# Status of Weed Biological Control Agents in Southland

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# Summary


## Project and Client

This report on the status of weed biocontrol agents in the Southland Region was prepared for Environment Southland by Landcare Research in August 2007. The project was funded by the Foundation for Research, Science and Technology's Envirolink programme for small advice grants (ESRC118).

## Objectives

- To check the current status of the 23 species of weed biocontrol agents released in Southland during the past 23 years.
- To make recommendations about how biological control programmes could best be further developed in Southland.

## Methods

- Information from a Landcare Research database was used to compile a list of Southland release sites and was cross-checked with information held by Environment Southland. Updates on release sites were also provided by Environment Southland staff.
- Information about control agents that have not been released in Southland is included where relevant.

## Main Findings

- Of the 23 weed biocontrol agents that have been released in Southland during the last 23 years 10 are so far known to be established (broom psyllid, broom seed beetle, broom twig miner, gorse spider mite, gorse thrips, gorse pod moth, nodding thistle receptacle weevil, nodding thistle crown weevil, cinnabar moth, ragwort flea beetle), two established but their host plant has since been controlled (old man's beard leaf fungus, old man's beard leaf miner), two have failed to establish for unknown reasons (Californian thistle leaf beetle, Californian thistle flea beetle), two failed to establish because of sheep grazing and/or other control activities (Californian thistle gall fly, nodding thistle gall fly), and the fate of the remaining seven is currently unknown (gorse soft shoot moth, gorse colonial hard shoot moth, hieracium gall midge, hieracium gall wasp, ragwort crown-boring moth, ragwort plume moth, Scotch thistle gall fly).
- Of the agents that are established, probably only three species are widespread (broom twig miner, gorse spider mite, ragwort flea beetle) and no project is yet complete. For each weed target tackled to date there are still control agents that should be considered for release (see Recommendations below).

## Conclusions

- The establishment success of weed biocontrol agents in Southland is following similar trends to the rest of New Zealand. While the climatic conditions experienced in Southland could make it more difficult to establish some insect agents it does not appear to have been a major obstacle so far. A greater problem affecting establishment success has been other weed management activities that have resulted in a considerable number of release sites being destroyed.
- There has been a considerable investment made to date in developing biocontrol programmes for weeds in Southland but more will be required to complete projects and reap the benefits. Also, agents for new targets will continue to become available in the future.

## Recommendations

- Harvest and redistribute the broom psyllid, broom seed beetle, and gorse thrips to areas where they are not yet present. Check the distribution of the broom twig miner and gorse pod moth and if necessary shift them around too. Monitor gorse colonial hard shoot moth, gorse soft shoot

moth, hieracium gall midge, hieracium gall wasp, ragwort crown-boring moth and plume moth release sites to check for establishment and to see if any further releases or harvesting and redistribution activities are needed.

- Release the broom leaf beetle, broom shoot moth, broom gall mite, Californian thistle stem miner, green thistle beetle, hieracium hover flies and hieracium plume moth as soon as they are available. Make additional releases of the gorse colonial hard shoot moth, ragwort crown-boring moth, and possibly the Scotch thistle gall fly. It may be worth trying again to establish the Californian thistle gall fly on land which is not subjected to grazing.
- Take no further action to promote biocontrol for old man's beard unless the current DOC weed-led control project is unsuccessful. Likewise no further action against nodding thistle is required since the plant is now required to be controlled wherever it occurs.
- Take greater care with the selection of release sites and put in place increased measures to ensure their security to minimise wastage of agents.
- Continue to be an active member of the National Biocontrol Collective to ensure that work to develop biocontrol for targets of interest to Southland continues.

# 1. Introduction

This report on the status of weed biological control agents in Southland, New Zealand, was prepared for Environment Southland by Landcare Research in August 2007. The project was funded by the Foundation for Research, Science and Technology's Envirolink programme for small advice grants (ESRC118).

# 2. Background

Weeds threaten many of the landscapes and agricultural systems in New Zealand, and Southland is no exception. Biological control, where natural enemies (usually insects and fungi) are put to work against weeds, is a key strategy for managing serious widespread weeds, and may even be the only practical or sustainable approach (see Appendix 1). Consequently 23 species of weed biocontrol agents have been released in Southland by Environment Southland (ES) and the Department of Conservation (DOC) during the past 23 years. This report reviews progress achieved in developing biological control programmes in Southland to date and makes recommendations about the next steps that should be taken. We did not attempt to measure the impact of the control agents as such a study would require substantial resources over many years and was therefore beyond the scope of this project.

# 3. Objectives

- To check the current status of the 23 species of weed biocontrol agents released in Southland during the past 23 years.
- To make recommendations about how biological control programmes could best be further developed in Southland.

# 4. Methods and Data Sources

Landcare Research maintains a database about where weed biocontrol agents are released nationwide and their fate. Information from this database was used to compile a list of known release sites and their status, and this was cross-checked against a database that a Southland Institute of Technology student, Jesse Bythell, has been working on for Environment Southland. Environment Southland staff, especially Peter Ayson, provided additional information about the status of sites. Information about control agents that have not been released in Southland is also included where relevant. Dates are given in the form DD/MM/YY, MM/YY or Year.

# 5. Main Findings

## 5.1 Broom (*Cytisus scoparius*)

### 5.1.1 Broom twig miner (*Leucoptera spartifoliella*)

The broom twig miner is a stem-mining moth whose larvae damage broom by feeding on the stem tissues. When a large proportion of green material has been affected then bushes grow and flower less, and whole branches and even entire bushes may die. The twig miner is believed to have arrived in New Zealand accidentally about 50 years ago, and it is now common and widespread throughout most of the country. During the last 10–15 years some large outbreaks in the South Island have caused noticeable damage to broom plants, especially where the plants are under stress.

The broom twig miner was initially released in Southland in 1987, with additional releases made at a further six sites in the late 1990s. While no information is available about their fate at these sites, the twig miner is apparently now widespread in Southland and heavy damage to broom has been seen in some places (e.g. Mararoa). Surveys are needed to check if there are areas still free of the twig miner, where it would be useful to release the moth.

**Table 1** Broom twig miner release sites in Southland

| Site name | Grid reference/GPS | Date released | Date checked | Comments |
|---|---|---|---|---|
| Otautau, Holt Park, Dicksons Hill | NZMS1 S168 031 327 | 9/12/87 | | |
| Nokomai, Nokomai Station, 1242 Nokomai Rd | E2170640 N5506966 | 16/12/98 | | |
| Waikaia, Glenaray Station, Whitecomb Run | NZMS1 S152 958 185 | 14/12/87 | | |
| Waikaia, Glenaray Station, Whitecomb 1 | E2205871 N5520401 | 21/12/98 | | |
| Waikaia, Glenaray Station, Whitecomb 2 | E2205871 N5520401 | 21/12/98 | | |
| Waikaia, Glenaray Station, Dome Burn A | E2176291 N5498553 | 21/12/98 | | |
| Waikaia, Glenaray Station, Dome Burn B | E2176284 N5499721 | 21/12/98 | | |
| Te Anau Downs, Te Anau–Milford Rd, Quarry | E2103525 N 5543831 | 8/01/99 | | |

### 5.1.2 Broom psyllid (*Arytainilla spartiophila*)

The broom psyllid is a sap-sucking insect. Both adults and nymphs suck sap out of the tender new growth in spring. When populations are high the damage to new growth can be severe. This agent was released widely throughout New Zealand in the mid-1990s, established readily, and is gradually becoming common and widespread. Some damaging outbreaks have been seen but overall the psyllid has not yet lived up to expectations. This may be due to predation, but more studies are needed. Given the relatively short time that has elapsed since this insect was first released here, and the impact it has on broom in its native range, we should not yet discount the possibility that the psyllid may still make a contribution towards broom control.

The psyllid has established at the two sites it was released at in Southland, despite one being sprayed (Table 2). The psyllid appears to be doing extremely well at Mararoa and causing obvious damage to plants. This is possibly the site at which the psyllid has performed best in New Zealand so far. We do not believe that this insect normally disperses quickly, so it is unlikely that the psyllids are widespread in Southland. Surveys to check the distribution of the psyllid are needed and then a harvesting and redistribution programme should be undertaken.

**Table 2** Broom psyllid release sites in Southland

| Site name | Grid reference/GPS | Date released | Date checked | Comments |
|---|---|---|---|---|
| Hamilton Burn, Smith/ Affleck Rd, Hamilton Burn River Bridge | NZMS260 E44 362 804 | 23/11/95 | 12/03 | Site has been sprayed but still able to find psyllids here |
| Te Anau, Hillside Manapouri Rd, Mararoa/Whitestone Rivers confluence | NZMS260 D43 005 065 | 23/11/95, 13/11/97 | 12/06 | Still present in huge numbers and damaging young plants. Doing extremely well here |

### 5.1.3 Broom seed beetle (*Bruchidius villosus*)

The broom seed beetle is a seed-feeding insect. The larvae are the damaging stage and each larva attacks a single seed. This agent was released widely throughout New Zealand during the mid-1990s, has established readily, and is becoming common and widespread. Infestation levels have only been measured at a few sites to date, and have shown that the beetle is capable of destroying 80–90% of broom seeds in New Zealand. Modelling work suggests that at the very least this level of seed destruction should significantly slow the spread of broom.

