ECOLOGICAL ASPECTS OF HERBICIDE USAGE ON POWER LINE RIGHTS-OF-WAY

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Abstract. The effect of a herbicide-oriented vegetation management program on the diversity of vegetation in power line rights-of-way and the resulting vegetation's potential usefulness to wildlife was evaluated in three eco-regions of Alberta -- The Dry Parkland/Prairie, the Moist Parkland and the Mixed Boreal zones. In herbicide treated areas, plant communities consisted of grasses, herbaceous forbes, shrubs and small trees. The proportion of plants in these four growth forms was similar for plant communities in both the treated rights-of-way and the adjacent untreated areas for the Parkland zones. In the Mixed Boreal zone, herbicide treatment favoured the proliferation of herbaceous forbes and grasses while discouraging understorey shrub growth. The herbicide treatment had little effect upon the diversity of plant communities that established in the Dry Parkland/Prairie zone but increased the diversity in the Moist Parkland and Mixed Boreal zones. The diversity increased due to a change in species richness. The wildlife food utilization value of the plant communities that developed on the treated rights-of-way was equal to that of untreated areas in the Dry Parkland/Prairie zone, but was greater than that of untreated areas in the Moist Parkland or Mixed Boreal zones.

Vegetation management is an important component in the maintenance of power lines. Tall-growing trees must be controlled under and around power lines to prevent their intercepting the lines and causing power transmission failure or fires, and to permit quick access in the area to facilitate emergency repairs. For practical and safety reasons, trees are best controlled while they are still young and small. This is most easily done with the use of selective herbicides that suppress the growth of incompatible tree species. Herbicide use is favoured over that of mowing or mechanical clearing as it is more cost effective and less damaging to the environment (6, 7).

Some concern has been expressed by environmentally conscious members of the public with regard to the use of herbicides for control of weeds and brush on the rights-of-way. These groups are largely aware that the brush must be controlled but are concerned with the effects of the herbicide on the environment. To date, there is very little documented evidence as to the effects of herbicide treatments upon the quality of the environment under power lines in various regions of Alberta. Therefore in 1990, an investigation of the diversity of plant species and their relative abundance in treated rights-of-way in comparison to adjacent untreated (control) areas was conducted to determine how the plant community had been altered by the herbicide treatment.

Methods

Site selection and plot establishment. Sites were selected in three eco-regions of Alberta in which vegetation management practices in rights-of-way are commonly conducted. The three eco-regions studied were: 1) the dry parkland prairie zone (Lat. 51°N, Long. 114°W), a relatively open area consisting of native prairie grass stands with frequent outcroppings of woody stands of aspen, poplar, wild rose and western snowberry; 2) the moist parkland zone (Lat. 53°N, Long. 113°W), similar to the previous zone but having more moisture and greater abundance of woody stands with willow being more common; 3) the mixed boreal zone (Lat. 54°20'N, Long. 116°W.), a relatively heavily wooded area consisting of deciduous trees (aspen, poplar and willow) and coniferous trees (black and white spruce and lodgepole pine).

Study sites were located in areas that had topography and vegetation typical for the region. At each study site, plots of the treated right-of-way and a representative control were established. The treated plots were located directly under or adjacent to power lines in areas that had been treated two to five years previous with Desormone 700 (330 g/L of 2,4-D and 350 g/L of dichlorprop) and where evidence of the treatment still existed, i.e., dead trees were present under the power lines. The herbicide had been applied using ground equipment to these sites during the growing sea-

son as a spray directed at young trees using a water volume of 1600 L/ha (11.2 kg active ingredient 2,4-D/2,4-DP per hectare). The rights-of-way had been treated before incompatible tree species exceeded 1.5 m in height. No tall trees developed in these plots. The plots of right of way adjacent showed no evidence of herbicide treatment or mowing. There were five sites for each of the dry parkland prairie and the mixed boreal zones, and in nine sites in the moist parkland zone. Plot size was approximately 110 m long and 6 m wide.

