Report No. 133

Report on a survey conducted for the New Zealand Forest Site Management Cooperative on Scotch broom management in New Zealand

By Karina Potter

Ensis/Scion

Date: April 2007

Commercial in Confidence

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EXECUTIVE SUMMARY

A survey was undertaken as part of a New Zealand Forest Site Management Cooperative project titled “Scotch broom management in Forestry” to gather information regarding current and past Scotch broom (*Cytisus scoparius*) herbicide treatments and management regimes, ascertain the views of the New Zealand forest industry on the significance of Scotch broom as a forest management problem and identify key questions and areas of future research. The majority of surveys were undertaken in an interview format over the telephone and 15 forest managers from a total of 11 companies were interviewed. In the majority of cases, Scotch broom was either listed as an existing significant weed problem or highly likely to become one in the future. Scotch broom management regimes differed significantly between interviewees. Key management issues and areas of interest for future research were grouped under the themes of Scotch broom biology and ecology, competition between Scotch broom and crop tree and herbicide treatments. It was recommended that these themes be used in conjunction with the results of the literature review of Scotch broom biology, ecology and management to direct bids for future Foundation for Research Science and Technology and industry cooperative funding.

Objective

The objective of this study was to survey the New Zealand forest industry and determine: i) current and previously used Scotch broom herbicide treatments and their effectiveness; ii) current and previously used Scotch broom management regimes (chemical and non-chemical) and their effectiveness and iii) key management questions and research topics in relation to Scotch broom.

Key Results

Scotch broom was either listed as an existing significant weed problem or highly likely to become one in the future. Management regimes varied between companies. This was probably driven by the forest location, climate and the severity of the infestation being managed. All companies used an aerial application of varying ratios of glyphosate + metsulfuron with a surfactant for site preparation. Approximately 40% of interviewees utilised spot-release as standard practice when planting and approximately 87% employed at least one aerial release operation within their Scotch broom management regime. Interviewees commented that the Scotch broom problem was likely to increase due to continued spread and the move to later rotations, and that this would make adhering to Forest Stewardship Council requirements to reduce chemical use more difficult. Interviewees were asked to suggest key management issues and areas for future research that would assist in their Scotch broom management strategies. These were grouped under the themes of Scotch broom biology and ecology, competition between Scotch broom and crop tree and herbicide treatments.

Application of Results

This survey identified that Scotch broom is already costing the New Zealand forestry industry significant amounts of money in management, and that this expense is unlikely to diminish with time. In order to mitigate this concern, the areas of interest for future research identified by this survey should be considered in combination with relevant data from the literature review on Scotch broom biology, ecology and management. The data also provide the background information needed to develop a new project focusing on national approaches to Scotch broom management in forests.

Further Work

It is recommended that the information gathered by this survey be used to guide the direction of a new Forest Site Management Project and to support the next application for funding from the Foundation for Research Science and Technology.

REPORT ON A SURVEY CONDUCTED FOR THE NEW ZEALAND FOREST SITE MANAGEMENT COOPERATIVE ON SCOTCH BROOM MANAGEMENT IN NEW ZEALAND

Karina Potter

April 2007

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Information for Ensis abstracting:

Contract number	J59012
Other materials used	Interview on Scotch broom management, industry identification of key research areas to direct future funding applications
Participants	New Zealand Forest Managers / Site Management Cooperative members

INTRODUCTION

This survey was undertaken as part of a New Zealand Forest Site Management Cooperative project titled “Scotch broom management in Forestry”. The survey was designed to gather information regarding current and past Scotch broom (*Cytisus scoparius*) herbicide treatments and management regimes (both chemical and non-chemical), ascertain the views of the New Zealand forest industry on the significance of Scotch broom as a forest management problem and identify key questions and areas of future research. The majority of surveys were undertaken in an interview format over the telephone and 15 forest managers from a total of 11 companies were interviewed.

