Indirect effects of conifer release alternatives on songbird populations in northwestern Ontario

by John Woodcock¹, R.A. Lautenschlager², F. Wayne Bell² and John P. Ryder¹

The effects of conifer-release alternatives on songbird densities (determined by territory mapping, mist netting, and banding) in four young (four to seven year old) spruce plantations were examined. Twenty to 38 (block dependent) species bred on each treatment block. Post-treatment data revealed no major treatment-related changes in breeding bird species composition. The mean density of all birds decreased from 6.9 pairs ha⁻¹ pre-treatment, to 6.3 pairs ha⁻¹ in the first post-treatment growing season ($P > 0.05$). Mean densities of the 11 most common species increased by 0.35 ha⁻¹ on the control plots during the first post-treatment growing season, but decreased on treated plots by 1.1 ha⁻¹ (brush saw), 1.6 ha⁻¹ (Silvana Selective), 0.14 ha⁻¹ (Release®) and 0.72 ha⁻¹ (Vision®). Following the conifer-release treatments, Chestnut-sided Warbler (*Dendroica pensylvanica*) had lower ($P < 0.05$) mean densities on the brush saw- and Silvana Selective-treated plots than on the control plots and fewer ($P < 0.05$) female birds were captured in the first post-treatment year.

Key words: brush saw, Chestnut-sided Warbler, conifer-release, Fallingsnow Ecosystem Project, glyphosate, mist netting, Silvana Selective, songbirds, territory mapping, triclopyr

Les effets du dégagement des conifères sur les densités d'oiseaux chanteurs (déterminés par la cartographie du territoire, les nids et le bagage) pour quatre jeunes plantations d'épinette (de 4 à 7 ans) ont été étudiés. Vingt-deux à 38 espèces (dépendantes des blocs) se sont reproduites sur chaque bloc du traitement. Les données recueillies après le traitement n'ont indiqué aucune modification importante reliée au traitement dans la composition des espèces d'oiseaux se reproduisant. La densité moyenne de tous les oiseaux a diminué passant de 69 couples ha⁻¹ avant traitement à 63 couples ha⁻¹ au cours de la première saison de croissance ($p < 0.05$) après traitement. Les densités moyennes de 11 des espèces les plus communes ont augmenté de 0.35 ha⁻¹ dans les parcelles témoins au cours de la première saison de croissance après traitement, mais ont diminué dans les parcelles traitées de 1.1 ha⁻¹ (scie débroussailluse), 1.6 ha⁻¹ (Silvana Selective), 0.14 ha⁻¹ (Release®) et de 0.72 ha⁻¹ (Vision®). Suite aux traitements de dégagement des conifères, la fauvette à flancs marrons (*Dendroica pensylvanica*) a connu dans les parcelles traitées des densités moyennes inférieures ($p < 0.05$) suite au traitement à la scie débroussailluse et au Silvana Selective et moins de femelles ($p < 0.05$) ont été capturées au cours de la première année suivant le traitement.

Mots clés: scie débroussailluse, fauvette à flancs marrons, dégagement de conifère, projet écosystémique de Fallingsnow, glyphosate, nids, Silvana Selective, oiseaux chanteurs, cartographie territoriale, triclopyr

Introduction

Foresters commonly use conifer-release treatments to reduce angiosperm competition from around young, planted or naturally regenerated, conifers (Walstad and Kuch 1987). Because strong relationships exist between vegetation and avian community structure (Johnston and Odum 1956; MacArthur 1964; Morgan and Freedman 1986; Mills et al. 1991), habitat manipulations such as conifer-release, that drastically alter vegetation, should affect breeding bird populations. Most studies (Lautenschlager 1993) of the effects of conifer-release treatments with herbicides on songbirds, however, found no significant, or minimal short-term effects, potentially because many lacked sufficient replicates, pre-treatment data, and/or controls; or because of songbird site tenacity (Wiens and Rotenberry 1985) and/or migrant deception (Lautenschlager 1993).

Here the results of the first two years of a longer-term study (Lautenschlager et al. 1997) are presented. Study objectives were to document the effects of a variety of conifer-release alternatives on songbird reproductive output and breeding and post-breeding season area use.

