Small Mammals in Glyphosate-treated Clearcuts in Northern Maine[1]

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Effects of glyphosate [N-(phosphonomethyl) glycine] on small mammals in four- to five-year-old clearcuts were evaluated by snap- and pit-trapping one area one year after treatment, one area two months before and after treatment, and one untreated control. All areas were sampled simultaneously in four trapping periods from July to October, 1984. Seven species were captured, but Masked Shrews (*Sorex cinereus*), Deer Mice (*Peromyscus maniculatus*), Southern Red-backed Voles (*Clethrionomys gapperi*), and Pygmy Shrews (*Microsorex hoyi*) comprised 97% of 290 captures. Only Southern Red-backed Voles were affected by glyphosate application, being significantly more abundant on the control and less numerous on the one-year-old spray area. No short-term changes in captures occurred after the 1984 herbicide application.

Key Words: Glyphosate, herbicide, small mammals, silviculture, Maine.

The use of herbicides in forest management in Canada and the United States is expanding. In Maine, herbicides are used to release young spruce (*Picea* spp.) and Balsam Fir (*Abies balsamea*) from angiosperm competitors. The total area treated in Maine has increased steadily since 1979 and reached ca. 11.3×10^4 ha in 1984 (McCormack 1985).

Although some research has been done in the Pacific Northwest (Black and Hooven 1974; Sullivan and Sullivan 1982) and in West Virginia (Kirkland 1978), few data are available on effects of this type of habitat alteration on small mammals in the northeastern United States. Our study was undertaken to assess short-term changes in a small mammal community after silvicultural herbicide treatment of young clearcuts.

Study Area and Methods

Field work was conducted in Piscataquis County, Maine (46° 00′ N, 69° 15′ W) from July to October 1984. The land is managed primarily for spruce-fir pulpwood. Three treatment areas of 10 to 20 ha each were located in a 40-ha clearcut that was whole-tree harvested in 1979-80 and planted with Black Spruce (*Picea mariana*) and White Spruce (*P. glauca*) in 1980. Balsam Fir and Red Spruce (*P. rubens*) were present as advanced natural regeneration.

Glyphosate, as Roundup®, was applied by helicopter at a rate of 2.25 kg/ha on one treatment area ("83") on 9 August 1983 to suppress Red Raspberry (*Rubus idaeus*), Quaking Aspen (*Populus tremuloides*), Red Maple (*Acer rubrum*), Pin Cherry (*Prunus pensylvanica*), Gray Birch (*Betula populifolia*), Paper Birch (*B. papyrifera*), and other angiosperms that may potentially compete with conifer regeneration. A second treatment area ("84") was aerially sprayed with glyphosate at the same rate on 6 September 1984, and a third treatment area was an unsprayed control ("C").

Two parallel trapping transects 30 m apart were established from a randomly located starting point in the 83, 84, and C areas; paired transects were located at least 100 m from treatment boundaries. Each transect had 20 stations spaced every 15 m. At each station, two snap-traps were set and baited with peanut butter and rolled oats, and were placed within 1.0 m of the station marker. At alternate stations, a single pit-trap was set. Trapping was conducted on 18-21 July, 4-9 August, 20-23 September, and 13-16 October 1984 (i.e., 4200 trap nights).

Chi-square analyses (Schefler 1969) were used to examine differences in total captures of the four most abundant small mammal species relative to treatment area.

Results

Herbicide treatment in 1983 was judged to be effective; only Red Raspberry showed some tolerance to glyphosate, while other angiosperms were controlled. Sprayed Red Raspberry produced some new foliage (ca. 10% cover) where it occurred in dense patches, but it was not as vigorous as on the unsprayed control. As is typical of aerial spray operations, two narrow (< 5 m wide) strips were missed during herbicide application; the strips included 5 of 40 trapping stations. These five stations were all

dominated by Red Raspberry. Field observation of leaf margin necrosis in September-October indicated that broad-leaved species would also be suppressed by glyphosate application on the 84 treatment. However, substantial changes in plant cover were not anticipated until leaf-out in 1985.

A total of 290 individual small mammals, representing seven species, was captured (Table 1). Four species accounted for 97% of the captures: Masked Shrew (*Sorex cinereus*), 48% of all captures; Deer Mouse, (*Peromyscus maniculatus*), 24%; Southern Red-backed Vole, (*Clethrionomys gapperi*), 16%; and Pygmy Shrew (*Microsorex holi*), 8%. Pit-traps were used because they increase capture of shrews (Macleod and Lethiecq 1963; Williams and Braun 1983); in the present study, 58% of all shrews were caught in pit-traps.

Relative composition of the total capture through time revealed that species responded differently to habitat, season, and/or trapping (Table 1). Deer Mice were the most consistent proportion of the catch through the season, while shrews increased and Southern Red-backed Voles decreased on all treatment areas in fall. Combining all sampling periods, only Southern Red-backed Voles were affected by herbicide treatment on the different areas ($\chi^2 = 17.74$, $p < 0.05$); they were more numerous on the C and less numerous on the 83 site. Number of captures on the 84 site before ($\chi^2 = 2.20$, $p > 0.05$) and after ($\chi^2 = 3.81$, $p > 0.05$) application were similar to those on the C site (Table 2).

