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Manaaki Whenua
Landcare Research

Weed Biocontrol

WHAT'S NEW?

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Great Results in the Cook Islands

The technical advisory group for the Cooks Islands Biocontrol Project met in Rarotonga in June, which gave Quentin Paynter an opportunity to visit and assess the performance of the agents recently released there to combat a variety of invasive weeds. He was excited by some of the results visible already. He returned in early November with colleagues to run a training workshop by which time even further progress towards the goal of controlling six serious weeds was evident.

The most spectacular is a rust fungus (*Puccinia archavaletae*) released in December 2017 against grand balloon vine (*Cardiospermum grandiflorum*). This plant was rampant there, but the rust has quickly knocked the weed hard. Analysis of 20 photo points set up at release time indicated that by June 2018 grand balloon vine percentage cover had declined by 90%. Both native and exotic plants have benefited from balloon vine control, although the greatest increase was recorded for another biocontrol target, mile-a-minute (*Mikania micrantha*).

"Grand balloon vine is often intertwined with this other weedy climber, so the impact isn't yet that obvious to the casual observer," said Quentin. However, hopefully this will be short-lived, as another rust (*Puccinia spegazzinii*), released on mile-a-minute, although slower to get going is now becoming widespread on Rarotonga. If the impacts of *Mikania* rust are similar to those reported from Vanuatu and elsewhere, there should be comprehensive control of the plant starting to happen in the next couple of years throughout Rarotonga.

"We always knew that removing just one of the weedy vines would not be enough, which is why we tackled the three main invasive vines in Rarotonga," said Quentin. The third vine targeted is red passionfruit (*Passiflora rubra*). The red postman butterfly (*Heliconius erato cyrbia*), released against this plant in 2016, has also already had a noticeable impact. "In June we found around 60% of the stem tips we examined had been attacked by the larvae of this butterfly, and that in some localities the adults are extremely abundant," said Quentin.

Fears resulting from early reports of female butterflies laying eggs on edible purple (also known as black) passionfruit (*Passiflora edulis*) have been allayed after only 1% of leaf tips of purple passionfruit examined had either an egg or early instar larva present on them. "This is likely to be what we call 'spill-over' attack, where there are such high numbers of butterflies that they try to lay eggs on nearby plants even if there is little or no chance of the larvae surviving," Quentin said. "No mature larvae were found on these vines nor any evidence of significant feeding damage, so it is unlikely to be having any effect on the plant or its ability to produce passionfruit," Quentin added. This is consistent with host range test results, which indicated that the edible passionfruit vines are toxic to the red postman larvae, which die before causing noticeable damage to the plants. Such spill-over damage is expected to decrease as the red passionfruit declines and the butterflies become less numerous.

There have also been good results with the cocklebur rust fungus (*Puccinia xanthii*), which is now widespread and has previously been observed to be causing reduced vigour of cocklebur (*Xanthium strumarium*). "We can also confirm that the first agent, a mite (*Colomerus spathodeae*), to be released for the African tulip tree (*Spathodea campanulata*) is well established and becoming widespread, dispersing more rapidly than expected. A second agent for this tree, a leaf-mining flea beetle (*Paradibolia coerulea*), is currently being developed by Iain Paterson from Rhodes University. We hope to submit an application to release this beetle in Rarotonga soon," confirmed Quentin.

The main involvement by Manaaki Whenua – Landcare Research in this 5-year project is due to end soon, but there will be some ongoing work for local experts to continue with under the guidance of Dr Maja Poeschko at the Ministry of Agriculture. The training workshop held in November was designed to train a wider group of locals to keep the good work going. Future activities needed include establishing more widely a scale insect (*Tectococcus ovatus*) released to control strawberry guava (*Psidium cattleianum*). The scale is currently only established in a localised area on Rarotonga and, given that natural dispersal of this agent will be slow, it will definitely require some help to become more widespread. Another key task will be to monitor and document the ongoing impact the biocontrol agents have over time, and to release the agents on other islands in the Cooks group.

"It is exciting that we are making serious inroads on the vines and trees that were starting to smother Rarotonga. We are thrilled with the results already, and our decision to hit multiple weed targets with a range of host-specific agents appears to have been validated," concluded Quentin.

