Forest Herbicide Use:

Vegetation, Small Mammals and Diversity

Forest Herbicide Use

The use of herbicides to temporarily reduce competing vegetation in coniferous plantations and young stands is an important forest management practice. Reduction of competing vegetation on certain sites allows successful establishment and growth of coniferous crop trees, a desirable goal in responsible stewardship of forest resources. The forest habitats in which herbicides are used are early successional stages after harvesting. Such areas are frequently dominated by herbaceous plant species such as fireweed and grasses and deciduous species such as alder, willow, aspen, poplar, raspberry, salmonberry, maple and birch. Associated with these plant communities are several species of small mammals. These wildlife species are dependent on plant products (seeds, fruits, foliage) of the deciduous and coniferous vegetation as a food source. They also periodically consume invertebrates such as insects. In turn, these small mammals are a vital food source for avian and terrestrial predators such as hawks, owls, weasels, marten, coyotes and lynx.

Indirect and Direct Effects

The indirect effects of forest herbicide use on small mammals can occur through short-term habitat alteration. The direct effects of herbicides on demographic parameters in small mammal populations could arise from ingestion of treated vegetation (seeds, fruits, vegetative parts) or invertebrates that contain chemical residues. Therefore, the potential exists for a forest herbicide treatment to directly affect demographic parameters. Small mammals might come into direct contact with a herbicide during application, although this is unlikely because of the interception of spray by overstory herbs and shrubs.

Scientific Studies

Four relatively long-term studies on the influence of forest herbicide (glyphosate) use on small mammals have been conducted in B.C.: 1) the small mammal community in the coastal western hemlock zone in south coastal B.C.; 2) small mammal community and vegetation changes; 3) snowshoe hare populations and vegetation changes in a sub-boreal spruce forest near Prince George; and 4) small mammal and vegetation changes in an interior cedar-hemlock forest near Salmon Arm.

South Coast Forest

Small mammal populations were monitored in control and treatment Douglas-fir plantations near Maple Ridge from 1981 to 1985.

Study area 1981 (pre-treatment)

Study area 1982 (post-treatment)

Study area 1983 (post-treatment)

Study area 1985 (post-treatment)

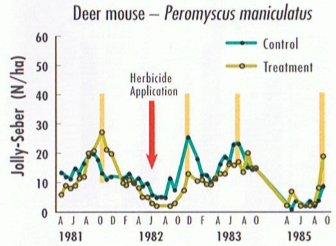
Small mammal species included:

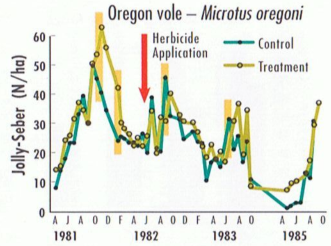
Deer mouse – *Peromyscus maniculatus*

Townsend chipmunk – *Eutamias townsendii*

Shrew – *Sorex* spp.

In terms of the response to habitat change, there was little difference overall in abundance of deer mice, Oregon voles and shrews between control and treatment study areas. Deer mouse and chipmunk populations showed only a short-term decline after treatment. However, there were significant differences between control and treatment populations during specific sampling periods (indicated by shaded bars).

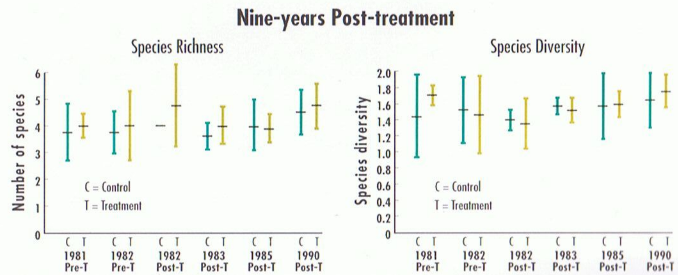




Therefore, if a limited sampling scheme (one or two census periods per year) was used, there is a very high probability that erroneous conclusions will be reached with respect to numbers of animals on control and treatment areas. Weekly or monthly variation in the abundance of a given species on a control or treatment area may yield a misleading result if sampling was conducted during such times. Clearly, small mammal populations vary sufficiently over time on a given area that intensive monitoring is the only objective and rigorous method to assess potential impacts from habitat alteration.

The direct effects of a forest application of glyphosate herbicide on reproduction, growth and survival in deer mice and Oregon voles was investigated by comparing populations in control and treatment habitats. The study concluded that these demographic attributes were similar in the mouse and vole populations occupying these habitats.

