ISSUE 78 / NOV 2016

LANDCARE RESEARCH
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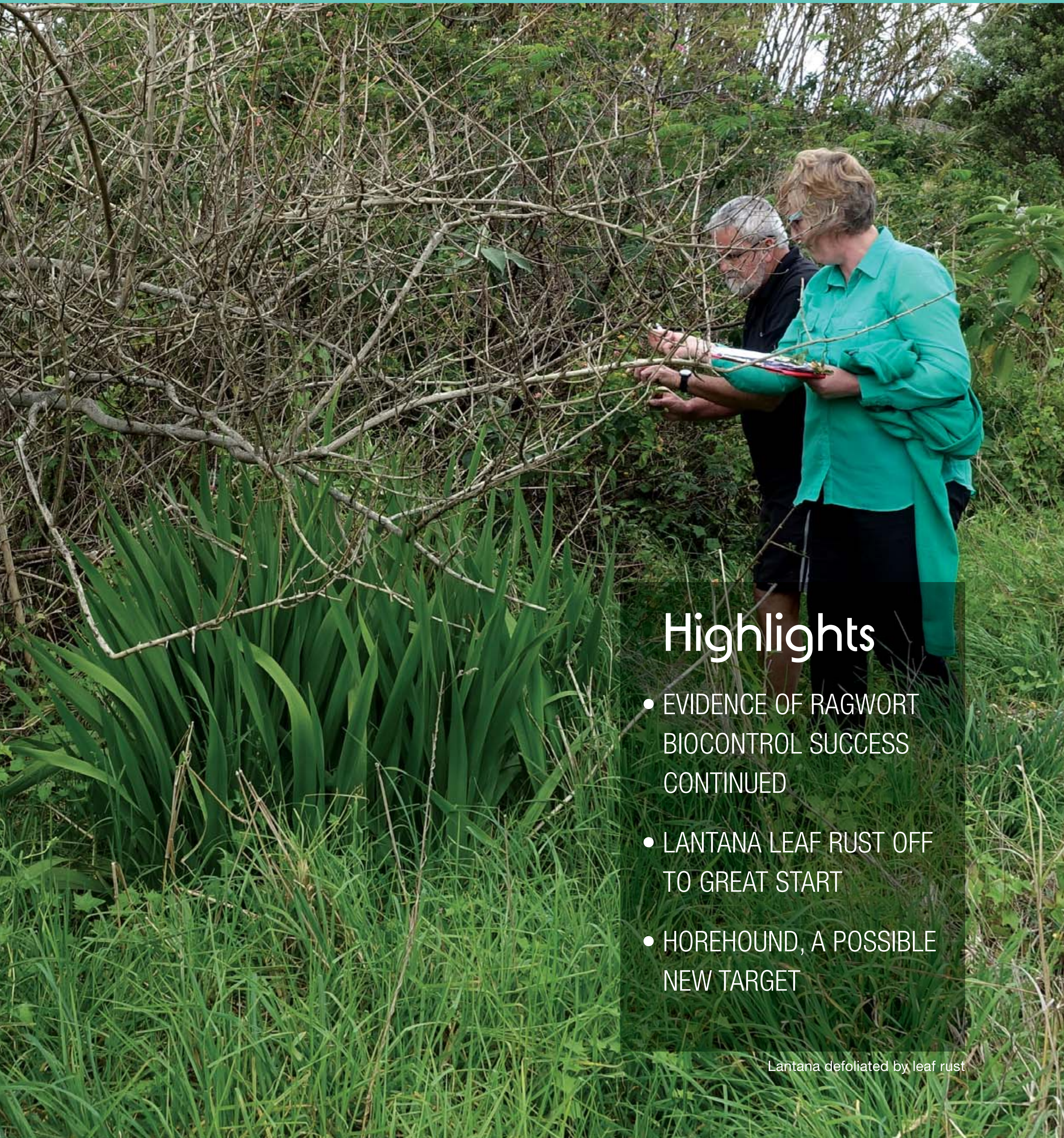
Weed Biocontrol

WHAT'S NEW?