As well as the biocontrol component to this project, a study into the appropriateness of targeting an eighth species, peltate morning glory (*Decalobanthus peltatus*, formerly *Merremia peltata*), has been completed. There were conflicting views on whether this invasive vine is native or introduced to the Pacific, and a molecular study has been undertaken to resolve this. Samples from across the Pacific have been analysed, and it was concluded that there is evidence that peltate morning glory has been present in the South Pacific for millennia, with additional introductions made more recently. This indicates that the vine is native to the Pacific region, including the Cook Islands, but it has also been moved around more recently by humans, suggesting there may be some truth to the rumours that American forces deliberately planted it as fast-growing camouflage during the second world war.

"It seems likely that peltate morning glory has become weedy in recent decades in some places because it thrives on human and other disturbance (including cyclones), although some studies have indicated that global change might be a factor, as elevated atmospheric CO_2 levels can favour the growth of woody vines over forest trees," said Quentin. "Although natural enemies may occur in other parts of peltate morning glory's native range that could potentially be introduced to reduce its vigour in the Cook Islands, I wouldn't recommend it at this stage without further studies," he added, noting that in an agricultural context peltate morning glory can be considered to be beneficial by some Cook Islands farmers as it is relatively easy to control and it smothers worse weeds.

This project is funded by New Zealand's Ministry of Foreign Affairs and Trade. We acknowledge the assistance of Dr Maja Poeschko and other staff at the Ministry of Agriculture in Rarotonga, and members of the Technical Advisory Group who have supported this project. Thanks also to everyone who provided samples of peltate morning glory.

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Balloon vine in December 2017 before the rust was released (top), visibly diminished 6 months later (middle), and virtually gone by November 2018 (bottom).

International Weed Biocontrol Symposium

In August, 203 weed biocontrol experts, representing 100 organisations from 25 countries, attended the 15th International Symposium on Biological Control of Weeds (ISBCW) at Engelberg in Switzerland. The first-ever ISBCW was held in Switzerland in 1969, and over the years this event has become the key forum for refining international best practice and developing new collaborations for weed biocontrol. Since weed biocontrol projects always involve an overseas component of work, such international collaboration is critical for every project, and this discipline is renowned for the generosity with which information and resources are shared willingly.

Europe has for many decades helped other parts of the world to develop biocontrol for weeds of European origin but is only just beginning to have the processes and support for the development of biocontrol for its own weeds. Agents have recently been released in Europe to attack Japanese knotweed (*Fallopia japonica*), Himalayan balsam (*Impatiens glandulifera*), and Sydney golden wattle (*Acacia longifolia*), and it is hoped other agents can be released against further targets soon. Further support for biocontrol in Europe will hopefully be boosted as people become aware of the benefits. A leaf beetle (*Ophraelia communa*), recently self-introduced to Europe, will hopefully help with this. The beetle is providing useful control of ragweed (*Ambrosia artemisiifolia*), leading to a substantial reduction in hay fever and other allergic symptoms experienced by many people in Europe. Ragweed pollen is down 85% since the beetle established.

Despite the strong history of international collaboration, the international weed biocontrol community has struggled since the Nagoya Protocol came into force in 2014. This is a supplementary agreement to the Convention on Biological Diversity aimed at the fair and equitable sharing of benefits arising from the utilisation of genetic resources. There were several presentations, lots of discussions, and a workshop on this topic. Each country that is a party to the agreement (currently 104) needs to figure out how it will implement the protocol. Many are not restricting access to genetic resources such as biocontrol agents, but others are, and it is taking some time to clarify the requirements and best-practice processes that will once again allow biocontrol agents to be freely shared. However, it is looking more hopeful that this situation is starting to improve. Key groups will continue to lobby for classical biocontrol agents to be treated as a special case since they are used for public good rather than commercial enterprise.

Participants at IBSCW2018. CABI

Although New Zealand is a small country, with a modest budget for weed biocontrol, it continues to more than hold its own on the international stage. Supportive legislation and stakeholders, relatively stable funding, and the dedication of a passionate group of researchers has seen New Zealand continue to steadily release new agents where other countries have struggled or stalled. The Kiwi team presented seven oral papers and six posters, as follows.

