Ontario

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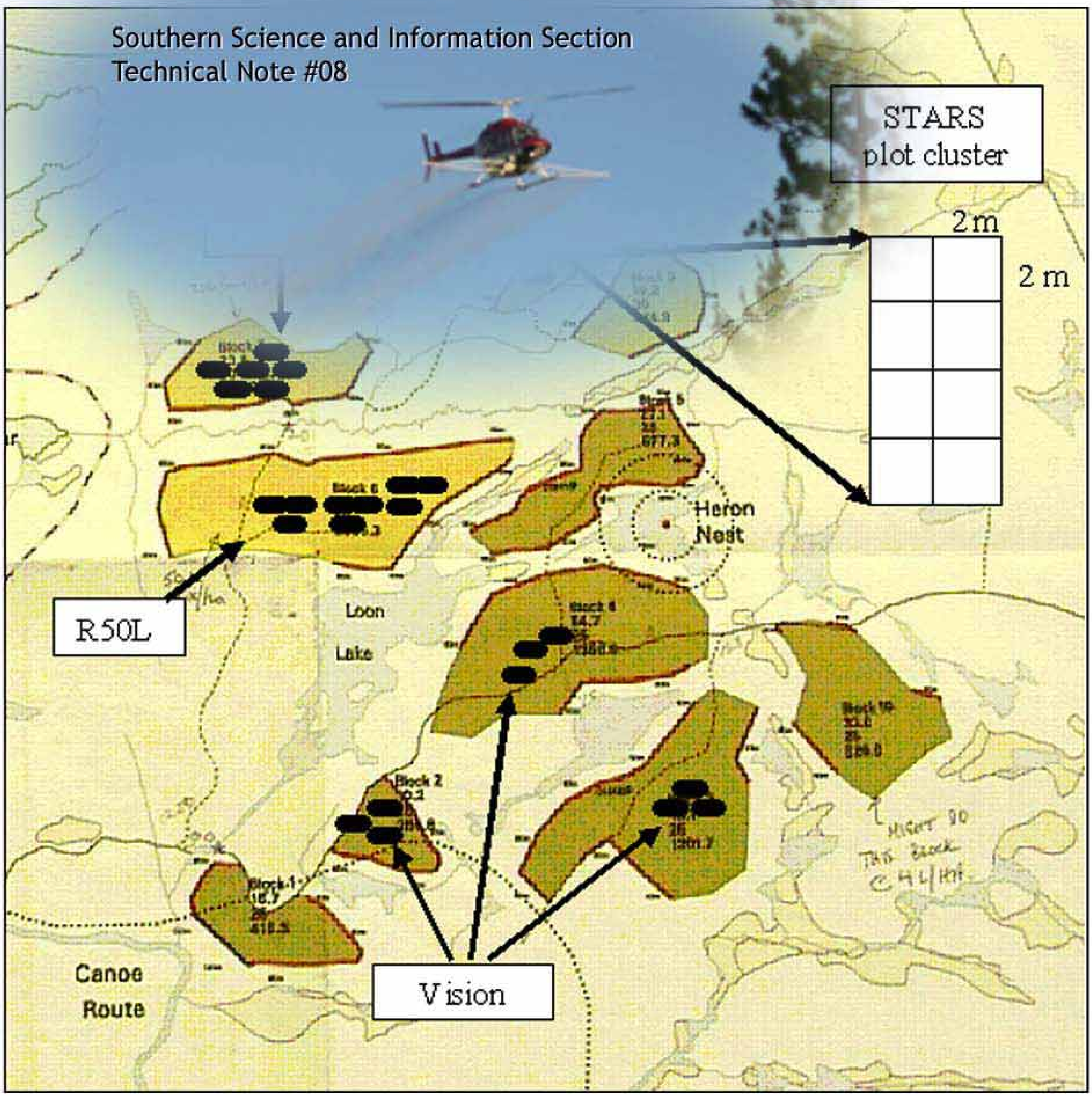
Southern Science and Information Section
Technical Note #08



Aerial herbicide release treatments in a uniform shelterwood system for white pine.