Highlights

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Lantana defoliated by leaf rust

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ISSN 2463-2961 (Print) ISSN 2463-297X (Online)

www.landcareresearch.co.nz

Comparing Ragwort Then with Now: Part Two

In the previous issue we introduced a project where we trialled a new approach that involved revisiting 71 farms on which the ragwort flea beetle (*Longitarsus jacobaeae*) had been released some 20–30 years ago. This project looked at the extent of ragwort (*Jacobaea vulgaris*) on those farms now and also asked questions about land management, including herbicide use. Farmers were also asked what they thought about the impact of the beetles and whether they had done a good job.

"The survey results have provided some incredibly useful data," said Simon Fowler, who did the analysis. "Not surprisingly, given the time elapsed since the early releases, it was unusual for the same landowners and council staff who were involved at release time to be involved in this survey, emphasising the need for good record keeping," Simon said. However, the records on file were sufficient to at least get close to the release points. The data show conclusively that ragwort density has declined enormously following the release of the ragwort flea beetle, particularly in drier regions. Only in very wet regions, such as the west coast of the South Island and Southland, where the beetles struggle, are the densities of ragwort still relatively high.

The survey found that the density of ragwort is lower on farms that have low herbicide use than those with high herbicide use. Sustained low weed density is most likely due to biocontrol. However, the higher incidence of ragwort on the farms with high herbicide use could indicate that herbicide interferes with the effectiveness of biocontrol agents, or that landowners are using more herbicide where they have a bigger problem.

"We found that the use of boom spraying had declined dramatically (from 21 farms down to 5), with much less intensive herbicide use or even manual control such as pulling/grubbing," said Simon. On six of the farms, the farmers thought that control was entirely attributed to stock (sheep) grazing pressure. The data do not support this, with no significant difference between initial mean number of ragwort plants per hectare in sheep, beef or dairy farms. If sheep were contributing to suppression of ragwort on heavily infested farms, sheep farms would be expected to have lower levels of ragwort compared to beef or dairy farms when the flea beetle was released. "We have been particularly encouraged by the 16 farms where ragwort control is no longer needed," said Simon. The most obvious explanation is that biocontrol by the ragwort flea beetle has virtually eliminated ragwort from these farms.

Spot herbicide treatments (spray or granules) and carpet rolling are the best weed control treatments to use in conjunction with the ragwort flea beetle as these generally leave smaller plants for the beetle while preventing ragwort from flowering. Only boom spraying is likely to be wholly incompatible with biocontrol, as no food resources are left intact," explained Simon. "Since the beetles were released there have been major reductions in the use of indiscriminate boom spraying against ragwort," said Simon. "Instead there were increases in spot spraying/prilling, pulling/grubbing or the use of stock (sheep or goats), all of which are much more compatible with biocontrol," Simon added.

Despite the ragwort flea beetle, the results from the survey suggested that ragwort control costs were still high on a few of the farms (up to NZ$20,000/year). "Only one farm provided ragwort control costs before and after biocontrol: but on this farm control costs reduced from NZ$4000/year pre-biocontrol, to NZ$100/year post-biocontrol (a reduction of 98%)," said Simon. A majority of farms in the Auckland/Northland region and the drier eastern regions of the North Island reported spending very little on ragwort control. But some of the southerly and westerly regions are still spending a reasonable amount on control, reflecting the reduced effectiveness of the ragwort flea beetle in cooler and/or wetter areas.

A recent economic analysis found that the savings in ragwort control on dairy farms in New Zealand as a direct result of the flea beetle were predicted to be $44 million for 2015 alone. A net present value analysis of the annual benefits and costs from 1926 onwards gave a benefit-cost ratio of 14:1, i.e. every dollar invested in ragwort biocontrol New Zealand has gained $14 in reduced ragwort control costs. This figure does not include benefits to other farming types or even all benefits to dairy (e.g. reduction in cattle deaths, increased pasture production). This study found that the best results were achieved on beef and sheep farms, which suggests that the $44 million dollar figure and the NPV are extremely conservative measures of the value of ragwort biocontrol to New Zealand.

Respondents were also asked to sum up what they thought of the biocontrol programme for ragwort in just three words (see table). There were some interesting responses! Of the 52 farmers that responded, 25 were very positive about biocontrol, with 19 intermediate/uncertain views, leaving only 8 of the farmers that either thought biocontrol was useless or were unaware of biocontrol. "What I found interesting was that all eight farmers who were unaware of biocontrol or considered it useless, actually had excellent reductions in ragwort density on their farms," exclaimed Simon. Two farmers attributed the excellent ragwort control to sheep alone, even though sheep were clearly not controlling ragwort before the release of the ragwort flea beetle. "However, we do acknowledge that sheep are likely to complement the action of the flea beetle," Simon commented. Five farmers appeared convinced that their ragwort suppression was solely a result of repeated herbicide use. This highlights the importance of communicating which land management practices are complementary to biocontrol.