- Quentin Paynter gave a keynote address summarising insights arising from underpinning research undertaken in New Zealand, which has helped to both refine best practice and cut the costs of developing biocontrol programmes. This includes robust data-driven processes for choosing the best targets, and minimising wastage, through avoiding agents that are likely to be parasitised or subjected to heavy predation, or rejected unnecessarily because of non-target feeding damage which is simply an artefact of cage/indoor testing. Quentin also prepared a poster on the substantial achievements of the Cook Islands project (*see page 2*).
- Lynley Hayes, and collaborator Michael Day from Australia, spoke about weed biocontrol efforts in Vanuatu and outlined the new project now underway to develop further weed biocontrol programmes there (*covered in Issue 85*).
- Simon Fowler shared recent studies on the economics of biocontrol for St John's wort (*Hypericum perforatum*), ragwort (*Jacobaea vulgaris*), mist flower (*Ageratina riparia*), and alligator weed (*Alternanthera philoxeroides*) (*all covered in previous issues*). A key message was that even if you don't have a lot of data to work with, which is often the case, you can still do a surprising amount with it. He revealed that the $3 million invested in the four programmes evaluated to date delivers an astonishing $67 million in benefits to New Zealand annually.
- Ronny Groenteman outlined the new project to developing biocontrol for horehound (*Marrubium vulgare*), and the approach taken for handling the vigorous opposition from medical herbalists, which potentially could have derailed the project. Soon after ISBCW we heard that the Environmental Protection Authority had approved the release of the horehound moths (*more on this in the next issue*).
- Lindsay Smith presented a poster on pre-release screening of weed biocontrol agents for pathogens, which became mandatory in New Zealand in 1984 but (incredibly) is still

not a requirement in other parts of the world. Subsequent follow-up of agents released here pre-screening has fortunately not found any evidence that diseased agents were released (*covered in Issue 73*).

- Hugh Gourlay prepared two posters. The first outlined the challenges involved in attempting to develop an artificial diet for the Japanese honeysuckle stem beetle (*Oberea shirahatai*). This beetle can take up to 2 years to complete its life cycle, and it was hoped that an extra nutritious diet could help to speed that up, providing more beetles for release more quickly. However, it has proven too difficult to reliably produce beetles without deformations when using this approach. The second poster summarised the project to develop biocontrol agents for tutsan (*Hypericum androsaemum*), which has recently resulted in the release of a beetle (*Chrysolina abchasica*) and a moth (*Lathronympha strigana*) (*covered in Issue 80*).
- Hester Williams, who is undertaking a PhD at Auckland University but is located with the team at Lincoln, presented results from her study looking at the influence of low-density populations and Allee effects on biocontrol agents. Using the tradescantia leaf beetle (*Neolema ogloblini*) as a study organism, Hester found that establishment was better when larger numbers of beetles were released, and that predation may play a significant role in this.
- Graeme Bourdôt, of AgResearch, spoke about a joint project between AgResearch and Manaaki Whenua – Landcare Research, which found that, when the costs and benefits of biocontrol for nassella tussock (*Nassella trichotoma*) were modelled, this project appeared highly worthwhile (*covered in Issue 81*). This has resulted in a funding application to progress this work being submitted in August.
- Mike Cripps, of AgResearch, prepared a poster on the impact of the green thistle beetle (*Cassida rubiginosa*) on Californian thistle (*Cirsium arvense*) in New Zealand, which found that once densities of ≥10 larvae per shoot are achieved this beetle provides useful control (*see page 7*).
- Dilani Hettiarachchi, of Lincoln University, shared results from her PhD study in which she has looked at the importance of plant volatiles in host-plant selection by female green thistle beetles (*Cassida rubiginosa*). This beetle attacks a range of thistles in the Cardueae tribe, and this study found that as phylogenetic distance from the primary host (*Cirsium arvense*) increases, the beetles' preference for alternative hosts decreases for all factors tested: olfactory choice, feeding and oviposition preference.
- Seona Casonato, of Lincoln University, shared the findings of a student project she co-supervised, which compared two isolates of a fungus (*Sclerotinia sclerotiorum*). This fungus has been explored by AgResearch for a number of years as a potential bioherbicide for Californian thistle (*Cirsium arvense*), but challenges around ensuring reliable efficacy remain to be resolved. This study concluded that the two isolates could potentially be used together to overcome differences in the susceptibility of different genotypes of Californian thistle.

