The Highs and the Lows: an Overall Economic Analysis of Classical Weed Biocontrol in New Zealand

Manaaki Whenua
Landcare Research

Simon Fowler, Ronny Groenteman, Quentin Paynter
Manaaki Whenua - Landcare Research, New Zealand

Classical weed biocontrol

- Classical biological control can be a highly successful, nature-based solution for the management of exotic invasive weeds
- Selected natural enemies (insects/plant pathogens), are extensively safety testing, and then reunited with their host plant in the country or region where the plant has become an invasive exotic weed
- Successes can be hugely beneficial, providing ongoing benefits without any further investment

Case study: biocontrol of heather in New Zealand

- Heather, *Calluna vulgaris*, is a valued native in Europe but invasive in New Zealand
- Heather beetle: native pest of heather in Europe; successful introduced biocontrol agent in NZ

Grey = dead heather; native plants recovering

Classical weed biocontrol – economic caveats

- CAVEAT 1: Upfront investment high (NZ$0.8-2m, spread over 5-20 years, per weed target)
- CAVEAT 2: Level of weed suppression uncertain in advance (historically, approx. 50% of targets successfully controlled)
- Justifying long-term investment, especially with uncertainty of success, emphasises the need for overall economic analyses

New Zealand weed biocontrol

- One of the 'top 5' countries practising weed biocontrol worldwide*
- Notable economic studies on the successful biocontrol of the pasture weeds, ragwort and St John's wort
- Very high benefit:cost ratios - ragwort 860:1 , SJW 6254:1**
- Large ongoing annual benefits: for 2022 these were $41.2m/year for ragwort; $15.5m for SJW**
- Huge successes against these major weeds – but what of programmes that were less successful or failed to exert any impact on their target weeds?
- To avoid "cherry picking", we need an overall economic analysis of all weed biocontrol in NZ

*Schwarzländer et al 2018. BioControl 63, 319-331

**updated from Fowler et al. 2016. NZ J. Agric. Res. 59, 205-215; Fowler et al. 2023 NZ J. Agric. Res. (online)

Overall economic analysis of NZ weed biocontrol* – five steps

1/ Take all successful weed biocontrol programmes and determine the benefit per weed species (the economic difference between scenarios with, and without, biocontrol)

2/Sum these benefits across weed species avoiding "*double-counting*" of benefits (more later)

3/ Assess the total investment in classical biological control programmes in NZ, including all unsuccessful projects/agents

4/ Bring all costs/benefits forward to give "present values"

5/ Calculate the overall benefit-cost ratio for classical weed biocontrol in NZ

*Fowler, SV, Groenteman, R, Paynter, Q. 2023. The highs and the lows: a cost benefit analysis of classical weed biocontrol in New Zealand. BioControl DOI: 10.1007/s10526-023-10225-2

Economic benefits of weed biocontrol in NZ

- First, we asked which weed biocontrol programmes in NZ have, historically, produced measurable benefits?
- Used independent reviews to shortlist 6 programmes
- This process excluded NZ weed biocontrol programmes where impacts were too low, or were too recent to assess reliably
- Excluded programmes included several incipient successes (that will need future evaluation)
- Biocontrol looking promising: buddleia, Californian thistle, Scotch broom, Scotch thistle and tradescantia

Six evaluated weed biocontrol programmes in NZ

Ragwort, *Jacobaea vulgaris*

St John's Wort, *Hypericum perforatum*

Nodding thistle, *Carduus nutans*

Alligator weed, *Alternanthera philoxeroides*

Mist flower, *Ageratina riparia*

Heather, *Calluna vulgaris*

Benefits of the six historically successful weed biocontrol programmes in NZ

Weed	Cost assessed (adjusted to 2022)	Annual cost without biocontrol	Annual biocontrol benefit
Ragwort	Control costs on dairy farms	$60.0m	$41.2m
St John's wort	Lost pasture productivity	$15.7m	$15.5m
Nodding thistle	Control costs in pasture	$32.2m	$28.0m
Alligator weed	Control costs in water bodies	$8.4m	$0.61m
Heather	Control costs in native ecosystems	$0.12m	$0.12m
Mistflower	Control costs in native ecosystems	$0.14m	$0.14m