To conclude, we understand that monitoring weed biocontrol outcomes can be expensive and this presents a conundrum for funders, who need to weigh up spending funding on follow-up assessment against targeting new weed species. The survey has shown that it is possible to design a cost-effective monitoring system in which stakeholders help to collect the data. It also enabled comparisons to be made between weed abundance at the time of release and now. This yielded important information such as the level of weed density with existing management practices, current control measures used for ragwort, presence/absence of all the ragwort biocontrol agents and land manager views on biocontrol. It also provided an opportunity to reconnect with the land managers and continue dialogue about weed biocontrol, including the most complementary land practices for biocontrol agents. In 20 years' time few will remember the problem that ragwort once posed and how a small gold beetle changed farming for many in New Zealand. Nevertheless this study completes a compelling story about a big success that happened here, and the benefits that biocontrol can provide to communities.

This project was funded and data for it was collected by the National Biocontrol Collective. A huge thanks to everyone who contributed to this survey!

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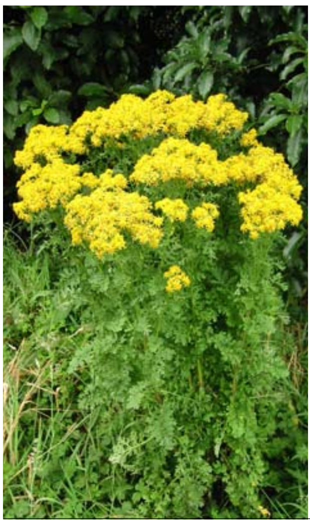
Farmer comments on ragwort biocontrol compared with percentage reductions in ragwort on their properties. *Sites still boom sprayed when revisited.

Anti-biocontrol or unaware	% reduction in ragwort	Intermediate or unsure	% reduction in ragwort	Pro-biocontrol	% reduction in ragwort
Not very effective	-100.00%	Ragwort is disappearing over time.	-98.33%	Fantastic, cheap, timesaving!	-99.99%
Load of bollocks	-100.00%	It is a tool	-99.98%	Success, biocontrol worthy.	-100.00%
Not very good	-99.91%	Tool, not be all and end all	-99.96%	It worked well	-100.00%
It didn't work	-100.00%	Give it time	-100.00%	Seems very effective	-100.00%
Ok if needed	-100.00%	Ok only	52.50%*	Working well, terrific	-100.00%
Made no difference	-99.95%	Certainly a help	-100.00%	Simple long-term solution	-100.00%
Got a bit worse	-91.66%	Unsure yet	-100.00%*	Seemed to work	-100.00%
Didn't know about it.	-91.66%*	Worth a try	-99.93%	Great	-99.33%
		Certainly a help	-100.00%	Job well Done!	-100.00%
		Reasonable with sheep	-99.17%	It does work	-99.97%
		Need more info	-99.84%	It's been marvellous	-99.99%
		Is coming back (ragwort flea beetle)	-20.00%	It is worth it	-100.00%
		Very slow	-99.98%	Seemed to control ragwort	-100.00%
		Good idea	-99.99%	Very good	-93.47%
		Good, interested in it	-100.00%	Very good manager	-100.00%
		Support natural control	-94.50%	Highly efficient - absolutely fantastic.	-100.00%
		Farmer: Does a good job. Wife: Does not	-99.97%	Simple consistent reliable	-49.83%
		Compatible, effective with chemicals	-98.90%	The cat's whiskers	-100.00%
		Ideal if worked.	-43.75%*	Excellent	-100.00%
				Environmentally brilliant	-99.09%
				Must have worked	-100.00%
				Easy Simple Effective	-91.66%
				Greatly assists control	-99.96%
				Much prefer b/c than chemicals	-99.33%
				Effective Environment friendly	-100.00%

