



Manaaki Whenua
Landcare Research

Rapid Evolution: What is Entailed for Weed Biocontrol Systems?

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Rapid Evolution

- Evolution of introduced biocontrol agents & their host plants is inevitable
- Recent review¹ suggests: adaptation should be the norm in biocontrol systems
- Such evolution can be beneficial e.g., if an agent that initially performs poorly adapts to the novel environment & subsequently thrives

¹Szucs M et al 2019. Implications of rapid eco-evolutionary processes for biological control – a review. *Entomologia Experimentalis et Applicata* 167: 598-615



Rapid Evolution – The Mystery of Heather Beetle Establishment Rates

- Barely established when first released in the 1990s (1 out of 18 sites)
- Redistribution from the single established site: higher establishment (7 out of 18 sites)
- In the 2000s, populations growing exponentially around redistribution sites in Tongariro NP



Rapid Evolution – The Mystery of Heather Beetle Establishment Rates

Recent observations:

- Heather beetle populations exploding, &
- New foci popping up spontaneously in parts of the NP, including where 1990s releases failed to establish!

What is going on?



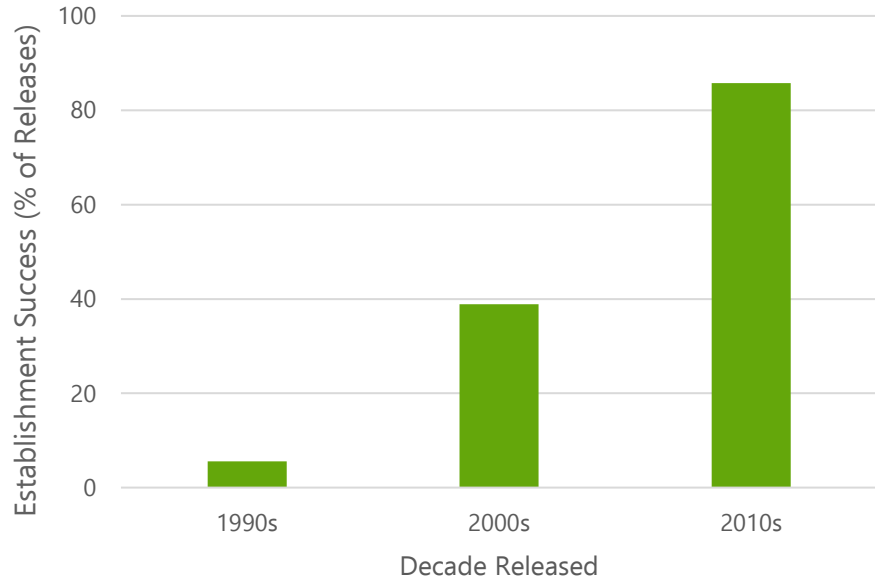


Heather Beetle Establishment Rates Through the Decades

- Experiment set up with urgency to capture establishment rates before the entire Park is covered with beetles
- 30 'releases' made in areas ahead of the beetle fronts. Risk of release points becoming swamped unavoidable by then.
- Now or never!



Heather Beetle Establishment Rates Through the Decades



	Decade establishment attempted		
	1990s	2000s	2010s
Established	1	7	12
Failed	17	11	2
% established	5.6%	38.9%	85.7%

% establishment increases:
 $\chi^2 = 21.1, P = 0.00026$

What is driving this dramatic change???

Heather Beetle Establishment Rates –

Alternative Hypotheses

It may be too early for molecular tools to tell us if the higher establishment rates we see are the result of rapid evolution

But!

We could start by eliminating other alternatives



Heather Beetle Establishment Rates –

Three Alternative Hypotheses

- Purely environmental change
- Purely numbers game:
the population has increased enough
- Numbers increase, combined with beetles have adapted to overcome something that was a barrier in the 1990s



Heather Beetle Establishment Rates –

Alternative Hypotheses

- Climate: Data loggers
- Plant nutrition: Nitrogen level
- Pure numbers game
- Body size, fat reserves, low frost tolerance
- Behavioural adaptation to frost





Rapid Evolution – What does this Mean for Biocontrol?

- Helps understand why agents fail – failure due to lack of adaptation
- If adaptation should be the norm in biocontrol systems, then...
- Can we change release strategies to drive faster adaptation???



Rapid Evolution – What does this Mean for Biocontrol?

- We can manage the sources of release differently:
- Avoid mixing release sources to stop **out**breeding depression
- Keep release sites far apart to avoid mixing populations
- Avoid swamping a single site with repeated large releases

Rapid Evolution –

- Continue to study the heather system in detail
- Nodding thistle: Has it adapted to flower at a smaller size in response to pressure from biocontrol agents?

Watch this space

Next Steps



Rapid Evolution – the Stakes are High

for Weed Biocontrol

- Evolution of introduced biocontrol agents & their host plants is inevitable
- We are only beginning to appreciate the potential importance for weed biocontrol in New Zealand
- Consequence of rapid evolution can be significant for environmental safety as well for effectiveness of weed biocontrol – an area of future research growth