Other items from ISBCW of interest included the following.

- The possibility of using gene drives to control weeds (*see page 6*).
- A programme to develop biocontrol for yellow flag iris (*Iris pseudacorus*) has recently been initiated for South Africa, with the assistance of Belgian collaborators. Surveys in Belgium and Italy have uncovered two promising natural enemies, which are now being tested to determine their suitability: the iris flea beetle (*Apthona nonstriata*) and a flower-feeding weevil (*Mononychus punctumalbum*).
- Follow-up evaluation of a programme against parrot's feather (*Myriphyllum aquaticum*) in South Africa, a decade after the release of a leaf-feeding beetle (*Lysanthia* sp.), has found impressive results. The weed is now absent from most of the 56 sites monitored and only still weedy at two.
- Further agents will be sought for woolly nightshade (*Solanum mauritianum*) in South Africa, as the lace bug (*Gargaphia decoris*) and the flowerbud weevil (*Anthonomus santacruzi*) seem unlikely to exert sufficient control alone. This is a good opportunity for further collaboration on this target between South Africa and New Zealand.
- A study in Australia has found that observed severe dieback of blackberry (*Rubus fruticosus* agg.) there is associated with *Phytophtora* species. However, testing has shown that these pathogens are not sufficiently host-specific to use for biocontrol purposes.
- Follow-up evaluation of the impact of the white smut (*Entyloma ageratinae*) on mist flower (*Ageratina riparia*) in Australia has, like in New Zealand, found a major reduction in the weed with a corresponding benefit to native plant species richness and abundance.
- A workshop was held on biocontrol for grasses. Grasses were previously believed to be too difficult to target with this approach, but with recent work on projects such as giant reed (*Arundo donax*) showing what is possible, there is now increasing interest in targeting more grasses.
- The world catalogue, which has information about all weed biocontrol agents released so far, will be updated soon. It is available online at *www.ibiocontrol.org*. All ISBCW proceedings are also available on this website.

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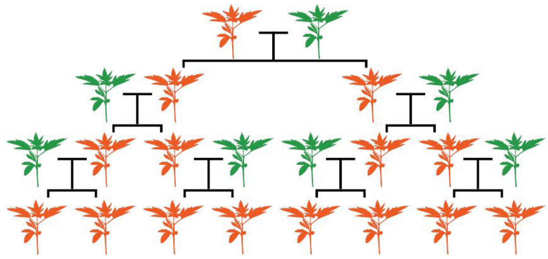
Could Gene Drives be Used to Control Weeds?

Better methods are needed for managing increasing numbers of unwanted pests worldwide, and the use of genetic modifications involving gene drives is being seriously considered. The idea behind a gene drive is to preferentially increase the frequency of selected genes throughout a target population, in this case genes that would be deleterious to the unwanted pest. Most naturally occurring genetic alterations are only inherited conventionally, and spread is generally linked to fitness advantages in nature, but the use of gene drives could change that.

The potential applications for gene drives has taken a leap forward since the development of a relatively easy genetic splicing technique, called CRISPR/Cas. In the US, New Zealand and Australia, regulatory authorities have opted to explore this line of research because of its theoretical potential, albeit with extreme caution. The CRISPR/Cas method enables genes to be automatically inserted into an organism's, DNA which can then be inherited by all offspring, even if it is present in only one of the parents. For example, genes determining sex expression could, after a number of generations, drive an entire population to be either male or female. The repetition of the gene expression in all progeny of subsequent generations is high because CRISPR/Cas acts as a selfish genetic element, altering the same genes on both paired chromosomes (see graphic).

The potential of this approach has triggered a wave of research into pest control applications. Rapidly reproducing pests, such as insects, are of early interest, because the desired trait can filter down through a population relatively quickly. Researchers overseas are proposing to use the technology to reduce the incidence of insect-borne diseases such as malaria and dengue fever by manipulating the sex ratio of mosquitoes.