Vegetation Survey. For a detailed examination of the vegetation within the plots, 10 sub-plots were established at 8 to 15 m intervals (randomly selected) within the plot. In each sub-plot, two by one meter in size, all vegetation was identified and the number of plants of each species recorded. The survey was conducted in July and August 1990. Plant species were grouped according to plant life forms: grasses, herbaceous forbes, shrubs, and trees. In the diversity measurements, total plant abundance (all sub-plot totals) for each site was used in the calculations performed.

To evaluate species richness (diversity measure based upon the number of species present), two separate measures were used. 1) The total plant species (S), which is the number of species identified in the defined sampling unit ($20m^2$), was expressed as an average value of S for each zone. Larger values for S indicate greater species richness. 2) Margalef's Diversity Index (D*(mg)*) adjusts species richness to the total number of plants surveyed to eliminate bias due to differences in plant populations on the site (3). The Margalef Index is calculated by the following equation:

$$D(mg) = (S-1)/\ln N$$

where S = total number of species, ln = natural logarithm, and N = total number of plants surveyed. Larger values of D *(mg)* indicate greater species richness.

To evaluate plant diversity, two further indices were used. The Shannon Diversity Index (H) measures the proportional abundance of all species present (9, 10). The Shannon Index (H) is calculated from the equation:

$$H = -\Sigma(p\,(i) \cdot \ln p(i))$$

where $p(i)$ = the proportion of individuals in the *i* th species whose estimate is n(i) /N (where $n(i)$ = the actual numbers of individuals surveyed for a particular species, and N = total number of plants surveyed), ln = natural logarithm, and Σ = the summation of the values calculated. Larger values of H indicate greater plant diversity in the population.

The Simpson Diversity Index (1/D) measures the proportional abundance of the most common species (11). The Simpson Index is a measure of dominance in the plant community among all species present. The Simpson Index (1/D) is calculated by:

$$D = \Sigma[(n(i)(n(i)-1)/(N(N-1))]$$

where $n(i)$ = the number of individuals for the *i* th species, N = the total number of plants present, and Σ = the summation of the values calculated. The Simpson Index is expressed in the reciprocal form (1/D) so that an increase in the value of the Index accompanies an increase in diversity and a reduction in dominance.

Potential Wildlife Use. The species present on each site were assigned a wildlife feed utilization value (4, 8). Food value rating (0 to 10, where 0 = not used, 10 = used in 50% or more of their diet) were assigned to each animal group. The animal groupings were: game birds (i.e., grouse, partridges), song birds (i.e., sparrows, finches, chickadees), small mammals (i.e., rabbits, squirrels, bears), rodents (i.e., mice, chipmunks, gophers), and hoofed mammals (i.e., deer, moose). To provide a value for Potential Wildlife Utilization (PFU) in a particular site, the following formula was utilized.

$$PFU = \Sigma(n(i)\,FV(i))$$

where $n(i)$ = the number of individual plants for the *i* th species, $FV(i)$ = the potential food value for a particular group of the *i* th species, and Σ = the summation of the values. Larger numbers indicate greater potential feed utilization.

