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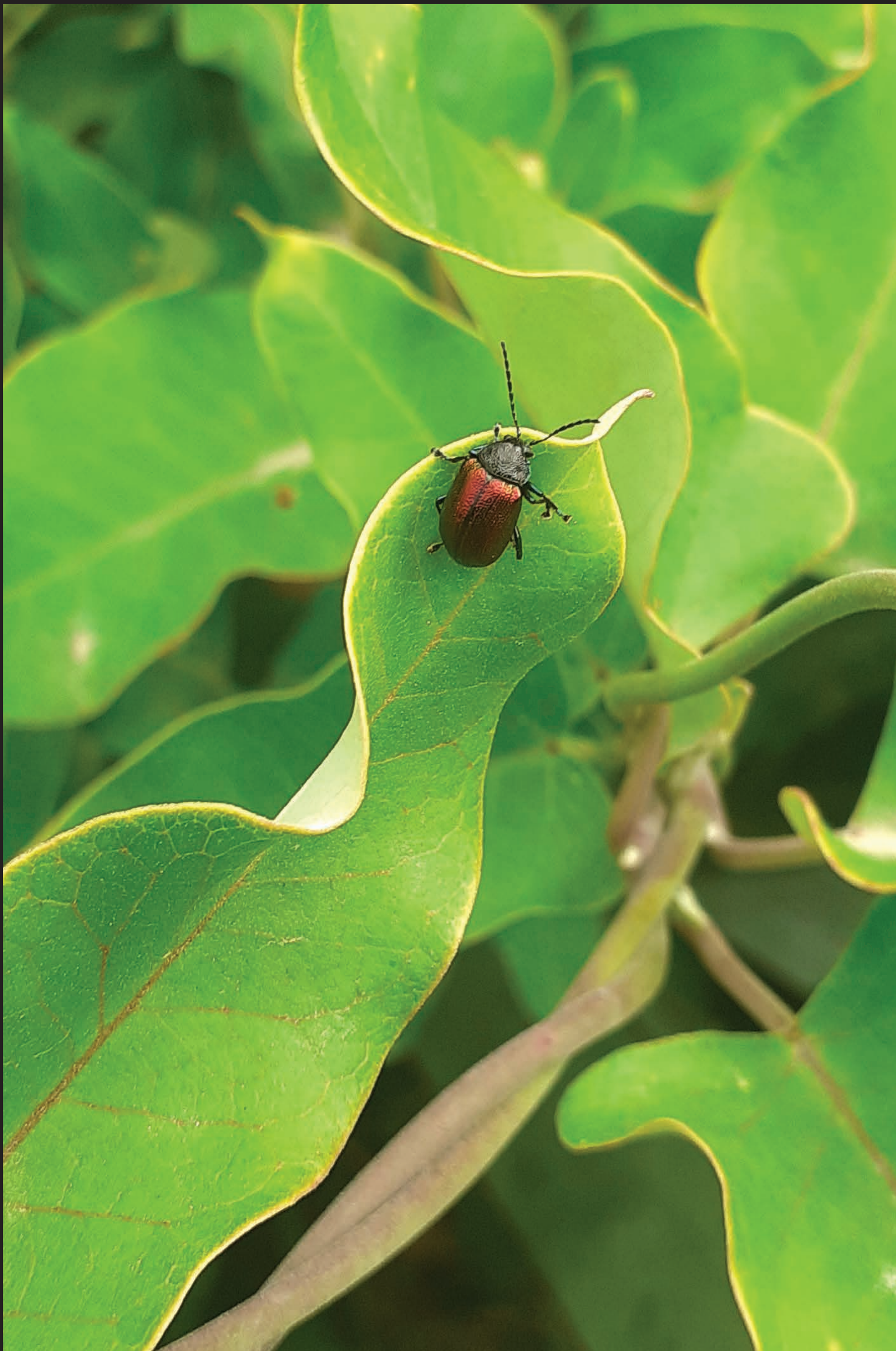
Manaaki Whenua
Landcare Research

Weed Biocontrol

WHAT'S NEW?