The broom seed beetle has been released at a large number of sites in Southland (20) and appears to be establishing slowly (Table 3). Many of the sites are large infestations of broom and it may take a few more years before it is possible to detect the beetles at them. Four sites have been destroyed. This agent is believed to be a moderate disperser, and surveys are needed to check its distribution, but it seems likely that a harvesting and distribution programme would be useful.

**Table 3** Broom seed beetle release sites in Southland

| Site name | Grid reference/GPS | Date released | Date checked | Comments |
|---|---|---|---|---|
| Blackmount, Blackmount–Redcliff Rd, Redcliff Bridge | NZMS260 D44 940 880 | 28/10/99 | 28/11/06 | None found, failed |
| Bluff, Bluff Hill Rd, Water Works | NZMS260 E47 526 900 | 28/10/99 | 17/12/02 | None found |
| Colac Bay, Lake George, near Ward Rd turnoff | NZMS260 D46 155 155 | 27/10/99 | 15/12/03 | 85 beetles found |
| Dunsdale, Dunsdale Picnic Ground Rd | NZMS260 E45 694 436 | 28/10/99 | 30/10/06 | 72 beetles found |
| Ermedale, Ermedale Rd, South end between Pourakino Valley Rd & Omutu Rd (Longwoods) | NZMS260 D46 215 290 | 14/11/95 | 12/11/97 | Site sprayed, no broom left |
| Hamilton Burn, Smith/ Affleck Rd, Hamilton Burn River Bridge | NZMS260 E44 362 804 | 13/11/97 | 13/12/02 | Sites has been sprayed, no beetles found (were seen here previously) |

| Site name | Grid reference/GPS | Date released | Date checked | Comments |
|---|---|---|---|---|
| Manapouri, Hillside–Manapouri Rd, Home Creek Bridge | NZMS260 D43 920 028 | 4/11/99 | 28/11/06 | Ex Mararoa site, failed to establish |
| Monowai, Lake Monowai Rd, South side of cattle stop (Borland) | NZMS260 C44 885 785 | 28/10/99 | 28/11/06 | None found, failed |
| Nokomai, Nokomai Station, 1242 Nokomai Rd | E2170655 N5507108 | 11/03/98 | 29/12/03 | Infested pods ex John Keoghan, did not establish |
| Roslyn Bush, corner of Lorne–Dacre Rd (SH98) & Irving Rd (Potato) | NZMS260 E46 589 194 | 28/10/99 | 12/05 | 1 beetle found in 2002 but none in 2005, failed? |
| Sandy Point, Forest Block | NZMS260 E47 466 051 | 28/10/99 | 17/12/02 | None found |
| Te Anau, Hillside Manapouri Rd, Mararoa/Whitestone Rivers confluence | NZMS260 D43 005 065 | 14/11/95 | 28/11/06 | 25 beetles found |
| Te Anau Downs, Te Anau–Milford Rd, Dunton Creek | NZMS260 D42 095 485 | 28/10/99 | 12/05 | A huge area of broom. Some seen in 2002, but none in 2005 |
| Waikaia, Argyle Burn/Winding Creek Rd, Brighams Leap, Marginal Strip | E2190316 N5488308 | 3/11/00 | 5/12/06 | 2 beetles found |
| Waikaia, Glenary Station, Steeple Creek Rd, McIvors 3, South | NZMS260 F44 868 977 | 29/10/99 | 23/12/03 | Site destroyed 2003 |
| Waikaia, Glenaray Station, Whitecomb 1 | E4526954 N16907098 | 17/11/00 | 12/05 | None found |
| Waikaia, Glenaray Station, Whitecomb 2 | E4529666 N16907005 | 17/11/00 | 12/05 | None found |
| Waikaia, Glenaray Station, Whitecomb 3 | NZMS260 F43 066 222 | 25/2/02 | 12/05 | None found |
| Waikouro, Waikouro–Wairio Rd, NZ Rail access road | NZMS260 D45 219 469 | 12/11/97 | 25/11/02 | Site bulldozed (beetles found here previously) |
| Wallacetown, Iron Bridge (North-West Bank) | NZMS260 E46 453 209 | 28/10/99 | 19/11/03 | 1 beetle found |

### 5.1.4 New broom agents

The Environmental Risk Management Authority (ERMA) has recently approved an application by the Canterbury Broom Group to release two new broom agents in New Zealand. The first new agent is the broom leaf beetle (*Gonioctena olivacea)*. The adults feed on foliage and the larvae attack the leaves and stem tips. Newly hatched larvae are voracious feeders and their active period should coincide perfectly with broom regrowth after twig miner attack. Mass-rearing is now underway and the beetle is expected to be available for release from spring 2007. It is hoped that the broom leaf beetle will be released for the first time in Southland either later this year or next spring.

The second new agent is the broom shoot moth (*Agonopterix assimilella*), which is a close relative of the gorse soft shoot moth (*Agonopterix ulicetella*). The larvae feed on the leaves and kill off stem tips by ring-barking them. It is hoped that this moth will be available for release from spring 2008.

A third new agent, a gall-forming mite (*Aceria genistae*), did not need ERMA approval as it has already been recorded in New Zealand, but on gorse. Recent research shows that *Aceria genistae* includes a number of distinct strains, each of which is specific to one species of plant. We are certain that the mites we are introducing will only attack broom and are unlikely to interbreed with the resident strain. During winter the mites live in colonies inside the base of stem buds. In the spring, feeding by mites causes the buds to develop into green fleshy galls, about 5–30 mm across, instead of shoots. Unlike many insects that attack broom, the mite is believed to cope well with shade. It is hoped that releases of this mite will be made from spring 2008.

In their native range each of the new broom agents is known to severely affect broom plants from time to time. The moth and beetle can strip plants bare, so that no green growth remains above ground. By forming galls on successive years' growth the mites cause stunting, reduced flowering, and even kill whole bushes. We recommend that all three new agents are released at at least two sites in Southland as soon as possible.

## 5.2 Gorse (*Ulex europaeus*)

### 5.2.1 Gorse seed weevil (*Exapion ulicis*)

The gorse seed weevil attacks gorse seeds produced during spring/summer. The damage is caused by the larvae with each one attacking a single seed. The weevil was one of the first biocontrol agents to be released in New Zealand back in the 1930s. It established successfully and is now extremely common on gorse throughout most of New Zealand, except for the lower part of the West Coast (south of Hari Hari). Given that the weevil is already widespread in Southland, no further attempts to increase their distribution are needed.

### 5.2.2 Gorse pod moth (*Cydia succedana*)

The gorse pod moth also damages gorse seeds and, unlike the gorse seed weevil, is able to attack seed produced during autumn/winter as well as during spring/summer. The caterpillars destroy the seeds, with each one consuming the contents of 2–3 pods. This agent was released widely throughout New Zealand during the 1990s, has established well, and is now common and widespread. Attack by the moth has augmented the effect of the seed weevil in spring. In one recent study spring seed production contributed little to the annual seed crop as a result of the activity of these two agents. However, the amount of damage caused to the autumn/winter seed crop is not as high as hoped, typically around 10–15%. In many places seed produced at this time of the year forms the bulk of annual production, and so gorse pod moth has little overall effect. Recent research has suggested that this may be because in New Zealand the timing of the insect's life cycle (phenology) is not ideally aligned with the plants. As time passes selection pressure may see moth populations become better synchronised with the plant, in which case the percentage of seed attacked will rise.

The moth has been released at 14 sites in Southland but unfortunately nine of them have been sprayed or cleared (Table 4). Of the remainder the moth is known to have established at one (Knutsford Rd). The moth has also been found at Slaughter House Rd, which is a release site for other gorse agents (colonial hard shoot moth and gorse thrips), and it is likely that the moths have dispersed here from Knutsford Rd. This agent is considered to be a rapid disperser. It would be worth monitoring the release sites for which there is no information, and also checking for the presence of the moths in areas close to release sites as well as further beyond. It is likely that there will still be areas where the moth is not yet established, and that a harvesting and distribution programme would be useful.

