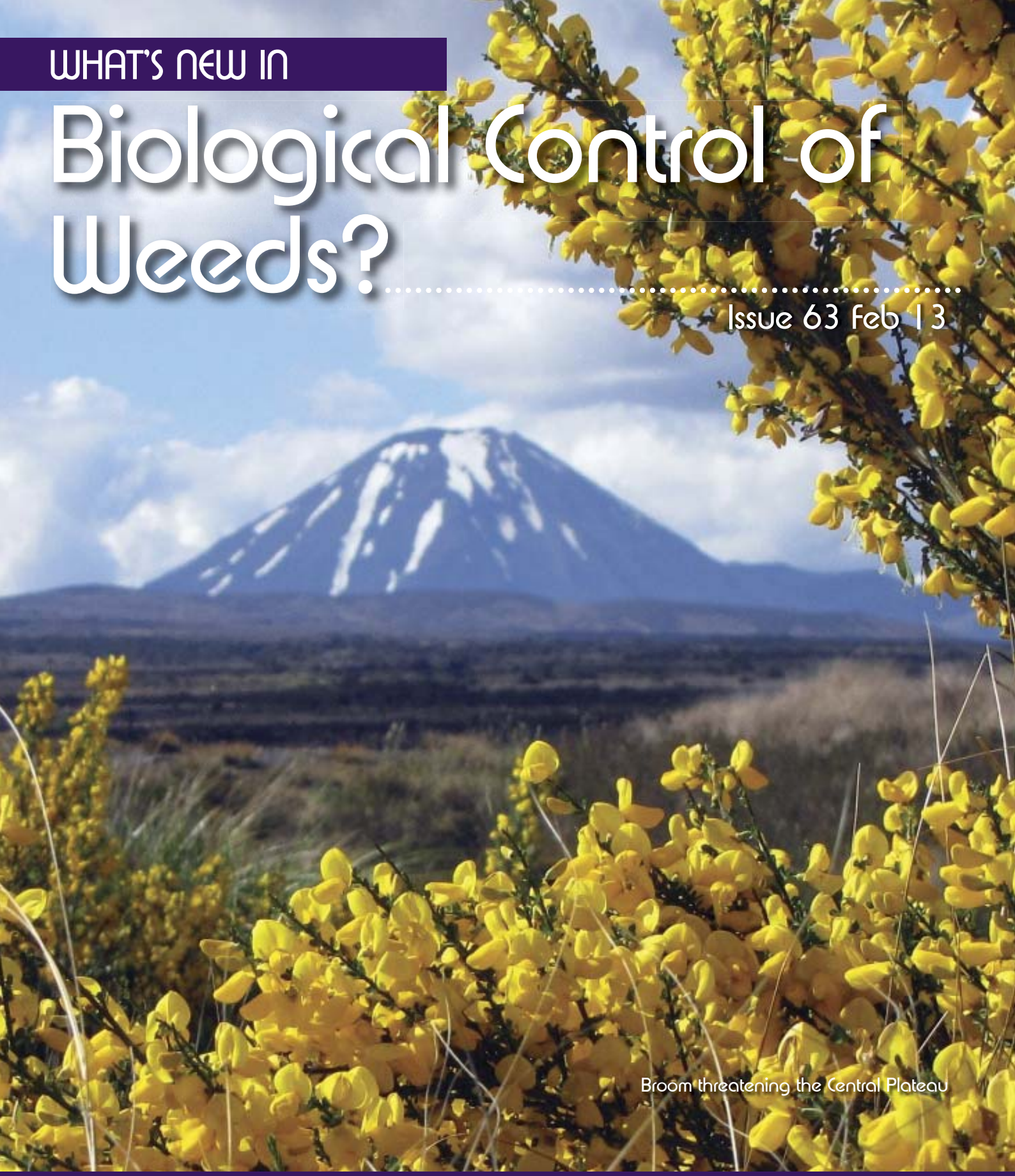
WHAT'S NEW IN

Biological Control of Weeds?