Contents

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Farewell to Lindsay Smith and Chris Winks

It is with great sadness that we bid farewell to two of our talented and dedicated weed biocontrol technicians, Lindsay Smith and Chris Winks, who are retiring at the end of February and March, respectively. They have both had long careers at Manaaki Whenua – Landcare Research (MWLR) and its predecessors, making a significant contribution to the conservation of New Zealand's biodiversity and the management of invasive alien plants. We thank Chris and Lindsay for their outstanding contributions and wish them a happy and fulfilling retirement. Fortunately, both are planning to sign up to be MWLR research associates (an unpaid honorary role), and we are glad that we will still be able to call upon their expertise from time to time. Below are some of their career highlights.

Chris and Lindsay bookend the front row at a Weeds Team meeting in the mid 1990s.

Chris Winks

Chris Winks started at the Department of Scientific and Industrial Research (DSIR), the predecessor of MWLR, in the mid-1980s. Chris was first tasked with wading through swamps and lakes infested with alligator weed (*Alternanthera philoxeroides*) in Northland and Auckland to release and monitor the alligator weed beetle (*Agasicles hygrophila*). After about a year and a half he emerged from the swamps and moved on to "yellower pastures", assisting with the release and monitoring of the ragwort (*Jacobaea vulgaris*) flea beetle (*Longitarsus jacobaeae*).

After a few years of working solely in weed biocontrol, Chris teamed up with the DSIR Insect Rearing Team and divided his time between rearing pest insects for agricultural research and beneficial insects for weed biocontrol. In addition to Chris's contributions to this research, some of the work he found the most rewarding and enjoyable was his contribution to the protection of some of New Zealand's most iconic endemic species. Perhaps his greatest claim to fame was his part in saving the Mercury Island tusked wētā (*Motuweta isolata*) from the brink of extinction. When this carnivorous species of wētā was discovered in 1970 it only occurred on Middle Island, an area of just 13 hectares, making it highly vulnerable to extinction. Once the precarious existence of the species was known, the Mercury Islands Tusked Weta Recovery Group, formed in 1990, aimed to establish new populations of the wētā on other islands in the Mercury island group. However, the wētā's rarity and confinement to one small island made wild-to-wild transfers of populations very risky, which called for a captive breeding programme. The rearing methods were developed by Chris and a co-worker, Graeme Ramsay, and a captive population was initiated with just two female and one male wētā. Offspring from the captive breeding programme were released on two nearby islands in 2000 and 2001, significantly reducing the chances of accidental extinction, and maximising the potential for the long-term survival of this large, secretive insect.

As well as rearing endangered wētā, Chris has reared many weed biocontrol agents that have been shipped and released all over New Zealand. His ability to successfully rear all kinds of insects results from his extensive experience, but also considerable dedication and commitment to the task. Chris has also helped with numerous site visits to subsequently check for establishment of the progeny.

Other important work that Chris has been involved with include his collaboration with Ross Beever (a former plant pathologist with MWLR) to identify the insect vector responsible for transmitting a disease of New Zealand's native cabbage trees known as cabbage tree sudden decline. Chris also worked with Ross and Stan Bellgard (another plant pathologist, previously with MWLR) on kauri dieback, and with Robyn Simcock (MWLR) on green roof projects, which aim to reduce the negative environmental effects of urbanisation.

One of Chris's favourite aspects of his weed biocontrol research was his surveys of invertebrates already associated with many weed species in New Zealand. This work has meant that Chris has become extremely knowledgeable about our invertebrate fauna. His accumulation of a large numbers of insect specimens over the years promises to keep him busy during his retirement, as Chris plans to develop a properly curated insect collection. But, according to Chris, there will also be time for "other fun things".