**Table 4** Gorse pod moth release sites in Southland

| Site name | Grid reference/GPS | Date released | Date checked | Comments |
|---|---|---|---|---|
| Awarua Siding, Sec 29 Blk III, Campbelltown | NZMS260 E47 527 991 | 3/11/99 | 2002 | Site has been cleared |
| Bluff, Flagstaff Road | NZMS260 D47 529 900 | 8/10/98 | 2002 | No sign, failed? |
| Branxholme, Viner Rd, Crooks gravel | NZMS260 E46 462 267 | 3/11/99 | | |
| Clifton, Station Road extension | NZMS260 E47 530 066 | 3/11/99 | | |
| Dipton West, 372 Riversdale School Rd | NZMS260 E45 475 652 | 18/11/92 | 23/11/95 | Site has been bulldozed. Moths failed to establish |
| Hamilton Burn, 3251 Wreys Bush–Mossburn Rd/Roy Rd | E2138123 N5486014 | 3/11/99 | 3/6/03 | Site has been bulldozed |
| Ligar Creek, Borland Lodge Rd, Ligar Creek Bridge | NZMS260 D44 941 775 | 2/11/99 | 30/9/02 | Site has been sprayed but still some gorse there |
| Lillburn, 143 Lillburn Valley Rd, B | NZMS260 C45 860 525 | 2/11/99 | 3/6/03 | Site has been sprayed but still some gorse there |
| Mossburn, Reid-McCauley Rd | NZMS260 E44 380 868 | 3/11/99 | 2002 | Site has been sprayed |
| Nokomai, Nokomai Station, Nokomai Rd 2 | NZMS260 F43 720 090 | 3/11/99 | 2005 | Site has been sprayed |
| Otautau, 175 Knutsford Rd, Scout Camp | NZMS260 D24 214 437 | 23/10/96 | 4/2/04 | 10 infested pods found |
| Raymonds Gap, corner of Otautau–Tuatapere Rd & Lower Scotts Gap Rd | NZMS260 D45 178 448 | 3/11/99 | 2005 | 5 infested pods found in 2005 but site was later bulldozed |
| Sandy Point, Forest Block | NZMS260 E47 472 046 | 3/11/99 | | |
| Waikaia, Glenaray Station, Steeple Creek Rd, McIvors 3, North | NZMS260 F44 865 982 | 3/11/99 | 2005 | Site has been sprayed |

### 5.2.3 Gorse soft shoot moth (*Agonopterix ulicetella*)

The gorse soft shoot moth is a foliage-feeding insect. The caterpillars are the damaging stage and they feed on the new growth buds and soft tips in the spring. Each caterpillar can destroy up to five shoots. This agent was released widely throughout New Zealand during the early to mid-1990s. For many years it was thought that establishment success had been poor and that the insect was only hanging on in low numbers at a limited number of sites nationwide. In recent years large outbreaks of the moth have been noticed in Marlborough and Canterbury, giving much cause for optimism.

The moth has been released at six sites in Southland (Table 5) but its establishment status is not currently known. The moths appeared to establish at one site (Waikouro) that was later cleared. Three of the sites are too recent to know their fate, but checks could begin this spring (late November/early December) when the caterpillars are most obvious. If the moths cannot be found in a couple of year's time then pheromone traps could be used to confirm their presence or absence. If the moths become abundant in due course then it would be worth implementing a harvesting and distribution programme as they are not believed to disperse rapidly. Given that the moth is abundant in Canterbury and

Marlborough it may be worth collecting more caterpillars from one of these regions and making further releases in Southland this spring.

**Table 5** Gorse soft shoot moth release sites in Southland

| Site name | Grid reference/GPS | Date released | Date checked | Comments |
|---|---|---|---|---|
| Browns, 784 Limehills–Browns Rd | E2114779 N5444708 | 21/11/90 | 23/12/04 | No sign of the moths |
| Nokomai, Dredge Hole, Nokomai Stream | E2174386 N5512267 | 12/12/05 | | |
| Nokomai, The Gorge, Nokomai Stream | E2172859 N5510503 | 12/12/05 | | |
| Raymonds Gap, corner of Otautau–Tuatapere Rd & Lower Scotts Gap Rd | E2117375 N5444883 | 28/11/01 | 2003 | Site has been destroyed |
| Waikaia, Glenaray Station, Hind Block, Gows Creek 14 | E2190640 N5505302 | 12/12/05 | | |
| Waikouro, Waikouro–Wairio Rd, NZ Rail access road | NZMS260 D45 219 469 | 24/12/96 | 22/12/04 | Moths were found in traps in 2000 but site has since been bulldozed and none seen since |

### 5.2.4 Gorse spider mites (*Tetranychus lintearius*)

The gorse spider mite is a foliage-feeding invertebrate. Both the adults and juveniles have sucking mouthparts that extract the cell contents. Foliage takes on a bleached and later a brown appearance. When present in large numbers the mites can cause considerable damage. Growth and flowering is reduced but they rarely stay on gorse bushes long enough to kill them. This agent was widely released throughout New Zealand during the late 1980s and early 1990s. Initially the mite established well except for in warm, wet areas. As a result other strains were imported and released that were expected to be better adapted to these climatic conditions. It is unclear whether the original strain managed to adapt to these conditions or if the new strains did in fact establish better, as dispersal was rapid and once mixed the strains could not be differentiated. However, the overall outcome was that gorse spider mites did became established in all regions of New Zealand during the mid-1990s. Unfortunately gorse spider mite populations tend to be regulated by predators. Large colonies form but do not tend to persist, and the mite's distribution tends to be patchy both temporally and spatially.

Because the mites are extremely mobile the original release sites are now only of historical interest and the details are not included in this report but are available if needed (the original strain was released at four sites in Southland and one of the new strains at one site). The mites established readily in Southland and were subsequently harvested and distributed to numerous sites. Combined with natural dispersal the mites can now be found throughout Southland and at times have substantial outbreaks. No further efforts to try to increase the distribution of the mites are warranted and only time will tell as to whether or not they are able to make a contribution to gorse control.

### 5.2.5 Gorse thrips (*Sericothrips staphylinus*)

The gorse thrips is a foliage-feeding insect. Adults and juveniles have sucking mouthparts that extract the cell contents. This feeding results in small white spots that give the gorse a mottled blotchy appearance. The thrips prefer new growth, but will feed on older, harder growth during winter. When present in good numbers, growth and flowering is reduced and seedlings may be killed. This agent was released widely throughout New Zealand during the 1990s and has established well. However, dispersal appeared to be extremely slow, because winged forms appear to be produced only rarely. As

a consequence another strain, that was believed to disperse more quickly, was imported from Portugal and released in the early 2000s, and it has also established. It is not possible to tell the strains apart so we cannot confirm whether or not this strategy has paid off, but the thrips are now being found more widely than before. While thrips can now be commonly found on gorse in some parts of New Zealand, it is less common to see gorse bushes that appear to be severely affected by them. A study in the UK found that gorse thrips could reduce the growth of seedlings, even when present in low numbers, and this may be where they have the greatest impact.

The Cornish strain of thrips was released at nine sites in Southland and the Portugese strain has also been released at four sites (Table 6). One site (54 Slaughter House Rd) has had releases of both strains. At present the thrips are only known to be established at this one site, but we cannot be certain if they are the Portuguese strain, or Cornish strain or both. Six sites have been destroyed and no information is available yet for three. It seems likely that the thrips are still not widespread, and it would be useful to undertake further surveys to assess their current distribution. A programme to collect and redistribute the thrips to areas where they are not yet present is likely to be needed.

**Table 6** Gorse thrips release sites in Southland

| Site name | Strain | Grid reference/GPS | Date released | Date checked | Comments |
|---|---|---|---|---|---|
| Browns, 784 Limehills–Browns Rd | Cornish | NZMS1 S169 385 407 | 17/10/90<br>28/11/91 | 3/11/93 | No thrips found |
| Nokomai, Nokomai Station, Nokomai Rd 1 | Cornish | E2164968 N5507522 | 12/03/98 | | Ex Southern Hill & High Country Group |
| Nokomai, Nokomai Station, Nokomai Rd 2 | Cornish | E2162963 N5507350 | 12/03/98 | | Ex Southern Hill & High Country Group |
| Otautau, 17 Lieman St | Cornish | NZMS260 D45 232 408 | 11/12/92 | 7/4/95 | Sprayed |
| Otautau, 197 Otautau Drummond Rd | Cornish | E2124730 N5440155 | 21/2/98 | 2003 | Site destroyed |
| Otautau, 54 Slaughter House Rd | Cornish | E2122647 E5440034 | 21/1/98 | 3/6/03 | Established here |
| Otautau, 54 Slaughter House Rd A | Portuguese | E2122647 E5440034 | 14/11/02 | | |
| Otautau, 54 Slaughter House Rd B | Portuguese | E2151937 N5415260 | 4/2/04 | 4/2/04 | None seen. |
| Otautau, 111 Slaughterhouse Rd, riverbank | Cornish | NZMS260 P46 225 402 | 29/11/91 | 15/5/03 | Thrips easy to find in 1998 including winged ones, then site destroyed |
| Raymonds Gap, corner of Otautau–Tuatapere Rd & Lower Scotts Gap Rd A | Portuguese | E2117383 N5444949 | 4/2/04 | 2005 | Site has been destroyed |
| Raymonds Gap, corner of Otautau–Tuatapere Rd & Lower Scotts Gap Rd B | Portuguese | E2117906 N5444973 | 4/2/04 | 2005 | Site has been destroyed |
| Waikaia, Glenary Station, Long Spur 1 | Cornish | E2189429 N5503195 | 12/3/98 | | Ex Southern Hill & High Country Group |
| Waikouro, Waikouro–Wairio Rd, NZ Rail access road | Cornish | NZMS260 D45 219 469 | 11/3/94 | 19/12/98 | Thrips were easy to find in 1998 but site has been bulldozed |

