An overview of prioritisation and evaluation approaches for biodiversity projects

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The Challenge in New Zealand...

33 documented extinctions in 100 years (including 16 birds, 9 terrestrial invertebrates, 6 vascular plants)

About 2000 threatened species and 3000 data deficient out of 90,000 indigenous species

Dep't of Conservation budget to improve status of threatened species NZ$32 million / year, 2006.

Joseph, Maloney, Possingham, 2008

In Australia

Between 600,000 and 700,000 species

20 mammal, 20 bird, 76 plant species have become extinct since European settlement

77 species of vertebrate animals & 236 species of vascular plants are endangered (likely to become extinct if present threats continue),

66 species of vertebrates and 652 species of vascular plants are vulnerable

http://www.environment.gov.au/biodiversity/strategy/index.html

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Beyond opportunism

The need for biodiversity conservation has been recognised for at least 25 years

Conserving biodiversity is a big challenge

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

Opportunism may explain many reserve choices, but the case for systematic approaches to <u>prioritisation</u> is at least 20 years old

More recently, concern with <u>evaluation</u> of projects

Key questions in Project Prioritisation

- What Objective Function to pursue?
- Which Variables in the Objective Function?
- What are the Constraints to actions?
- What Method used to select projects to pursue the Objective Function
- What Data types and Sources to use
- What are the Strengths and Limitations of each prioritisation approach?

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Foci

- Reserves, and reserve selection
- Species, and ranking species for the Ark
- Projects to manage species
- Ecological functioning and ranking species for the Ark

Reserves

Are the unit of choice for *in situ* protection

Goal – '*separate elements of biodiversity from processes that threaten their existence in the wild*' Margules and Pressey 2000

- Select reserves based on their characteristics, including complementarity of sites
- Data from biophysical databases, and use of surrogates to represent biodiversity

A four stage process – Sarkar *et al,* 2002

1. *Surrogates* are selected to represent the conservation *target* - species, vegetation type, ecosystem type, environmental parameters...
2. Using lists of the surrogates, places are *ordered* according to their biodiversity *content*
3. For each place, the *projected futures* of the surrogates - populations, species - is estimated and places are reordered based on their *biodiversity value*
4. Devise *management practices* for each place 'starting with highest valued places'

Where *and how* to manage - Zonation

Multiple actions are possible at sites, $ are limited, and actions are costly

Need to determine where and what actions to apply to maximize conservation benefits

Algorithm with benefit functions (effects of actions on species) needed to identify most beneficial actions at each site, given a cost constraint - spatial prioritization.

Biophysical, socio-econ data incl. expert opinion

Decision support - Marxan

Decision support to assist with the evaluation of existing marine & terrestrial reserve systems to identify gaps in biodiversity protection,

Identify areas to include in new reserve systems

Produce a number of different options that meet both socio-economic and conservation objectives

Includes data on ecological processes, threats, and condition

Use of Marxan

- Identify areas that efficiently meet targets for a range of biodiversity features for minimal cost
- Use the principle of complementarity to select planning units which complement the conservation area network
- Meet spatial requirements such as compactness of a reserve system
- Identify tradeoffs between conservation and socio-economic objectives
- Generate a number of 'very good' solutions

Species ranking

Metrick and Weitzman 1998 - we can rank projects to achieve highest payoff /$ available

$R_i = [D_i + U_i] \times (\Delta P_i / C_i)$

- D_i – distinctiveness
- U_i - utility
- P_i - Present value of change in conservation status
- C_i - Present value of costs

Allocate budget $ on highest ranked projects – fill the Ark

Ranking species for the Ark

Rank species or projects via cost efficiency metric

$$R_i = \frac{W_i \times \Delta P_i}{C_i}$$

Metrick & Weitzman

+ Include likelihood of project success - Project Efficiency

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

Joseph et al, 2009

W- species weights, B - biodiversity benefits, S probability of success

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Project Prioritisation Protocol *Joseph et al, 2009*

1. Define objectives
2. List biodiversity assets (threatened species)
3. Weight assets
4. List management projects
5. Calculate cost of each project
6. Predict benefits to species of each project
7. Estimate likelihood of success
8. State constraints
9. Combine info on costs, values, benefits, likelihood of success, rank projects on benefits/$, choose

Application of PPP

Systematic, transparent, and repeatable method for prioritizing actions to minimize the number of extinctions.

DoC assessed management projects & generated rank-ordered list for senior managers in resource allocation for > 2000 projects

<1.5 years, 105 experts consulted

'By incorporating, management costs, benefits, likelihood of success, ROI substantially improved.'

'Number of species managed and expected overall benefit to threatened species is remarkably improved.'

Allows merit ranking of projects, gain from new projects

Priority Threat Management, *Kimberley*

Alarming declines, diverse threats, losses forecast

How to select appropriate investment response?

- Focus on *actions* (fires, weeds, predators,...)
- Estimate costs of actions
- Feasibility of actions
- Probabilistic outcomes

Existing databases + Experts judgment

Expected outcomes /$ each region - cost effectiveness

Perry 2010, *Functional diversity*

Species are units but new Objective Function

Rank species by their contributions to *ecological functioning*

Noah's Ark is filled with most useful species to ensure functional ecosystem rather than an optimal zoo.