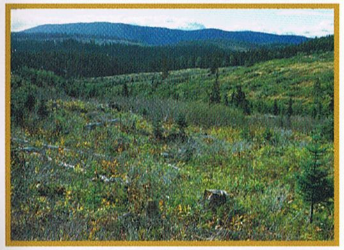
Species richness and diversity of small mammal communities were similar between control and treatment sites for all periods over the nine years since treatment.



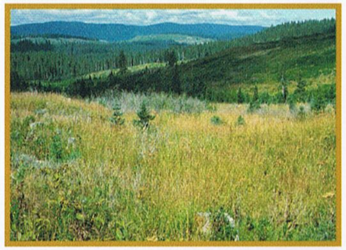
Small Mammals and Vegetation in Sub-Boreal Spruce Forest

A detailed quantitative assessment of changes in vegetation and small mammal populations in response to herbicide treatment was conducted from 1987 to 1992 in a sub-boreal spruce forest.

Study area 1987 (pre-treatment)

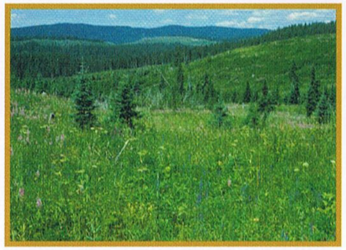


Study area 1988 (post-treatment)



Study area 1989 (post-treatment)

Study area 1991 (post-treatment)



Study area 1992 (post-treatment)

The major small mammal species included the deer mouse and:

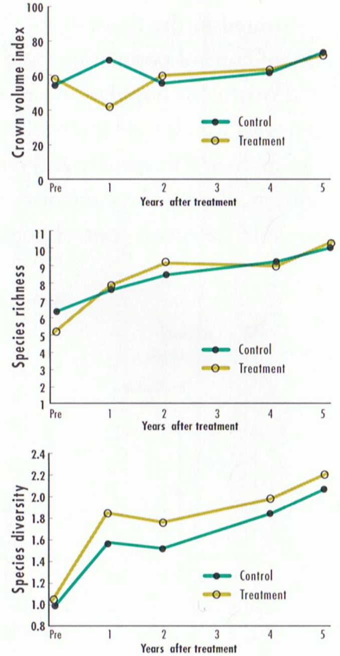
Meadow vole – *Microtus pennsylvanicus*

Red-backed vole – *Clethrionomys gapperi*

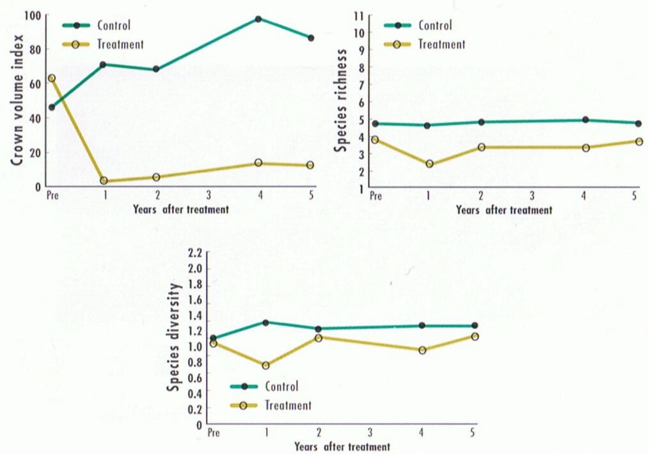
Herbicide treatment provided only a slight first-year reduction in abundance (crown volume) of herbaceous vegetation. Herbaceous crown volume on treated sites recovered to that of control sites by the second year after treatment. Species richness and diversity of herbs were not affected by herbicide treatment.

In contrast with herbaceous vegetation, herbicide treatment had a more dramatic and lasting effect on the abundance of target shrub species. After one year, shrub volume on treated sites represented <5% of the values observed on control sites. This difference was maintained for five years after treatment. Species richness and diversity of shrubs was initially reduced by herbicide treatment. This difference in richness was maintained for five years after treatment but the effect on species diversity was not apparent beyond the first year.