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Abstract

The objectives of this project were to assess

- the efficacy of aerial spraying of Vision® (glyphosate) and Release™ (triclopyr) herbicides in shelterwood stands on competing vegetation, and
- the growth and condition of white pine regeneration in response to the treatments.

Three different aerial spray treatments were applied in September 2000

- Vision® at a rate of 5 litres (L) ha^{-1} in a total spray volume of 25 L ha^{-1}
- Release™ at a rate of 4 L ha^{-1} in a total spray volume of 30 L ha^{-1}
- and Release™ at a rate of 4 L ha^{-1} in a total spray volume of 50 L ha^{-1}.

Baseline data was collected in August 2000 before treatment. Plots were re-assessed in July 2001 and 2002 to evaluate treatment efficacy.

The purpose of this project was operational monitoring; it was not a replicated trial. Results suggest that:

- Vision® is more effective at controlling white birch than Release
- Release™ is more effective at controlling red maple than Vision
- both herbicides are effective at controlling trembling aspen
- canopy gaps did not affect herbicide efficacy.

Résumé

Ce projet vise à évaluer

- l’efficacité de la pulvérisation aérienne des herbicides Vision® (glyphosate) et de Release™ (triclopyr) sur la végétation concurrente des peuplements à coupe progressive et

- la croissance et la santé de la régénération du pin blanc suivant le traitement.

Trois traitements différents ont été appliqués par pulvérisation aérienne en septembre 2000

- Vision® à raison de 5 litres par hectare, pour un volume total de 25 l/ha

- Release™ à raison de 4 litres par hectare, pour un volume total de 30 l/ha

- et Release™ à raison de 4 litres par hectare, pour un volume total de 50 l/ha.

Les conditions de base ont été relevées en août 2000 avant le traitement. Une nouvelle évaluation sur le terrain s’est effectuée en juillet 2001 et 2002 pour évaluer l’efficacité du traitement.

Le projet visait à suivre le progrès des activités; il ne s’agissait pas d’un essai répété. Les résultats semblent indiquer que :

- Vision® est plus efficace que Release™ pour enrayer la croissance du bouleau blanc

- Release™ est plus efficace que Vision® pour enrayer la croissance de l’érable rouge

- les deux herbicides sont efficaces pour enrayer la croissance du peuplier faux-tremble

- les écarts dans le couvert forestier ne semblent avoir aucun effet sur l’efficacité des herbicides.

Acknowledgements

Project funded by Westwind Forest Stewardship Inc., the Ontario Ministry of Natural Resources, and Tembec through the Forestry Research Partnership. Our thanks to Bill Parker and Doug Pitt for their thoughtful review and helpful comments on the paper, to Lisa Buse for her wonderful editing skills, and to Chris Lyons, Hillary Knack, Dalton Wagner, Allyson Batchelor, Victoria Lampkin, Sonia Kaminski, Shawn Carey, Linda Dwyer, and Justin Foreman for their assistance in establishing and collecting data on the study. We are grateful to Marty Martelle, MITIG Forestry Services, for planning and overseeing the treatments and helping with documentation and field tours. And finally, our thanks to Lyn Thompson for bringing this technical note to it's final state.

Disclaimer

Background and methodology

Effective and efficient release treatments are needed where suppressed white pine (*Pinus strobus* L.) seedlings are struggling to grow after the regeneration cut of a shelterwood system. Aerial herbicide applications offer a potential solution but are seldom attempted in uniform shelterwoods, partially because little information exists about both the efficacy of herbicides and the tolerance of white pine regeneration to herbicides where partial canopies are retained. Stratified vegetation and complex canopies can reduce herbicide deposition to understory target vegetation (McConkey 1958, Thompson et al. 1997). Thus, partial overstory canopies retained under shelterwood management may interfere with herbicide efficacy.