Issue 63 Feb 13



Broom threatening the Central Plateau

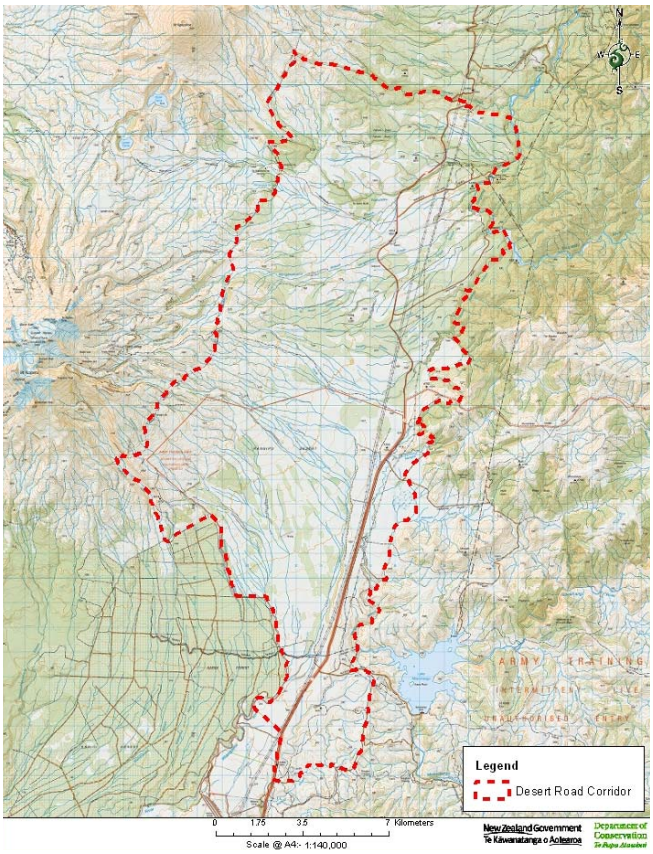
What's Inside?

Landcare Research
Manaaki Whenua

Protecting Biodiversity and Landscape Values on the Desert Road

Anyone with a keen eye for spotting weeds would have noticed that some undesirable plants have been gradually increasing along the Desert Road corridor between Taupo and Waiouru. Stopping the insidious spread of weeds across vulnerable landscapes, for which multiple parties are responsible, presents many challenges, which often means the weeds get the upper hand. A workshop was held recently at the Department of Conservation's (DOC's) Turangi office. The workshop was led by Richard Hill (Richard Hill & Associates) on behalf of Landcare Research, and brought together staff from eight organisations responsible for managing weeds along the Desert Road corridor. The objective was to determine whether there was a joint opportunity to limit the spread of leguminous weeds in the area before it is too late.

The northern section of the corridor forms part of Tongariro National Park and has a distinctive ecological and landscape character. This is New Zealand's oldest national park and now a world heritage site. The corridor includes the area known as the Rangipo Desert, which is a unique ecosystem containing volcanic dunes. Despite adequate annual rainfall (>1200 mm) the vegetation in the area remains low in stature due to the harsh winds, low humidity and coarse, sandy soils. Most of the native vegetation is in the form of tussocklands and dryland herbfields that support several threatened plants including *Pimelea microphylla.* Other exotic weeds being controlled by DOC and the army include: heather *(Calluna vulgaris)* and lodgepole or contorta pine *(Pinus contorta)*. While a biocontrol programme is in place for heather and showing some good results, it still poses a threat. Mouse-ear hawkweed *(Pilosella officinarum)* and marram grass *(Ammophila arenaria)* are also unwanted invaders.



The likely area of interest.

"The Desert Road has high natural values, both visually and in terms of biodiversity, but the integrity of the landscape is threatened by the spread of roadside weeds," says Richard. Vehicles appear to be one of the main pathways for weed invasion. The park has had a long history of recreational use and is a popular place for rock climbing, fishing, hiking and skiing in the winter. Seed is transported on the underside of vehicles or on tyres which also disturb the ground providing suitable conditions for seed germination. Not to mention the drivers of the vehicles who sometimes carry a variety of seeds on their socks! Most vehicles are linked with state highway traffic, army manoeuvres, hunting, skiing, and (in adjacent areas) beekeeping.