Herbaceous Vegetation

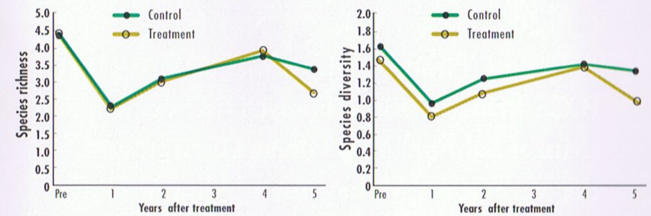


Shrubs



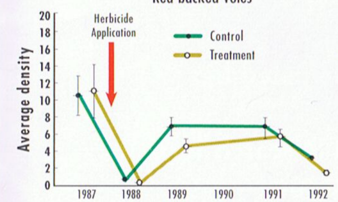
Species richness and diversity of small mammal communities declined from the pre-treatment year to the first post-treatment year on both control and treated sites. This pattern reflected a natural population fluctuation that was independent of the herbicide application. Herbicide treatment had no effect on richness or diversity of small mammal communities.

Small Mammals

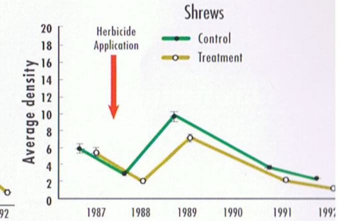


Mean numbers of red-backed voles were consistently higher on the control than on the treatment sites during 1988–1992. Shrew populations also followed this pattern. Mean abundance of meadow voles and deer mice were similar on control and treatment sites.

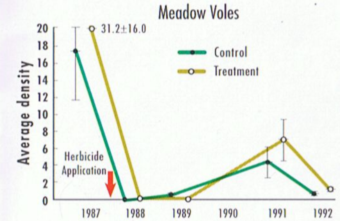
Red-backed Voles



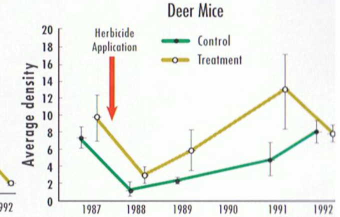
Shrews



Meadow Voles



Deer Mice



The most significant finding of this study is that hares seem able to persist in abundance in early to mid-successional (<25 years) habitats that undergo herbicide-induced alteration. This result may not necessarily be the case in other forest types or successional stages because of variable food and cover characteristics. Also, the type and quality of forest habitats surrounding a treatment may be critical to maintenance of hare populations. In addition, altered habitats may be less readily occupied in low years of the 10-year cycle. However, the study does suggest that the current operational program of vegetation management with herbicides appears not to have a significant impact on persistence of snowshoe hares in most treated habitats where hares are abundant. Nevertheless, a staggered approach to treatment of blocks should be followed in a given area whenever possible, since we have little information on response of hare predators to herbicide-induced habitat alteration.

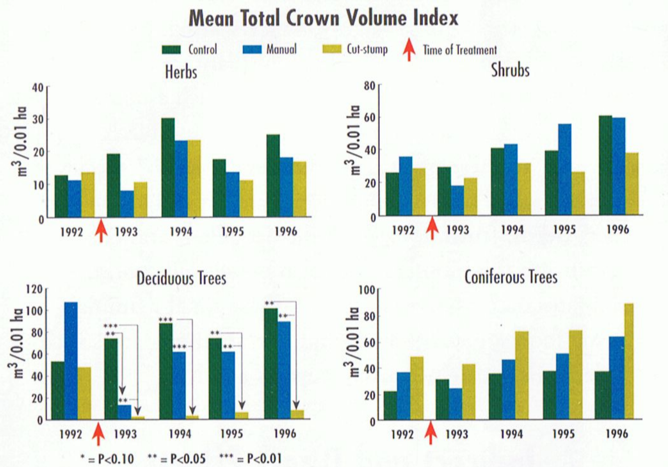
It could also be argued that hare populations, despite maintaining numbers in treatment habitats comparable to controls, did not perform well in terms of various demographic parameters.

Reproduction, growth and survival of hares was also monitored in this study. Proportions of adult hares in breeding condition and number of successful pregnancies showed no consistent differences between treated and untreated areas. Growth and weight of the hares was generally similar between treated and untreated areas. Comparisons of body weight distribution indicated that hares were not adversely affected by the use of herbicide and that there would be enough hares available as prey for predators.