Although white pine has shown tolerance to glyphosate (Downs et al. 1984), and is considered resistant to both glyphosate and triclopyr (McLaughlan et al. 1996), herbicide injury to white pine regeneration has occurred in shelterwood systems. Young white pine seedlings have been damaged by operational use of glyphosate when applied with air blast sprayers in shelterwoods. Triclopyr is a possible alternative but little information is available about the tolerance of white pine regeneration to this product in shelterwood systems (Darren Dillenbeck, Dow Agrosciences, 2002, pers. comm.). To begin addressing these issues, an operational spray trial was monitored near the French River, in the northwest corner of Westwind Forest Stewardship Incorportated's (Westwind) French/Severn Management Unit (Figure 1).

Figure 1. Approximate location of aerial spray project south of Sudbury, Ontario (green star).

The objectives for the project were to:

1) assess the efficacy of aerial applications of Vision® (glyphosate) and Release™ (triclopyr) herbicides in shelterwood stands in central Ontario, and

2) assess the growth and condition of understory white pine regeneration in response to the treatments.

Nine *Silvicultural Treatment Assessment and Reporting System* (STARS) (OMNR 2003) sample plots, each consisting of a cluster of eight 2 x 2-metre (m) sub-plots were established in August 2000 under a range of crown closures in areas scheduled for aerial spraying (Figure 2). Within each sub-plot, the percent cover and average height of all competing vegetation was recorded. One dominant, healthy stem of each species of tall shrub and tree in each plot was pinned (including white pine regeneration, when present) and the height and basal diameter was recorded. The health condition of each pinned stem was evaluated using the method described in Pitt et al. (1992), which assigns a health code to

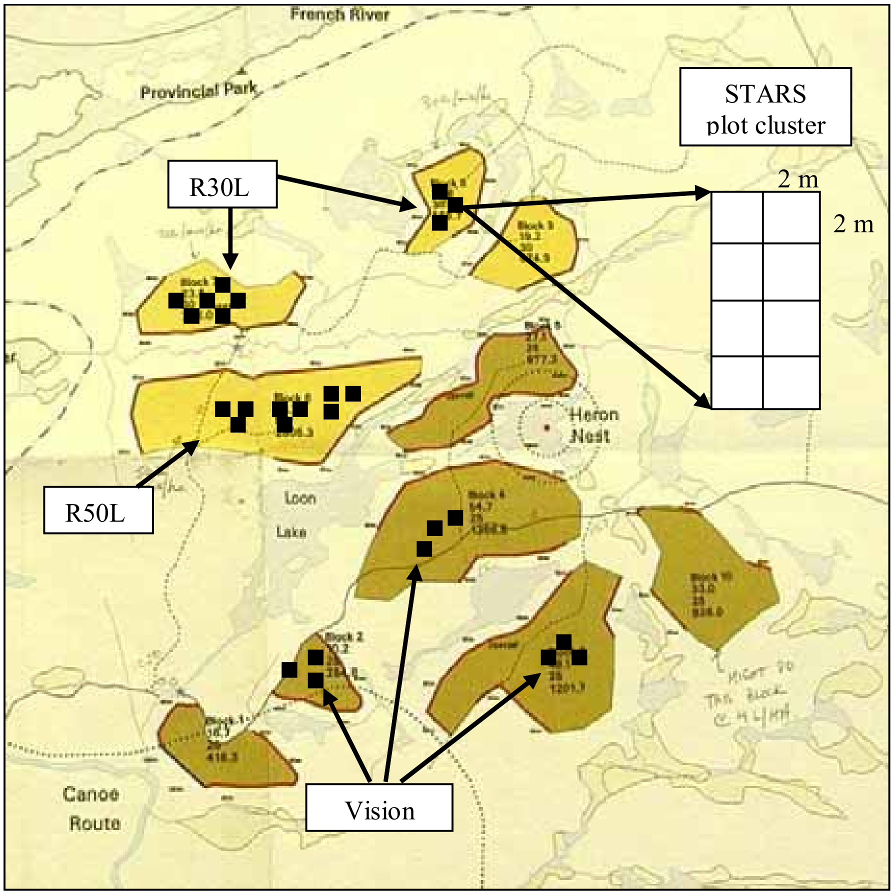

Figure 2. Treatment blocks and cluster locations within shelterwood aerial spray project. Where: Vision = Vision® @ 5 L ha^{-1} in a total spray volume of 25 L ha^{-1}, R30L = Release™ @ 4 L ha^{-1} in a total spray volume of 30 L ha^{-1}, and R50L = Release™ @ 4 L ha^{-1} in a total spray volume of 50 L ha^{-1}.