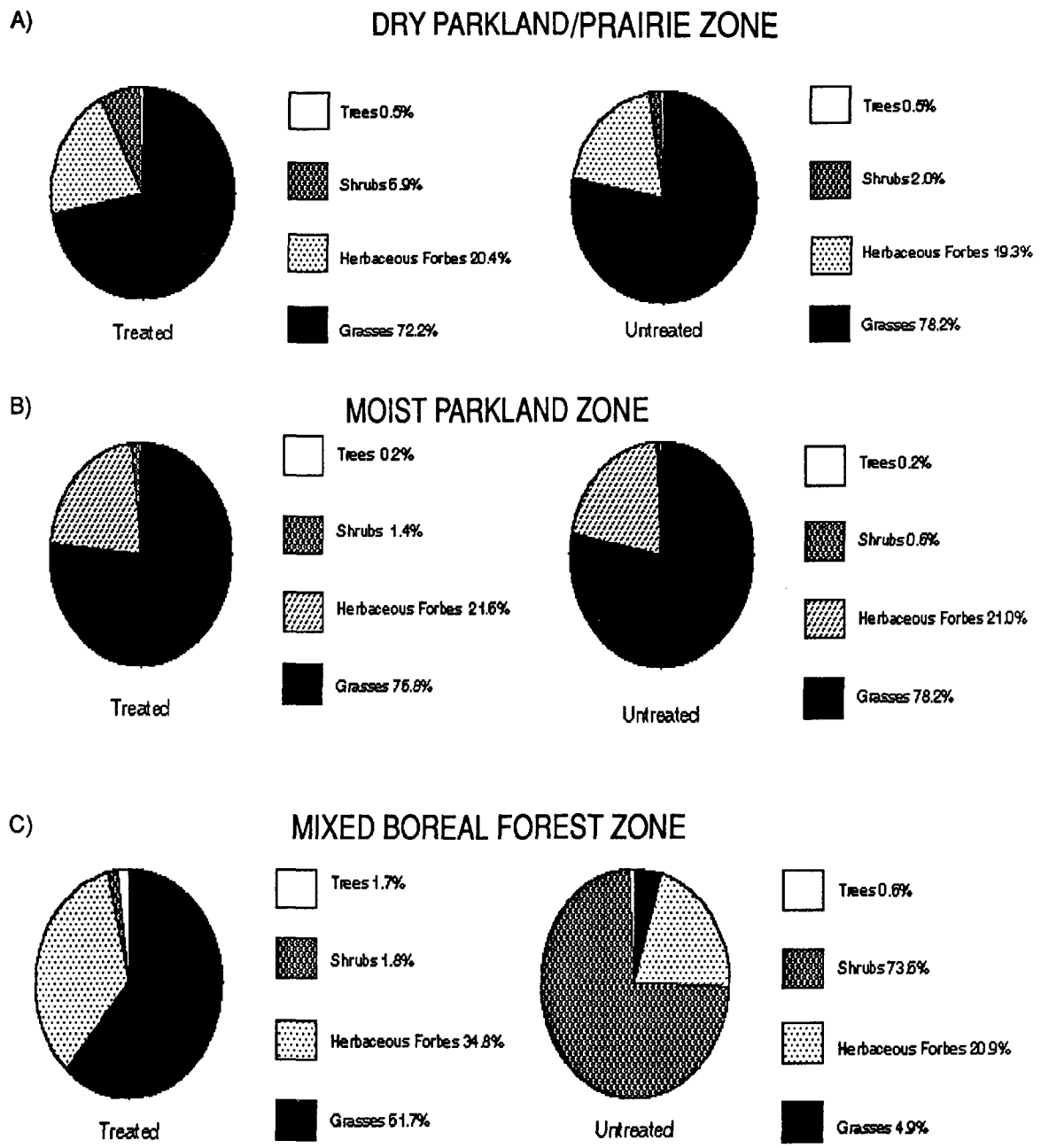

Figure 1. Plant abundance by growth form in herbicide-treated rights-of-way and untreated plant communities in three Alberta eco-regions.

Results and Discussion

The herbicide application to the power line rights-of-way created the desired change in the plant community by preventing the establishment of tall trees. The new plant communities created had a multitude of plant forms present (Figure 1). Based on plant forms, the type of community that developed in the treated areas was similar to that of the control areas in the dry parkland prairie and moist parkland zones. In the mixed boreal zone, the type of plant community was influenced by treatment. The herbicide application by inhibiting tree growth, which was the dominant canopy cover in the control areas, encouraged the growth of grasses and herbaceous forbes that prefer full sunlight and discouraged the growth of shrubs such as Labrador tea (*Ledum palustre*) and bear berry (*Acctostaphylos uva-ursi*) which prefer shaded conditions.