Discussion

Effects of herbicides on populations of small mammals depend on the extent of habitat alteration and specific habitat requirements of the fauna (Tietjen et al. 1967; Johnson and Hansen 1969; Black and Hooven 1974; Borrecco et al. 1979; Spencer and Barrett 1980). Small mammals in British Columbia showed no effect of glyphosate application one year after treatment in a 20-year-old Douglas-fir (*Pseudotsuga menziesii*) plantation (Sullivan and Sullivan 1982). Kirkland (1978) found that community composition of small mammals in West Virginia did not change after treatment with 2,4,5-T to release conifers, but microtines decreased slightly. In addition, 18 of 44 individuals captured before treatment were recaptured 10 weeks after treatment on the same trapping grid. Results presented here also suggest that glyphosate did not cause a short-term change in the small mammal community (Table 2).

Being dominated by Masked Shrews, Deer Mice, and Southern Red-backed Voles, the small mammal community in this study was comparable to those

TABLE 1. Number of captures of small mammals (N = 290) by trapping period and treatment (83 = glyphosate-treated in August 1983; 84 = glyphosate-treated in September 1984; C = Control) in northern Maine, 1984.

	Sampling Period														
	18-21 July			4-9 August			20-23 September			13-16 October			Totals		
Species	83	84	C	83	84	C	83	84	C	83	84	C	83	84	C
Sorex cinereus, Masked Shrew	1	5	2	6	5	10	18	17	25	18	21	13	43	48	50
Peromyscus maniculatus, Deer Mouse	8	2	2	8	7	4	4	5	11	5	5	9	25	19	26
Clethrionomys gapperi, Southern Red-backed Vole	1	7	7	3	4	12	1	2	5	0	1	2	5	14	26
Microsorex hoyi, Pygmy Shrew	1	0	0	0	0	0	2	2	3	10	2	5	13	4	8
Blarina brevicauda, Short-tailed Shrew	0	0	0	0	2	0	0	2	0	0	0	1	0	4	1
Synaptomys cooperi, Southern Bog Lemming	0	0	0	0	0	0	1	0	1	0	1	0	1	1	1
Zapus hudsonius, Meadow Jumping Mouse	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0
Totals	11	14	11	18	18	26	26	28	45	33	30	30	88	90	112
Sampling Effort (trap night)[1]	300	300	300	500	500	500	300	300	300	300	300	300	1400	1400	1400

[1]Includes both snap- (2 per station) and pit-traps (1 every other station).

TABLE 2. Distribution of captures on the 84 treatment area before (July-August) and after (September-October) glyphosate application (before and after captures from control area in parentheses).

	P. maniculatus		*S. cinereus*		*C. gapperi*		*M. hoyi*	
Before	9	(6)	10	(12)	11	(19)	0	(0)
After	10	(20)	38	(38)	3	(7)	4	(8)

reported in other studies in similar habitats not treated with herbicide (Richens 1974; Kirkland 1977; Martell and Radvanyi 1977). Because Southern Red-packed Voles prefer moist forest habitats with ground debris (Gunderson 1959; Kirkland and Schmidt 1982), their negative response to glyphosate was expected. Declining numbers of Southern Red-backed Voles as the season progressed on the 83 area may be explained by defoliation of overhead cover and exposure to evaporative drying of the area during summer.

Masked Shrews are often abundant (Burt and Grossenheider 1976), and their increase in numbers in early fall in our study was consistent with observations from Ontario (deVos 1957). Pygmy Shrews, although not widely captured in other studies (Martell and Radvanyi 1977; Swan et al. 1984), also became more numerous as summer progressed: 28% and 68% of their total capture occurred in September and October, respectively. The population peak could be attributed to a high reproductive potential or to removal of Masked Shrews (Table 1) which are also insectivorous.

In cataloguing the incidence of more than one capture of a species at a station over the entire study, 49 of 62 multiple captures occurred at stations where slash was a ground-cover component. If slash cover is used as foraging areas or travel routes by small mammals to avoid predation, perhaps greater activity and exposure to traps at stations with high amounts of slash accounted for multiple captures. Also, animals may prefer to nest and give birth in slash areas. If this is the case, harvesting and silvicultural regimes that create and maintain a site with less slash may support fewer small mammals. Although this site was whole-tree harvested, trees of unmerchantable size or species contributed to slash cover.

One year after glyphosate application, conditions were unfavorable only for Southern Red-backed Voles, while numbers of other species were not affected. Species richness of the small mammal community as a whole was not affected, but as with other habitat alterations, such as clearcutting (e.g. Kirkland 1977), relative abundance of at least one species did change. Further study is needed to ascertain the persistence of differences between sprayed and unsprayed sites, mindful that herbicide treatments are intended to promote a different, commercially desirable, plant cover than would develop if the site were not treated.

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