Linday Smith

Lindsay Smith's tenure with MWLR started in 1993, when it was a newly minted Crown Research Institute (CRI). What was originally only a 3-week contract turned into 26 years at Lincoln! Prior to that Lindsay also worked for the DSIR at Lincoln as an intern in the summer of 1979, sampling invertebrates in a pesticide trial. In between, Lindsay tried his hand at a number of things including bee-keeping, bird monitoring and banking, before he was lured back.

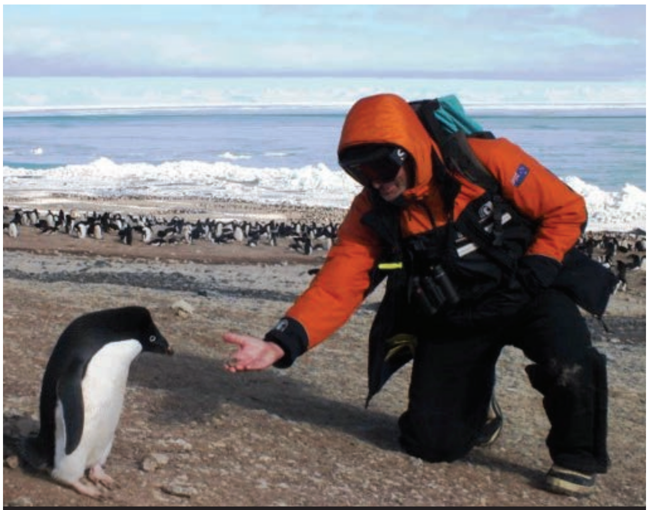
Lindsay's first assignment was to help Pol Syrett to curate a collection of insects from broom (*Cytisus scoparius*) in Spain. It wasn't long before Lindsay became involved in other biocontrol projects, which meant many hours spent in containment, testing and tending newly imported candidate biocontrol agents. According to Lindsay, he spent many, many, many hours and days shut away working in small containment cells. This kind of work takes a special kind of dedication, with insect cultures sometimes needing attention on weekends and public holidays.

Over the years Lindsay has been involved in a number of weed biocontrol projects, from alligator weed (*Alternanthera philozeroides*) to hieracium (*Pilosella* spp.), to tradescantia

Chris discovers that bridal creeper rust is in New Zealand.

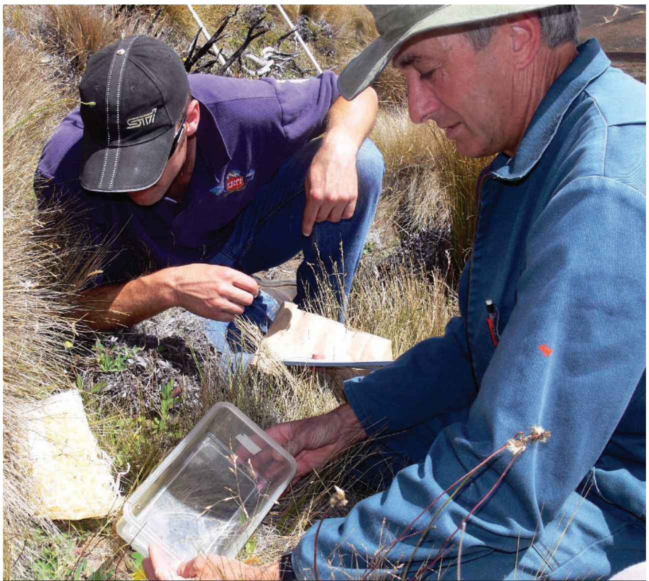
Chris and Rob Chappell (DOC) releasing Mercury Island tusked wētā.

Chris observing tradescantia leaf beetle damage.



Lindsay meeting the Antarctica locals.

Lindsay rearing tradescantia beetles in containment.



Lindsay releasing hieracium gall wasps.