The corridor is primarily managed by DOC and the Waiouru Military Training Area. Over the past 40 years the NZ Defence Force has managed pests and weeds to protect key values in the area. Other organisations with an interest in managing weeds in the area who attended the meeting, included the NZ Transport Authority, Waikato Regional Council, Rotoaira Forest Trust, Horizons Regional Council, Transpower and Genesis Energy. Despite previous and current efforts of the associated agencies to control existing and emerging weeds, legumes remain the big threat. Tree lupin (*Lupinus arboreus*), gorse (*Ulex europaeus*) and broom (*Cytisus scoparius*) all produce vast quantities of seeds that remain viable in the soil for decades. The meeting aimed to build on existing collaborations to come up with a better plan of attack.

Richard outlined the principles that are important when dealing with a woody legume invasion at a landscape level:

- Once a long-lived seed bank has established, management plans must be sustained for decades.
- It is vital to eliminate outlying flowering plants before they contribute to a significant seed bank.
- Prevention provides a greater return on investment than local eradication, which in turn is more efficient than containment or management at a wider level.
- Apart from eliminating outliers, prevention involves managing pathways of seed transport.
- Legume weeds do not respect property boundaries. The answer to one stakeholder's problem may well lie outside its jurisdiction. Collaboration is therefore essential, because once one member of a community has a problem, all do.

Richard stressed that controlling the invasion of long-lived weeds with long-lived seed banks is a difficult prospect requiring:

- Spatially complex plans providing different solutions in different areas.
- Long-term planning that can survive changes in land management regimes and staffing.
- A single-minded and focused approach to operations.
- Commitment and goodwill from the community involved.

Quentin Paynter presented information about the biology and ecology of broom with particular reference to the Desert Road. Quentin said that, due to its long-lived seed bank, broom had the potential to change ecosystem dynamics, displace native species and to persist in the landscape for a long time.

All of the participants agreed to develop a long-term, coherent plan for managing woody legume weeds across this landscape, and discussed the best approach. The four priorities identified by the workshop were closing knowledge gaps, addressing management of invasion pathways, gaining community agreement and participation, and undertaking sustainable operational planning.

Lack of knowledge about the distribution and density of each weed across the landscape was seen as a big barrier to acting collectively. These weeds can be reliably distinguished from other shrubs when flowering, so obtaining high resolution images of infestations was regarded as a priority. These will allow the weed threat to be quantified across the landscape, outliers identified for priority action, and baselines set for measuring change. Ground exploration will be required to validate some imagery, and to determine how well it represents the state of invasion. Other knowledge gaps identified were:

- Limits to knowledge of the biology of the weeds, e.g. the ecology of tree lupin.
- The true role of woody legume weeds in succession and vegetation dynamics in this environment.
- The role of animals in dispersing seeds.
- Best control practice in light of good knowledge of weed ecology, existing and new technologies.
- How control tactics might affect future biodiversity and landscape values.

Invasion of uninfested land occurs through a variety of pathways, which will need to be managed. All potential pathways, high value sites or values that require priority protection, and sites that are of particularly high risk of invasion need to be identified and attention given to:

- Managing risks around access points.
- Hygiene measures to manage seeds on service vehicles and equipment.
- Better understanding of the role of beekeeping in the dynamics of these weeds.
- Better understanding the consequences of fire for broom invasion and being ready to monitor and manage resulting invasions.
- Managing watersheds to control outlying plants in headwaters that contribute to invasion downstream.

Finally, the participants agreed that a coherent long-term management plan will only succeed if it has the whole-hearted support of the local community. While gorse is generally perceived as a weed, the others are not, and as long as broom and tree lupin occur in just ones and twos in the environment the public is unlikely to appreciate their real threat. Early involvement of the community was seen as vital to promote information-sharing and behaviour change, such as early removal of outlying plants. There is a clear role for local businesses as well as tramping clubs and other organisations that make up the community of interest.