MATERIALS AND METHODS

Survey questions (Appendix A) were developed in consultation with Ensis staff and trialled with forest managers from two companies. This led to some minor amendments to the wording of questions to provide extra clarification.

While the initial testing of the survey questions was carried out in a face-to-face interview, all further surveys were undertaken in an interview format over the telephone. This avoided the costs associated with travelling to meet each forest manager individually and the potential for a poor return rate from posted hardcopy questionnaires.

Forest managers targeted to participate in the survey included representatives of all companies within the Site Management Collaborative. Industry representatives on the collaborative committee either participated personally or recommended the most relevant person to contact. In some cases, more than one forest manager per company was interviewed as the plantation layout and level of Scotch broom infestation meant that managers of different parts of the estate implemented different Scotch broom management strategies. The aim was to engage the opinion of as many forest managers as possible.

RESULTS AND DISCUSSION

Cooperative member involvement

A total of 15 forest managers from 11 New Zealand forest companies contributed a response to the Scotch broom management survey. Interviews took approximately 30 - 40 minutes and in only two cases did interviewees state they did not have a Scotch broom problem.

Table 1: Companies that contributed responses to the survey questions, the number of forest managers interviewed per company and the region managed.

Company	Manager interviewed and region managed
Carter Holt Harvey	1 – Kinleith, Central North Island region
	2 – Nelson Bay region
City Forests	1 – Dunedin surrounds
Ernslaw One	1 – Otago/Southland
Hikurangi Forest Farms	1 – East coast of the North Island
Kiangaroa	1 – Central North Island
Pan Pac	1 – Central Hawkes Bay (Gwavas forest)
	2 – Central Hawkes Bay (Tangoio and Esk)
	3 – Central Hawkes Bay (Kaweka forest)
PF Olsen	1 – Rotorua, Taupo and Opotiki
Rayonier	1 – Otago and Southland
	2 – North Canterbury
West Coast Timberland	1 – West coast of the South Island
Wenita Forests	1 – Dunedin surrounds
Weyerhaeuser	1 – Nelson and Blenheim
Total = 11	Total = 15

The Scotch broom problem – questions 1.1 to 1.6

At least one interviewee, from all apart from one company, indicated that Scotch broom was a significant problem within their estate. In some cases, only particular forests were infested however where present, Scotch broom management cost companies considerable time, resources and dollars.

Interviewees described Scotch broom as either a stable or increasing problem on their estate. It was described as "stable" where the area cut-over each year was relatively constant and an "increasing problem" in areas where a) it has spread into previously uninfested forests and b) the move to later rotations has corresponded with an increase in Scotch broom density.

Scotch broom infestations were commonly observed in disturbed areas such as along roadsides, river margins and railway-lines, at skid sites, gravel pits, quarries and dredge tailings, near log moving/hauling equipment and on neighboring properties. Within a forest stand, Scotch broom was described as having both a patchy and a random distribution.

Interviewees often responded to the question "When you see Scotch broom in the field, is it usually as a monoculture or in a mixture with other weeds?" with a comment regarding Scotch broom density. Scotch broom was often described as a monoculture in areas of severe infestation however at lower densities it was observed in combination with other weeds such as gorse, buddleja, fire-weed, native regeneration, manuka, gorse, Himalayan honeysuckle, bracken, blackberry and grasses. Other comments that expanded on this response were that at some sites Scotch broom can overtake the crop tree height within 2 years of planting and that gorse is considered a lesser problem than Scotch broom as it doesn't grow as fast (and hence compete with the trees as soon or as vigorously as Scotch broom).

The primary causes of Scotch broom spread in and around plantation estates were transfer along roadsides, the transport of road metal and gravel, movement of harvesting equipment and other machinery between forests, retained old slash and ballistic spread.

Approximately 50% of companies also commented that they had specific hygiene procedures to restrict the movement of Scotch broom seed around the forest estate. These included wash-down stations for machinery and cars and targeted manual chemical control along dispersal avenues such as roads, quarries, and skid sites. Some interviewees commented however that they were not convinced at how effective wash-down procedures were at reducing seed spread.