(*Tradescantia fluminensis*). One of Lindsay's most memorable projects was one of his first, which involved the introduction of heather beetles (*Lochmaea suturalis*) from the UK to control heather (*Calluna vulgaris*) on the Central Plateau. At the outset the project seemed straightforward. A voracious beetle had been identified as a biocontrol agent, host specificity testing could be done with relative ease, the beetle would be released, and the heather would be a problem solved. However, it soon became something of a fraught journey: there was a battle to overcome a fungal parasite in the imported beetles, ministerial sign-off was required to release the exotic beetles in Tongariro National Park, and in 1996, the Mt Ruapehu eruption coated many of release sites with a thick layer of volcanic ash! Trying to put a positive spin on ash-covered heather was difficult. Nonetheless, some beetles survived, and with a little nurturing over the years by Paul Peterson they have persisted and now look to be well on their way to decimating the Tongariro heather stands. Also involved in the heather project was a collaborator in the UK, Simon Fowler, who later moved to MWLR and became Lindsay's manager for many years.

When funding for biocontrol of weeds became a bit scarce, the need to be flexible in sourcing other work allowed Lindsay to rekindle his interest in birds, having once worked for the Wildlife Service, a predecessor of the Department of Conservation (DOC). Phil Lyver generously offered an opportunity spanning several seasons to work in his team surveying grey-faced petrel populations on islands off the Coromandel, and later the Adelie penguin in Antarctica. Lindsay attributes his time in the field with Phil to his descent into a long-lasting gummy jet plane addiction!

Sourcing, testing, rearing and releasing insect biocontrol agents takes time, with many years of sustained energy and commitment required to see a project succeed. Some biocontrol programmes take decades to see significant, discernible impacts, so a quarter of century on Lindsay is well pleased with some tangible results from his contribution to weed biocontrol.

Looking back on his career, Lindsay says he feels grateful to have had so many opportunities to work with outstanding people – enthusiastic, passionate, generous and knowledgeable people. They include his immediate colleagues, the wider organisation, the many overseas collaborators essential to our work, and the end users in New Zealand – the farmers, regional council staff and general public. "All have shared my journey at MWLR to make it a most enjoyable 26 years, thank you," said Lindsay.

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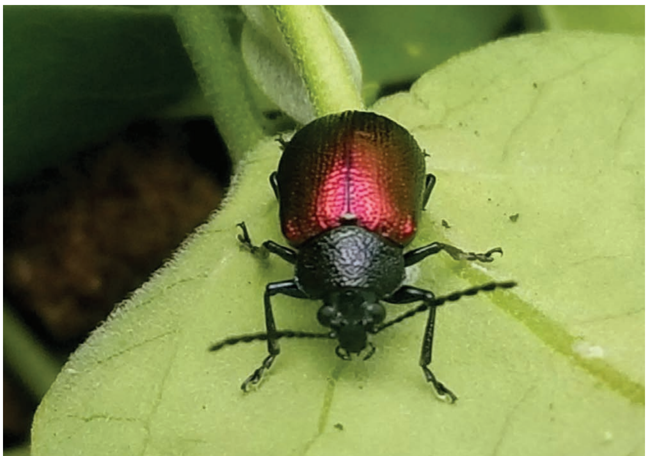
Introducing the Moth Plant Beetle, at Last!

We are very excited to report that the first releases of the moth plant beetle (*Freudeita cupripennis*) took place in December 2019 at sites in the Bay of Plenty and Northland. One hundred and fifty adult beetles were released on 13 December at Matapihi, near Tauranga, in the Bay of Plenty. Shane Hona (Bay of Plenty Regional Council), together with Hayden Henry, a representative of Ngai Tukairangi Resource Management Authority, released the beetles onto a moth plant infestation smothering harakeke/New Zealand flax (*Phormium tenax*). The second release, also consisting of 150 adult beetles, took place in the Awanui area near the Sweetwater Lakes in Northland, courtesy of Jenny Dymock (Northland Regional Council). Jenny conducted the release on 18 December as part of Bushland Trust's restoration plan for the lakes and the surrounding riparian/run-off zones.

