

Cost-Benefit Analysis & Cost-Effectiveness Analysis

Review

Recent CBA work

by Landcare Research

- CBA of flood-prevention measures in Sierra Leone
- CBA of organic certification for kava in Fiji
- CBA of controlling invasive *Acacia nilotica* in the Seychelles and Comoros Islands
- CBA of managing wilding conifers in New Zealand
- CBA of managing kiwi populations by community groups in New Zealand
- CBA of biocontrol for emergent pastoral weeds in New Zealand



Economics and IAS

- Managing IAS has traditionally been seen as the responsibility of biologists
- But the problem of invasive species is fundamentally economic
 - Most invasions can be linked to the intended or unintended consequences of economic activities
 - A major reason that IAS are considered a problem by human beings is because they ultimately impact economic systems and undermine human wellbeing



Economics and IAS

- Economics deals with more than just understanding the costs of IAS
 - Analyses causes
 - Links human behaviour and natural processes
 - Helps to identify solutions
- Economics represents *an approach* to analysing invasive species management



Economics and IAS

- Despite growing recognition by the scientific community of the need for economics, the application of economic approaches and tools to invasives remains a recent innovation
- Most literature deals with the economic costs of biological invasions, with case studies carried out in North America and Europe



Economics and IAS

- It is now widely acknowledged that economic analysis and the use of economic instruments are key to dealing with the problems associated with biological invasions
- Yet, there remains little guidance as to how economic approaches and tools should be applied in practice
- This course presents some practical methods and tools for economic analysis



Roles of Economic Analysis

- To determine proper resource allocation with a constrained budget → to set priorities
- To rule out projects in which the costs exceed the benefits → to avoid intervening when it's not worth it



Roles of Economic Analysis

- To avoid investing in a solution before identifying the problem and all possible remedies → to avoid ad-hoc solutions
- To identify priorities across multiple projects → to spend stakeholder money wisely
- NOTE: Decisions are typically not made solely on the basis of economic analyses, but they can be a useful tool to aid the decision-making process

Benefits of Economic Analysis in Decision-making

- Objectivity
 - Takes a community-wide or multi-stakeholder perspective
- Inclusiveness
 - Allows the consideration of a range of policy options and stakeholders

Benefits of Economic Analysis in Decision-making

- Emphasises efficiency
 - Determines which policy maximises net benefits to the affected area/parties
- Transparency and accountability
 - Allows benefits and costs to be compared over time
 - Can account for risk and uncertainty of options and estimates



Common Approaches

- Cost-benefit analysis (CBA)
 - Shows which options should be considered
 - Determines which option maximizes
 - total benefit
 - benefit per dollar of cost
- Cost-effectiveness analysis (CEA)
 - Identifies which option yields the “cheapest” way of achieving an objective/outcome
 - Often used when data on key benefits of a project are difficult to measure



Typical benefits

- Avoided costs - the value of inputs or lost outputs which would have been incurred in the absence of an intervention
 - Avoided infrastructure damage
- Productivity savings - reductions in existing levels of input expenditure which can be shown to result from the project
 - Higher agricultural productivity



Typical benefits

- Positive health and social impacts resulting from the project
 - Increased leisure time
 - Preserved traditional ecological knowledge
- Positive environmental impacts resulting from the project
 - Natural food harvesting
 - Protected biodiversity



Typical costs

- Research, design, and development costs
- Capital expenditures
 - Machinery
 - Control agents
- Labour costs
- Operating and maintenance costs for the entire expected economic life of the project
- Lost benefits associated with controlling the IAS
 - Consumption for food
 - Building materials



Complications

- Biological growth
- Discounting
- Uncertainty/Sensitivity
- Distribution

Steps in conducting a CBA

1. Determine the objectives of the Cost-Benefit Analysis



2. Identify costs and benefits



3. Value costs and benefits



4. Aggregate costs and benefits



5. Perform sensitivity analysis



6. Consider distributional impacts



7. Prepare recommendations



Rodent control on Conabio Island

- Mice are an emergent threat on Conabio Island, which is rich in biodiversity. The island has a small population of fishermen that dry fish for sale to the mainland. Mice sometimes eat the dried fish, causing income losses for islanders. Mice are also known to carry disease, and islanders sometimes get sick due to eating other food that has been contaminated by mice.
- The government is interested in controlling mice on Conabio Island to protect livelihoods as well as biodiversity, but it has many other budgetary priorities.
- You are an expert who has been tasked with developing a CBA of rodent control on Conabio Island over the next 20 years. Assume that the discount rate is 9%.



1. Determine the objectives of the CBA





Possible methods of control

- There are three possible approaches to management
 - laying traps by hand
 - spreading poison by hand
 - novel biocontrol programme

2. Identify costs and benefits

Benefits

-
-
-
-

Costs

-
-
-
-

Which are capital costs?
Which are annual costs?