- Most savings (>99%) from agricultural weeds (more later)
- Contrast these ongoing agricultural savings to the current annual NZ investment in operational weed biocontrol of $1.34m

Summing benefits – avoiding double counting

- Double-counting would occur if the successful biocontrol of one weed species, e.g., in a pasture system, then made the same pastures vulnerable to secondary invasion by another weed species, that was then also successfully biocontrolled
- We checked whether any of our 6 weeds had invaded similar habitats with sequential timing.
- Possible that dryland pastures only became vulnerable to nodding thistle invasion *because* St John's wort had previously been biologically controlled. But no data…..
- For our summing, we reduced the benefits from nodding thistle biocontrol by 100%, 50% and 0% to reflect worst to best case scenarios of secondary weed invasion

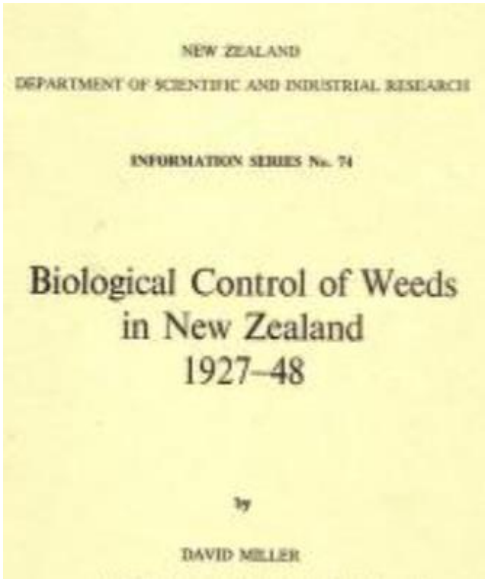
Summing annual savings from weed biocontrol

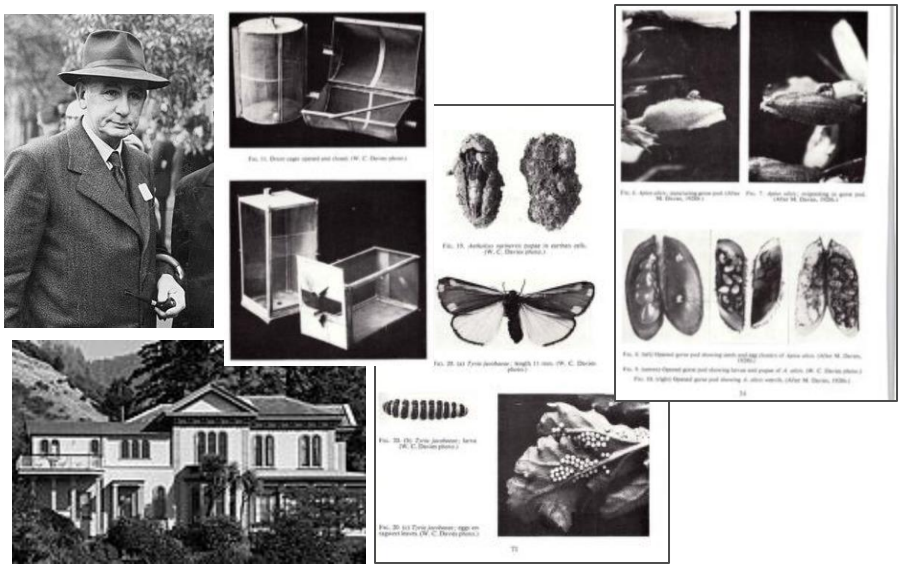
	Annual savings from weed biocontrol (NZ$m), 2022		
	Secondary weed issue: 0%	50%	100%
All weed biocontrol	85.6	71.6	57.6
Productive sector weeds	85.0	71.0	57.0
Environmental weeds	0.56	0.56	0.56