Moth plant (*Araujia hortorum*) is native to Brazil, Argentina, Paraguay and Uruguay and is particularly invasive in the northern regions of New Zealand. The vines of moth plant smother shrubs and small trees, and they spread along the ground, shading out small native plants and seedlings. Moth plant is currently dominant in urban and peri-urban areas, particularly around forest margins, hedges and wastelands, but in time it will pose a greater threat to healthy native forests in northern New Zealand. Moth plant's choko-like fruits produce 250 to 1,000 parachute-like seeds, which can disperse long distances in the wind. When damaged, moth plant exudes a white, waxy substance, which can stain clothing and with direct contact can cause skin irritation and serious eyes problems. Moth plant is so disliked in New Zealand that communities and school groups are dedicated to its demise. The Society Totally Against Moth Plant (STAMP), which has close to 500 members on Facebook, regularly goes on "control adventures" in the Auckland region. Moth plant is also subject to inter-school competitions, whereby teams vie to collect the highest number of pods, with the winner taking home prize money donated by Pest Free Auckland. In 2019 two teams from Botany College finished in first and second place, with Team Demons defeating The Cultured Moth Destroyers by a score of 2,265 to 1,878 moth plant pods.



Moth plant beetle

Moth plant smothering harakeke at the release site.

Callum McLean

The release of the moth plant beetle has been a long time coming. An application to release the beetles was first approved by the Environmental Protection Authority (EPA) in December 2011, but due to ongoing problems with exporting biocontrol agents from Argentina, the beetles had to be recollected from Uruguay and undergo a new batch of host specificity tests. The beetle population from the Melilla area, northwest of Montevideo, was approved for release by the EPA in May 2019, after which Zane McGrath, the technician on the project, worked very hard to build up beetle numbers for a release. According to Zane, "the beetles are a bit of a handful to rear in the lab, but in a good way. When first rearing the beetles, we left groups of adults on individual potted moth plants, until we noticed that the plants started dying due to the hundreds of larvae that were feeding on the roots of the plants, causing them considerable damage and stress. We had to adjust our rearing techniques to control the numbers of larvae per plant to ensure enough root material for all of them to complete their development to adulthood."

Hopefully the beetle larvae will have just as voracious an appetite for moth plant in the field as they do in the lab. "Although it is early days, the adult beetles, which are about 1 cm in length, should be easy to spot in the field, with their impressive metallic red wing cases and distinctive black head, thorax, antennae and legs," said Zane. The beetles are expected to have two to three generations per year in New Zealand. "Further releases of the beetles are planned this summer, before they slow down to enter diapause, a period of suspended development to survive the colder months," said Zane.

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This project is funded by the National Biocontrol Collective. A video of the first release of the moth plant beetle is available at https://www.youtube.com/watch?v=-mb3meB5Mcc

Biocontrol Success in the Waingaro Valley

The tradescantia yellow leaf spot fungus (*Kordyana brasiliensis*) was first released in Rotorua, in the Bay of Plenty, in March 2018, with subsequent releases taking place in Northland, Waikato, Wellington, Auckland, Manawatū–Wanganui, the West Coast and Nelson.

A visit to the Waingaro Valley by Ben Wolf (Waikato District Council), Chantal Probst and Dr Ben Gooden (a visiting plant pathologist from CSIRO, Australia) 10 weeks after the release of the fungus showed very promising results. Tradescantia plants in the area, which dominated the forest floor, displayed the characteristic yellow spots on the leaves, an indication of successful establishment. Despite this early success we could not have anticipated the transformation that has occurred at this site, just a year and a half down the line. Ben Wolf revisited the site in December 2019, reporting that "the fungus has steadily spread, causing extensive defoliation of tradescantia, which has allowed the seeds of native plants to germinate. This is a biocontrol success story, as the seedlings of our native endemic coniferous tree, kahikatea (*Dacrycarpus dacrydioides*), are now starting to outnumber tradescantia plants at the original release site," said Ben.