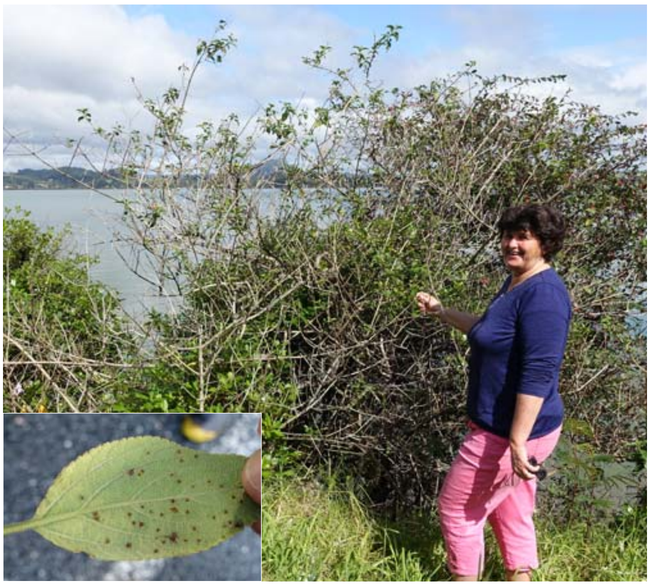


Lantana Leaf Rust Off to Great Start

Although lantana (*Lantana camara*) has a reputation for being one of the world's 10 worst weeds, in New Zealand it is mostly only problematic in Northland, with much of the country fortunately being too cold for it to thrive. However, given lantana's potential, especially since our climate is warming, biological control has been attempted here as a 'pre-emptive strike' rather than the more usual tactic of 'last resort'. The early signs are that this strategy is likely to be highly successful.

After receiving advice from Michael Day (Biosecurity Queensland), who has worked extensively on lantana biocontrol in Australia, that none of the insect agents were likely to thrive in New Zealand conditions, we focused instead on two rusts from South America. The lantana leaf rust (*Prospodium tuberculatum*) causes leaf-death and defoliation and the lantana blister rust (*Puccinia lantanae*) causes dead patches on stems, leaf stalks and leaves, and sometimes systemic infection leading to stem dieback. With the assistance of Michael's team in Australia, and Carol Ellison, Sarah Thomas and colleagues at CABI in the UK, we were able to determine that New Zealand lantana is susceptible to both pathogens and that no other significant damage to beneficial plants was likely to occur. With Northland Regional Council as applicant, a successful case was then made to the Environmental Protection Authority in 2012 to release both rusts. The leaf rust is well established in Australia but the blister rust had never been used as a biocontrol agent anywhere before.

The rusts were imported once our new plant pathogen containment facility was up and running in Auckland in 2013. After some initial teething problems successful transfers of both species onto potted plants were achieved. This allowed mass-rearing to get underway and field releases in Northland and the Bay of Plenty regions to begin in autumn 2015. Both rusts require warmth and moisture for infection, so spring and autumn are the best times for releases. The climatic requirements of the two rusts differ slightly. The lantana leaf rust is subtropical whereas the lantana blister rust is tropical. The expectation, therefore, was that the lantana leaf rust would likely be active across a wider area in New Zealand, including the more southern parts of lantana's range, while the lantana blister rust might be limited to the warmer and wetter areas of the Far North.



Jenny Dymock with a defoliated plant at Whangaroa Harbour. Inset: infected leaf.

An unusual cold snap in winter 2015 caused frost damage to some lantana in Northland and concern about what that might mean for the recently released rusts. However, in August 2016 Jenny Dymock (who helps the Northland Regional Council with biocontrol activities) reported seeing lantana that "was not looking quite right". So a group of Landcare Research staff checked out these sites with her in September. There was much excitement when it quickly became obvious that some lantana plants had been heavily defoliated at the Whangaroa and Cable Bay sites, with tell-tale signs of the leaf rust present on remaining leaves. "We did not expect to see this much damage so soon," said Lynley Hayes. "We were amazed at how easily infected leaves would drop at the slightest touch." Pathologists Chantal Probst and Mahajabeen Padamsee subsequently examined collected samples and confirmed that the leaf rust was the culprit. Since then Jenny has found similar damage and evidence of leaf rust establishment at Kohukohu in north Hokianga.