In all eco-regions, the plant communities that developed in the herbicide-treated rights-of-way consisted largely of grasses and herbaceous forbes, and fewer shrubs and small trees. These results closely parallel the plant cover found to dominate after herbicide application in rights-of-way in the Allegheny Mountain and Piedmont areas of Pennsylvania (2). The communities of shade-tolerant, understorey plants were discouraged.

In evaluating a plant community, emphasis is placed on diversity, the kinds of plants found on the site (species richness) and their relative abundance. A plant community with many species present and all species virtually equal in abundance is considered to have high diversity. Since the measurement of plant diversity is subjective, a large number of diversity measures and indices have been developed to compare diversity of two or more plant communities.

The major differences between the diversity indi-

Table 1. The effect of a vegetation management program employing herbicide treatments on the diversity of the plant community occurring on power line rights-of-way in comparison to adjacent untreated areas for three eco-regions in Alberta.

Zone	Treatments[1]	Total species (S)	Total population (N)	Margalef's index (D*mg*))	Shannon's index (H)	Simpson's index (1/D)
Dry parkland/ prairie	ROW	28.2	4991	3.20	1.77	4.74
	Control	25.6	5636	2.89	1.59	3.43
P-value		>0.5	>0.5	>0.5	>0.5	0.23
Coefficient of Variation		17.5%	47.4%	18.7%	25.8%	36.5%
Moist parkland	ROW	19.6	9680	2.02	1.14	2.78
	Control	15.5	7707	1.58	1.21	2.23
P-value		0.005	0.06	0.02	>0.5	>0.5
Coefficient of Variation		14.7%	21.5%	17.5%	34.3%	38.8%
Mixed boreal	ROW	29.2	8149	2.85	2.06	6.49
	Control	19.4	4066	2.24	1.51	3.35
P-value		0.008	0.02	0.1	0.16	0.14
Coefficient of Variation		13.1%	28.1%	17.2%	28.4%	59.3%