In two cases, interviewees reported that they believed that quail (or other birds) had transported Scotch broom seed into previously uninfested forests. Apart from observing quail in these areas, this comment was also clarified by the statement that no Scotch broom was observed in the particular forest at the time of initial site-preparation operations or during the first rotation however a problem arose at the time of site-preparation operations for the second rotation. Another possible explanation, not raised by interviewees, was that machinery used for the harvest and/or site-preparation operations was contaminated with Scotch broom seed.

General Scotch broom control – questions 2.1 to 2.6

All companies utilised chemical control (aerial with or without spot spray applications) as the primary element of their Scotch broom management regime and chemical control was considered to be the only cost and time-effective management tool available. The regimes used were generally based on the management of woody (or brush) weeds with the regime often referred to as a "Scotch broom and gorse" management regime.

Interviewees stated that the aim of Scotch broom control was to achieve Scotch broom knockdown to a level that restricted the weed competing with the plantation trees. The primary concerns associated with Scotch broom-tree competition were the impact of Scotch broom on tree mortality and tree growth. The impact of Scotch broom competition on wood quality was only mentioned by 2 (13%) interviewees. The height of the Scotch broom relative to the plantation tree was the standard indicator of competition used by forest managers. Common guidelines included: "if the Scotch broom is 75% of the tree height apply control" or "if 40% of the tree height is above the Scotch broom it is not necessary to spray". Some companies also considered the density of the Scotch broom infestation with one interviewee providing the example that a sparse Scotch broom infestation was less of a threat to plantation trees than a dense infestation as it is prone to collapse under exposure to high winds and snow while a dense Scotch broom infestation is less affected by these environmental conditions and is hence a greater threat to the trees.

In almost all cases (93%), Scotch broom management did not cease until trees were released from competition (i.e. tree height was above Scotch broom height) and it was anticipated that this state would be maintained for the remainder of the rotation. In only one case was it considered uneconomical to continue Scotch broom management at a certain stage in the management regime. Based on the assumption that a stable release state was reached in the year of the final aerial application, a stable release state was reached two years after planting for approximately 50% of interviewees, three years after planting for 33% of interviewees and the remainder either zero (= the year of planting), one or four years after planting. The management regime implemented to gain release from Scotch

broom competition was strongly influenced by the geographic location of the estate and the density of the Scotch broom infestation. One interviewee also commented that any surviving Scotch broom at the end of the Scotch broom management regime ceased to grow greater than 2.5 m due to suppression by the plantation trees and that the remaining Scotch broom probably had a positive impact on the stand by reducing tree branch size and fixing soil nitrogen.

Chemical control: pre-plant/site preparation – questions 3.1 to 3.8

The time of tree planting varied throughout the country but generally occurred between May and September. Some interviewees commented that planting began once soil moisture conditions had increased and seedlings had hardened off in the nursery.

100% of companies used an aerial application of a glyphosate + metsulfuron with a surfactant for site preparation (Figure 1). Glyphosate rates varied between 2160 – 5610 g ai/ha while metsulfuron rates varied between 36 -180 g ai/ha. Mixes were applied with between 100 – 200 L/ha of water. Many of the interviewees using 200 L/ha indicated that they were keen to reduce the water volume if they could maintain good Scotch broom control.