According to Chantal, the technician working on the project, climatic conditions in the Waingaro Valley are ideal for the fungus. "The tradescantia yellow leaf spot fungus will thrive in areas with cool, damp conditions all year round, with occasional flooding. We therefore recommend that similar conditions prevail at new release sites for the fungus," said Chantal.

The yellow leaf spot fungus was introduced in New Zealand to assist the three beetle biocontrol agents in reducing the biomass of tradescantia. Although the beetles are doing well, it was believed the fungus would be a more successful agent in areas prone to flooding, where the beetles don't establish. The fungus produces hundreds of spores, which are released in humid conditions, so a few rainy days at the right time create ideal conditions for sporulation and infection of new plants. In dry conditions the fungus is not able to release spores, and infected leaves eventually shrivel and die off.

Wolf, Waikato District Council.

Regeneration of native plants at Waingaro Valley release site.

Yellow leaf spot fungus on tradescantia and native seedlings.

Indeed, the limitations of dry conditions for the yellow leaf spot fungus have been observed both in New Zealand and across the ditch in Australia. Colleagues from CSIRO, Australia, have released the fungus at over 100 sites. Despite this impressive number of releases, infections have only been observed at two sites in New South Wales. "Australia's hot, dry climate is suspected to be the cause of limited establishment," said Chantal. Ben Wolf also reports that the ideal conditions observed in the Waingaro valley, which have facilitated the extensive damage to tradescantia and the recovery of native forest plants, have not been seen elsewhere, with the fungus dying off at some release sites because conditions are too dry. "The very dry summer we are currently having is unfortunately not helping the establishment and spread of the yellow leaf spot fungus. As a plant pathologist, I am hoping for a wet autumn and winter to help get this fungus going in other areas of the country where tradescantia is problematic!" said Chantal.

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The tradescantia project was funded by the National Biocontrol Collective. Trials to assess the impact of tradescantia biocontrol agents, including the fungus are being funded by the Ministry for Business, Innovation, and Employment as part of Manaaki Whenua – Landcare Research's Beating Weeds programme.

Applying to Release Weed Biocontrol Agents

The Environmental Protection Authority (EPA) regulates the importation, development and release of new organisms in New Zealand under the Hazardous Substances and New Organisms (HSNO) Act 1996. It has been widely acknowledged that the EPA process works well, providing a robust, coherent, fair and logical framework for making decisions about the release of weed biocontrol agents. It is the envy of many practitioners overseas battling more difficult regulatory environments. In the last 5 years the EPA has assessed and approved 13 biocontrol agents for New Zealand, including nine insects and two pathogens targeting eight weeds. Recently a paper has been published giving an overview of how the EPA regulatory process works, and the associated costs, which we summarise in relation to weed biocontrol below.

In terms of the process, applicants must submit a dossier of information that provides the evidence for why they consider a proposal to release a new organism meets the regulatory requirements. The information needs to inform the EPA about the risks, costs and benefits of the prospective biocontrol agent to allow for comparative evaluation. "The EPA has pioneered world-leading qualitative risk assessments to ensure environmental, economic, societal, public health, and cultural perspectives are addressed in a decision-making framework," said lead author of the paper, Clark Ehlers. The benefits and risks are considered in light of the status quo and future pest management strategies. The likelihood and magnitude of each benefit or risk is evaluated on a ranking scale, and the EPA will decline an application where the adverse effects are considered to outweigh the benefits. "Furthermore, the EPA must determine whether the prospective biocontrol agent can meet a set of minimum standards in the HSNO Act, e.g. whether a new organism is likely to cause significant displacement of native species within its natural habitat or is likely to cause significant deterioration of natural habitats," explained Clark.

