Glyphosate Treatment and Deer Mice in Clearcut and Forest

Abstract

Prior to planting conifers, herbicides are commonly used to reduce competition from deciduous trees and shrubs. Herbicides are usually not toxic to wildlife but do affect their habitats. We examined deer mice (Peromyscus maniculatus) to assess the impact of herbicides on small mammals. Deer mice from adjacent untreated and glyphosate-treated clearcuts had similar body sizes and numbers of placental scars and foeti. In untreated clearcut, deer mice were more abundant than in treated clearcut, but were less abundant than in surrounding old growth forest. Glyphosate altered vegetation and reduced density of deer mice in young seral stages. Habitat changes induced by glyphosate likely modified abundance and quality of food and cover for small mammals.

Introduction

Use of herbicides for intensive forest management is increasing rapidly in British Columbia (von Schuckmann 1986). Herbicides are used to reduce competition from deciduous trees and shrubs on overgrown sites prior to planting conifers and for “conifer release” in older plantations. Glyphosate (Roundup®) is a commonly used herbicide because it kills deciduous vegetation rapidly, but does not usually harm conifers (Sutton 1978). Glyphosate also has low toxicity to humans and wildlife.

While herbicide toxicity to wildlife is seldom a problem, herbicides alter vegetation. These habitat changes and their accompanying impact on small mammals vary with habitat type and species. Abundance of small mammals can be reduced by herbicide treatment (Johnson and Hansen 1969, Hooven and Black 1976), remain unaffected (Sullivan and Sullivan 1982) or increased (Anthony and Morrison 1985).

We examined the effect of glyphosate treatment in a clearcut on the body characteristics and population indices of deer mice (Peromyscus maniculatus). Other studies have reported the effects on small mammals of herbicides applied to clearcuts several years after logging (Borreco et al. 1979, Sullivan and Sullivan 1982). Our study was conducted on a site treated with glyphosate two years after logging, a seral stage not reported elsewhere.

Study Area and Methods

The study area is 50 km west of Kelsey Bay on northern Vancouver Island, British Columbia. It is situated in the wet subzone of the Coastal Western Hemlock Biogeoclimatic Zone (Klinka et al. 1979) and includes a 54 ha clearcut and surrounding old growth forest at an elevation of 500 m with a southwest aspect.

Three habitat types were examined in the study area: old growth forest, untreated clearcut and herbicide treated clearcut. After logging in 1983, approximately 70 percent of the clearcut was treated with glyphosate in fall 1985. A 21 ha portion of the clearcut was aerially sprayed with glyphosate at 1.2 kg/ha of active ingredient and an adjacent 17 ha area was hand sprayed at 1.1 kg/ha of active ingredient. Plant species composition was determined for 10 randomly selected circular plots (10 m in diameter) in each habitat type. Ocular estimates were obtained for percent cover of the canopy, understory and ground layers, and each major plant species.

Small mammals were snap-trapped between 15 and 27 July 1986. Traps were baited with a mixture of peanut butter and oatmeal and placed at 10 m intervals along straight line transects 10 m apart through each habitat type. Transect
lengths varied with size of the cutblock, but were generally 250 m long. Traps were set overnight, and trapping was conducted approximately every other night, usually in all three habitat types. Of the 1661 total trapnights, 550 were in the forest, 558 were in the untreated clearcut and 553 were in the treated clearcut. Transect lines were moved daily to avoid retrapping of areas. Each trapped mammal was weighed and standard measurements were taken. Reproductive tracts were removed from females and examined for placental scars and foeti. Deer mice were classified by body weight as juvenile (≤16 g) or adult (>16 g) (Sullivan and Sullivan 1982).

Results

Vegetation differed among the three habitat types. The forest had a dense canopy (83%) composed of amabilis fir (Abies amabilis) and western hemlock (Tsuga heterophylla) and a moderate understory (38%), composed of tall blue huckleberry (Vaccinium ovalifolium) and small conifers (Table 1). The forest had moderate slopes (40%), steeper than those in the clearcut (15%).