Since this workshop the participants have begun the planning process by obtaining aerial photos and data on the weeds' distributions. A further meeting is planned to develop governance structures, a common vision, to discuss options for delivering that vision, and to discuss avenues for future funding. It will be a big challenge to put together a plan that will last the decades necessary to beat these weeds. We can only hope that something that started as a modest workshop will lead to a powerful joint initiative that can save the unique values of the Desert Road, and serve as a model for others facing similar challenges.

The workshop was organised with the assistance of Horizons and Waikato Regional Councils, with funds from an Envirolink Small Advice Grant (HZLC89) awarded to Horizons Regional Council.

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Staff Changes

Sarah Dodd

Our plant pathologist Sarah Dodd has recently left our Auckland office for a more tropical life in Vanuatu for the next 3 years with her husband and family. Sarah will be continuing to do some work for us from afar and will put her skills to use in the Pacific. One project Sarah will be helping us with is sampling Pacific kauri trees (*Agathis macrophylla*) in Vanuatu for *Phytopthora* disease, as part of our project to understand how kauri collar rot has come to affect kauri trees (*Agathis australis*) in New Zealand. The kauri collar rot is thought to have been introduced to New Zealand but it is uncertain where this disease originates from. Previously Sarah was able to visit the island of Efate with forestry staff where they found two dead trees. *Pythium* (a close relative of *Phytopthora*) was isolated from the samples but no *Phytopthora*. Sarah hopes to organise sampling next on the island of Santo, which is thought to be the source of introductions of the Pacific kauri to New Zealand in the 1950s.

"Other projects I am hoping to become involved with include an Australian-funded weed biocontrol programme in Vanuatu run by Michael Day (Biosecurity Queensland)," says Sarah. Like, all Pacific islands Vanuatu has some fairly serious weed problems. Other possibilities include working with Miriam Seth at Vanuatu Livestock and Quarantine to help her set up a plant pathology laboratory that can provide basic services to the horticultural and forestry industries there. Sarah has taken over some essential items like a pressure cooker and an element so that Miriam and her team can sterilise their equipment, generate sterile water and make basic agar medium for culturing. She is also providing a digital camera so that Miriam can take pictures of disease symptoms on other islands (Vanuatu is made up of 81 islands) that can then be used to help diagnose plant diseases.

Sarah can still be contacted via her Landcare Research email address: dodds@landcareresearch.co.nz

Maj Padamsee

Some of Sarah's work, which she cannot undertake remotely from Vanuatu, will be picked up by Mahajabeen (Maj) Padamsee. Maj was trained as a fungal biologist at the University of Minnesota, USA. She worked as a postdoctoral fellow on the "Assembling the Fungal Tree of Life" project where she discovered her fascination with the plant pathogenic rust fungi. Maj was excited by the opportunity to work on the phylogenetics of the New Zealand rust fungi and started as a post-doctoral fellow at Landcare Research in 2010. The most commonly used group of fungi used in weed biocontrol are rusts, so we are extremely fortunate to have a rust expert to join our team, especially since we will be importing the lantana rusts (*Prospodium tuberculatum, Puccinia lantanae*) into containment shortly to allow releases to get underway. Outside of work Maj spends a lot of time walking her dog and tramping.

To contact Maj email her on padamseem@landcareresearch.co.nz or Ph 09 574 4171.

Chantal Probst

Our plant pathology technician Daniel Than left us last year to work for Biodiscovery, and Chantal Probst has now stepped into this role. Chantal is originally from Switzerland. She completed a Bachelor's degree in cellular biology and physiology and a Master's degree in plant biology and plant products, with an emphasis on plant pathology, in France. She then undertook a PhD at Lincoln University on the epidemiology and identification of *Cylindrocarpon* black foot disease in grapevines. After submitting her thesis, Chantal worked for the Ministry for Primary Industries in the Mycology and Bacteriology team for five months and then in the Virology team for six months before moving to Landcare Research. Chantal is involved in a number of projects including one to better understand the role of plant endophytes and the impact they have on weed biocontrol projects. In her spare time Chantal loves gardening, taking to the hills and meeting up with friends.