### 5.2.6 Gorse colonial hard shoot moth (*Pempelia genistella*)

The gorse colonial hard shoot moth (*Pempelia genistella*) is a foliage-feeding insect. The caterpillars are the damaging stage and they feed on the spines, leaves, buds, shoots and flowers causing foliage around the web to brown off and die. When the caterpillars are small, the area damaged is usually only a few centimetres in diameter; but as the caterpillars become larger in the spring, the damaged area can extend to 20–40 cm around the web. This agent has been released at sites throughout New Zealand in recent years, including one in Southland (Table 7). Establishment has only been confirmed so far at two sites in Christchurch. At one of these, Redcliffs, the moth has been causing obvious damage. The status of the Southland site is not yet known and it should be checked this spring. Given how often gorse sites are cleared it would be worthwhile releasing this moth at at least one more site in Southland as soon as possible.

**Table 7** Gorse colonial hard shoot moth release sites in Southland

| Site name | Grid reference/GPS | Date released | Date checked | Comments |
|---|---|---|---|---|
| Otautau, 54 Slaughter House Rd | E2122647 N5440034 | 15/2/02 | 12/11/02 | Nothing seen but too soon to be looking |

### 5.2.7 Potential new gorse agents

Surveys are currently underway overseas to check if there are any more potential control agents for gorse, including pathogens. The results from these are expected to be available later this year.

## 5.3 Hawkweeds (*Hieracium* spp.)

The six hawkweed agents covered below are expected to attack the weedy hawkweed species to varying degrees (Table 8).

**Table 8** Expected host range of hawkweed biocontrol agents (**preferred host, *less preferred host).

| Hawkweed species | Crown hover fly | Gall midge | Gall wasp | Plume moth | Root hover fly | Rust |
|---|---|---|---|---|---|---|
| *H. pilosella* | ** | ** | ** | ** | ** | ** |
| *H. praealtum* | ** | * | | * | ** | |
| *H. caespitosum* | ** | * | | ** | ** | |
| *H. aurantiacum* | ** | | ** | * | ** | |
| *H. lepidulum* | * | | | * | ** | |

### 5.3.1 Hieracium rust (*Puccinia hieracii* var. *piloselloidarum*)

A self-introduced rust (*Puccinia hieracii* var. *piloselloidarum*) was first noticed here in 1995 and is now commonly found on hieracium throughout the country, and is likely to be present in Southland. A study has suggested that the rust is only able to reduce the growth of plants by 10–20%. Given that the rust is widespread and better agents are available no futher action to enhance its distribution would appear to be warranted.

### 5.3.2 Hieracium gall midge (*Macrolabis pilosella*)

The hieracium gall midge (*Macrolabis pilosellae*) causes plant deformities to develop so plants are stunted in their growth. The larvae are the damaging stage and their feeding causes galls to develop in the crowns, leaf axils, stolon tips and sometimes the flowerheads. This insect has been widely released

throughout hieracium-infested areas of New Zealand by The Hieracium Control Trust (HCT) and appears to be establishing readily. It is too soon to know how effective it will be.

The gall midge has recently been released in Southland by the HCT at eight sites (Table 9). Monitoring should be undertaken in late summer/early autumn to determine if the midges have established. Given that the HCT is winding down, monitoring will need to be undertaken by Environment Southland staff and assistance is available from Landcare Research staff if needed. If the midges have established then a harvesting and redistribution plan should be put in place as the midges are not expected to disperse rapidly.

**Table 9** Hieracium gall midge release sites in Southland

| Site name | Grid reference/GPS | Date released | Date checked | Comments |
|---|---|---|---|---|
| Garston, 360 Cairnard Rd | E2167951 N5527292 | 26/1/06 | | |
| Garston, Lorn Peak Station, 1195 Kingston-Garston Highway, 1 | E2171646 N5527936 | 26/1/06 | | |
| Garston, Lorn Peak Station, 1195 Kingston-Garston Highway, 1 | E2180737 N5522975 | 26/1/06 | | |
| Lumsden, Burwod Station, Gorge Creek | E2121862 N5502351 | 28/1/06 | | |
| Lumsden, Nokomai, Nevis Valley | E2182665 N5527261 | 26/1/06 | | |
| Mt Nicholas, Beach Bay Rd, site 1, McKeller Flat | E2141065 N5538508 | 27/1/06 | | |
| Mt Nicholas, Beach Bay Rd ,site 2 | E2141637 N5539684 | 27/1/06 | | |
| Ohai, Mt Linton Station, Caravan Block | E2116520 N5475769 | 27/1/06 | | |

### 5.3.3 Hieracium gall wasp (*Aulacidea subterminalis*)

The hieracium gall wasp (*Aulacidea subterminalis*) damages the end of stolons, which reduces the plant's ability to spread vegetatively by producing daughter plants at the tips. The larvae are the damaging stage, and their feeding causes galls to develop in the stolon tips. This insect has been widely released throughout hieracium-infested areas of New Zealand by the HCT and appears to be establishing readily. It is too soon to know how effective it will be.

The gall wasp has recently been released in Southland by the HCT at five sites (Table 10). Early monitoring found galled plants at three sites but more recent checks at two of the sites have been less promising as changes in management practices have reduced the amount of hieracium at these sites. One last check of these sites should be made and also another check of Nokomai 1 (which has not been visited since 2002), and if the wasp has not established then further releases should be made at more secure sites. Again monitoring will need to be undertaken by Environment Southland staff and assistance is available from Landcare Research staff if needed.

**Table 10** Hieracium gall wasp release sites in Southland

| Site name | Grid reference/GPS | Date released | Date checked | Comments |
|---|---|---|---|---|
| Garston, Lorn Peak Station, 1195 Kingston-Garston Highway, swamp | E2172100 N5528800 | 11/2/00 | 26/1/06 | Galls seen previously but since then site has been converted to overwintering dairy unit and much less hieracium now |
| Mt Nicholas, Mt Nicholas Rd, Gorge Burn | E2139181 N5535795 | 10/1/00<br>3/12/03 | 26/1/06 | Galls seen previously but since then site has been fertilised and hieracium almost gone |
| Nokomai, Nokomai Station, 1242 Nokomai Rd, Site 3 | E2190171 N5540898 | 11/2/00 | 11/4/02 | Two galls found |
| Nokomai, Nokomai Station, 1242 Nokomai Rd, Site 4 | E2189266 N5537759 | 11/2/00 | 11/4/02 | No galls found |
| Ohai, Mt Linton Station, McKays Corner | E2116210 N5471725 | 12/2/00 | | No wasps seen |

### 5.3.4 New hawkweed agents

Approval has been given for the release of three additional agents against hawkweeds. The hieracium plume moth (*Oxyptilus pilosellae*) has only been released by the HCT at one site in Canterbury and is not thought to have established. The HCT has also made a limited number of releases of a crown hover fly (*Cheilosia psilophthalma*) and a root-feeding hover fly (*Cheilosia urbana*) in the South Island (but not in Southland) and it is too soon to know the fate of these. Difficulties in finding a way to breed the hover flies and the plume moth in captivity has meant that only a small number can be released in any one year. Given that the HCT is looking to wind up it will no longer be involved in releasing these new agents. Consideration should be given to making releases of all three agents in Southland as soon as possible. Larvae of the root hover fly damage the roots, and larvae of the plume moth and crown hover fly attack the above-ground parts of the plant.

## 5.4 Old man's beard (*Clematis vitalba*)

### 5.4.1 Old man's beard leaf fungus (*Phoma clematidina*)

The old man's beard leaf fungus is a foliar pathogen. Initially it causes black spotting and slight yellowing of the leaves, and later premature leaf death, leaf fall, and reduced vigour. Younger leaves are more vulnerable than older leaves, and the stems, flowers, seed pods, and seedlings can also be affected. The fungus was released widely throughout much of New Zealand during the mid-1990s. including one site in Southland (Orepuki). Damage was seen at this site and infected material was collected and released at three further sites. However, the status of the fungus is now unknown since old man's beard has been cleared from these sites after the plant became the target of a DOC weed-led control project. No further activity with the fungus is warranted given the likely success of the current DOC weed-led control project.