The untreated clearcut had no canopy, and a relatively dense understory (52%) dominated by tall blue huckleberry (27%), red elderberry (Sambucus racemosa) (10%) and fireweed (Epilobium angustifolium) (10%). The ground was covered with logging debris (29%) and lesser amounts of ferns and forbs (24%).

The treated clearcut had a relatively sparse understory (22%) composed of tall blue huckleberry (5%), salmonberry (Rubus spectabilis) (6%) and fireweed (6%). The ground was covered with greater amounts of logging debris (46%) and forbs and ferns (32%) than the untreated clearcut.

From 15 to 27 July, 307 small mammals were trapped during a total of 1661 trapnights. The majority (285/307) of mammals caught were deer mice. Because of the small representation of other species, they are omitted from further analyses. There was a significant difference in catch per unit effort (measured as the number of mice captured/trapnight) among habitat types (F = 153.63, P ≤ 0.05). Catch per unit effort was 0.29 (155 deer mice/550 trapnights) in the old growth forest, 0.18 (82 deer mice/558 trapnights) in the untreated clearcut, and 0.10 (48 deer mice/555 trapnights) in the treated clearcut. Catch per unit effort can be used as an estimate of relative density. Below a value of 0.20, the relationship between catch per unit effort and density is approximately linear. For values exceeding 0.20, the index must be transformed (Leslie and Davis 1939). The transformed relative densities for old growth forestuntreated clearcuttreated clearcut were 1.00:0.53:0.29 respectively.

Sex ratio and age structure of deer mice (Table 2) were not significantly different among habitat types (F = 0.48, P ≥ 0.05). No significant difference was detected among habitat types for body length or mass. Tail length was significantly greater in the forest habitat (F = 29.28, P ≤ 0.05) and may reflect microsite differences in allometric growth. The number of placental scars was not significantly different among habitat types (F = 0.94, P > 0.05). However the number of foeti was significantly smaller in the forest habitat (F = 12.62, P ≤ 0.05).

Discussion

Glyphosate does not affect reproductive rates of deer mice (Wahlgren 1979, Sullivan and Sullivan 1982). Sullivan and Sullivan (1982) used proportion of population breeding and juvenile recruitment as indices of reproductive rate. Although they were more concerned about direct effects of glyphosate, they did not detect significant differences in reproductive rates or growth of deer mice. Our results corroborate these previous
TABLE 2. Measurements and population characteristics of deer mice (Peromyscus maniculatus) trapped in forest, clearcut, and clearcut treated with glyphosate near Kelsey Bay, B.C. Sample size in parentheses. For each adult measurement, means followed by different letters are significantly different ($P < 0.05$). $M =$ males, $F =$ females.

<table>
<thead>
<tr>
<th></th>
<th>Forest</th>
<th>Untreated Clearcut</th>
<th>Treated Clearcut</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>155</td>
<td>73</td>
<td>48</td>
</tr>
<tr>
<td>Sex Ratio (M/F)</td>
<td>0.96</td>
<td>1.09</td>
<td>1.18</td>
</tr>
<tr>
<td>% Juveniles</td>
<td>0.37</td>
<td>0.23</td>
<td>0.31</td>
</tr>
</tbody>
</table>

**Adult Measurements**

<table>
<thead>
<tr>
<th></th>
<th>$\bar{X}$ ± SD</th>
<th>$\bar{X}$ ± SD</th>
<th>$\bar{X}$ ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass (g)</td>
<td></td>
<td>18.3 a 1.4 (52)</td>
<td>18.4 a 1.5 (30)</td>
</tr>
<tr>
<td>Total length (mm)</td>
<td>F 188.4 a 9.2 (43)</td>
<td>173.8 b 8.4 (25)</td>
<td>173.7 b 7.9 (13)</td>
</tr>
<tr>
<td></td>
<td>M 186.3 a 10.8 (52)</td>
<td>172.7 b 10.9 (30)</td>
<td>170.4 b 6.6 (19)</td>
</tr>
<tr>
<td>Body length (mm)</td>
<td>F 99.5 a 5.5 (43)</td>
<td>88.8 a 6.3 (25)</td>
<td>89.6 a 5.3 (13)</td>
</tr>
<tr>
<td></td>
<td>M 89.6 a 5.7 (52)</td>
<td>87.6 a 5.7 (30)</td>
<td>89.7 a 4.9 (19)</td>
</tr>
<tr>
<td>Placental scars</td>
<td>3.2 ± 2.4 (43)</td>
<td>2.3 ± 2.2 (24)</td>
<td>2.1 ± 2.3 (13)</td>
</tr>
<tr>
<td>Foeti</td>
<td>0.0 a 1.4 b (43)</td>
<td>2.1 ± 2.2 (24)</td>
<td>1.9 b 2.2 (13)</td>
</tr>
</tbody>
</table>