Small Mammals and Vegetation in Interior Cedar-Hemlock Forest

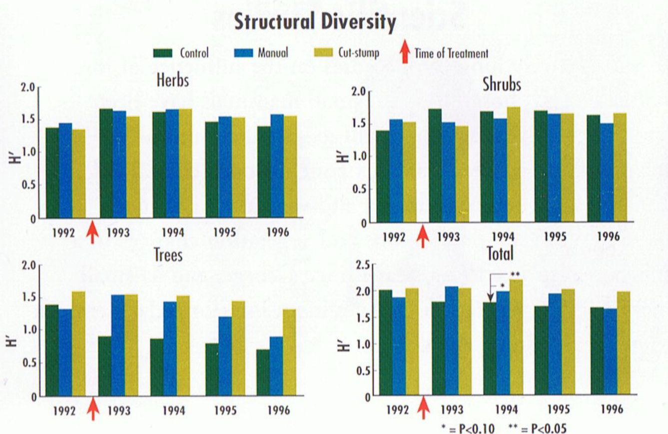
This study compared the alternative treatments of manual cutting and cut-stump applications of glyphosate with controls in young mixed-conifer plantations. Although abundance of the herb and shrub layers appeared to change over time, there were no differences between control and treatment plantations. The treatments reduced deciduous tree volume within the manual and cut-stump treated plantations during the first post-treatment year. The control plantations increased in mean volume of deciduous trees during this same period. This suppression of deciduous tree volume was maintained during all post-treatment years for the cut-stump treatment.

Although abundance of the coniferous tree layer appeared to change over time, control and treatment plantations were not significantly different. The control plantation showed only a slight increase in volume of coniferous trees throughout the five years. However, the annual incremental increase in the volume of coniferous trees in the manual (44%) and cut-stump (29%) plantations was higher than the control (5%).



There were no differences in species richness or diversity of herbs, shrubs or trees among control and treatment plantations during the study. Similarly, structural diversity of herb, shrub and tree layers was not different between treatments and control. By opening the canopy and decreasing the dominance of the deciduous tree layer, both manual and cut-stump treatments showed greater total structural diversity relative to the control in the first post-treatment year.

There were no effects of manual or cut-stump treatments on abundance of deer mice, northwestern chipmunks, southern red-backed voles or long-tailed voles.



Management Implications

1. If herbicide-treated habitats induce only short-term reductions in the diversity of woody plants, and limited effects on the diversity of components such as herbaceous vegetation and small mammals, there should not be a detrimental effect on biological diversity.
2. Diversity may be enhanced if different types of habitat (such as conifer-dominated stands with associated shrub and herbaceous species) that support particular wildlife communities are part of the overall landscape mosaic.
3. Silvicultural practices, such as conifer release with herbicide, may contribute to a diversity of stand structures and wildlife habitats if appropriately designed and implemented.

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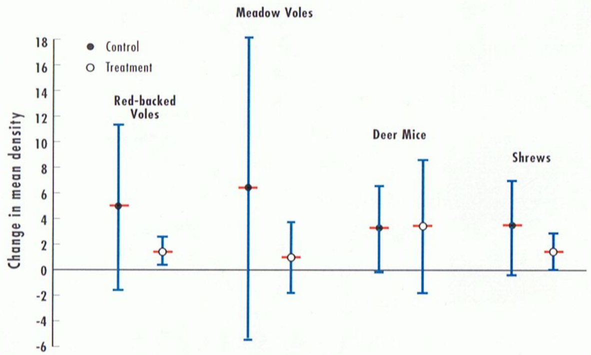
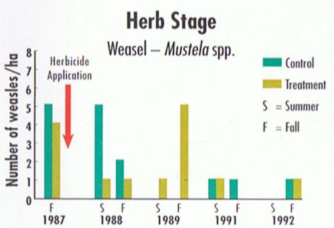
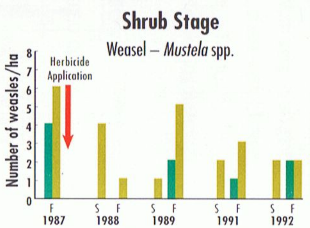
The biological significance of these differences in abundance is illustrated in the figure below. The annual change in mean density of control populations and the difference between control and treatment populations have overlapping 95% confidence intervals for all four species. Except for the deer mouse, the mean change in density and confidence interval are considerably smaller for the control-treatment differences than for annual changes in control populations.



Sampling of terrestrial predator populations in this study was limited to the small weasels: short-tailed stoat (*Mustela erminea*), long-tailed (*M. frenata*), and least (*M. nivalis*). It was not possible to accurately identify the species of each individual captured prior to its release. In general, weasels appeared on those control and treatment areas that supported prey populations of mice and voles.