The blister rust had also been released at Cable Bay and Kohukohu but there are no signs yet that it has established. "The blister rust is a little more difficult to work with. Unlike the leaf rust, which can be applied to the leaves as spores mixed with talcum powder, whole plants infected with blister rust need to be placed in the field and survive long enough for disease transmission to occur," explained Lynley. The two rusts have never been found co-occurring naturally although they happily do on plants in the lab so it is presumed this will be possible in New Zealand.

We will now be watching with interest the impact the leaf rust has on lantana plants over time, and how quickly it spreads, while keeping a hopeful eye out for the appearance of the blister rust.

This project was funded by the National Biocontrol Collective with additional funding provided by Northland Regional Council, Auckland Council, Bay of Plenty Regional Council, and Greater Wellington Regional Council.

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Farmers Seek Biocontrol for Smelly Weed

Recently Ronny Groenteman was contacted by a high country merino farmer, Gavin Loxton, asking about the possibility of biocontrol for horehound (*Marrubium vulgare*), a putrid-smelling weed that reduces lucerne yields and wool quality. Although there are no biocontrol agents available for this weed in New Zealand there are some available just across the ditch. Biocontrol for horehound in Australia was developed during the 1990s and two moths were released: a plume moth (*Wheeleria spilodactylus*) that attacks the above ground vegetation, and a clearwing moth (*Chamaesphecia mysiniformis*) that attacks the roots. The moths provide excellent control of horehound in Australia in many situations. Other potentially good agents that could also be considered were identified, but not released.

Horehound is a perennial shrub resembling mint, native to temperate Eurasia, Europe, the Middle East and the Mediterranean region, including North Africa. As well as Australia and New Zealand, horehound has become a weed in southern USA and South America. Recorded as naturalised here in 1867 horehound was first classified as a weed in 1902. It is frost resistant and drought tolerant but also occurs in higher rainfall areas. Horehound occurs in eastern parts of New Zealand from Northland to Southland, particularly in Canterbury and Otago.

Horehound has become an increasing problem on dryland farms across the country over recent years and is now recognised as one of the worst weeds in lucerne crops. Chemical control of horehound is problematic in lucerne stands for a number of reasons. The waxy coating on the leaves provides horehound with some protection against herbicides. The most cost-effective chemical, Metsulfuron, has a long residual period and farmers must wait for 2–3 years before sowing any legumes in sprayed areas. During this time horehound can regrow from its long-lived seedbank. Also, young lucerne stands cannot tolerate Metsulfuron in their first 3-4 years and, to make matters worse, horehound is possibly beginning to develop resistance to this spray. Horehound also degrades pasture as it is unpalatable to livestock and its prickly burrs reduce the value of wool.

Simon Paterson

Horehound in 4 year old pasture in Central Otago.

Gavin Loxton has first-hand experience battling the weed on his 8000 hectare property, Sawdon Station, near Lake Tekapo. Herbicides were just not working, Gavin said. They damaged clover, lucerne, and the soil. “They leave residual chemicals that stunt the lucerne and significantly reduce yields – as much as 30 per cent. If it happens to coincide with a dry year, you can also lose a lot of lucerne plants. They’re not actually solving the problem. You’re simply left with unproductive land.” Herbicides were also difficult and costly to apply in high terrain, Gavin said.

After talking to Ronny, Gavin formed the Horehound Biocontrol Group, which hopes to be able to release the two moths in New Zealand. Some host-testing may be required but, given the amount of work already done by Australia, this should be a relatively straightforward project. Soon after its formation the Horehound Biocontrol Group conducted a survey, in conjunction with Landcare Research, to get a better idea of the scale of the problem to ensure that biocontrol would be justified. Farmers were questioned about the size of the horehound infestation on their property, control measures they’re using and the effect it’s having on their lucerne crops. In a short time more than 60 responses were received. Many noted that horehound cover doubles every 2–3 years if left unattended. Others noted that horehound is now invading areas where it has not been seen before. The data suggest that the impact of horehound on lucerne crops alone costs around $29m to $39m per year.

“The survey made me realise that horehound is a much bigger problem than I envisaged,” said Gavin. “Farmers were disillusioned about finding a viable management option, and weren’t talking about horehound. The possibility of biocontrol brought back some hope.” An application for funding to develop biocontrol has now been submitted to the Ministry for Primary Industries Sustainable Farming Fund with strong financial support/commitment from affected farmers. “While horehound is still a relatively small problem in New Zealand, it would totally make sense to nip in the bud now,” concluded Ronny.