The potential for using CRISPR/Cas gene drives to control weeds was raised at the recent International Symposium on Biological Control of Weeds by Andy Sheppard from CSIRO (Australia), who has been investigating the potential benefits. This approach requires understanding the functions of genes and therefore which ones to target. Weeds in agricultural settings are likely to be easier targets initially, since more is known about what genetic elements are responsible for dictating whether offspring are male or female. A gene drive could potentially result in a sexually biased population; for example, by driving the formation of male-only pollen so that female plants become locally extinct. The term 'population-suppression drives' has been coined to describe this line of research. Andy pointed out that the challenge would be to target genes that reduce population fitness without reducing individual fitness. Other applications could include reducing seed persistence or competitive ability, or altering resistance of weeds to common pathogens.



A gene drive quickly results in all progeny having the inserted gene.

Another avenue of research is to develop 'population sensitising drives', whereby genes that confer herbicide resistance are silenced, potentially reversing the increasing abundance of herbicide-resistant weed genotypes. Andy suggested that this may be more palatable to the general public or regulators since it targets genes that have already been artificially modified by human activities, returning the populations to ancestral herbicide-susceptible genotypes and allowing weeds to be better managed using approved chemical approaches. A lot of research has already focused on mutations that confer herbicide resistance, which could speed up gene drive development, giving this approach a potential head start. Other possibilities include manipulating the time it takes for seeds to mature so that weeds are not harvested with a crop and inadvertently moved around.

Despite its potential for some sexually reproducing agricultural weed species, others would not be suitable candidates. Andy suggested that weeds that reproduce vegetatively could not be targeted, and long-lived perennial weeds with a long-lived seed bank, such as gorse (Ulex europaeus), would also be challenging targets.

Despite its potential, the challenges facing the development of this technology are many. Public acceptability and the ability to manage the risks associated with releasing a self-replicating GM gene-drive system into nature are top of the list. Questions have been raised as to how quickly species in the wild could develop resistance to and nullify the gene-drive system. Other concerns relate to broad-scale implications associated with impacts on ecosystem processes and food webs.

Andy concluded by saying that the public acceptability of GM technologies and associated regulatory systems will need to radically change, and the risks of these new approaches and their management better understood, before any trials would be acceptable in countries like Australia and New Zealand (where GM technologies currently cannot be released). That is unless natural gene drive systems can be adapted. The main recognised research organisations interested in this type of research globally have agreed to an international full disclosure code of practice supported by national regulators, ensuring public awareness and accountability as research to explore the opportunities progresses.

How Effective is the Green Thistle Beetle?

Since its release in 2007, the green thistle beetle (*Cassida rubiginosa*) has been starting to make good progress towards reducing Californian thistle (*Cirsium arvense*) populations in many areas. It has also been making a good impression on the farmers who have been nurturing them. The beetle was first introduced by the lower South Island-based Californian Thistle Action Group, with the support of Manaaki Whenua – Landcare Research, with funding provided by the Sustainable Farming Fund (SFF). In 2014 another SFF project, co-funded by Beef + Lamb New Zealand, enabled the original project to expand. "The beetle has established in many areas of New Zealand, but a more concerted effort has been made recently to establish the beetle on high-country sheep and beef farms, where other control options are limited by the terrain," said AgResearch scientist Mike Cripps, who has been leading the SFF project.

"The grant has also enabled better dialogue with the farming community, and, importantly, has provided us with the capacity to collect quantitative data on the beetle's impact," Mike said. The farming community have been able to see first-hand the feeding damage on Californian thistle. "Each year of the project we established cages on three farms in Canterbury and three in the Manawatū, which each started with 50 beetles. This enabled the farmers to see for themselves what impact the beetles could have on the thistle population," said Mike. The defoliation rates were higher than expected from an initial population of 50 beetles, indicating good beetle reproduction, which is a prerequisite for successful establishment.

"Despite getting good reports back from the farming community, we were lacking robust data to evaluate their impact," explained Mike. "To remedy this, we have been testing the impact of beetle damage at a property in Scargill, North Canterbury, since 2015. We specifically looked at damage to the above-ground vegetation to see what effect that has on the plant in the following growing season," Mike said. The experimental areas were established with variable numbers of beetles. Either 5, 10, or 20 larvae per shoot were introduced, and the results compared with a control group where no beetle larvae were applied. This was replicated four times.