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Maj Padamsee

One Introduced Species Helping Another

Fruit-infesting insects that survive passage through the digestive tract of fruit-eating (frugivorous) vertebrate species are not that common, and there is debate as to whether these plant–insect–disperser 'triads' have co-evolved or not. Most of the recorded 'triad' cases are in captive conditions involving birds and mammals, with only few cases reported in the wild. However, in the course of their work in Central Otago, Landcare Research scientists Carlos Rouco and Grant Norbury came across an unusual example of a plant–insect–disperser triad in the wild involving sweet briar (*Rosa rubiginosa*), a rose seed wasp (*Megastigmus aculeatus*), and possums – all introduced species in New Zealand.

Sweet briar is an extremely invasive wild rose species affecting dry areas of South Island hill country. Infested land has a greatly reduced stock carrying capacity. This prickly plant was first recorded growing as a garden plant in 1835 and by 1900 had been classified a noxious weed. The seed wasp was probably introduced to New Zealand at the same time as sweet briar. While the wasp can be commonly found attacking sweet briar here, infestation rates are too low to have any noticeable impact on the plant. Biological control for sweet briar was explored in the 1960s but the project was terminated, without releasing any control agents. There were a number of reasons for abandoning the project, including the challenge of finding suitable agents that would not harm the large number of horticulturally important related plants, and the logistics involved in undertaking the necessary safety testing to prove this.

Sweet briar blooms from November to January and the bright red rose hips last from February–March through until August–September. Adult female seed wasps lay eggs inside the hips when the fruit begins development just after petal-fall (late February–May). The wasps overwinter as mature larvae within the seed, and emerge as adults in January–February. Other researchers had suggested that the wasp may survive gut passage through small- to medium-sized mammals, but this had not been recorded in the wild.

As possums in dryland areas are known to like eating rose hips, Carlos and Grant decided to collect possum faecal pellets to assess emergence rates of adult wasps from seeds in the pellets, and compare this with emergence rates from uneaten seeds. "As it takes about 50 hours for the seeds to pass in one end of a possum and out the other we expected this would compromise the viability of the seeds and hence the survival of the wasps," explained Carlos. By February, 146

Possum pellet showing seed wasp emergence holes.

adult wasps had emerged from 700 possum pellets that had been collected. A high proportion (88%) of pellets contained rose seeds and 19% of pellets were infested by wasps. By comparison, 42% of unconsumed rose hips were infested by wasps. Nearly 7% of seeds within these fruits were infested, which was significantly higher than in seeds in possum pellets (4.7%). However, contrary to expectations, survival of adult wasps in unconsumed fruit was no higher than in seeds that passed intact through the possums' digestive system (85%).

Because the wasp has very limited flight capacity, some researchers believed birds eating infested seeds played a vital role in dispersal. In New Zealand, blackbirds are the most widely distributed avian seed disperser but they mainly disperse seeds over short distances of 50–100 m, and only occasionally over longer distances. By comparison, possums in the dryland study area have home ranges up to 54 ha and would therefore potentially spread the wasp much further. However, because of the low prevalence of seed infestation in both fruits and possum pellets, Carlos and Grant believe the wasps are unlikely to reduce the spread of sweet briar. "Because all three players involved in this triad are introduced species, their interdependence could not have co-evolved; instead the relationship is simply a fortuitous one derived from the wasps' pre-existing ability to conceal themselves inside seeds and survive vertebrate ingestion and gut passage," concluded Grant.

Rouco C, Norbury GL 2013. *An introduced species helping another: dispersal of a rose seed infesting wasp by a marsupial in New Zealand.* Biological Invasions. doi: 10.1007/s10530-013-0415-1

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New Technology Helps Control 'Wilding' Pines

Recent advances in wilding tree control allow operators to work from the air, which is more cost effective and efficient than dropping off crew at individual trees. "The new technology reduces the need to deliver staff, armed with chainsaws, by helicopter to control individual outlying trees in remote areas," says Stefan Gous from Scion, who has played a key role in developing the new techniques.

