is useful
- Average cost-effectiveness of each recovery treatment computed
- Need to know:
  - Actual nest #'s
  - Counterfactual nest #'s
  - Cost of conservation measures (variable cost used)

$\hat{N}_{2006}$ $\hat{\beta}$

Average cost of providing additional nest

	(a)			(b)		
Prediction Model	3©—Without Sea Lion			3(f)—Including Sea Lion		
Actual nests, N_{2006}	462.5			462.4		
Coefficient of treatment magnitude						
Intensive Management						
Counterfactual nests,	461.0	424.3	403.4	443.8	409.5	392.0
Nests gained from treatment (total)	1.5	38.2	59.1	18.6	52.9	70.4
Site-years receiving treatment		57			57	
Nests gained from treatment per site-year	0.03	0.67	1.04	0.33	0.93	1.24
Total replacement cost of treatment (NZ$)		$2,619,350			$2,619,350	
Average cost of treatment per site-year (NZ$)		$45,954			$45,954	
Nests gained from treatment per NZ$100,000	0.06	1.46	2.26	0.71	2.02	2.69
Average cost per additional nest (NZ$)	$1,746,233	$68,569	$44,321	$140,827	$49,516	$37,207

Comments

Intensive Management is effective,
- – 5.4% average increase in growth rate
- – $68,000 per additional nest

Comparison to other CEA results:
- – Cost/additional *kokako* pair $31,898 (Cullen *et al*. 2005)

Monitoring biological output is essential

Need to keep track of costs

Project Evaluation

"Few well designed empirical analyses assess even the most common biodiversity conservation measures" (Millennium Ecosystem Assessment, 2005)

"If any progress is to be made in stemming the global decline of biodiversity, the field of conservation policy must adopt state-of-the-art program evaluation methods to determine what works and when." (Ferraro & Pattanayak, 2006)

"Fenced sanctuaries warrant careful evaluation" (Scofield and Cullen, 2011)

Cost Effectiveness of projects

Cullen et al. 2001, 2005; Laycock et al 2011

Need a technique to determine which projects provide the best payoff from resources invested

Projects vary in duration, species face differing threats, and recover at differing rates

Need a measure of output that can capture these variations in output across the species

Cost Utility Analysis measures the status of a species '*with management*' to a counterfactual - its status '*without management*'

Cost Utility Analysis

Can we compare a species status, to what would have happened if there was no species management?

Expert assessment required

Quantify the gain from management

$$COPYi = \sum_t (Si_{tw} - Si_{tw/o})$$

Si_{tw} is species' i conservation status in year t with management

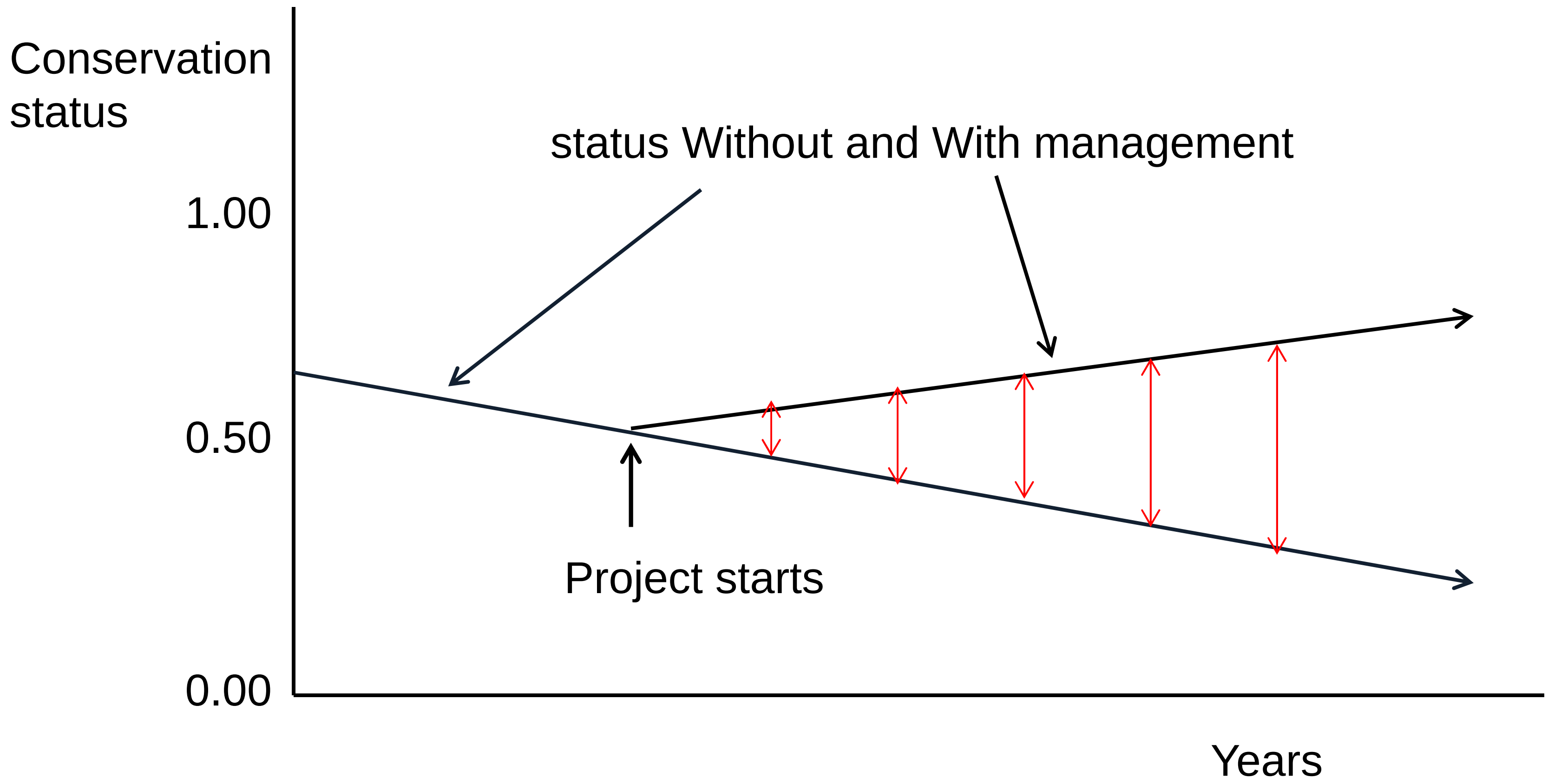
$Si_{tw/o}$ is species i conservation status in year t without management