Methods

Area and Treatments

The study area was located 60 km southwest of Thunder Bay, Ontario in the Great Lakes-St. Lawrence forest region (Rowe 1972). The area was clearcut and planted four to seven years before our study began. We used a randomized complete block design, with three white spruce (*Picea glauca* [Moench] Voss) and one black spruce (*Picea mariana* [Mill] B.S.P.) blocks of 28 to 52 ha each (Table 1), and the following operational (Bell et al. 1997a) conifer release treatments: (1) motor-manual release with brushsaws (mid-late October 1993); (2) mechanical release with the Silvana Selective/Ford Versatile (late October – early November 1993); (3) helicopter applied solutions containing Release^{®3} (a.i. triclopyr) herbicide (mid-August 1993); (4) helicopter applied solutions containing Vision^{®4} (a.i. glyphosate) herbicide (mid-August 1993); and (5) control (no treatment). The blocks were selected to represent a range of site conditions typical of northwestern Ontario and commonly differed in aspect, slope, drainage, and soils (Simpson et al. 1997). The four blocks were separated by 1.3 to 3.0 km of mature forest.

Territory Mapping

Territory mapping described by Koskimies and Väisänen

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Table 1. Areas (ha) treated by treatment and block¹

Treatment	Block 1	Block 2	Block 3	Block 4	Total (ha)
Control	8.1	3.3	10.5	5.0	26.9
Brushsaw	6.0	4.7	12.4	4.4	27.5
Silvana	8.4	6.7	10.4	8.1	33.6
Release ®	4.9	6.5	8.1	9.3	28.8
Vision ®	9.9	6.5	10.4	5.3	32.1
Total	37.3	27.7	51.8	32.1	148.9

¹Based on Bell et al. (1997a).

(1991), and Ralph et al. (1993) was used pre- (1993) and post- (1994) treatment, from late May to mid-July, to document species composition and territory density for birds that exhibited territorial behaviour on the blocks. Birds detected, aurally or visually, during repeated (10) visits were plotted (usually to within 5 m) on field maps. To ensure that birds were likely not missed because of observer absence during a species-specific activity period, starting points for each replicate visit were changed to ensure that all parts of the blocks were visited at different times.

Observers from the adjacent halves of the same block compared data each morning to eliminate duplications. This comparison also helped identify possible discrepancies between observers. To further identify discrepancies, observers switched blocks on at least one occasion. After ten visits, an analysis of individual species maps revealed clusters of detections, and territories for individual birds heard singing on at least three visits (IBCC 1970) were assigned.

Mist Netting

Birds that bred on or used the blocks in the latter part of the breeding season and during the post-breeding season (early July through mid-August) were captured using mist nets and banded. The same net locations were used in pre- and post-treatment years. Nets were erected at first light each morning and taken down by 11:00 AM. Six to 20 nets were erected each day. Netting effort was rotated regularly among blocks, and was proportional to block size. Captured birds were identified, sexed, and aged using the methods of Pyle et al. (1987), then banded (aluminum numbered and plastic colour) during pre- and post-treatment years, measured (wing cord), and released.

Post-spray Investigation

Vision® and Release® herbicides used in this study were applied at nominal rates of 1.5 and 1.9 kg a.e. ha⁻¹ respectively (Thompson et al. 1997). Thompson et al. (1997), in this volume, report that average deposit of the two herbicides at 3.5, 1.0, and 0.5 m above ground was 60, 25, and 12% respectively. During the week following these applications (17–23 August 1993), herbicide treated plots were intensively searched for evidence of direct songbird mortality. Much time was spent searching for casualties, and one morning was spent capturing birds within the Release® treatment on block one.

Vegetation

Bell et al. (1997a), in this volume, document methods used and vegetation responses to these treatments.

Statistical Analysis

The number of territories of each bird species was calculated from the territory maps, and mean population densities

were determined for each treatment in pre- and post-treatment years. These data were normally distributed, with the exception of a few outliers associated with vegetation anomalies, such as clumps of residuals missed by the treatments. Multiple analysis of variance (MANOVA) tests for completely randomized block design were used to evaluate differences in densities of the 11 most abundant species among treatments and blocks. Tukey's analysis was used to determine among-treatment differences. Paired *t*-tests were used to analyze differences in densities between years for each species summed for five treatments on four blocks. Regression analysis, comparing the number of territories determined from mapping with the number of males captured for each of the two years of the study, was used to evaluate territory mapping results. Frequency analysis was used to assess changes in the ratio of males to females captured in the 2 years. Minimum significance level was $P < 0.05$.

Results

Treatment-related differences in shrub densities, measured as percent cover and height among treatments were found (Bell et al. 1997a). Cover percentages of aspen and birch did not change significantly between years in the controls plots but were reduced in the treated plots. Untreated patches and missed strips of vegetation occurred within the cutting (~10%) and herbicide-treated (25%) plots respectively.