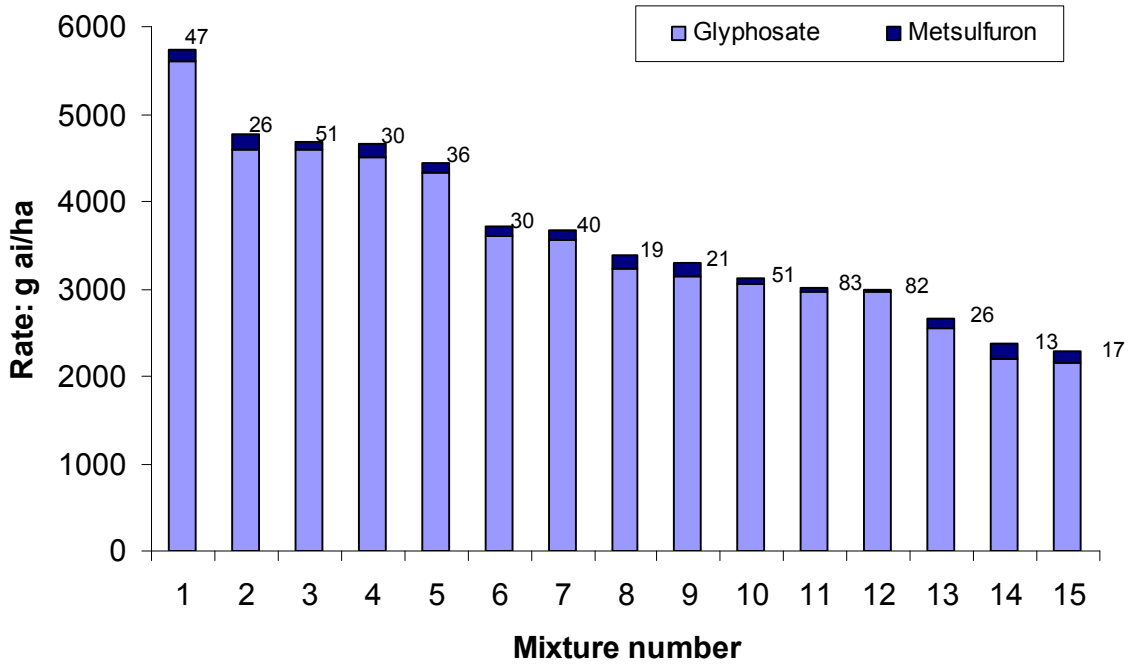

Figure 1: Rate of glyphosate and metsulfuron in site-preparation mixtures. The number above the bar indicates the ratio of glyphosate to metsulfuron.

The time of pre-plant herbicide application was influenced by a number of factors. Principally, as metsulfuron has residual capabilities, pre-plant applications were applied at least 8 weeks prior to tree planting. Most companies also attempted to apply pre-plant treatments when the weeds were actively growing and with enough time between cut-over and pre-plant application to allow for weed seed germination. Weed complex and growth

rate also influenced the time and rate of herbicide application. In some cases, if the weed load was particularly severe, higher chemical rates were applied. One company also commented that they adjusted their pre-plant application date to greater then 8 weeks prior to planting when higher chemical rates were required. One interviewee noted that if cut-over occurred too late to provide the required 8-week withholding period, a "glyphosate only" pre-plant treatment was applied up until the day of planting. Other companies left sites in this situation to be planted the following year.

"Cost effectiveness" and "tried and tested" were the justification for using the metsulfuron + glyphosate mix for Scotch broom control. Other comments included: it is possible to kill Scotch broom seedlings using rates at the lower end of the recommended label rate; by applying label rates we know that the chemicals are safe and there is some guarantee of success; the mixture may be doubled if the weeds have had a very long time to grow.

72% of companies interviewed were certified by the Forest Stewardship Council (FSC). These companies indicated that the requirement to show continued reductions in chemical use as part of FSC reporting had impacted on their site-preparation operations in the last 5-10 years. Of the companies that were not FSC certified, all indicated that they operated under strict environmental protocols and with respect to chemical use usually followed the regulations set by FSC. Changes in chemical application methods in the past 10 years including the configuration of aerial spray equipment (e.g. nozzle and boom configurations), use of GPS and surfactants were noted to be of significant benefit to reducing chemical use.

Other comments relating to how site preparation has changed over the past 5-10 years include: pressure to move away from mechanical pre-plant methods as burning, and slash and line-rake cultivation caused soil erosion and was not economical and the use of cover-crops. Two interviewees mentioned that mechanical pre-plant methods were a useful tool to reduce total chemical use and others were concerned that as Scotch broom density increased with further rotations (due to the presence of a seed bank) it will become more difficult to maintain the FSC requirement to reduce chemical use.