Measure the cost of management

Calculate amount of conservation gain per $ cost

Data from project and species managers

Cost Utility Analysis



Species Risk Classifications and scores

Threat category	**Range on continuum**
Not Threatened (NT)	0.99 to 1.00
At Risk – Sparse (S)	0.95 - 0.98
At Risk – Range Restricted (RR)	0.87 - 0.94
Chronically Threatened – Gradual Decline (GD)	0.76 -0.86
Chronically Threatened – Serious Decline (SD)	0.62 - 0.75
Acutely Threatened – Nationally Vulnerable (NV)	0.45- 0.61
Acutely Threatened–Nationally Endangered (NE)	0.24-0.44
Acutely Threatened – Nationally Critical (NC)	0.01 - 0.23
Extinct (E)	0.00

Productivity of single species recovery programmes

Species recovery programme	Present value of total cost d = 6%	Present value of COPY produced d=6%	Present Value cost per present value of COPY*
Brothers Island tuatara *Sphenodon guntheri*	13,694	0.33	40,780
Cook Strait tuatara *Sphenodon punctatus*	13,694	0.18	76,457
Campbell Island teal *Anas anas nesietis*	39,940	0.39	103,178
Short tailed bat *Mystacina tuberculata*	318,938	1.73	184,570
Yellow-eyed penguin *Megadyptes anipodes*	603,013	1.97	305,344
Hector's dolphin *Cephalorynchus hectori*	773,844	0.74	1,048,245
Black stilt *Himantopus novaezelandiae*	2,441,822	2.26	1,077,724
Takahe *Porphyrio hochstetteri*	3,278,178	1.41	2,327,560
Mean	935,390	1.23	645,482

Comparison across multiple species projects

NZ manages some species on Offshore Islands and some on Mainland Habitat Islands.

Compare cost / COPY of the multi species projects to see which are performing best.

Multi species projects are potentially lower cost way of managing species than are single species projects.

Economies of scope - *lower cost per species if managed in a multi species project than if managed in series of single species project*.

Measure number of COPY for each species and calculate total output for each multi species project.

Comparison of six multiple species projects

Project and location	Area (ha)	Present value of costs r = 6%	Annualized cost per ha	Present value of COPY* produced	Present value cost per present value of COPY*
Offshore islands					
Little Barrier Island	2,817	$780,345	$28.52	1.83	$427,385
Tiritiri Matangi	218	$1,547,381	$730.84	0.08	$19,516,305
Maud Island	320	$2,162,521	$695.80	1.54	$904,821
Mean offshore island	1118.3	$1,496,749	$485.06	1.15	$6,949,504
Mainland habitat islands					
Rotoiti	825	$1,408,457	$347.18	0.00	undefined
Hurunui	12,000	$863,498	$25.78	1.04	$828,510
River Recovery	11,000	$3,966,070	$45.22	0.28	$14,111,199
Mean mainland island	7941.7	$2,079,342	$139.56	0.44	$7,469855

Evaluation of multiple species projects

Only six observations, and variation in outputs

Some MHI and some Offshore Islands seem very high cost way of managing species

MHI seem at least as costly as Offshore Islands

Compare Multiple to Single species projects, no sign of economies of scope. Mean $/COPY is 10x larger!

Multi species projects may be less productive than are single species projects because less is known about how to manage many of the species

Summary

To maximize conservation gain within budgets, need to consider costs, and evaluate projects

Need to use techniques that provide the most useful information for decision makers

Costs vary greatly between projects

Effectiveness needs to be carefully assessed

Cost Effectiveness Analysis and Cost Utility Analysis are low cost, readily usable, can provide useful information for decision makers

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