each tree/shrub (see Table 1). Basal area (using a Basal Area Factor [BAF] 2 prism) and crown closure measurements was also recorded at the centre of each cluster. Crown closure was determined from digital photographs (Kodak DC210, 29 mm lens) taken vertically towards the sky from each cluster centre at about 1.7 m above ground level. The proportion of sky versus foliage (overstory trees only) was calculated for each digital photograph using Arcview® spatial analyst software.

Forest Resource Inventory (FRI) descriptions and stand treatment histories for sampled blocks are provided in Appendix 1. Baseline data was collected in August 2000 before treatment. Herbicide applications occurred on September 13, 2000 with a Bell 206B helicopter using a boom equipped with D-10 disc nozzles set at 50 pounds per square inch (psi) (Figure 3). Three different aerial spray treatments were applied: Vision® at a rate of 5 litres per hectare (L ha)$^{-1}$ in a total spray volume of 25 L ha^{-1}, Release™ at a rate of 4 L ha^{-1} in a total spray volume of 30 L ha^{-1}, and Release™ at a rate of 4 L ha^{-1} in a total spray volume of 50 L ha^{-1}. Plots were re-assessed in July 2001 and 2002 to evaluate the treatment efficacy. The purpose of this project was operational monitoring: it was not a replicated trial.

Table 1. Description of tree health ratings (from Pitt et al. 1992).

Health class		Description of characters	Probability of survival
1	Vigorous	No visible imperfections, good morphological characteristics and obvious good growth	Certain, 90-100%
2	Healthy	Visual signs of one minor health ailment (i.e. insect damage, disease, mechanical damage, etc.) but otherwise healthy	Probable, 75-90%
3	Mediocre	Morphological, physiological, and (or) mechanical damage clearly noticeable	Uncertain, 40-75%
4	Moribund	Significant health problems (i.e. top kill, severe chlorosis or necrosis, serious insect, disease and (or) herbicide damage, etc.)	Unlikely, < 40%
5	Dead	No foliage, no green cambial tissue	0%

Figure 3. A Bell 206B helicopter spraying a uniform shelterwood.

Results

Effect of overstory crown closure

One hypothesis about aerial herbicide applications over uniform shelterwoods is that efficacy may decrease where there are fewer or smaller canopy gaps. We did not find any significant correlation between percent crown closure (range: 20–90 percent [%]) or basal area (range: 6–30 metres squared per hectare [m^2/ha]) of the residual overstory around clusters and the amount of defoliation that occurred within clusters. Our data suggests that crown closure doesn't predictably influence herbicide effectiveness. However, a controlled experiment that assesses herbicide deposit and effectiveness from different spray equipment, droplet sizes and spray volumes is needed in shelterwood conditions to address this question in a conclusive way.

Herbicide effectiveness – Defoliation

White birch (*Betula papyrifera* Marsh.) and red maple (*Acer rubrum* L.) were the most common competing species, occurring in almost all clusters. Each stem was healthy before treatment. For each pinned stem, percent defoliation was used as a measure of herbicide

Figure 4. Defoliation of understory vegetation following aerial spraying with Vision®.

effectiveness; stems were assumed dead when 100% defoliation persisted into the second year (Figure 4). Less than 100% defoliation was considered partial control, with stems expected to recover over time.

Two years after treatment, control of white birch was very good (92% defoliation) with Vision® , but only mediocre (about 42% defoliation) with either mix volume of Release™ (Figure 5). Red maple control was best with the low mix volume of Release™ (68% defoliation); control with Vision® was poor (less than 30% defoliation). Trembling aspen (*Populus tremuloides* Michx.) control was high with both herbicides, but possibly less with lower rate of Release™ (R50L results should be interpreted with caution because of the small sample size—trembling aspen occurred in only two of the nine clusters). These results are consistent with label recommendations; however, white birch control was less than expected with the Release™ herbicide treatment. None of the herbicide treatments completely eliminated competing vegetation.