If you have a problem with horehound or are interested in supporting the Horehound Biocontrol Group please contact with Ronny or Gavin.

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Where Did Giant Buttercup Come From?

Finding the exact area of origin for some of our weeds is important detective work because it enables us to pinpoint where to seek biocontrol agents that are most closely linked to the plant and therefore more likely to establish and be effective. When it comes to giant buttercup (*Ranunculus acris*), a weed that dominates many dairy pastures in high rainfall areas of New Zealand, we found that it was not a simple task to pinpoint its origin. The *R. acris* complex is a group of closely related plants that extend across European countries as far east as Asia and Japan. The plant has also naturalised in a number of other countries including Canada, South Africa and USA. Although giant buttercup was introduced into New Zealand around the time of early European settlement, it was not known for sure where 'our' plants originated from.

As it turns out, recent studies have found that the plant is quite variable in its form and genetic structure, making it challenging to work on. Understanding genetic relationships between populations of plants would usually involve sequencing the nuclear genome (DNA within the cell nuclei) but because of the presence of multiple sets of chromosomes (polyploidy) in this plant, that method is not an option. Instead, examining the variation within the *R. acris* complex has involved extracting the genetic information contained within chloroplasts, the part of the cell responsible for photosynthesis amongst other functions.

Initial investigations led by molecular biologist Gary Houliston found that giant buttercup chloroplasts have remarkably diverse genetic information, which is inherited from parent chloroplast material. Gary refers to the variability within this independent genetic information as chloroplast haplotype diversity. "Typically chloroplast haplotypes do not vary much within plant species or even the same genera so it was quite unusual to find such a high diversity in the chloroplasts of giant buttercup growing at one site here in New Zealand," said Gary. "This points towards multiple introductions of giant buttercup into New Zealand," he explained.

Giant buttercup taking over valuable pasture .

Gary's more recent research compares chloroplast diversity in the New Zealand populations of *R. acris* to the chloroplast diversity in the plant's native range, including areas that he suspected were the likely source of the New Zealand plants. In total, Gary looked at 57 samples sourced from around the world. Much to his surprise, Gary found that the samples sourced from other countries had equally high chloroplast diversity. "We would expect that over time, the diversity in the genetic material would diminish through drift – a process where variation is lost over time. This is often the case for invasive species that are doing well in a new environment, especially if they underwent a bottleneck on arrival," explained Gary. "Giant buttercup established in New Zealand close to 150 years ago and to find such a high degree of variation is therefore quite surprising," said Gary.

Samples from Central Europe proved to be a good match to most of those found in New Zealand, but Gary has also found common haplotypes between the Canadian samples and those from New Zealand. "It is highly likely that most of the introduced *R. acris* in New Zealand has come from the United Kingdom, but that there have been multiple introductions," said Gary. However, he is still puzzling over why the high haplotype diversity in both Europe and New Zealand has been maintained over time, and it could be a while before we get to the bottom of this.

Given the extensive problem that this weed causes in dairy pastures, and its evolved resistance to phenoxy and possibly other classes of herbicide, a number of alternative control methods are being sought. Massey University and AgResearch have been working on methods for dairy farms, where the plants are avoided by cattle due to their bitter taste. A mycoherbicide based on the fungus *Sclerotinia sclerotiorum* has been developed but commercialisation of this product is awaiting development of a cost-effective formulation. One of the most promising options is pre-graze mowing. Although biocontrol is not out of the question, this is likely to be a difficult and costly option. "The large number of native *Ranunculus* here means we need to be very cautious when selecting potential agents," said Simon Fowler. "Plus all the potential agents look likely to be difficult to work with." At present it seems that giant buttercup is not widespread enough to warrant the cost of developing a full biocontrol programme.

This project was funded by AgResearch's Undermining Weeds programme.