1 ROW = Rights-of-way (treated), Control = Adjacent area (untreated).

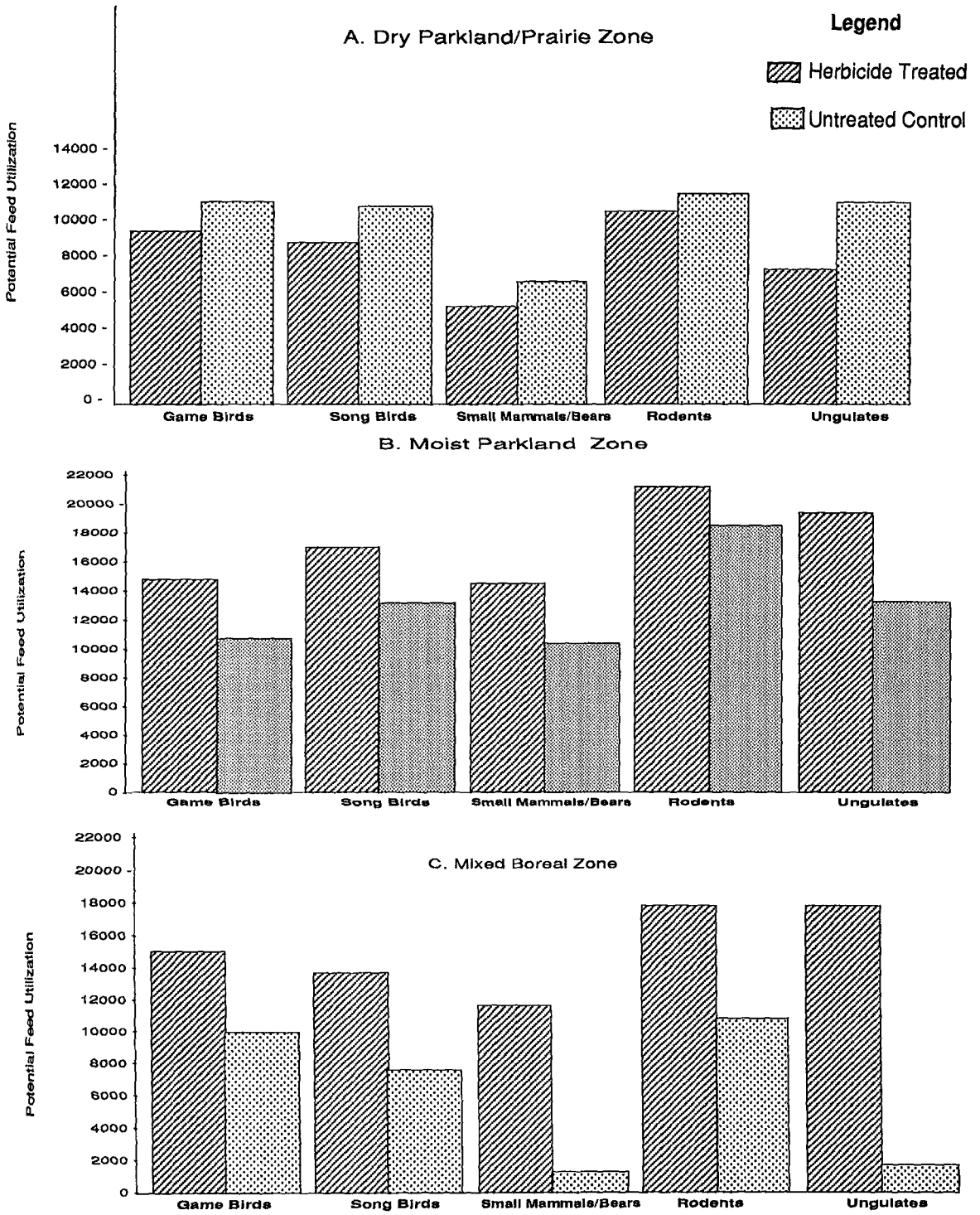

Figure 2. Potential food utilization for five classes of wildlife in herbicide-treated rights-of-way and untreated plant communities in three Alberta eco-regions.

ces lie in the relative weights they give to species richness (kinds) or species abundances. In this study, four indices of plant diversity were used. Two measures of species richness were used, the number of species found and the Margalef's diversity index. To assess diversity according to species abundance, the Shannon diversity Index and the Simpson Index, were used. For all the diversity indexes the larger the number the greater the plant community diversity and the lower the level of dominance exemplified by a single or group of plant species.

Plant community response to the herbicide treatments varied with the eco-regions. In the drier eco-regions, the treatments had no significant effect upon the species richness, abundance or diversity (Table 1).

The wetter eco-regions represented by the moist parkland and mixed boreal zones displayed definite differences in plant community diversity due to the treatments and a greater total population and plant species richness was observed in the treated rights-of-way compared to the controls. At Wetaskiwin (moist parkland zone), the Total Number of Species (S) identified and the Total Population (N) were approximately 30% and 28% greater, respectively, in the rights-of-way than in the control. The differences were even greater at Whitecourt (mixed boreal zone), where S and N were 51% and 100% greater, respectively. Even when the plant communities existing in the right-of-way are corrected for bias due to a greater abundance than the control areas, species richness as measured by Margalaf's Index still remains significantly higher.

Significant differences in the diversity indices that measure diversity as determined by proportional abundances of plants species were not significantly different between the treated and control communities for either zone. However, in the mixed boreal zone, a strong trend toward reduced plant dominance was demonstrated in the treated areas.

It appears that the herbicide treatments produce a transitional phase plant community. This community appears to be relatively stable and diverse. Repeat applications of selective herbicides continue to prevent tree development. This permits other lower growing members of the plant kingdom to form a new community consisting of a large number of plant species. As a result, several members of various plant groups form the vegetation that occupies the site.