The term 'wilding trees' generally refers to conifers that regenerate naturally, spreading into grassland or shrubland. Many of these species were actively planted for erosion control in the past. The most common method of spread is from exposed take-off sites, where the prevailing winds allow seed to be blown into nearby habitat. The main culprits are lodgepole or contorta pine *(Pinus contorta)*, Corsican pine *(P. nigra)*, European larch *(Larix decidua)* and Douglas fir *(Pseudotsuga menziesii)*. Many of these species were actively planted for erosion control in the past.

Wilding conifers are a problem primarily in the Marlborough Sounds, the South Island high country and the central plateau of the North Island, but are also invading natural habitats in Otago and the Mackenzie Basin. Because these trees grow in dense stands, and are not able to be managed as a plantation would be, they have no economic value. Instead, wildings reduce the value of managed pasture, displace native biodiversity and alter the character of the landscape. The impacts of wildings on productive land and on conservation values are well documented but control programmes present a number of challenges. As well as the sheer scale of the problem some of the areas affected by wildings are remote and difficult to access, making it a dangerous and costly exercise to reach them.

Spraying wilding trees with a specially designed gun.

As with other invasive species in New Zealand, pines have a competitive advantage here. In their native range, pines are pioneer species and are efficient colonisers but have insect seed predators that have a big effect on seed viability. In contrast, New Zealand has few bark borers, wood borers or seed predators adapted to living on *Pinus*, which is partly why the forest industry is so successful. Biological control was considered at a workshop attended by affected stakeholders in 2003, and the availability of some highly specific seed-feeding potential control agents was noted. However, it was also clear that there were a lot of questions about the potential safety and usefulness of biocontrol agents. In particular concern was expressed that if the serious disease, known as pine pitch canker (*Fusarium circinatum*), was ever accidentally introduced to New Zealand biocontrol agents might exacerbate the situation by spreading it around. Along with the feeling that the battle could still be won with existing tools (subject to sufficient funding and skilled operators) biocontrol was not pursued further, and instead efforts went into improving existing tools.

The new technology developed by Scion has involved developing a suitable cocktail of herbicides that have good penetration, uptake by the plants and mortality rates. "A combination of triclopyr and paraffin oil has been tested and is showing great results," says Stefan. Up to 85% mortality has been seen in trees treated this way. Another advantage of this herbicide is that it can be applied outside of the growing season of the pines. The key to applying it is in the specially designed gun with a 1.5-m wand that can be operated from within a helicopter. The wand enables operators to spray the crown of the tree thus minimising the effects on surrounding vegetation. By eliminating the need to fell the trees, there is no physical disturbance to the surrounding vegetation, therefore reducing the chances of secondary weeds moving in such as gorse or broom. "The Department of Conservation is already using the new spraying system with success and expect there will be a significant reduction in operating costs as a result," confirmed Stefan.

This project is funded by the Ministry of Business, Innovation and Employment as part of Landcare Research's Beating Weeds Programme.

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Autumn Activities

There are a few things you might want to fit in before the wind-down towards winter. We would be very interested to hear about what you find.

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

- Check release sites 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.
- Any harvesting of caterpillars should be left until spring.

Broom gall mites (*Aceria genistae*)

- Check release sites for galls, which look like deformed lumps and range in size from 5 to 30 mm across. Occasionally galls can be found on broom that are not made by the gall mite, but these are much less dense. We are happy to help confirm the identity of any galls you find.
- Harvesting of galls is best left until spring when predatory mites are less abundant.

Gall-forming agents

- Early autumn is the best time to check release sites for many gall-forming agents. If you find large numbers of galls caused by the mist flower gall fly (*Procecidochares alani*) and hieracium gall wasp (*Aulacidea subterminalis*) you could harvest mature specimens and release them at new sites.
- Do not collect galls caused by the hieracium gall midge (*Macrolabis pilosellae*) as this agent is best redistributed by moving whole plants in the spring.
- At nodding and Scotch thistle gall fly (*Urophora solstitialis* and *U. stylata*) release sites 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 bags on fences and over winter the galls will rot down allowing adult flies to emerge in the spring.
- At Californian thistle gall fly (*Urophora cardui*) release sites look 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.