Chemical control: post-plant treatments – questions 4.1 to 4.11

Differing opinions existed as to the primary purpose of release operations. These included; a) ensuring tree survival as seedlings were valuable (i.e. expensive) genetic stock, b) the removal of competing vegetation (weeds) that reduce tree growth and, c) the creation of a more uniform stand to manage and harvest. Some interviewees commented that while the driver of past modelling research was the negative impact of weeds on tree growth (i.e. impact of weeds on the *quantity* of wood produced) there is now greater interest in producing high *quality* wood due to the poor market for lower quality timber.

Land-based release operations

Approximately 40% of interviewee's utilised spot-release as standard practice when planting, a further 33% of interviewees tended to use it on a more selective basis and 27% did not use spot-release as a Scotch broom control technique. Chemicals commonly used for spot-release included terbuthylazine (500 g ai/L) + Tordon Brushkiller (picloram 100 g

ai/L + triclopyr 300 g ai/L), Valzine (terbuthylazine 425 g ai/L + hexazinone 75 g ai/L), Valzine Extra (terbuthylazine 400 g ai/L + hexazinone 100 g ai/L) and Forest Mix granules (67 g ai/kg hexazinone + 150 g ai/kg atrazine). Where used, spot-release treatments were usually applied within 2 months of tree planting, generally as soon after planting as possible and were reported to provide approximately 12 month residual control. Spot size varied but was usually around 1.5-2 m. Those interviewees that used a spot-release treatment on a targeted basis only applied this control method on sites dominated by grasses or where Scotch broom was noted during pre-plant operations and extra residual control was required. In some cases, due to the short interval between pre-plant application and spot-release, only grasses had germinated at the time of the spot-release.

Aerial release operations

According to the majority of interviewees, aerial release operations were scheduled to coincide with when weed competition threatened tree survival. This was influenced primarily by: a) stand location and local climatic conditions, b) the type, frequency and success of land-based release operations performed prior to an aerial release and c) the weed complex present. All of these factors have the ability to influence both tree and weed growth rates and hence when trees require release from weed competition.

Approximately 87% of interviewees employed at least one aerial release operation within their Scotch broom management regime. In most cases, this was applied in spring or summer two years after planting (Year 2: Table 2). Only one company scheduled a second aerial release as a blanket operation (Regime 3). In this regime, standard aerial release applications were applied one and two years after planting with a targeted third aerial release application applied in Year 3 to a very small portion of the estate. In most cases, a second aerial release was only applied if an error was made with the first application or to a specific targeted area. According to interviewees, common reasons for a second aerial release were human error, inappropriate timing of herbicide application in relation to weed phenology or weather conditions, poor weed kill due to weeds hardening off, and frost.

Chemical mixtures and rates used for aerial release varied considerably between interviewees, both between and within individual companies (Table 3). Aerial release mixtures could be divided broadly into two groups, clopyralid plus picloram and/or triclopyr (either alone or pre-mixed as Tordon Brushkiller) mixtures and terbuthylazine plus hexazinone mixtures. Further details on herbicides can be gained from Gous (2003).

Interviewees reported that the use of aerial herbicide application rather than land-based operations such as manual cutting was the primary change in post-plant release techniques in the last 5-10 years. It was also noted that the cost of herbicides has decreased, the efficacy of available chemicals has increased and advances in aerial application technology, such as high precision spray booms, has made aerial application more cost-effective.

Table 2: Year of standard aerial release operation (Grey = year of standard aerial release) and total number of applications per regime. Stripes indicate an alternative year for the previous year's application.