There can be a long lead time to prepare and submit an application. The effort required to collate all the supporting information means significant costs for the applicant and EPA staff, who provide advice and support throughout. As well as drafting the application, applicants bear the costs of consulting with independent technical experts and reviewers, and with Māori (an obligation under the Treaty of Waitangi and written into New Zealand law). Following formal receipt of an application, strict statutory timeframes apply. A decision to release a new biocontrol agent must be made public within 100 business days of receiving an application. Within this time, the EPA publicly notifies the application, which involves inviting comments from the public; performs a scientific and cultural assessment of the application; and holds a public hearing and consideration meeting, at which time an independent committee makes a decision to approve or decline the application. Applicants must cover their costs associated with responding to any comments received following the public notification process, and for preparation for and attendance at a public hearing. The EPA sets its application fees in line with the understanding that research and development of new biocontrol agents may take many years and success is not always guaranteed. They recently reassessed their fees, and concluded that for some applications there is a high public benefit that needs to be taken into consideration (e.g. weed biocontrol agents), and for others there may be significant commercial benefits (e.g. developing IP protected new endophyte strains for pest control in crops).

With this public good in mind, the EPA currently charges $23,000 to process and assess a weed biocontrol agent application, which is not based on full cost recovery. The EPA charge comprises about 41% of the total regulatory costs per agent ($55,550). "When the EPA was first formed, I expressed concerns that the new regulatory costs would impose a significant burden for weed biocontrol programmes, even causing some to fail or be abandoned, but I am been pleased to be proven wrong," said Simon Fowler, a co-author on the paper. Overall, these regulatory costs are only 15% of the total research and development costs required to obtain EPA approval for release of an agent where New Zealand is taking a pioneering role ($364,550), or 39% of the total costs to New Zealand ($138,300) where other countries have already invested substantially.

Furthermore, the full regulatory, research and development costs are also low when compared to the benefits that could eventually accrue from approved biocontrol agents. Ironically, with weed biocontrol releases, end-users can benefit from reduced pest control costs even if they did not invest in any of the costs upfront. Such programmes are unlikely to be seen as a good investment by the private sector. Hence, the costs for new biocontrol agents tend to be borne by government agencies in New Zealand.

As well as the benefits arising from better managing weeds through biocontrol, the work undertaken to inform EPA applications provides supplementary benefits, such as contributing to the field of invasion biology. In addition, surveys of the invertebrate fauna and pathogens contribute to our understanding of the ecology of weeds, as well as our knowledge of the food webs and ecosystem services associated with plants in their native ranges and when they have become invasive species in non-native environments.

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For further details see: Ehlers GAC, Caradus JR, Fowler SV (2020). The regulatory process and costs to seek approval for the development and release of new biological control agents in New Zealand. BioControl 65(1): 1–12. https://doi.org/10.1007/s10526-019-09975-9

Summer Activities

Gall-forming agents

- Check broom gall mite (*Aceria genistae*) sites for signs of galling. Very heavy galling, leading to the death of bushes, has been observed at some sites. Harvesting of galls is best undertaken from late spring to early summer, when predatory mites are less abundant.
- Check hieracium sites, and if you find large numbers of stolons galled by the hieracium gall wasp (*Aulacidea subterminalis*) you could harvest mature galls and release them at new sites. Look, also, for the range of deformities caused by the hieracium gall midge (*Macrolabis pilosellae*), but note that this agent is best redistributed by moving whole plants in the spring.
- Check nodding and Scotch thistle sites for gall flies (*Urophora solstitialis* and *U. stylata*). Look for fluffy or odd-looking flowerheads that feel lumpy and hard when squeezed. Collect infested flowerheads and put them in an onion or wire-mesh bag. At new release sites hang the bags on fences, and over winter the galls will rot down, allowing adult flies to emerge in the spring.
- Check Californian thistle gall fly (*Urophora cardui*) release sites for swollen deformities on the plants. Once these galls have browned off they can be harvested and moved to new sites (where grazing animals will not be an issue), using the same technique as above.
- Look for swellings on giant reed (*Arundo donax*) stems caused by the giant reed gall wasps (*Tetramesa romana*). These look like small corn cobs on large, vigorous stems, or like broadened, deformed shoot tips when side shoots are attacked. Please let us know if you find any, since establishment is not yet confirmed.