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Welcome Hester Williams

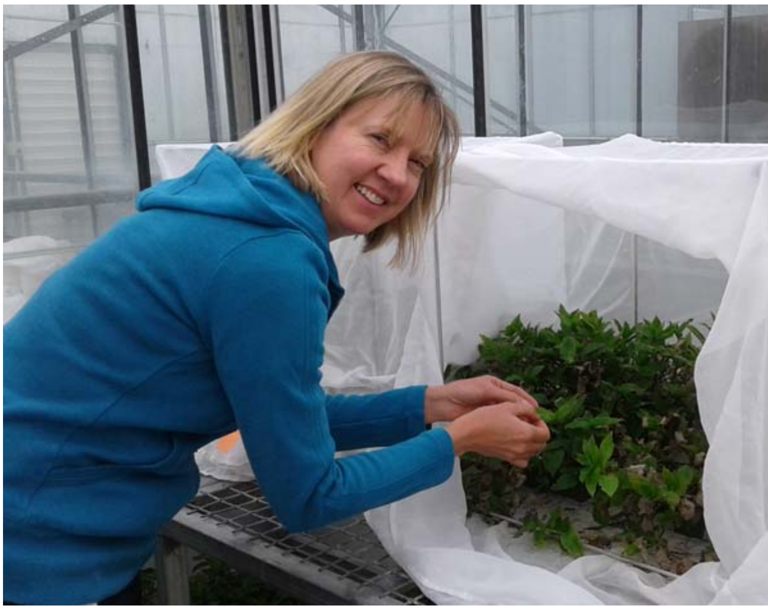
We are very pleased to introduce a new PhD student, Hester Williams, who is based at Landcare Research in Lincoln. In 2007, South African-born Hester and her husband moved to Canada, but are now pleased to have settled in Christchurch where they have close relatives. Hester has been awarded a scholarship through Auckland University and the Ministry of Primary Industries to develop strategies to eradicate invasive insect species at the early stage of invasion.

The idea behind her research is that biocontrol agents released in New Zealand can act as a proxy for invasive insects. "Sometimes insects arrive in New Zealand unintentionally but the factors that govern whether they establish and how quickly they spread have rarely been studied under field conditions," said Hester. "Basically I will be looking at why small populations of certain species do not establish. Apart from environmental factors, there may be other intrinsic factors that affect population growth or make it difficult for small populations to survive (Allee effects), such as genetic diversity, that can affect establishment in a new country," explained Hester.

The early stages of establishment are critical but more often than not we don't get a chance to study newly established insect pests because they go undetected until they are widespread. By this time, eradication can be very difficult. Some of the factors affecting the establishment of newly arrived insects include the presence of predators and competitors, environmental conditions, host-plant quality, and the age structure and genetic diversity of the founder population.

"By using a range of field experiments I hope to show which factors and conditions are the most likely to result in establishment of founder populations," said Hester. "Ironically, once the populations have established, I will be looking at methods to eradicate them using techniques that will lower the population level to a critical level (below the Allee threshold where the population will go extinct). This can be done, for example, by removing a proportion of the host plant, altering the host plant distribution to create a fragmented resource or by manipulating predation rates," Hester said.

Although the finer details of Hester's studies are still to be decided, it is likely she will use biocontrol of tradescantia (*Tradescantia fluminensis*) as a model system and look at the key factors that affect establishment and extinction of small founder populations of the beetles that have recently been introduced as biocontrol agents to manage this plant. "One of the things that makes tradescantia a good host plant to work with is that the agents are not yet widespread – so it is still possible to find areas that are not under attack to conduct experiments," Hester added.



Hester Williams

In addition to these experimental approaches, Hester will also undertake a detailed quantitative review, using data mining, of the successful and failed releases of biological control agents, to identify the key factors that could be used to predict successful and unsuccessful 'invasions' and cases where temporary establishment occurred but agents subsequently went extinct. Hester is not new to the field of biological control and spent the early part of her career working as a biocontrol researcher at the Plant Protection Research Institute of the Agricultural Research Council in Pretoria, South Africa. Much of her work focused on the biocontrol of lantana *(Lantana camara)* and cat's claw creeper *(Macfadyena unguis-cati),* an invasive climber from South America. Both of these plants are in New Zealand as well, and while lantana is already the focus of biocontrol in New Zealand, cat's claw creeper is classified as an unwanted organism and is expected to become a more widespread problem in New Zealand in future. She might well come across these old enemies at some stage in New Zealand. "At the start of my career, I couldn't decide whether I preferred working with plants or animals but as it turned out I got to work on both!" said Hester jokingly. "But what I enjoy most is the combination of field and lab work," she added.

Hester's PhD project is part of the new 'Urban Eradication' programme funded by the Ministry of Business, Innovation and Employment (MBIE) programme. Hester is being supervised by Darren Ward and Mandy Barron (Landcare Research) and Ecki Brockerhoff (Scion).