Herbicide effectiveness – Dominance and percent cover

Before spraying, 18% of sub-plots were dominated by white pine (i.e. a white pine was present and taller than any competing species), 61% were dominated by hardwood tree species (red maple, white birch, and trembling aspen) and the remaining 21% were dominated by other species (beaked hazel [*Corylus cornuta* Marsh.], bracken fern [*Pteridium aquilinum* (L.) Kuhn], and herbs). Total stocking to white pine, however, was 71% (percent of plots where at least one white pine was present). This confirms the results of the regeneration survey conducted by Westwind that the stands were well stocked to white pine but required tending.

Aerial spraying of herbicides increased white pine dominance by 7–15%, depending on the herbicide used, with the largest increases in the Vision® and the higher volume rate of Release™ herbicides (Figure 6). The percent of plots dominated by trembling aspen was reduced by all treatments. Changes in dominance by red maple and white birch reflected their susceptibility to the different herbicide treatment: red maple dominance decreased

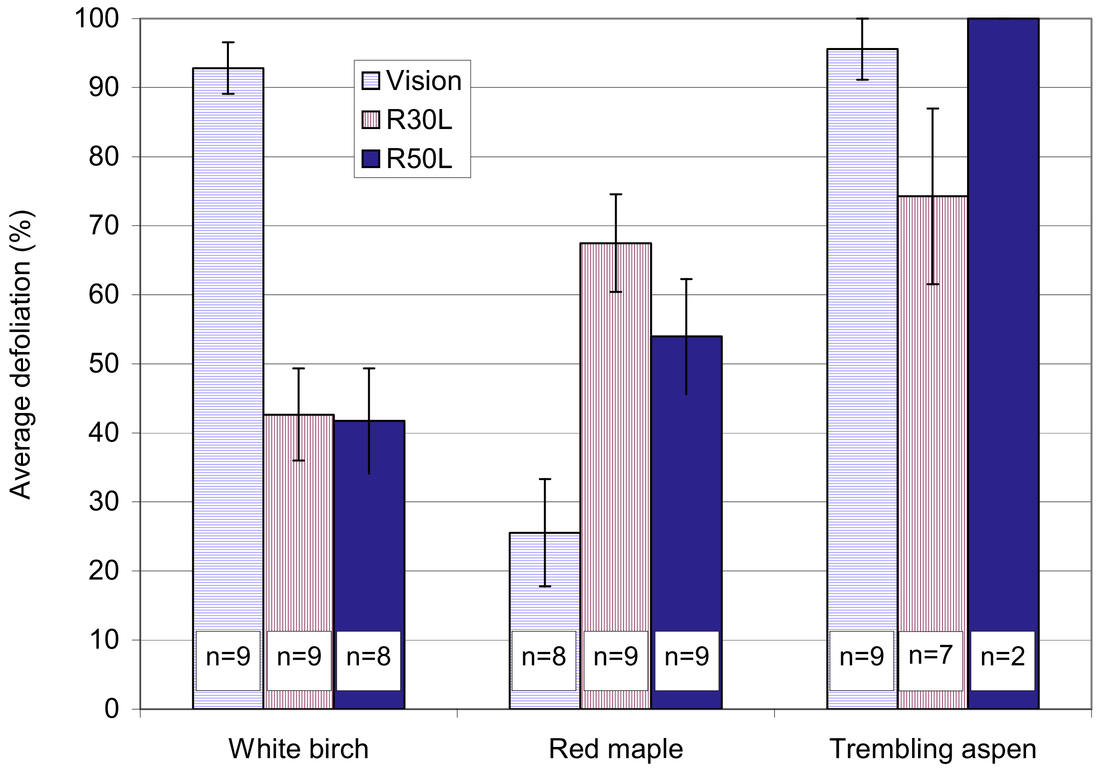

Figure 5. Defoliation of major competitors two seasons after treatment. Error bars represent the standard error of each mean. Sample size indicated at bottom of each bar (n=#). Where: Vision® = Vision® @ 5 L ha^{-1} in a total spray volume of 25 L ha^{-1}, R30L = Release™ @ 4 L ha^{-1} in a total spray volume of 30 L ha^{-1}, and R50L = Release™ @ 4 L ha^{-1} in a total spray volume of 50 L ha^{-1}.