Honshu white admiral (*Limenitis glorifica*)

- Look for the adult butterflies at release sites, pale yellow eggs laid singly on the upper and lower surfaces of the leaves, and for the caterpillars. When small, the caterpillars are brown and found at the tips of leaves, where they construct pier-like extensions to the mid-rib. As they grow, the caterpillars turn green, with spiky, brown, horn-like protrusions.
- Unless you find lots of caterpillars, don't consider harvesting and redistribution. You will need to aim to shift at least 1,000 caterpillars to start new sites. The butterflies are strong fliers and are likely to disperse quite rapidly without any assistance.

Privet lace bug (*Leptoypha hospita*)

- Examine the undersides of leaves for the adults and nymphs, especially leaves showing signs of bleaching.
- If large numbers are found, cut infested leaf material and put it in chilly bin or large paper rubbish bag, and tie or wedge this material into Chinese privet at new sites. Aim to shift at least 1,000 individuals to each new site.

Tradescantia leaf, stem and tip beetles (*Neolema ogloblini, Lema basicostata, N. abbreviata*)

- Look for the distinctive feeding damage and adults. For the leaf and tip beetles, look for the external-feeding larvae, which have a distinctive faecal shield on their backs.
- If you find them in good numbers, aim to collect and shift at least 100–200 beetles using a suction device or a small net. For stem beetles it might be easier to harvest infested material and wedge this into tradescantia at new sites (but make sure you have an exemption from MPI that allows you to do this).

Tradescantia yellow leaf spot (*Kordyana brasiliensis*)

- Look for the distinctive yellow spots on the upper surface of the leaves, with corresponding white spots underneath, especially after wet, humid weather. Send a photo to us for confirmation if you are unsure, as occasionally other pathogens do damage tradescantia leaves.
- The fungus is likely to disperse readily via spores on air currents. If human-assisted distribution is needed in the future, again you will need permission from MPI to propagate and transport tradescantia plants. These plants can then be put out at sites where the fungus is present until they show signs of infection, and then planted out at new sites.

Tutsan moth (*Lathronympha strigana*)

- Look for the small orange adults flying about flowering tutsan plants. They have a similar look and corkscrew flight pattern to the gorse pod moth (*Cydia succedana*). Look, also, for fruits infested with the larvae. Please let us know if you find any, as establishment is not yet confirmed.
- It will be too soon to consider harvesting and redistribution if you do find the moths.

Woolly nightshade lace bug (*Gargaphia decoris*)

- Check release sites by examining the undersides of leaves for the adults and nymphs, especially leaves showing signs of bleaching or black spotting around the margins.
- It is probably best to leave any harvesting until spring.

National Assessment Protocol

For those taking part in the National Assessment Protocol, autumn is the appropriate time to check for establishment and/or assess population damage levels for the species listed in the table below. You can find out more information about the protocol and instructions for each agent at: www.landcareresearch.co.nz/publications/books/biocontrol-of-weeds-book

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Target	When	Agents
Broom	Dec–April	Broom gall mite (*Aceria genistae*)
Lantana	March–May	Leaf rust (*Prospodium tuberculatum*) Blister rust (*Puccinia lantanae*)
Tradescantia	Nov–April	Leaf beetle (*Neolema ogloblini*) Stem beetle (*Lema basicostata*) Tip beetle (*Neolema abbreviata*)
	Anytime	Yellow leaf spot fungus (*Kordyana brasiliensis*)
Woolly nightshade	Feb–April	Lace bug (*Gargaphia decoris*)