"Although results differed between years, overall it seems that the percentage of foliage damage was significantly greater in all beetle treatment groups compared with the control group, and that densities of ≥10 larvae per shoot are required to significantly reduce the density and spread of Californian thistle," Mike said. Shoots incurring greater feeding damage were less likely to become reproductive, but by late summer there was no longer any feeding activity by the beetle, and most of the shoots had senesced.

In the first year there was a long, dry period with lower than average rainfall. This stunted the growth of the plants, leading to fewer reproductive shoots and more pronounced effects on the thistle when the larval densities were high. "This suggested to us that rainfall is an important factor in determining the level of damage to the thistle," Mike said, adding that "other studies have also shown that moisture stress can enhance the effectiveness of biocontrol agents." This might also explain why the green thistle beetle has not performed well to date in the south where rainfall is higher. However, habitat factors such as the presence or absence of suitable overwintering sites for the beetle could also be involved, and further research is needed to explore this.

"Two field days were scheduled each year (one in the North Island and another in the South Island) as part of the SFF project. These were aimed at informing sheep and beef farmers about the project, as well as presenting initial results and observations from the field trial and cage release sites," said Mike. At the recent event, AgResearch provided farmers with a pamphlet containing basic information about how to identify the beetle and how to detect damage on the thistle. "We were also able to provide green thistle beetle starter kits containing live beetles to some of the participants from hill-country farms," added Mike.

Mike concluded by saying, "We know that thistle growth in one season directly influences growth in the following season, so it important for us to factor this into our experimental design." Future research is likely to move the monitoring to a broader scale, looking at the influence of different grazing regimes that could alter the competitive ability of pasture, adding to the effectiveness of the green thistle beetle.

Thanks to Tom Maxwell (sheep & beef farmer, Scargill, Canterbury), for allowing the field trial to be carried out on his property, and for hosting a field day on thistle biocontrol.

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AgResearch

Happy farmers with Mike Cripps and their green thistle beetle starter colonies.

Summer Activities

Broom gall mites *(Aceria genistae)*

- Check for galls, which look like deformed lumps and range in size from 5 to 30 mm across. 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. Aim to shift at least 50 galls to each site and tie them on to plants so the tiny mites can move across.

Darwin's barberry weevil *(Berberidicola exaratus)*

- Although it is early days for checking release sites, you could beat plants in late summer to look for new adults, which are small (3–4 mm long) and blackish. Also examine the fruits for signs of puncturing.
- It will be too soon to consider harvesting and redistribution.

Giant reed gall wasp *(Tetramesa romana)*

- Again, although it is early days it might be worth checking release sites this summer to look for swellings on the stems caused by the gall wasps. These look like small corn cobs on large vigorous stems, or like broadened deformed shoot tips when side shoots are attacked.
- It will be too soon to consider harvesting and redistribution.

Green thistle beetles *(Cassida rubiginosa)*

- December is often when green thistle beetle activity is at its peak. Look for adults, which are 6–7.5 mm long and green, which means 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 eggs on the undersides of leaves.
- If you find good numbers, use a garden leaf vacuum machine to shift at least 100 adults to new sites. Be careful to separate the beetles from other material collected, which may include pasture pests.

Japanese honeysuckle white admiral *(Limenitis glorifica)*

- Look for the adult butterflies at release sites over summer, the 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 pontoon-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 activities.

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 feeding damage and adults. For the leaf and tip beetles look for the external-feeding larvae which have a distinctive protective covering over their backs.
- If you find them in good numbers, aim to collect and shift 50–100 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 brasiliense)*

- Although the fungus was only released this past autumn, promising signs of likely establishment seen only a few months afterwards make it worth checking release sites this spring. Look for the distinctive yellow spots on the upper surface of the leaves, with corresponding white spots underneath, especially after wet, humid weather. Take a photo to send 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, you will need to have permission to propagate and transport tradescantia plants from MPI. 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)*

- Although the moths were only released last autumn, if you can't wait, 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.
- It will be too soon to consider harvesting and redistribution.

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 Anytime	Leaf beetle (*Neolema ogloblini*) Stem beetle (*Lema basicostata*) Tip beetle (*Neolema abbreviata*) Yellow leaf spot fungus (*Kordyana brasiliense*)
Woolly nightshade	Feb–April	Lace bug (*Gargaphia decoris*)

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