Regime	Year of Planting (Year 0)	Year 1	Year 2	Year 3	Year 4	No. of standard applications + targeted application

[a] applied as a salvage operation only, [b] herbicide applications in year 1 or 2 are very rare

Table 3: Aerial Release mixtures

Mix no.	Chemical 1: ai/ha applied	Chemical 2: ai/ha applied
1	**Clopyralid 300 g ai/L (Versatill)**	**Triclopyr 300 g ai/L + Picloram 100 g ai/L (Tordon Brushkiller)**
	750 g ai/ha	triclopyr 150 g ai/ha + picloram 50 g ai/ha
	1350 g ai/ha	triclopyr 150 g ai/ha + picloram 50 g ai/ha
	1500 g ai/ha	triclopyr 150 g ai/ha + picloram 50 g ai/ha
	1500 g ai/ha	triclopyr 300 g ai/ha + picloram 100 g ai/ha
	1500-1740 g ai/ha	triclopyr 174 g ai/ha + picloram 50-58 g ai/ha
	1800 g ai/ha	triclopyr 150 g ai/ha + picloram 50 g ai/ha
2	**Clopyralid 300g ai/L (Versatill)**	**Triclopyr 600 g ai/L (Grazon)**
	1260g ai/ha	360 g ai/ha
	1500g ai/ha	300 g ai/ha
	1500g ai/ha	360 g ai/ha
3	**Clopyralid 225 g ai/L + Picloram 150 g ai/L (Radiate)**	
	clopyralid 450-562.5 g ai/ha + picloram 300-375 g ai/ha	
4	**Terbuthylazine 500 g ai/L**	**Hexazinone 750 g ai/kg (Velpar DF)**
	6000 g ai/ha	1875 g ai/ha
	7500 g ai/ha	1125-1500 g ai/ha
5	**Terbuthylazine 425 g ai/L + hexazinone 75 g ai/L (Valzine)**	
	terbuthylazine 8500 g ai/ha + hexazinone 1500 g ai/L	
6	**Terbuthylazine 435 g ai/L + hexazinone 65 g ai/L (Release KT)**	**Triclopyr 300 g ai/L + picloram 100 g ai/L (Tordon Brushkiller)**
	terbuthylazine 7395 g ai/ha + hexazinone 1105 g ai/ha	triclopyr 150 g ai/ha + picloram 50 g ai/ha

Non-chemical control – question 5.1

Interviewee's listed mechanical cultivation, grubbing, chainsaws, brushcutters, slashing, biological control and cover crops as non-chemical methods of Scotch broom control however there were mixed opinions as to the relative importance of these as Scotch broom management tools. Non-chemical control methods were described as useful in stands of minor species that were more difficult to manage using chemicals and in areas that were difficult to access. Mechanical cultivation was usually implemented within the site

preparation regime to improve soil structure and drainage, with Scotch broom control considered a secondary benefit. Approximately 50% of interviewees also commented that biological control would be a valuable Scotch broom control tool if significantly damaging agents could be introduced into New Zealand. One third of interviewees further commented that the current agents were not damaging enough to be an economical option.

20% of interviewees sowed cover crops as a Scotch broom management tool. Cover-crops ranged from mixtures of Yorkshire fog grass, lotus and trefoil to 100% Yorkshire fog grass. The remainder either did not sow cover crops or sowed cover crops but did not consider them to be a Scotch broom control technique. One interviewee commented that in order to gain a benefit from sowing cover crops, a high level of accuracy was required with the scheduling of pre-plant application, cover crop sowing and planting date. For example, it was noted that if seed was sowed too late then the grass did not provide enough competition to suppress the Scotch broom seedlings. Some forest managers noted that the difficulties associated with scheduling cover crop sowing and choosing a competitive grass mix made their use uneconomical.