Weasel – *Mustela* spp.





Snowshoe Hares and Vegetation in Sub-Boreal Spruce Forest

Changes in vegetation and snowshoe hare (*Lepus americanus*) populations were assessed in areas of "conifer release" and "backlog conversion" herbicide treatments from 1987 to 1991 in a sub-boreal spruce forest.

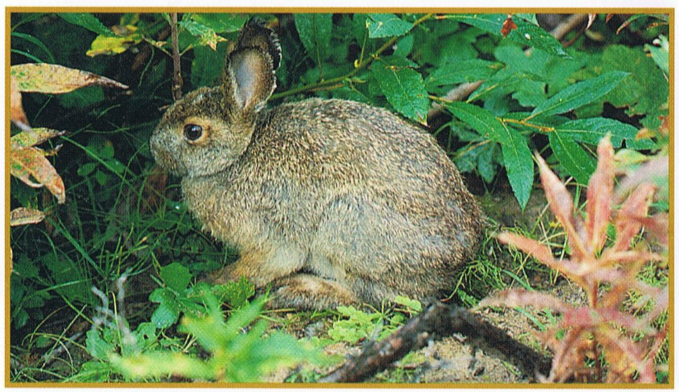
Conifer release study area pre-treatment 1988

Conifer release study area post-treatment 1989

Backlog conversion study area pre-treatment 1989

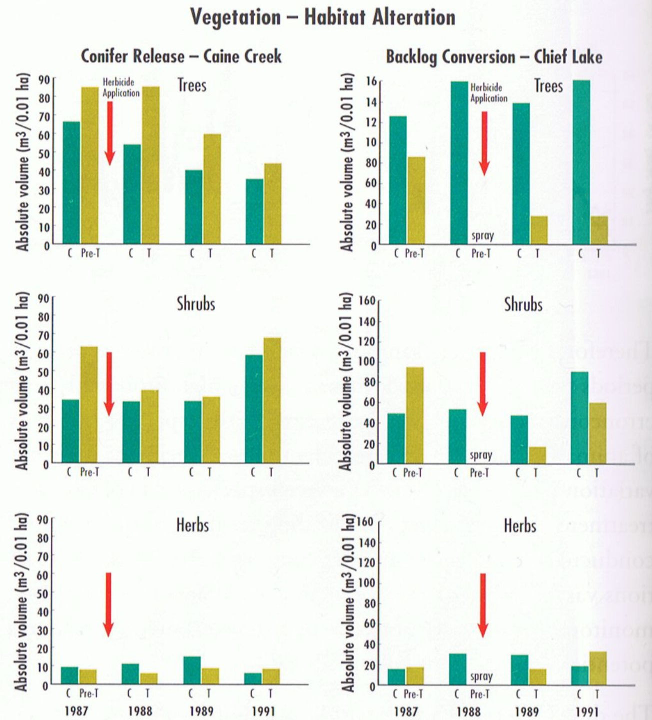
Backlog conversion study area post-treatment 1992

Intensive population sampling and monitoring of vegetation were conducted in replicate control and treatment blocks.



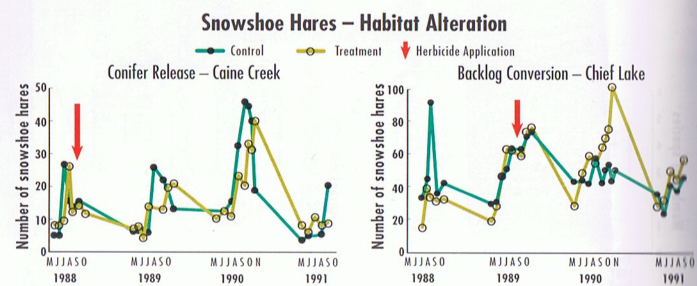
Snowshoe hare – *Lepus americanus*

Volume and cover values of vegetation showed the herb layer recovering to control levels by two to three years post-treatment. Shrub and tree layers were little affected in the conifer release treatment where coniferous species dominated these layers. In the backlog conversion treatment, the dominant deciduous trees and shrubs were relatively slow to recover.



There were no significant differences in species richness of the plant communities between control and treatment blocks, nor in species diversity of herbs and shrubs. Diversity of trees was lower in treatment than control blocks.

Herbicide-induced habitat alteration appeared not to affect abundance of snowshoe hares, at least in areas of optimum habitat during summer–fall periods.



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