- Overall benefits remain high even when nodding thistle considered a secondary weed (following St John's wort suppression)
- Benefits from productive sector weeds massively outweigh the rather small monetary benefits from environmental weed biocontrol (nb. no secondary weed invasion issues with latter)

Investment in NZ weed biocontrol

- Total historical investment in weed biocontrol in NZ, including programs that succeeded or failed
- NZ released 69 agent species against 28 weeds since 1920s
- No $$ data, but excellent, detailed historical records of past projects





- Relatively easy to attach modern costs to these given we do the same things, then CPI-adjust back to actual $$/year

Benefit:cost ratios: present value calculations

- To compare costs/benefits over many years we convert all figures to present values
- All past costs/benefits inflated at a 'discount rate' of 4%/yr
- Sum the present value benefits from biocontrol for each year (for the 6 programmes with substantial benefits – taking secondary weed invasion into account)
- Sum the summed present value of the costs of the investment in biocontrol across – *all programmes, all years* (1920s to present)
- Overall benefit:cost ratio

Overall benefit:cost ratios for NZ weed biocontrol

- Benefit:cost ratio for all NZ weed biocontrol: 52:1 to 73:1
- For every $1 invested in weed biocontrol, NZ has seen a return of $52 to $73
- Page & Lacey (2005) figure for Australia was 23:1 , and likewise was strongly dependent on benefits to the agricultural sector
- We then split our data into weed biocontrol of agricultural v. environmental weeds:
- Agricultural weed biocontrol: B:C = 155:1 (very strong returns on investment)
- Environmental weed biocontrol: B:C = 0.88:1 (a negative return – invest $1 get $0.88 back)

Why the low monetary returns on biocontrol of environmental weeds?

- Data difficult to source - diverse range of stakeholders (e.g. mist flower, alligator weed)
- Control efforts abandoned as intractable, ineffective or side-effects too damaging (e.g. heather)
- Weeds targeted early in their spread (e.g. mist flower)
- Main issue: challenging to monetarise benefits to biodiversity, and ecosystems services – major reasons for managing these weeds

Solutions?

- Value biodiversity gain/ecosystem services – more on final slide…
- Use chemical/mechanical control costs for what complete suppression of an environmental weed *would* cost rather than actual expenditure
- For heather this was estimated as $1.77m/yr (2022 figures)
- But open to criticism that this is unrealistic
- Reduce the 4% discount rate in present value calculations (e.g. 'social discount rate' of 3%*) and embrace longer time frames
- Alternative methods e.g. multi-criteria analysis: useful for semi-quantitatively deciding between alternative strategies but it is not a benefit:cost analysis
- NZ Biosecurity Act (1993) requires cost benefit analyses in weed management strategies

*Turpie 2004. S. Afr. J. Sci. 100, 87-93

Valuing biodiversity gains

- Key research in South Africa valuing ecosystem service benefits from weed biocontrol*
- But 85% of value in South African study was weed invasion impacts on provision of water or grazing (neither relevant to most/all of NZ environmental weed biocontrol)
- In their 'Biodiversity Intactness Index', the methods relevant to NZ are contingent valuations of non-use values of biodiversity
- Contingent valuation – ask people to value biodiversity e.g. by 'willingness to pay' – but plenty of room for bias/debate**
- Ongoing research….. we would like to explore valuation of heather biocontrol in connection with recognised cultural, geological and biodiversity/ecosystem service values of Tongariro National Park

*De Lange & van Wilgen 2010. Biol. Invasions 12, 4113-4124

**Dickson, R., et al. 2005. Making economic valuation work for biodiversity conservation. *Land and Water Australia*

Thanks

Acknowledgments: All data sources used, and especially the National Biocontrol Collective and regional council staff. Funding was mainly from the Science and Innovation Group in the Ministry for Business, Innovation and Employment (MBIE: contracts C09X0210, C09X0504, C0X0905), Landcare Research core funding from MBIE, and MPI Sustainable Farming Fund and SFFF