Gorse pod moth (*Cydia succedana*)

- Autumn is a good time to check pods for creamy-coloured caterpillars and/or their granular frass, as gorse seed weevil (*Apion ulicis*) is not present to confuse you. You may also see small entry/exit holes in the pod wall.
- This agent is widespread but can be redistributed by moving branches of infested pods if you find areas where it is not present.

Nodding thistle flower infested with *Urophora solstitialis*. Note the shiny white pappus hairs remain attached.

Tradescantia leaf beetle (*Neolema ogloblini*)

- Check the older release sites. 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. You may see the dark metallic bronze adults but they tend to drop or fly away when disturbed. It may be easier to spot the larvae, which have a distinctive protective covering over their backs. The white, star-shaped pupal cocoons may be visible on damaged foliage.
- We would not expect you to find enough beetles to be able to begin harvesting and redistribution just yet.

Tradescantia stem beetle (*Lema basicostata*)

- Check the older release sites. The black knobbly adults may be hard to spot as they also tend to drop or fly away when disturbed. They chew elongated windows in the upper surfaces of leaves and sometimes consume entire leaves. The larvae are inside the stems so look for signs of their feeding (collapse and necrosis of stems) and brown frass.
- We would not expect you to find enough beetles to be able to begin harvesting and redistribution just yet.

Woolly nightshade lace bug (*Gargaphia decoris*)

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

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Heat Turned Up on Chilean Weevils

Since our last article on Darwin's barberry (*Berberis darwinii*) back in August 2011 (Issue 57), the Environmental Protection Authority (EPA) has given approval to release two weevils that attack this invasive species. The application to release the first biocontrol agents to be used against Darwin's barberry anywhere in the world was put forward by Environment Southland on behalf of the National Biocontrol Collective. With that hurdle out of the way the next step was to begin mass-rearing and releasing the two weevils. The seed weevil *(Berberidicola exaratus)*, as its name suggests, lays eggs inside barberry fruit with larvae feeding on the seeds. The flower bud weevil *(Anthonomus kuscheli)* lays its eggs in the new barberry flowers. Lindsay Smith, who is leading the project, has noticed that feeding by adult flowerbud-feeding weevils significantly damages new flowers on potted barberry in containment. But he said, "It's the larvae that will really deal to the flowers – eating the entire contents of the flower and then pupating in the remaining capsule."

Our colleague Dr Hernán Norambuena, who undertook the weevils' host range safety testing in Chile, collected populations of the weevils from their native range in central to southern Chile and delivered them to Lincoln in October last year. Hernán's visit was made possible thanks to an AGMARDT fellowship that will allow to him to come to New Zealand twice to assist with the project. "Hernán has been helping to fine-tune the weevil rearing, and his expertise has been extremely valuable," said Lindsay.

The weevils must initially come into containment and be reared through one generation there. This is so we can check for disease and any parasitoids that might have come along for the ride. However, synchronising the arrival of the weevils in New Zealand with the flowering of potted plants in containment has proved challenging. Despite starting out with a large number of Darwin's barberry plants, few of them have cooperated, either refusing to grow in pots or to flower. "It is interesting how difficult it can be to deliberately grow some weeds!" commented Lindsay. So in the end there were only a limited number of flowers available to the newly imported weevils and even fewer fruits and seeds. However,

Hernan Norambuena and Randall Milne (Environment Southland) discussing release sites for the new Darwin's barberry weevils.

supplementary feeding with cut flower stems and fruit seems to have worked and there are now larvae reaching maturity. "It was a great moment when I dissected my first weevil-infested barberry fruit in containment and found a large larva and all the seeds chewed on," said Lindsay.

The synchronicity issues have meant that there won't be enough weevils to begin releases this autumn, as initially hoped, so the plan is to now begin releases next spring. This also means that the weevil releases can be better timed to coincide immediately with the availability of flowers and fruits in the field, which will increase the likelihood of establishment. The lessons learnt this season should put us in good stead for greater success next spring. Further shipments from Chile next spring will also help to boost numbers available for release.

This project was funded by the National Biocontrol Collective. Dr Hernán Norambuena's Visiting Fellowship is funded by the Agricultural and Marketing Research and Development Trust (AGMARDT).

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