following the higher volume of Release™ and increased following the Vision® treatment; white birch dominance increased following the Release™ treatments and was eliminated by the Vision® treatment.

Overall percent cover (percent of the 4-m^2 subplot covered by foliage of individual species) decreased for all main competitors following the aerial herbicide treatments, except for a slight increase in red maple following the Vision® treatment.

White pine health

White pine appeared to be in poorer health following the Vision® and higher volume Release™ (R50L) treatments, with 12% and 3% mortality, respectively (Figure 7). This decrease in health could have been caused by herbicide injury; however, other factors such as drought stress or competition could also be contributing. A rigorous study of white pine herbicide tolerance in shelterwood situations is required to adequately address this question.

White pine growth response

Using the size classes adopted by Westwind, we summarized the initial height response of white pine seedlings to release (note: some sample sizes are very small). Initial response

Figure 6. Change in percent of plots dominated (i.e., where that species is the tallest in the plot) by an individual species before (August 2000) and after (July 2002) aerial spray of herbicide (n=72), where Vision® = Vision® @ 5 L ha^{-1} in a total spray volume of 25 L ha^{-1}, R30L = Release™ @ 4 L ha^{-1} in a total spray volume of 30 L ha^{-1}, and R50L = Release™ @ 4 L ha^{-1} in a total spray volume of 50 L ha^{-1}.

varied with initial seedling size (Table 2). We plan to measure these seedlings for five years after treatment.

Management implications

Aerial spraying of shelterwoods using Vision® or Release™ herbicide is probably a viable tending option for forest managers in central Ontario. Canopy gap size had little effect on herbicide efficacy or crop injury. Vision® appears to be a more effective product for sites with abundant white birch and trembling aspen and Release™ appears more effective for sites dominated by red maple. Vision® at a rate of 5 L ha^{-1} may cause some injury to white pine regeneration (up to 12% mortality). Total stocking to pine averaged 71% on these sites, however only 30% were considered open-grown or dominant after aerial herbicide treatments, indicating a need to improve the effectiveness of aerially applied herbicides.

Initially, it appears that aerial spraying of shelterwoods can be used to release advance white pine regeneration from competition, however questions remain related to herbicide injury to white pine growing in shelterwood stands, and which spray equipment to use to minimize the amount of herbicide needed to adequately control competing vegetation.