### 5.4.2 Old man's beard leaf miner (*Phytomyza vitalbae*)

The old man's beard leaf miner is a foliage-feeding insect. Larval feeding disrupts the flow of nutrients around the leaves by mining through the veins. Heavily scarred leaves turn brown, shrivel up, and fall off the plant. Both the larval mines and the adults' feeding punctures can allow fungal pathogens to invade the plant. This agent was released widely throughout much of New Zealand during the mid-1990s including two sites in Southland (Paper Mills, Redfern) and was thought to have established at the latter. However, the status of the leaf miner is now unknown since old man's beard

has been cleared from these sites since the plant became the target of a DOC weed-led control project. No further activity with the leaf miner is warranted given the likely success of the current DOC weed-led control project.

### 5.4.3 New old man's beard agents

The old man's sawfly is a foliage-feeding insect. The larvae are the damaging stage and each larva may eat several leaves, sometimes leaving only the central vein intact. This agent was released at a limited number of sites throughout New Zealand during the late 1990s – early 2000s. The sawfly has not been seen again at any of the 16 release sites nationwide and establishment is looking increasingly unlikely. In the event that the sawfly has definitely failed to establish then another attempt may be made to import and release the sawfly because of the severity of the old man's beard problem in many regions.

Research is underway to determine whether a beetle (*Xylocleptes bispinus*), that mines beneath the bark ring-barking and killing whole vines, might be suitable for release in New Zealand. If the beetle is unsuitable then it is possible that the potential for any other agents may be explored further. Further work is also likely to be undertaken on pathogens that attack old man's beard. It seems unlikely that any further agents will need to be released to attack old man's beard in Southland given the likely success of the current DOC weed-led control project.

## 5.5 Ragwort (*Senecio jacobaea*)

### 5.5.1 Cinnabar moth (*Tyria jacobaeae*)

The cinnabar moth is a foliage-feeding insect. The caterpillars are the damaging stage and they feed on the leaves and flowers. The severity of the attack depends on the number of caterpillars, and can vary from a few damaged leaves to bare stalks. This moth was one of the first biocontrol agents to be released in New Zealand, from the late 1920s to the early 1930s. However, the moth only established successfully in the lower North Island, so from the 1980s to early 1990s fresh attempts to increase its distribution were made. As a result the moth has established in all regions of New Zealand, but its distribution still tends to be patchy temporally and spatially. While the caterpillars can heavily defoliate ragwort, in New Zealand the plant is often able to subsequently regrow. Cinnabar moth is thought to be an effective agent in cold regions of Canada where there is no opportunity for regrowth following defoliation.

The cinnabar moth was released in Southland at five sites (one was flooded soon after) and managed to establish at Ward Rd (Table 11). Caterpillars harvested from Ward Rd have been released at a further nine sites and have only established at one of those (Macpherson Rd). At these two established sites there are large outbreaks of caterpillars in some years. Given that the cinnabar moth seems to be difficult to establish and is of limited usefulness, no further effort to increase its distribution appears to be warranted, especially when more-promising control agents are available.

**Table 11** Cinnabar moth release sites in Southland

| Site name | Grid reference/GPS | Date released | Date checked | Comments |
|---|---|---|---|---|
| Bayswater 111, Bayswater Rd, south side of road | E2125113 N5442415 | 5/2/99 | 1/2/00 | Ex Ward Rd. Failed to establish |
| Gorge Rd, 96 Holz Rd, A | E2182300 N5401300 | 1/11/90 | 4/2/94 | None found, failed to establish |
| Grasmere, 144 Heywood St (Renfrew St) | E2150727 N5415293 | 3/2/99 | | Ex Ward Rd. Failed to establish |
| Glencoe, opposite 243 Wilson Rd A | E2174279 N5439727 | 20/3/00 | | Ex Ward Rd. Failed to establish |

| | | | | |
|---|---|---|---|---|
| Glencoe, opposite 243 Wilson Rd B | E2174221 N5439658 | 9/2/99<br>8/2/00 | | Ex Ward Rd. Failed to establish |
| Hokonui, 107 Macpherson Rd | E2167904 N5445225 | 26/1/99<br>19/2/00 | 2004 | Ex Ward Rd, well established here |
| Mavora lakes, Mavora River, between North and South Mavora lakes | E2131443 N5535701 | 2/3/00 | | Ex Ward Rd. Failed to establish |
| Rimu, 553 Rimu Rd | NZMS1 S177 493 043 | 3/12/87<br>18/12/89<br>1/11/90<br>3/10/91 | 2004 | Did not establish, no ragwort there now |
| Colac Bay, 536 Ward Rd A (Longwoods) | NZMS1 S176 966 096 | 17/1/84 | 26/1/99 | Established in good numbers |
| Colac Bay, 536 Ward Rd B (Longwoods) | NZMS1 S176 000 105 | 17/1/84 | 26/1/99 | Flooded soon after release |
| Seaward Bush, 605 Tramway Rd (Tisbury) | E2156800 N5410000 | 8/12/89 | 2004 | Did not establish, no ragwort there now |
| Waikaia, Glenaray Station, Cinnabar | E2193268 N5504845 | 22/2/00 | | Ex Ward Rd. Failed to establish |
| Wallacetown, Collean Street East | E2147996 N5419484 | 29/1/99 | | Ex Ward Rd. Failed to establish |
| Winton, 40 Obrien Rd | E2150519 N5443870 | 22/2/00 | 20/2/01 | Ex Ward Rd, destroyed by sheep |

### 5.5.2 Ragwort flea beetle (*Longitarsus jacobaeae*)

The ragwort flea beetle damages the roots and crowns of ragwort rosettes. Heavily infested plants die, and plants that are not killed produce fewer flowering stems. The beetles have established extremely well nationwide and are now successfully controlling ragwort in many places, with no other control measures required.

The flea beetle was initially released at nine sites in Southland (Table 12). Later more beetles were beetles sourced from Environment Canterbury and harvested from established sites in Southland resulting in releases at a further 84 sites (details of these are available from Environment Southland). At present the beetles are known to have established at 12 sites, and a number have been destroyed. Some good results have been seen at some sites but the plant has continued to be a problem at others.

An intensive study (Gourlay et al. 2006) has recently explained why the flea beetles are unable to control ragwort on the West Coast of the South Island. Overseas studies have shown that ragwort populations do best when there is high rainfall and ground disturbance and both these events are common on the West Coast. At the same time high rainfall probably has a negative effect on flea beetle populations as beetle density appears to be lower at higher-rainfall sites. The level of beetles per plant was lower at West Coast sites than at some East Coast sites where control has been achieved. Previous work has suggested that you need at least four beetles per rosette in order to get control. On average during the West Coast survey there were never more than three beetles counted. The highest number of beetles recorded on a single rosette was only 10 whereas as many as 50 have been recorded in Auckland. Unlike other parts of New Zealand where the beetle has several generations per year, on the West Coast the beetle has only one life cycle a year. So it seems that West Coast conditions allow ragwort to do very well but the same is not true for the beetles.

It seems likely that the above is also true at least in part for Southland. For this reason the emphasis should now go on attempting to establish the two new ragwort agents, the plume moth and crown-boring moth, in areas where the flea beetles have not done well. Some continued effort to increase the distribution of the flea beetle may also be warranted in lower-rainfall and/or less disturbed areas such as DOC land.