Territory Mapping

Twenty to 38 species (block dependent) bred on each of the four blocks (Woodcock 1997). Territory densities for American Goldfinch (*Carduelis tristis*) and Cedar Waxwing (*Bombicilla cedrorum*) were not determined because they did not exhibit territorial behaviour until late in the season. Eleven species were common enough for statistical comparisons. Chestnut-sided Warbler (*Dendroica pensylvanica* L.) was the most abundant (Table 2). Pre-treatment densities of five species differed among blocks, with most of the variability occurring on block four, a drier, more open site. In the post-treatment year, there were fewer block differences. In the pre-treatment year, only the density of Northern Flicker (*Colaptes auratus*) differed among designated treatment plots.

In the post-treatment year, the density of Chestnut-sided Warbler differed between the controls and the brush saw and Silvana Selective treatments ($P < 0.05$). Pre- to post-treatment decreases in the densities of Alder Flycatcher (*Empidonax alnorum*), Chestnut-sided Warbler (Fig. 1) ($P < 0.05$), Red-eyed Vireo (*Vireo olivaceus*), and Veery (*Catharus fuscescens*) were noted on the cut (brush saw and Silvana Selective) plots (Table 2). Densities of Chestnut-sided Warbler and Mourning Warbler (*Oporornis philadelphia*) declined during the growing season after the herbicide (Release® and Vision®) treatments, with Mourning Warblers also declining in controls. A post-treatment increase in the density of White-throated Sparrows (*Zonotrichia albicollis*) was observed on Release® and Vision® plots, while Song Sparrow (*Melospiza melodia*) numbers increased on the Silvana Selective plots, and Lincoln's Sparrow (*Melospiza lincolni*) increased on the Silvana Selective and Vision® plots (Table 2).

Mist Netting

In July and August of 1993 and 1994, 527 and 714 of the most common species of birds were banded, respectively

(Table 3). Banding was terminated when it became evident that a large proportion of non-resident, non-territorial, birds were being captured. Densities mapped and individual males captured were highly correlated in both years (r^2 ; 0.71 [93], 0.91 [94]).

In the pre-treatment year 258 male and 154 female birds were captured (1.68 male female⁻¹). In the post-treatment year 365 male and 149 female birds (2.45 male female⁻¹) were captured. There was a significant ($\chi^2_{1,1} = 2.705$) change in the sex ratios between years. The male to female ratio increased after treatment for Chestnut-sided Warblers from 1.6 to 2.6 (control), 2.7 to 13.0 (cut plots), and 2.4 to 5.8 (herbicide plots). The number of male Alder Flycatchers captured remained the same between years but the number of females captured declined by 50%. The sex ratio did not change for White-throated Sparrow and Song Sparrow although the number of captures of both sexes doubled (Table 3).

Discussion

With the exception of Slagsvold (1977), no one has attempted to examine the effects of conifer-release alternatives on breeding songbird numbers. The net reduction in numbers of birds in our study was negligible, contrasting with Slagsvold's (1977) report of 30% reductions in bird numbers. No major shifts in species composition of the bird communities using the treated plots were noted between pre- and post-treatment years. Freedman *et al.* (1988) reported similar findings. In our study only Chestnut-sided Warbler densities differed significantly between control and alternative treatments. Greatest reductions were on the cut (brush saw and Silvana Selective) treatments. Morrison and Meslow (1984) reported a similar response by Wilson's Warbler (*Wilsonia pusilla*), a species also associated with deciduous tree cover, to conifer-release with herbicides. Greenberg (1979) found that the Chestnut-sided Warbler was more highly stereotyped in its foraging repertoire than were other *Dendroica* species. Collins (1981, 1983) noted different requirements for song perches and nest sites among eastern warblers. Changes in these structures would affect the use of an altered habitat by a bird with a specific narrow niche. The cover percentage of aspen and birch did not change significantly between years in the controls, but was significantly reduced in the other treatments (Bell *et al.* 1997a). Changes in Chestnut-sided Warbler densities paralleled these treatment-induced vegetation changes, and it is likely that lack of foraging plasticity resulted in the reductions observed.