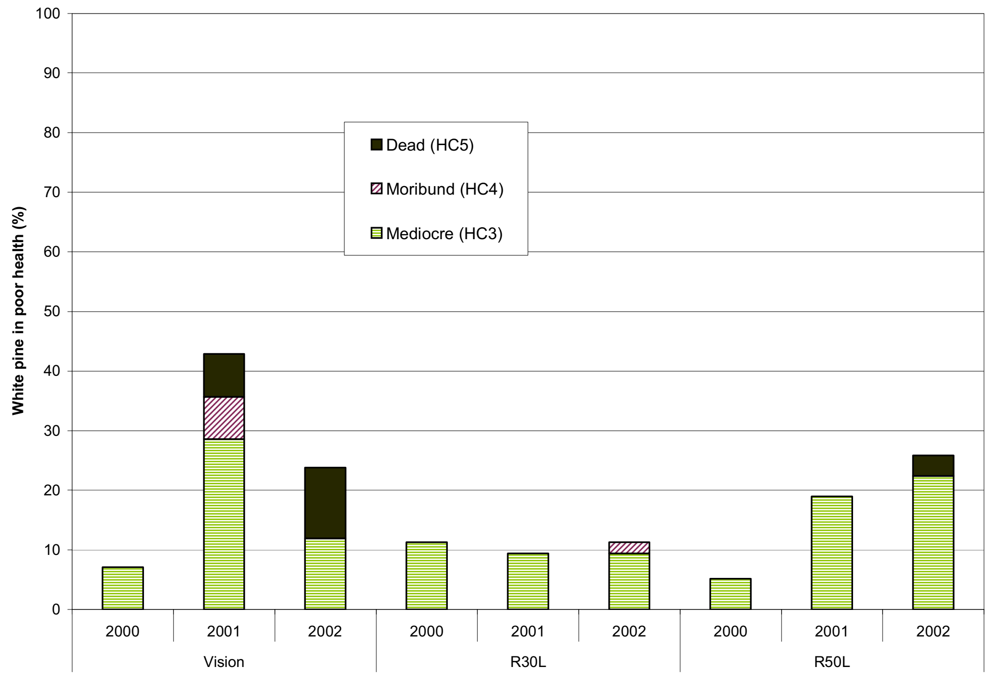

Figure 7. Summary of white pine in poor condition (health class 3, 4 or 5) before (2000) and for two years after treatment (2001 and 2002) (Vision n=42, R30L n=58, R50L n=53), where Vision® = Vision® @ 5 L ha^{-1} in a total spray volume of 25 L ha^{-1}, R30L = Release™ @ 4 L ha^{-1} in a total spray volume of 30 L ha^{-1}, and R50L = Release™ @ 4 L ha^{-1} in a total spray volume of 50 L ha^{-1}.

Table 2. Second year growth and survival response of white pine seedlings in different size classes to aerial spray of herbicides.

		Growth (2000-2002)			
Seedling height class before treatment	Treatment	Height increment (cm)	Diameter increment (mm)	Mortality after two years (%)	Sample size (N)
<25 cm	Vision®	2.8	0.01	43	7
	R50L	5.3	0.07	7	15
	R30L	7.2	0.33	12	8
	Overall mean	**5.5**	**0.2**	**17**	
26-100 cm	Vision®	14.8	0.8	17	23
	R50L	18.6	0.6	4	26
	R30L	24.2	1.4	0	25
	Overall mean	**20.0**	**1.0**	**7**	
101-300 cm	Vision®	34.6	1.1	0	12
	R50L	44.2	2.2	7	15
	R30L	36.3	2.6	0	18
	Overall mean	**38.0**	**2.1**	**2**	
>300 cm	Vision®	n/a	n/a	n/a	0
	R50L	52.5	1.2	0	2
	R30L	74.0	5.0	0	2
	Overall mean	**63.0**	**3.1**	**0**	

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Appendix 1. Stand description and treatment history for sampled blocks.

Block number and FRI descriptions	Treatment history
Block 2 Pw6Po2Pr1Sw1 117 years old, 23.5 m in height 0.4 stocking, Site Class 2	1992 Cut (regeneration cut of shelterwood system) 1992 Mechanical site preparation (straight blade) 1992 Plant white pine
Block 3 Pw6Po2Pr1Sw1 117 years old, 23.5 m in height 0.4 stocking, Site Class 2	1993 Cut 1994 Mechanical site preparation
Block 4 Pw6Po2Pr1Sw1 117 years old, 23.5 m in height 0.4 stocking, Site Class 2	1989 Cut 1990 Mechanical site preparation 1992 Plant white pine
Block 6 Pw5Po2Bf1Bw1Sw1 107 years old, 22.5 m in height 0.5 stocking, Site Class 2	1985 Cut 1990 Brush saw release 1996 Brush saw release
Block 7 Pw5Po2Bf1Bw1Sw1 107 years old, 22.5 m in height 0.5 stocking, Site Class 2	1985 Cut 1990 Brush saw release
Block 8 Pw5Po2Bf1Bw1Sw1 107 years old, 22.5 m in height 0.5 stocking, Site Class 2	1991 Cut 1992 Mechanical site preparation 1996 Plant white pine