**Table 12** Ragwort flea beetle release sites in Southland

| Site name | Grid reference/GPS | Date released | Date checked | Comments |
|---|---|---|---|---|
| Awarua, 1370 Motu Rimu Rd | NZMS260 E47 565 043 | 19/3/96 | 20/11/02 | Site destroyed by sheep |
| Bayswater, 111 Bayswater Rd, Site A | E2124891 N5442289 | 19/3/96 | 20/5/07 | Ex ECAN, beetles established |
| Bayswater, 111 Bayswater Rd, Site B | E2124586 N5442099 | 16/4/98 | 22/5/07 | Ex ECAN, beetles established |
| Colac Bay, 272 Ward Rd | NZMS1 S176 997 106 | 21/3/85 | 13/5/92 | Failed, flooded soon after release |
| Colac Bay, 536 Ward Rd B | NZMS1 S176 968 098 | 2/3/85<br>8/4/85 | 18/2/99 | Beetles well established |
| Glencoe, opposite 243 Wilson Rd B | E2139566 N5356247 | 25/2/91<br>17/4/98 | 30/5/06 | Ex ECAN, beetles established |
| Gorge Rd, 96 Holz Rd | NZMS260 F47 825 015 | 24/3/88<br>30/3/89 | 3/6/03 | Beetles seen previously but no-longer can be found |
| Hokonui, 107 Macpherson Rd, A | E2167851 N5445127 | 17/4/98 | 12/6/07 | Ex ECAN, beetles well established – site used for harvesting |
| Invercargill, Bay Rd, 461 Bay Rd | NZMS260 E46 490 132 | 10/4/97 | 20/11/02 | Failed, reason unknown |
| Lillburn, 143 Lillburn Valley Rd, Site 3 | E2084586 N5452055 | 17/4/98 | 14/6/97 | Ex ECAN, beetles established |
| Makarewa, 682 North Makarewa–Grove Bush Rd A | NZMS260 E46 553 244 | 16/3/95 | 27/6/07 | Beetles well established |
| Mokotua, 248 Mokotua Rd | E2170700 N5411000 | 26/3/92 | | Site sprayed annually from 1994, no beetles ever found |
| Northope, Lochiel Bridge Rd, Site A | E2146100 N5433600 | 16/4/98 | 27/3/00 | Ex ECAN |
| Pourakino, 1135 Pourakino Valley Rd | E2117866 N5431647 | 14/5/99<br>18/5/00 | 13/6/97 | Ex ECAN, beetles established |
| Spring Hills, 562 Gill Rd | E2158183 N5436799 | 14/4/00<br>5/4/02 | 11/6/07 | Beetles established |
| Waikaia, Glenaray Station, Hind Block, Gows Creek 14 | E2191037 N5503195 | 8/06/2001 | 19/6/06 | Ex ECAN, beetles established |
| Waikaia, Glenaray Station, Site 4, Deer Park | E2194528 N5504737 | 30/04/1999 | 27/6/0 | Ex ECAN, beetles established |

| Site name | Grid reference/GPS | Date released | Date checked | Comments |
|---|---|---|---|---|
| Waikouro, 31 Waikouro–Wairio Rd | | 21/3/89<br>26/3/92 | 2004 | Beetles established but site was sprayed |

Note only the initial releases from Lincoln and those which came from elsewhere and have established are included in this table.

### 5.5.3 Ragwort crown-boring moth (*Cochylis atricapitana*)

The ragwort crown-boring moth is a foliage-feeder and the caterpillars are the damaging stage. Their mining thickens young stems and suppresses flowering, and tends to kill older stems and the root crowns of rosette plants. Releases of this agent have been made at a limited number of sites nationwide since autumn 2006, and it is too soon yet to know how well they are establishing or what impact they will be able to have.

One release of the crown-boring moth has been made in Southland (Table 13) and it is too soon to know if it has been successful. Moths should be released at at least one more site as soon as possible, and monitoring should be undertaken at these sites to check for establishment and to see if any further releases or harvesting and redistribution will be needed.

**Table 13** Ragwort crown-boring moth release sites in Southland

| Site name | Grid reference/GPS | Date released | Date checked | Comments |
|---|---|---|---|---|
| Tiwai Peninsula, NZ Smelter | E2157962 N5391445 | 1/3/07 | | |

### 5.5.4 Ragwort plume moth (*Platyptilia isodactyla*)

The ragwort plume moth is a foliage feeder. The caterpillars are the damaging stage and can severely harm the crown and roots of ragwort plants. Attack by as few as 2–3 larvae can kill a plant. If plants are not killed then they produce fewer flowers and seeds. This agent has been released at a limited number of sites nationwide since autumn 2006, and it is too soon yet to know how well the moths are establishing or what impact they will be able to have.

Two releases of the plume moth have been made in Southland (Table 14), and it is too soon to know yet if they have been successful. DOC may undertake its own rearing programme in the future and this would be a useful initiative to help speed up widespread establishment. Both release sites should be monitored in future to check for establishment and to see if any further releases or harvesting and redistribution will be needed.

**Table 14** Ragwort plume moth release sites in Southland

| Site name | Grid reference/GPS | Date released | Date checked | Comments |
|---|---|---|---|---|
| Hokonui, Hedgehope, MacPherson Rd | E2167851 N5445127 | 22/11/06 | | |
| Orawia, 272 Orawai–Pukemaori Rd | E2106359 N5446058 | 25/1/07 | | |

## 5.6 Thistles (*Carduus* spp., *Cirsium* spp.)

### 5.6.1 Californian thistle flea beetle (*Altica carduorum*)

The Californian thistle flea beetle is a foliage feeder and both adults and larvae feed on the leaves and stems. It was released widely throughout New Zealand in the early 1990s, and after doing well initially at a number of sites appears to have died out. The reasons for the beetle failing to establish are not understood.

The beetle was released at one site in Southland, which showed exactly the same trend as mentioned above (Table 15). Given that the beetle has not established in New Zealand and better agents will be coming on stream soon, no further efforts to try to establish this beetle appear to be warranted.

**Table 15** Californian thistle flea beetle release sites in Southland

| Site name | Grid Reference/GPS | Date Released | Date Checked | Comments |
|---|---|---|---|---|
| Wreys Bush, 1165 Otautau–Wreys Bush Rd | NZMS260 E45 498 313 | 1/12/95 | 20/1/98 | Feeding damage seen initially but beetles failed to establish |

### 5.6.2 Californian thistle leaf beetle (*Lema cyanella*)

The Californian thistle leaf beetle is also a foliage feeder with both adults and larvae feeding on leaves and stems. It was released widely throughout New Zealand in the early 1990s, but is thought to have established only at one site near Auckland. Numbers of beetles at this site have remained low but there were some promising signs this summer that they may be starting to build. The reasons for the poor establishment of the beetle are also not understood.

Three releases of the beetle were made in Southland at one site, Browns, but they did not establish there (Table 16). Given the poor track record of the beetle elsewhere in New Zealand and that better agents will be coming on stream soon, no further efforts to try to establish this beetle appear to be warranted, unless the beetle begins to show more promise at the Auckland site.

**Table 16** Californian thistle leaf beetle release sites in Southland

| Site name | Grid reference/GPS | Date released | Date checked | Comments |
|---|---|---|---|---|
| Browns, SH96, 541 Winton–Hedgehope Rd via Cahill Rd | NZMS260 E45 544 429 | 30/1/92<br>3/11/94<br>4/5/95 | 3/6/03 | No sign of the beetles, failed |

### 5.6.3 Californian thistle gall fly (*Urophora cardui*)

A fly (*Urophora cardui*) that attacks Californian thistle stems is also established in New Zealand, but is not common or widespread. Larval feeding tricks the plant into diverting valuable nutrients (which would normally be used for plant growth and increasing root reserves) into forming galls to feed the developing larvae. The fly is limited in its usefulness because stock tend to eat the galls.

Five farmers in Southland participated in a programme to attempt to establish the gall fly by rearing it in cages and the fly was also released at two further sites (Table 17). Although galls were commonly produced, sheep grazing and thistle mowing prevented the fly becoming established. Given these limitations, and that there are better agents coming, further efforts to establish the fly are probably not warranted, unless there are sites that will not be subjected to control (such as DOC land).

**Table 17** Californian thistle gall fly release sites in Southland

| Site name | Grid reference/GPS | Date released | Date checked | Comments |
|---|---|---|---|---|
| Branxholme, south of Viner Rd (by Oreti River) | NZMS260 E46 462 263 | 19/1/00<br>8/10/00 | 9/12/00 | Failed |
| Centre Hill, Centre Hill–Mavora Lakes Rd, Landcorp Centre Hill Station | E2128811 N5507757 | 18/1/00 | 1/4/00 | Gate left open and thistles grazed by sheep |
| Drummond, 613 Heddon Bush-Drummond Rd | NZMS260 E45 475 345 | 14/1/00 | 1/3/00 | Galls produced but later eaten by sheep |
| Hedgehope, Southdown | | 9/10/00 | | |
| Ohai, 338 Mt Linton Rd, Mt Linton Stn | NZMS260 D45 108 693 | 3/12/99 | 18/12/00 | Galls produced but later eaten by sheep |
| Te Anau, 547 Gillespie Rd (Takitimu) | E2101005 N5502945 | 19/1/00 | 3/6/03 | Failed |
| Waicola, 309 Waicola Rd | NZMS260 D45 205 558 | 12/11/00 | 3/6/03 | Site destroyed |

### 5.6.4 Nodding thistle crown weevil (*Trichosirocalus horridus*)

The nodding thistle crown weevil damages the crowns and roots of thistle rosettes. Plants that are not killed are stunted, with fewer flowering stems, and any lateral regrowth may be attacked. Plants of all sizes are attacked. While nodding thistle (*Carduus nutans*) is believed to be the preferred host, the weevil attacks a number of thistle species: plumeless (*Carduus acanthoides*), winged (*Carduus tenuiflorus*), slender-winged (*Carduus pynocephalus*), Scotch (*Cirsium vulgare*), marsh (*Cirsium palustre*), and cotton (*Onopordum acanthium*) thistles. It was released widely throughout New Zealand in the late 1980s and early 1990s, and establishment has been excellent. The weevil is believed to have contributed to a decline in nodding thistles in many regions.