Current management regimes

This survey gathered information on management regimes currently used by the New Zealand forestry industry for Scotch broom control. A comparison of old and new Scotch broom management regimes can be found in the literature review also prepared for the Site Management Cooperative as part of this project. In comparing the current management regimes used by different companies it was noted that:

- Only two of the interviewees utilised cover-crops as a significant component of their Scotch broom management regime.
- All companies used a glyphosate plus metsulfuron mix for site preparation.
- The majority of interviewees used a spot-release operation as part of their regime and a terbuthylazine plus hexazinone mix was the most commonly applied treatment.
- Most companies applied a single release operation and only applied a second on a case-by-case basis.
- Those companies that applied an aerial release operation in the year of planting or 1 year after planting applied a terbuthylazine plus hexazinone mixture while those applying a release operation 2 years or more after planting commonly used a herbicide mixture containing clopyralid.

Key management questions and research topics – question 6.1

The final section of the survey interview encouraged more general discussion with the interviewee about what they considered to be key questions with respect to Scotch broom management and suggestions of where future Scotch broom research should be focused. The comments gathered were then grouped into themes and are summarised below. These comments have been integrated into the recommendations for future Scotch broom management research described in the literature review "Overview of Scotch broom (*Cytisus scoparius*) Ecology and Past and Present Management Practices in Commercial Forestry" also prepared for the Site Management Cooperative as part of the project titled "Scotch broom management in Forestry 2005/06".

1. Scotch broom Biology and Ecology

- What is the input to the seed bank over time? Is there a particular season or age when the plant is most productive at producing seed?
- Some foresters noted that Scotch broom does not have many opportunities to flower and set seed within a forest stand due to pre-plant and release herbicide operations and canopy closure.
- Within the forestry setting, what is the relative importance of competing vegetation (for space/nutrients/light), temperature and moisture conditions for Scotch broom seed germination?
- How many annual site preparation operations would stimulate 99% germination of the seed bank?
- Exploration of management options that trigger a greater proportion of seeds within the seed bank to germinate at the one time would enable a single pre-plant operation to destroy a larger proportion of the seed bank.
- By understanding germination stimulants, managers could better schedule the sowing of cover crops to compete effectively with weeds on the site. For example, what soil temperatures does Scotch broom need to germinate? Grass seed germinates at 7°C. and gorse at 10°C.
- What is the structure of the Scotch broom population being treated with the pre-plant application? Are the plants all newly germinated seedlings or are there also plants that have re-sprouted following the mechanical site preparation operations?

2. Competition between Scotch broom and crop tree

- What is the relative growth rate of trees and Scotch broom at different sites in New Zealand?
- What is the impact of the time of release operations, both within a season and year since planting, on management regimes?
- Can certain herbicide applications be eliminated from the regime by better timing of other applications?

3. Herbicide treatments

- Almost all companies were confident that the chemical brews they were using for Scotch broom control worked and they were generally able to explain the cause of any failures, eg. weather, operator error etc.

- However, companies still aimed to reduce chemical use to adhere to FSC and to reduce costs.
- While label rates generally achieve a good knockdown and/or kill, is it possible to apply lower rates and achieve similar results with the advantage of reducing costs?
- How does the susceptibility of Scotch broom to herbicide change a) during its life span and b) within a season?
- How does the time of herbicide application (within a season and year since planting) effect tree health, form and wood quality?
- What is the impact of plant physiology at the time of herbicide application on the efficacy of application? i.e. what is the impact of the plants physiological state and local weather conditions on efficacy.
- Some indication exists that lower rates are successful in areas where weeds do not harden off due to high rainfall (i.e. west coast of NZ).

4. Other miscellaneous comments

- Foresters have a keen interest in biological control and myco-herbicides as potential Scotch broom control options.
- How do different herbicides and rates affect trees? i.e. some trees suffer from herbicide application more than others.
- Interest in new site-preparation options; both chemical and mechanical, to reduce weed problems. Some have tried creating mounds that turn the soil 180° upside down and put the seed bank on the bottom of the pile. This makes it difficult for the Scotch broom seed to germinate.