In the Cochrane region, the herbicide treatments did not appear to significantly affect the wildlife utilization potential of the new plant community produced compared to the control area (Figure 2). However, in the Wetaskiwin and Whitecourt regions, the plant communities in the rights-of-way had greater potential feed values for many animal groups compared to the control. This is similar to the results of the study by Bramble and Byrnes which evaluated the effect of herbicide use on Pennsylvania rights-of-way on wildlife food and cover (1) and found it of benefit to wildlife.

Conclusion

Herbicide treatments applied to power line rights-of-way to remove incompatible species produce a distinct change in the plant community. The rights-of-way have a dense cover of a wide variety of vegetation forms ranging from grasses and herbaceous broadleaf forbes to shrubs and small trees. Treated rights-of-way have more kinds of plant species that adjacent untreated areas. These new plant communities are relatively stable and have a diversity that equals or exceeds that of the untreated areas. This facilitates potential use of the treated area by a large variety of wildlife.

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Resumé. L'effet d'un programme de gestion orienté de la végétation au moyen d'un herbicide sur la diversité de la végétation dans les corridors des lignes électriques de transport et le potentiel utilisable de la végétation résultante par la faune sauvage étaient évalués dans trois régions écologiques de l'Alberta, soient la prairie boisée (forêt-parc) sèche, la forêt-parc humide et les zones boréales mixtes. Dans les aires traitées à l'herbicide, les communautés de plantes se constituaient d'herbes, de plantes herbacées, d'arbustes et de petits arbres. Dans les zones de forêt-parc, la proportion de ces quatre groupes de plantes était similaire dans les corridors traités et les aires adjacentes non traitées. Dans la zone boréale mixte, le traitement à l'herbicide favorisait la prolifération de plantes herbacées et d'herbes alors qu'il décourageait la croissance d'arbustes de sous-bois. Le traitement à l'herbicide avait peu d'effets sur la diversité des communautés de plantes qui s'établissaient dans la zone de la forêt-parc sèche, mais augmentait la diversité dans la forêt-parc humide et dans les zones boréales mixtes. La diversité augmentait en raison d'un changement dans la richesse d'espèces présentes. La valeur d'utilisation, comme source de nourriture, des plants sauvages qui se développaient dans les corridors de transport traités était égale à celle des aires non traitées pour la zone de la forêt-parc sèche, mais elle était plus élevée que celle des aires non traitées pour les zones de forêt-parc humide et boréales.

Zusammenfassung. Die Auswirkung einer Grünpflege mit Herbizideinsatz auf die Artenvielfalt einer Vegetation im Bereich von oberirdischen Stromleitungen und die daraus resultierende potentielle Nutzbarkeit der Vegetation für die Tierwelt wurde in drei ökoregionen Albertas ausgewertet - in trockener Parklandprärie, feuchtem Parkland und in gemischten borealen Zonen. In herbizidbehandelten Bereichen bestanden Pflanzengesellschaften aus Gräsern, krautartigen Pflanzen, Büschen und kleinen Bäumen. In den Parklandgebieten war das Verhältnis dieser vier Pflanzenformen in den behandelten Bereichen ähnlich denen in den angrenzenden unbehandelten Bereichen. In der gemischten borealen Zone begünstigte die Herbizidanwendung die Sprossung krautartiger Pflanzen und Gräser, während das Buschwachstum im unteren Bereich verhindert wurde. Die Herbizidebehandlung hatte wenig Wirkung auf die Vielfalt der Pflanzengesellschaften, die sich in der trockenen Parklandprärie gebildet haben, aber vermehrte die Vielfalt in dem feuchtem Parkland und in den gemischten borealen Zonen. Die Vielfalt vermehrte sich aufgrund einer Veränderung in dem Artenreichtum. Der Wert der Pflanzengesellschaften als Nahrungsguelle für Wildtiere, die sich in den behandelten Stromleitungsbereichen entwickelten, war gleichwertig wie der, der unbehandelten Bereichen in der trockenen Parklandprärie, war aber größer als der, der unbehandelten Bereiche in dem feuchten Parkland oder der gemischten borealen Zonen.