studies. We conclude that glyphosate treatment does not affect reproductive rates or body size of deer mice inhabiting young clearcuts in the Coastal Western Hemlock Biogeoclimatic Zone.

We observed significantly fewer foeti in deer mice from the forest. The mean number of placental scars was greater in deer mice from the forest but not significantly different from clearcuts. The presence of fewer foeti suggests that deer mice in the forest were breeding earlier than mice in clearcuts. Van Horne (1981) reported that high population density of deer mice may result in both a shorter and an earlier breeding season. Our results differ from those of Sadlier (1974) who found no differences in reproductive rate of deer mice in old growth forest and clearcuts.

The three habitat types in our study differed in density of deer mice. Transformed relative density of deer mice in the forest exceeded, by 87 percent, that in the untreated clearcut which in turn exceeded, by 83 percent, that in the treated clearcut. In some areas low densities of deer mice in clearcuts, relative to old growth forest, persisted for several years following logging (Harris 1968). In other areas, there was no difference in density of deer mice inhabiting mature forest and recent clearcuts (Petticrew and Sadlier 1974). Habitat differences could account for disparities among studies reporting densities of deer mice inhabiting forests and clearcuts. Slash burning, age of seral stage, and amount of logging debris could influence abundance of deer mice.

The density of deer mice in a 20-year-old plantation was not significantly different after glyphosate treatment (Sullivan and Sullivan 1982). However, density of deer mice in our untreated clearcut was greater than that in the treated clearcut. Perhaps differences in seral stages are responsible for the different results. The study by Sullivan and Sullivan (1982) was conducted on an older seral stage, a 20-year-old plantation. Conifers remaining after herbicide treatment may have been sufficient to provide thermal and concealment cover for small mammals. In addition, conifer seeds may have substituted for loss of food plants killed by glyphosate. Because of the scarcity of vegetation on the treated clearcut in our study, reduced amounts of food and cover would be available to deer mice, especially during winter when annual plants are dead and other plants buried by snow. Food abundance

Glyphosate Treatment and Deer Mice
affects populations of deer mice (Gashwiler 1979) and may be a factor in differences in density of deer mice among habitats near Kelsey Bay.

Anthony and Morrison (1985) report little impact of glyphosate on small mammal populations in Oregon. Only creeping vole (Microtus oregoniit) was affected by glyphosate treatment. Abundance of creeping vole increased after herbicide treatment but there were no differences in abundance of other species, including deer mice. Anthony and Morrison (1985) concluded that an increase in grass due to shrub defoliation favoured creeping voles. Our site lacked the grass component prominent in the Oregon study. Of the 307 small mammals trapped near Kelsey Bay, only three were Townsend voles (Microtus townsendii) and they were captured in the treated clearcut.

Besides habitat factors, differences in size of study area contribute to differences between this study and that of Sullivan and Sullivan (1982). The treated clearcuts monitored in our study were larger than those studied by Sullivan and Sullivan (1982), >17 ha vs 4.9 ha. These larger areas reduce the effects of immigration and thus more accurately reflect population changes due to glyphosate treatment at operational scales.

Glyphosate treatment of the clearcut reduced percent cover and species composition of the understory layer. These changes may have affected the seasonal availability of food and cover important to deer mice and contributed to decreased densities of deer mice. Herbicide treatments appear to have different impacts in different seral stages. In young seral stages densities of deer mice are reduced, whereas in older seral stages deer mice are not affected.

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Literature Cited


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