The weevil has been released in Southland at four sites (Table 18) but is only established at one (Ohai Quarry) because the other sites have been controlled. Given that the emphasis is now on controlling all known infestations of nodding thistle it does not appear to be worth making any further efforts to increase the distribution of this weevil.

**Table 18** Nodding thistle crown weevil release sites in Southland

| Site name | Grid reference/GPS | Date released | Date checked | Comments |
|---|---|---|---|---|
| Browns, SH96, 541 Winton–Hedgehope Rd via Cahill Rd | E2153183 N5442514 | 3/2/93 | 3/6/03 | Weevils seen here early on but now no thistles |
| Hamilton Burn, 3251 Wreys Bush–Mossburn Rd | NZMS260 E44 348 879 | 11/6/93 | 3/6/03 | Weevils seen here early on but now no thistles |
| Ohai, Ohai Quarry, 60 Gorge Rd | E2120341 N5465088 | 1/3/89 | 18/1/98 | Weevils established, fewer thistles now |
| Riversdale, 124 McKay Rd | NZMS260 F45 778 705 | 15/4/97 | 2004 | Site sprayed |

### 5.6.5 Nodding thistle receptacle weevil (*Rhinocyllus conicus*)

The nodding thistle receptacle weevil attacks the flowerheads of nodding thistles and a number of other thistle species to a lesser degree (plumeless, winged, slender-winged, Californian, and Scotch thistles). The weevil was released widely throughout New Zealand in the 1970s and 1980s and established well. It is now common and is believed to have contributed to a decline in nodding thistles in many regions.

The weevil was released at three sites in Southland and is believed to have established at one (also Ohai Quarry; Table 19). Given that the emphasis with nodding thistle is now total control it does not appear to be worth making any further efforts to increase the distribution of this weevil.

**Table 19** Nodding thistle receptacle weevil release sites in Southland

| Site name | Grid reference/GPS | Date released | Date checked | Comments |
|---|---|---|---|---|
| Browns, SH96, 541 Winton–Hedgehope Rd via Cahill Rd | NZMS1 S169 375 370 | 3/12/87 | 1/12/96 | Not thought to have established |
| Hamilton Burn, 3110 Wreys Bush–Mossburn Rd (Heenans) | NZMS260 E44 371 861 | 6/2/97 | 3/6/03 | Site sprayed |
| Ohai, Ohai Quarry, 60 Gorge Rd | NZMS260 D45 202 650 | 13/11/96 | 2007 | Weevils established despite spraying, not many thistles left |

### 5.6.6 Nodding thistle gall fly (*Urophora solstitialis*)

The nodding thistle gall fly (*Urophora solstitialis*) attacks the flowerheads of nodding thistle and plumeless thistle and reduces seed production in these species. It is becoming quite common and widespread throughout much of New Zealand.

The fly was released at five sites in Southland that have all since been controlled, and the fly is not thought to be established anywhere in Southland (Table 20). Given that the emphasis with nodding thistle is now total control it does not appear to be worth making any further efforts to establish this fly.

**Table 20** Nodding thistle gall fly release sites in Southland

| Site name | Grid reference/GPS | Date released | Date checked | Comments |
|---|---|---|---|---|
| Browns, SH96, 541 Winton–Hedgehope Rd via Cahill Rd (McKerchar Bush Block) | NZMS260 E45 544 429 | 14/1/94 | 2004 | Has been sprayed |
| Hamilton Burn, 3110 Wreys Bush–Mossburn Rd | NZMS260 E44 371 861 | 6/2/97<br>16/12/97 | 2004 | Has been sprayed |
| Lumsden, Castle Rock, 109 Double Rd | NZMS260 D44 541 843 | 13/12/96<br>16/12/97 | 2004 | Has been sprayed |
| Oreti River, Mossburn | | 2000 | 2002 | Ex Canterbury, site failed due to flooding. |
| Te Anau, SH94, 960 Te Anau–Mossburn Highway | NZMS260 D43 025 125 | 22/2/94<br>22/12/94 | 16/1/97 | Destroyed by sheep during drought in 1995 |

### 5.6.7 Scotch thistle gall fly (*Urophora stylata*)

A fly (*Urophora stylata*) that attacks the flowerheads of Scotch thistle, reducing seed production, is established in New Zealand. The fly has established readily in most areas but is not yet common or widespread.

One release of the fly was made in Southland but it is unclear whether it has established (Table 21). The release site should be checked again next autumn and if the fly has established a harvesting and redistribution programme should be undertaken. If the fly has not established then further attempts could be made to establish it if the Scotch thistle problem was deemed serious enough.

**Table 21** Scotch thistle gall fly release sites in Southland

| Site name | Grid reference/GPS | Date released | Date checked | Comments |
|---|---|---|---|---|
| Ohai, 338 Mt Linton Rd, Mt Linton Station Barco Holding Block | NZMS260 D45 108 693 | 21/2/00 | 2006 | Thistles almost disappeared soon after release, one possibly infested flowerhead seen recently |

### 5.6.8 New thistle agents

ERMA has recently given permission to release two new thistle agents. The Californian thistle stem miner (*Ceratapion onopordi*) feeds on thistle stems and roots and acts as a vector for the Californian thistle rust (*Puccinia punctiformis*). This rust is present in New Zealand but is limited in its ability to disperse and infect Californian thistles. The rust benefits from improved dispersal by the weevil, which in turn does better on rust-infected thistle stems than uninfected ones. The weevil prefers Scotch thistle and Californian thistle (if rust-infected) but is likely to also attack other thistle species to a lesser extent. The green thistle beetle (*Cassida rubiginosa*) is a foliage feeder. It prefers Californian thistle but is likely to attack most species of thistles. It is hoped that releases of the green thistle beetle will begin in 2007 and of the stem miner in 2008. Initial releases of both will be made available to the Californian Thistle Action Group, which has supported this project – Environment Southland is a member of this group and can therefore expect to get some releases via this mechanism. Efforts should be made to establish both new thistle agents in Southland as soon as possible.

## 5.7 New targets

Biological control programmes are continually being developed in New Zealand for new targets, including those of interest to Southland. For example a programme is currently underway to find suitable agents for Darwin's barberry (*Berberis darwinii*). The prospects for biocontrol of African club moss (*Selaginella kraussiana*) and Chilean flame creeper (*Tropaeolum speciosum*) have been explored and there is no reason not to proceed if funding to undertake these projects could be found. Such feasibility studies could also be undertaken to explore likely biocontrol prospects for English ivy (*Hedera helix*), cotoneaster (*Cotoneaster* spp.), sycamore (*Acer pseudoplatanus*) and others. Environment Southland is currently an active member of a national collective that sets priorities for and funds biocontrol of weeds research (see Appendix 1).

# 6. Conclusions

The establishment success of weed biocontrol agents in Southland is following similar trends to the rest of New Zealand. Of the 23 weed biocontrol agents that have been released during the last 23 years 10 are known to have established, two established but their host plant has since been controlled, two have failed to establish for unknown reasons, two failed to establish because of sheep grazing and/or other control activities, and the fate of the remaining seven is currently unknown (Table 22). While the climatic conditions experienced in Southland could make it more difficult to establish some insect agents it does not appear to have been a major obstacle so far. A greater problem affecting establishment success has been other weed management activities that have resulted in a considerable number of release sites being destroyed.

**Table 22** Status of weed biocontrol agents in Southland

| Target | Species | Status on West Coast |
|---|---|---|
| Broom | Broom psyllid | Established |
| | Broom seed beetle | Established |
| | Broom twig miner | Established |
| Gorse | Gorse colonial hard shoot moth | Unknown |
| | Gorse pod moth | Established |
| | Gorse seed weevil | Established |
| | Gorse soft shoot moth | Unknown |
| | Gorse spider mite | Established |
| | Gorse thrips | Established |
| Hawkweeds | Hieracium gall midge | Unknown |
| | Hieracium gall wasp | Unknown |
| Old Man's Beard | Old man's beard leaf fungus | Host plant is being eradicated |
| | Old man's beard leaf miner | Host plant is being eradicated |
| Ragwort | Cinnabar moth | Established |
| | Ragwort crown-boring moth | Unknown |
| | Ragwort flea beetle | Established |
| | Ragwort plume moth | Unknown |
| Thistles (*Carduus* spp. and *Cirsium* spp.) | Californian thistle flea beetle | Failed for unknown reason |
| | Californian thistle leaf beetle | Failed for unknown reason |
| | Californian thistle gall fly | Failed to establish due to control activities |
| | Nodding thistle crown weevil | Established |
| | Nodding thistle gall fly | Failed to establish due to control activities |
| | Nodding thistle receptacle weevil | Established |
| | Scotch thistle gall fly | Unknown |

Of the agents that are established, probably only three species are widespread (broom twig miner, gorse spider mite, ragwort flea beetle) and no project is yet complete. For each weed target tackled to date there are new control agents which should be considered for release (Table 23). Biological control agents are also likely to become available for other targets in coming years, e.g. Darwin's barberry.