3. Value benefits of control

- With the current population of mice:
 - 0.05 endemic bird species are expected to go extinct annually
 - 15 islanders go to the hospital each year, on average, due to eating contaminated food
 - 25 tonnes of dried fish are spoiled annually
- Your research shows that:
 - According to benefits transfer analysis, Mexicans value each bird species at \$1,000,000
 - The average cost of a hospital visit is \$300
 - The wholesale price of dried fish is \$1750 per tonne



3. Value costs of control

- Trapping:
 - 1500 traps (\$350/trap)
 - 200 person days of labour/year to set/check traps (\$100/day)
 - 30 days of labour/year for management/monitoring (\$250/day)
- Poison:
 - 20 sets of protective clothing (\$40/set)
 - 8000 KGs of poison/year (\$10/kg)
 - 150 person days of labour/year to spread poison (\$100/day)
 - 30 days of labour/year for management/monitoring (\$250/day)
- Novel biocontrol:
 - 1 biological agent (\$200,000/agent)
 - 50 person days of labour/year to release the agent (\$100/day)
 - 30 days for management/monitoring (\$250/day)



4. Aggregate costs and benefits

What information is missing?

- Biological properties:

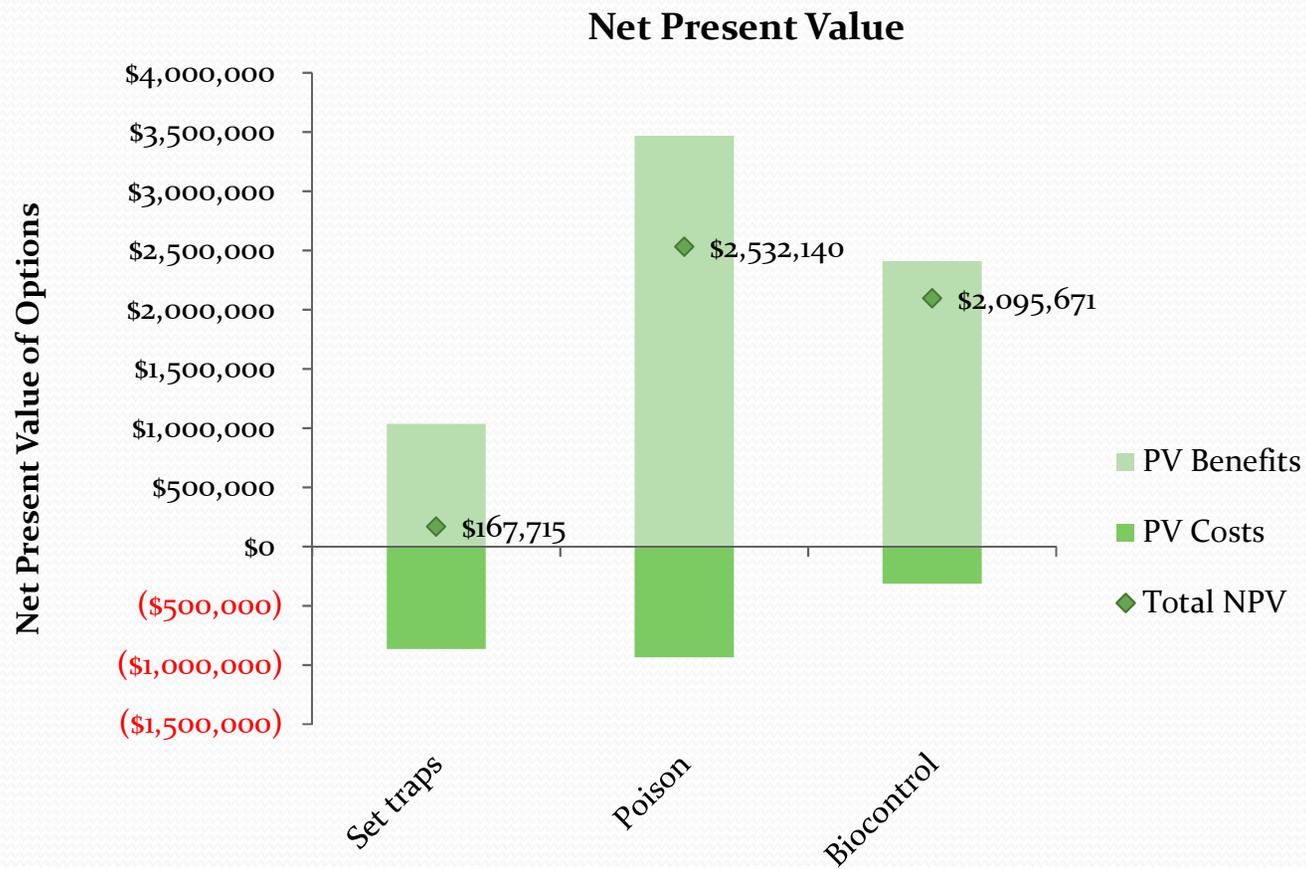
$$g(N) = bN_o [1-(N_o/N_{max})]$$

- Current population estimated at 10% of carrying capacity
- Intrinsic growth rate estimated to be 0.4
- Effectiveness of control
 - Trapping: $b=0.29$
 - Poison: $b = 0.09$
 - Novel biocontrol: $b=0.17$