Morrison and Meslow (1984) suggested that small patches of untreated vegetation scattered throughout a herbicide-treated area were sufficient to maintain an avian community similar to that on untreated areas. Probst *et al.* (1992) suggested that species dependant on shrubs would presumably be eliminated in stands where such vegetation was removed by herbicides or other means. Such 'clean' treatments, however, were rare in this study and sizeable pockets of shrubs remained in all treatments (Bell *et al.* 1997b). Such "skips" occur frequently in operational cutting treatments because shrubs are not removed where there are no crop trees, and operational aerial herbicide treatments commonly miss small areas within treated areas. The presence of untreated patches of vegetation in most treatments, however, helped maintain the diversity of the avian community.

The breeding densities of Alder Flycatcher, Chestnut-sided Warbler, Mourning Warbler, Red-eyed Vireo, and

Table 2. Number (mean $\pm$ SE) of territories/10 ha of common bird species pre- (1993) and post- (1994) treatment (N = 4 blocks/treatment)

	Control				Brushsaw				Silvana				Release ^a				Vision ^b			
	1993	SE	1994	SE	1993	SE	1994	SE	1993	SE	1994	SE	1993	SE	1994	SE	1993	SE	1994	SE
Alder flycatcher	5.72	1.94	8.54	3.59	5.69	0.94	3.29b	1.23	7.10	1.97	3.08b	1.04	7.30	1.76	7.20	1.16	6.84	1.63	6.47	1.68
American robin	0.75	0.32	0.58	0.30	0.94	0.20	0.79	0.29	0.97	0.68	0.58	0.33	0.55	0.20	0.90	0.57	0.62	0.40	1.12	0.68
Chestnut-sided warbler	24.43	7.52	24.74	2.42	23.42	9.40	8.25ab	3.04	24.23	5.65	9.22ab	2.95	23.41	2.34	17.00b	2.94	21.63	4.63	13.78b	2.55
Lincoln's sparrow	2.32	0.89	1.94	0.92	1.96	0.39	4.17	0.74	1.17	0.28	3.20b	0.63	1.77	0.65	3.63	1.13	2.36	0.19	4.14b	0.64
Mourning warbler	9.90	1.05	8.08b	0.76	10.45	1.56	8.54	4.27	7.27	1.83	7.50	0.67	12.12	1.02	8.52b	2.59	8.61	1.26	4.78	1.16
Nashville warbler	2.06	0.43	2.97	1.43	3.10	1.48	1.74	1.03	1.36	0.63	1.05	0.38	1.93	0.26	3.96	0.76	1.91	0.65	2.84	0.60
Northern flicker	0.27	0.12	0.71	0.29	0.44	0.09	0.40	0.14	0.71	0.12	0.62	0.22	0.80	0.19	0.60	0.25	0.30	0.08	0.56	0.15
Red-eyed vireo	2.34	1.36	3.36	1.37	2.91	0.98	1.35b	0.87	3.61	0.66	1.48b	0.52	2.23	0.75	0.91	0.55	3.30	0.69	1.76	0.85
Song sparrow	8.77	2.06	6.55	2.55	8.18	2.65	12.91	0.55	5.40	1.49	11.09b	1.73	7.50	1.86	8.25	1.68	8.79	1.47	8.29	0.79
Veery	1.73	0.89	3.51	1.67	3.34	1.32	1.30b	0.63	3.83	1.18	1.81b	0.80	1.80	0.40	2.02	1.03	2.96	1.10	3.66	1.76
White-throated sparrow	4.98	1.91	5.78	1.93	5.47	0.65	6.29	1.46	4.52	1.08	4.18	0.91	5.90	1.55	10.90b	1.60	4.67	0.98	7.42b	2.05
Total	63.27		66.76		60.43		49.03		60.17		43.81		65.31		63.89		61.99		54.82	

^a indicates significant differences among treatment ($P < 0.05$).

^b indicates significant differences between years ($P < 0.05$).

Fig. 1. Density changes in Chestnut-sided Warblers between years, among treatments.

Veery decreased after treatment in all treated plots. These reductions were greatest where the shrubs were physically removed (brush saw and Silvana Selective) because of the removal of foraging and nesting substrates. The reductions in breeding density of the five species were not as striking in the herbicide-treated plots, where although shrub foliage was reduced substantially, the physical structure of the defoliated stems remained. Beaver (1976) reported no shifts in abundance or breeding composition of breeding songbirds in herbicide-treated brushfields and suggested that the birds had responded to habitat structures that remained unchanged. Chestnut-sided Warblers depend on dense shrubs for nest placement. Therefore the observed reductions should be expected in areas where shrubs have been removed, such as the brush saw and Silvana Selective treatments.