**Table 23** Possible new weed biocontrol agents for Southland

| Target | Agents still to be released or established |
|---|---|
| Broom | Broom gall mite |
| | Broom leaf beetle |
| | Broom shoot moth |
| Hawkweeds | Hieracium crown hover fly |
| | Hieracium plume moth |
| | Hieracium root hover fly |
| Thistles | Californian thistle stem miner |
| | Green thistle beetle |

For advice on how to source biocontrol agents that are not available yet in Southland please contact the author. For information about how best to harvest and redistribute biocontrol agents from existing sites see www.landcareresearch.co.nz/research/biocons/weeds/ or contact the author.

Biological control is a very long term approach and it may take 50 years or longer to see changes in the distribution of long-lived weeds. Experience has shown that not all projects attempted will be successful, but that the successful ones more than pay for the failures (Page & Lacey 2006). There has been a considerable investment to date by Environment Southland and the Department of Conservation to develop biocontrol programmes for weeds in Southland, and some good progress has been made but more resources will be required to complete projects and reap the benefits, as well as to develop biological control for additional targets.

# 7. Recommendations

## 7.1 Broom

- Harvest and redistribute the broom psyllid and broom seed beetle to areas where they are not yet present.
- Check if there are any areas where the broom twig miner is not yet present and if necessary harvest and release them there.
- Release the broom leaf beetle, broom shoot moth, and broom gall mite as soon as they are available.

## 7.2 Gorse

- Harvest and redistribute gorse thrips to areas where they are not yet present.
- Check the distribution of the gorse pod moth and if it is not widespread then harvest and redistribute them in areas where they are not yet established.
- Monitor gorse soft shoot moth and gorse colonial hard shoot moth release sites for establishment. Consider making further releases of the soft shoot moth given that it can now easily be collected in Canterbury and Marlborough. Release gorse colonial hard shoot moths at at least one more site.

### 7.3 Hawkweeds

- Monitor hieracium gall wasp and gall midge release sites for establishment. If they have established – undertake a harvesting and redistribution programme; and if not – consider making further releases.
- Release the hieracium hover flies and plume moth as soon as they are available.

### 7.4 Old man's beard

- No further action is required unless the current DOC weed-led control project is unsuccessful and the weed continues to be a problem.

### 7.5 Ragwort

- Monitor ragwort plume moth and ragwort crown-boring moth release sites to check for establishment. Release the crown-boring moth at at least one more site.
- Continue to harvest and release ragwort flea beetles if there are still areas where the beetles are not yet established and that are likely to be suitable for them.

### 7.6 Thistles

- Release the Californian thistle stem miner and green thistle beetle as soon as they become available. Only consider fresh attempts to establish the Californian thistle gall fly if sites can be found that will not be grazed.
- No further action to increase the distribution of nodding thistle control agents is warranted while the plant is to be totally controlled.
- Monitor the Scotch thistle gall fly site for establishment, and if it is established consider undertaking a harvesting and redistribution programme.

### 7.7 Other

- Take greater care with the selection of release sites and put in place increased measures to ensure their security to minimise wastage of agents.
- Continue to be an active member of the National Biocontrol Collective to ensure that work to develop biocontrol for targets of interest to Southland continues.

## 8. Acknowledgements

This project was instigated by Randall Milne of Environment Southland. A big thanks to Peter Ayson who has largely looked after the release of biocontrol agents in Southland, the monitoring of release sites and the subsequent redistribution of agents over the past 23 years. Thanks to Jesse Bythell for helping to reconcile information about the release sites. Thanks also to Keith Crothers and Richard Bowman for their support over many years. Finally thanks to Hugh Gourlay who reviewed this report, Christine Bezar who edited it, and Wendy Weller who assisted with formatting.

## 9. References

Gourlay AH, Fowler SV, Rattray G 2006. Abundance of ragwort flea beetle (*Longitarsus jacobaeae*) at five sites on the West Coast, South Island, New Zealand. Landcare Research Contract Report LC0405/131 prepared for the West Coast Ragwort Control Trust. 20 p.

Page AR, Lacey KL 2006. Economic impact assessment of Australian weed biological control. CRC for Australian Weed Management Technical Series #10. 151 p.

## Appendix 1 What is biological control?

Weeds tend to be plants that are not native to New Zealand, and one of the reasons that introduced plants become weeds is that they don't have any natural enemies here. Landcare Research develops biological control strategies for weeds aimed at restoring the natural balance between these weeds and the environment by reuniting them with some of their traditional natural enemies, usually insects or fungi. Many years of careful research go into finding suitable biocontrol agents and thoroughly testing them to ensure they will not attack other desirable plants. Permission must be granted by the Environmental Risk Management Authority before any new biocontrol agents are introduced to New Zealand. All new introductions spend some time in a containment facility to ensure they are free of disease and parasites. Because we are able to free biocontrol agents of their own natural enemies they have the potential to be even more damaging in New Zealand than in their homelands.

Because substantial long-term (5–10 years) funding is required to develop and implement biological control programmes, large organisations, rather than individuals, have been asked to contribute to the task. The National Biocontrol Collective, which includes all regional councils and unitary authorities plus the Department of Conservation, funds most current and new biocontrol programmes. Collective decision-making is undertaken annually to decide which weeds to target and how best to progress current projects. A number of biocontrol programmes are also funded by community groups through MAF Sustainable Farming Fund grants, such as the one run by the Californian Thistle Action Group against Californian thistle.

There is no guarantee that any biocontrol agent will establish in New Zealand, but our current success rate is high. Many of the agents being used in New Zealand have never before been released outside of their native range, so we cannot easily predict beforehand how much damage they will cause to their target plants. Even agents that have been used in other countries may behave differently here. Also the impact of any one agent is likely to vary throughout New Zealand, and from year to year, so as a rule, to have a significant impact on a weed, several control agents are usually required. If successful, biological control can provide long-term environmentally friendly suppression of weeds.

Biological control is not appropriate in all situations:

- Biocontrol may be an option when you do not need to eradicate a weed. Biocontrol agents do not eliminate weeds, because they can never find or utilise every plant. Rather, a successful biological control attack may reduce the vigour and abundance of a weed so that it stops spreading, and it may reduce existing infestations to a level that we can live with or eliminate effectively and economically by other means. If biocontrol is successful, plants become increasingly rare and the agent population reduces accordingly, so a new equilibrium forms between the abundance of agents and their host plants. Where a weed needs to be eradicated biocontrol may be a stepping stone towards achieving that goal. However, for low-incidence plants, conventional weed control techniques may be more appropriate because of the costs and time frames involved in developing biocontrol and the uncertainty about how successful it might be.
- Biocontrol may be an option when you do not need to control a weed immediately, because it takes time to find, test, and import suitable control agents, and then build up damaging populations in the field. An advantage of removing weeds gradually is that large areas of soil are not exposed to erosion, and invasion by other undesirable species is limited.
- Biocontrol may also be an option when weeds are difficult to control by chemical means, or conventional control methods are not physically possible or economically viable. Biocontrol is often the only practical method of tackling widespread intractable weeds.
- Biological control may be an option when it is important that you only harm the target weed – a result that can be difficult to achieve by mechanical or chemical means. Also none of the biocontrol agents in New Zealand pose health risks to handlers or the public.

**Mycoherbicides**

Plant pathogens can be used to control weeds in a similar way to chemical herbicides. The term mycoherbicide is used for a herbicide in which the active ingredient is a plant pathogenic fungus. Fungi used in mycoherbicides are usually found naturally in the area in which they are used, and are not always highly host specific. Under natural conditions fungal disease epidemics occur and damage plants from time to time, but the potential of these fungi is usually limited in some way, e.g. the environment is not always conducive to good disease development or the fungus may be limited in its dispersal ability. By developing the fungus into a mycoherbicide these constraints can be overcome. Mycoherbicides can be applied in many ways, e.g. as aerial sprays, through 'cut and paste application', or in a powder applied to the soil. They are not likely to be cheaper than chemical herbicides, and, like chemicals, offer knockdown rather than permanent suppression. However, they may be more selective and are kinder to the environment.