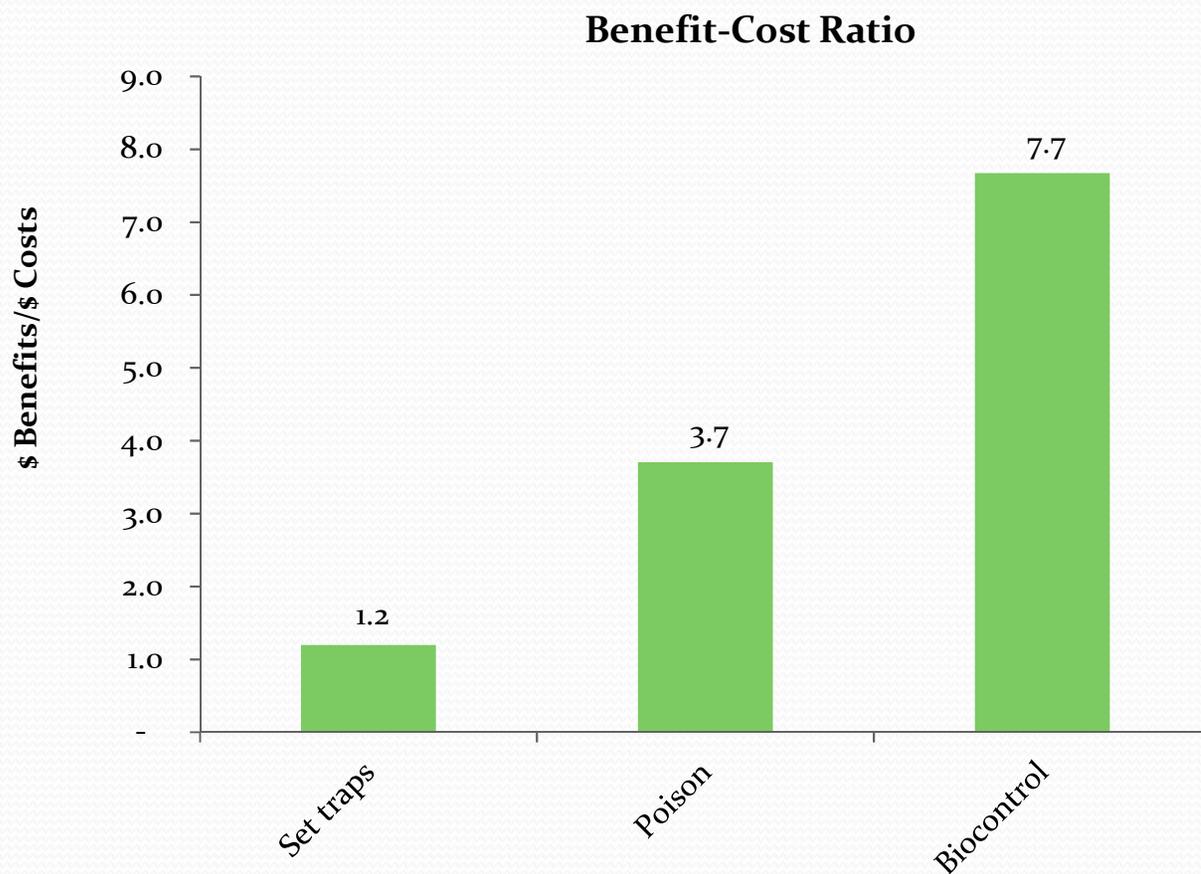


7. Prepare recommendations

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Cost-Effectiveness Analysis

- As an ecologist, you estimate that management will save the following number of species from extinction:
 - Trapping: save 1 bird species
 - Poison: save 4 bird species
 - Novel biocontrol: save 3 bird species

7. Prepare recommendations

Summary of Cost-effectiveness Analysis for Invasive Species Management

Option	Cost Effective Metric Measured (unit)	Cost Effectiveness (\$/unit measured)	Rank of Option based on Cost Effectiveness
Do Nothing	0.0	n/a	n/a
Set traps	1.0	\$867,320	3
Poison	4.0	\$234,119	2
Biocontrol	3.0	\$104,702	1