The cost of saving species and the impact of each $ spent determine their importance

Reformulate law, target *ecological interactions*

Focus on *Ecosystem Services*

Investment Framework for Environmental Resources INFFER Pannell et al. 2012

Based on BCA principles, streamlined, simplified

Provides structured means to identify projects with highest Benefit : Cost ratios

$$BCR = \frac{VPPB \times A \times (1-RF) \times DF}{TPVEPC}$$

VPPB - $ value of benefits

A - proportion of project work expected to be achieved

DF - discount factor

TPVEPC - total PV of expected project costs

INFFER

Includes assessment of *effectiveness* of on-ground actions

Includes assessment of *adoptability* of project work and actions

Can compare *relative* merit of projects via B : C

Assumptions: linearity of effects, time lags, level of future B and C,

Need large investment in skill, time, resources,

Potential for use in biodiversity prioritisation

Species Prioritisation - Summary

Need for prioritisation is generally accepted

3 Phases - Places, Actions, Projects

Spatial prioritization widely used

Cost effectiveness measures used in some countries

B : C ratios – INFFER – powerful efficiency test

Adoption of tools - relies on support by decision-makers / funders

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Project Evaluation

Many evaluation possibilities, but…

"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)

Knowing which conservation actions are effective and cost-effective enables us to steer resources toward effective uses, and may attract new resources.

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

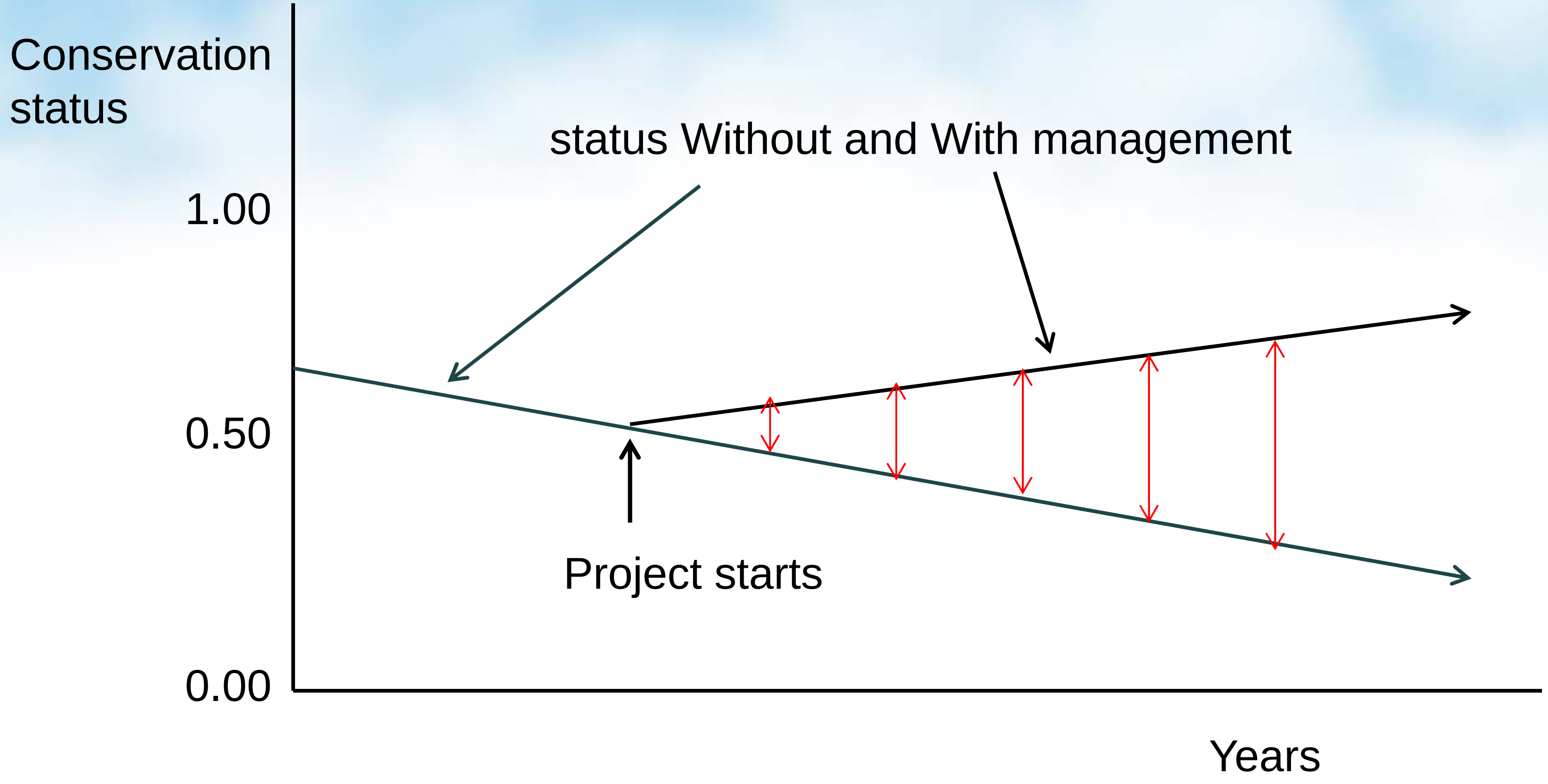
Si_{tw} is species' i conservation status in year t with management

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

Measure the cost of management

Calculate amount of conservation gain per $ cost

Cost Utility Analysis



Treatment effectiveness – Panel data Regression

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

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

Results - Intensive management is effective,

- 5.4% average increase in growth rate
- $68,000 per additional nest

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Summary

To maximize gain from biodiversity investments, within a budget, need systematic prioritisation of actions

Predicting impacts of actions is essential, tricky, but increasingly completed

To determine if investments have been effective need to assess payoff from biodiversity actions

Data availability a challenge

Cost effectiveness measures provide useful information for decision makers

Demonstrated benefits from rigorous evaluations will encourage adoption of tools

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