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Summer Activities

Summer is a busy time in the world of biocontrol. Some activities you may need to schedule are listed below.

Boneseed leafroller (*Tortrix* s.l. sp. "*chrysanthemoides*")

- Look for feeding shelters made by caterpillars webbing together leaves at the tips of stems. Also look for 'windows' in the leaves and sprinkles of black frass. Small caterpillars are olive green in colour and become darker, with two parallel rows of white spots as they mature.
- Caterpillars can be harvested if you find them in good numbers. Cut off infested boneseed tips and wedge them into plants at new sites. Aim to shift at least 500 caterpillars to sites where scale insects and invasive ants are not known to be present.

Broom gall mites (*Aceria genistae*)

- Check for galls, which look like deformed lumps ranging in size from 5 to 30 mm. Very heavy galling, leading to the death of bushes, has already been observed at some sites.
- Harvesting of galls is best undertaken from late spring to early summer when predatory mites are less abundant. If galls are present in good numbers, aim to shift at least 50 to each site and tie them on to plants so the tiny mites can shift across.

Broom leaf beetles (*Gonioctena olivacea*)

- Look for beetles by beating plants over a tray. The adults are 2–5 mm long and goldish-brown (females) through to orangey-red (males), with stripes on their backs. Look also for greyish-brown larvae, which may also be seen feeding on leaves and shoot tips.
- The beetles can be harvested if you find them in good numbers. Aim to shift at least 100 beetles to sites that are not yet infested with gall mites.

Green thistle beetles *(Cassida rubiginosa)*

- Look for adult beetles, which are 6–7.5 mm long and green so they camouflage quite well. Both the adults and the larvae make windows in the leaves. Larvae have a protective covering of old moulted skins and excrement. You may also see brownish clusters of eggs on the undersides of leaves.
- It should be possible to harvest beetles at many of the older sites. Use a garden leaf vacuum machine and aim to shift at least 50 adults from spring throughout summer and into autumn. Be careful to separate the beetles from other material collected, which may include pasture pests. Please let us know if you discover an outbreak.

Privet lace bug (*Leptoypha hospita*)

- Although it is early days it might be worth checking release sites to look for any signs post winter. Examine the undersides of leaves for the adults and nymphs, especially leaves showing signs of bleaching.
- It is likely to be too soon for any harvesting to begin.

Tradescantia leaf beetle (*Neolema ogloblini*)

- Look for the shiny metallic bronze adults or the larvae, which have a distinctive protective covering over their backs. Also look for notches in the edges of leaves caused by adult feeding, or leaves that have been skeletonised by larvae grazing off the green tissue.
- The beetles can be harvested if you find them in good numbers. Aim to collect and shift 50–100 beetles using a suction device or a small net.

Tradescantia stem beetle (*Lema basicostata*)

- The black knobbly adults can be difficult to see so look for their feeding damage, which consists of elongated windows in the upper surfaces of leaves, or sometimes whole leaves consumed. Also look for stems showing signs of larval attack: brown, shrivelled or dead-looking.
- If you can find widespread damage, you can begin harvesting. If it proves too difficult to collect 50–100 adults with a suction device, remove a quantity of the damaged material and put it in a wool pack or on a tarpaulin and wedge this into tradescantia at new sites (but make sure you have an exemption from MPI to do this).

Tradescantia tip beetle (*Neolema abbreviata*)

- Look for the adults, which are mostly black with yellow wing cases, and their feeding damage, which like stem beetle damage, consists of elongated windows in the leaves. Larvae will be difficult to see inside the tips, but brown frass may be visible. When tips are in short supply, the slug-like larvae feed externally on the leaves.
- The beetles can be harvested if you find them in good numbers. Aim to collect and shift 50–100 beetles using a suction device or a small net.

National Assessment Protocol

For those taking part in the National Assessment Protocol, summer 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

Target	When	Agents
Broom	Dec–April	Gall mite (Aceria genistae)
Privet	Feb–April	Lace bug (Leptoypha hospita)
Tradescantia	Nov–April	Leaf beetle *(Neolema ogloblini)* Stem beetle *(Lema basicostata)* Tip beetle *(Neolema abbreviata)*
Woolly nightshade	Feb–April	*Lace bug (Gargaphia decoris)*

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