RECOMMENDATIONS AND CONCLUSIONS

This survey identified that management of Scotch broom is a significant cost to the New Zealand forestry industry and that this expense is unlikely to diminish in the near future. In order to mitigate this concern, the key management questions and research topics identified by this survey should be the focus of future funding applications through avenues including the Foundation for Research Science and Technology and industry cooperatives. It is recommended that a team of scientists, in consultation with industry, should formulate a research programme to be integrated into the Foundation for Research Science and Technology Weeds bidding round scheduled for 2007/8. Specific parts of the research programme should also be flagged as appropriate for funding by industry cooperatives or potential student or postgraduate projects.

ACKNOWLEDGEMENTS

The author would like to gratefully acknowledge the support of the New Zealand Site Management Cooperative and the Foundation for Research, Science and Technology in funding this work. Thanks also go to all those members of the Co-op

that contributed responses to the survey questions. The information gained will be of immense value in documenting the current state of Scotch broom management for reflection in the future and in assuring forthcoming research is applicable and of benefit to the New Zealand forest industry. Thanks also go to Stefan Gous, Brian Richardson and Darren Kriticos for their feedback on this report.

APPENDIX A

Industry Interview – Scotch broom management 2006

BACKGROUND
Contact name:
Company name:
Estate size:
Age range:
Plantation Species:

1. THE SCOTCH BROOM PROBLEM
Q1.1. Is Scotch broom a significant weed problem on your estate?

Q1.2. Are there particular forests or parts of your estate where Scotch broom occurs or is absent or where it is particularly serious problem?

Q1.3. Do you think Scotch broom is an increasing or decreasing problem in your plantation estate? Comment why?

Q1.4. At the more local scale, can you comment on where you see Scotch broom within a forest stand?

Q1.5. When you see Scotch broom in the field, is it usually as a monoculture?

Q1.6. What is the main cause of Scotch broom spread in and around your forests?

2. SCOTCH BROOM CONTROL - GENERAL
Q2.1. Do you have specific treatment schedules for Scotch broom control or do you have a more general weed control regime?

Q2.2. What methods do you use to control Scotch broom?

Q2.3. What makes x (*chemical control*) your preferred choice for Scotch broom control?

Q2.4. What factors influence the way you manage your Scotch broom?

Q2.5. At what point do you not bother to control Scotch broom any more?

Q2.6. Do you use a contractor for Scotch broom management?

3. CHEMICAL CONTROL - Site preparation / pre-plant treatments
Q3.1. When is considered planting time for radiata pine? Douglas fir?

Q3.2. What method do you use to apply pre-plant treatments?

Q3.3. What determines when you apply a pre-plant treatment?

Q3.4. Is there a particular window/season when you will apply a pre-plant treatment?

Q3.5. What is the total volume of spray per ha applied as a pre-plant treatment?

Q3.6. What chemical brew (including surfactant) and rate do you usually use?

Q3.7. Can you comment about why you use these particular products?

Q3.8. How has your site prep-practices changed over the last 5-10 years? What has influenced this?

4. AFTER PLANTING TREATMENTS

Q4.1. What type of follow-up weed control do you perform?

Landbased application

Q4.2. Under what circumstances do you apply a land-based release application?

Q4.3. What chemicals/adjuvants do you usually use if Scotch broom is your target weed?

Q4.4. Is there a particular time of the year when you schedule land based applications?

Q4.5. Are there any particular weeds or situations when a land-based operation is preferable to an aerial application?

Aerial release

Q4.6. Under what circumstances do you apply an aerial release?

Q4.7. When during the year do you apply a follow-up aerial treatment?

Q4.8. What controls your decision to apply a follow-up aerial control treatment?

Q4.9. What chemical brew (including adjuvant) do you usually use when Scotch broom is the target?

Q4.10. Under what circumstances do you apply a second aerial release application?

Q4.11. How has your post-planting management (aerial or land-based) changed over the last 5-10 years? What has influenced this?

5. NON-CHEMICAL CONTROL OF SCOTCH BROOM

Q5.1. Do you use any non-chemical methods to control Scotch broom?

6. KEY MANAGEMENT QUESTIONS AND RESEARCH ISSUES

Q6.1. What do you consider to be the key management questions related to Scotch broom control?