Songbird densities in the Release® and Vision® plots were most similar to the controls, suggesting that the structure of the remaining stems following herbicide treatments provided acceptable habitat. Lautenschlager (1993) proposed a "migrant deception" hypothesis: that birds arriving in the spring before foliation may occupy herbicide treated sites because they do not perceive that the stems are dead. This offers some explanation for the lack of response by breeding songbirds to the herbicide treatments; however, between years, male to female sex ratios increased for species whose densities decreased, whereas sex ratios remained the same for species whose densities increased. These results are consistent with the "female choice of mates" hypothesis proposed by Searcy (1979).

Stronger site fidelity in males has been reported in many passeriform species (Walkinshaw 1966a,b; Berger and Radabaugh

1968, Darley et al. 1977, Nolan 1978). Excess unmated males holding territories results in inflated breeding population estimates based on song counts. This unfortunate reality was supported by the higher proportion of males captured following these treatments.

MacKinnon and Freedman (1993) found that in the first post-treatment year, there were few declines in abundance of breeding birds. We concur with their suggestion that the census technique used (territory mapping) does not include a measure of breeding success. Our findings that the proportion of female birds in the population declined suggests that although breeding success may have been reduced, the reduction was masked by the sampling method - counting singing males. These observations reinforce the supposition that male site fidelity is an important factor affecting response to treatments, and interpretations of those responses.

These data suggest that in the first post-treatment growing season, the cutting treatments (brush saw and Silvana Selective), through removal of foraging and nesting habitat, have the most substantial negative effect on breeding songbird use of treated areas. Density reductions, however, were buffered by the presence of small untreated areas, that provided nest and foraging sites, within treated areas. Potential effects of different treatments on songbird abundance should be evaluated at a variety of scales; for instance, although Chestnut-sided Warblers and White-throated Sparrows are locally abundant they are species of concern (Thompson et al. 1992; Hussell et al. 1992). In the first post-treatment year, herbicide-treated plots maintained bird populations more similar to controls than cut plots. The three common sparrows on the plots responded favourably to the treatments. Conifer release with herbicides had no direct

Table 3. Number of common bird species captured pre- (1993) and post- (1994) treatment

	Control						Brushsaw						Silvana						Release®						Vision®					
	1993			1994			1993			1994			1993			1994			1993			1994			1993			1994		
	♂	♀	juv.	♂	♀	juv.	♂	♀	juv.	♂	♀	juv.	♂	♀	juv.	♂	♀	juv.	♂	♀	juv.	♂	♀	juv.	♂	♀	juv.	♂	♀	juv.
Alder flycatcher	3	9	0	9	7	4	8	8	9	1	2	0	4	4	1	3	1	2	10	11	20	10	4	2	5	11	4	11	7	5
American robin	0	0	0	1	0	0	1	1	0	0	0	5	0	0	0	0	0	1	0	0	0	2	1	3	0	1	0	1	0	0
Chestnut-sided warbler	16	10	0	24	9	7	14	8	3	9	0	2	10	1	1	4	1	1	26	8	5	26	4	1	19	5	2	20	4	4
Lincoln's sparrow	3	3	0	3	0	1	5	0	2	4	2	1	1	0	0	3	3	1	8	1	1	8	1	6	3	4	0	0	1	5
Mourning warbler	6	0	1	11	3	1	10	3	1	2	0	0	6	2	0	3	3	4	7	5	5	3	2	0	8	0	4	7	1	2
Nashville warbler	1	0	0	3	1	2	3	0	3	0	0	1	2	2	0	2	0	10	1	0	9	6	0	0	3	0	0	8	0	21
Red-eyed vireo	6	2	0	4	2	5	6	3	0	0	0	0	3	5	0	1	0	0	1	3	2	1	4	0	5	8	1	4	4	0
Song sparrow	2	0	1	7	5	2	5	3	4	13	5	9	9	2	3	7	1	10	5	3	3	11	7	6	6	3	5	10	8	2
Veery	2	0	0	4	1	3	4	1	0	3	2	0	1	1	0	1	0	1	0	1	2	8	1	0	2	1	0	5	2	0
White-throated sparrow	9	3	1	14	10	6	11	3	4	9	6	6	5	3	2	21	7	21	10	6	10	30	15	7	8	6	3	32	13	24
Total	48	27	3	79	38	31	66	29	26	41	17	19	41	20	7	45	16	50	44	40	57	103	38	22	59	38	19	97	40	63

effect on most breeding songbirds one growing season after treatment.

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