

# AN EVALUATION OF THE POTENTIAL OF GLYPHOSATE HERBICIDE FOR WOODLAND CARIBOU HABITAT MANAGEMENT

Milo Mihajlovich<sup>1</sup> and Peter Blake<sup>2</sup>

<sup>1</sup>Incremental Forest Technologies Ltd., 7327-118A Street, Edmonton, AB, Canada T6G 1V3;

<sup>2</sup>Canadian Forest Products Ltd., Bag 100, Grande Prairie, AB, Canada T8V 3A3

**ABSTRACT:** Two studies evaluating the effects of glyphosate used for habitat management on caribou lichens and dwarf shrubs were undertaken. Glyphosate substantially reduced blueberry cover at all rates tested in both cutover and uncut areas. Glyphosate did not affect caribou lichen cover.

ALCES VOL. 40: 7-11 (2004)

**Key words:** caribou lichen, glyphosate, habitat management, tolerance

Woodland caribou (*Rangifer tarandus*) are listed as a threatened species, in Alberta and Canada (by Alberta Sustainable Resource Development, Fish and Wildlife Division and Committee on the Status of Endangered Wildlife in Canada – Anonymous 2002). As a threatened species, woodland caribou are on the Blue List of species at risk of declining to non-viable levels and meriting special attention in forest management and forest management research. These efforts include developing an understanding of the factors hindering woodland caribou population recovery when management regimes are altered in their favour.

Wildlife managers suggest predation on woodland caribou young is, at present, the major factor limiting population response to more favourable management regimes. James (1999) and Chowns (2003) suggest woodland caribou in Alberta and Ontario historically used habitats that limited contact with other ungulate species, thus reducing the frequency of encounter with predators (especially wolves, *Canis lupus*). Reduced frequency of encounter is suggested as a primary means of woodland caribou avoiding predation of their young by wolves. The boreal ecotype of woodland

caribou achieves this through use of habitats unfavourable to other ungulate species (for example, jackpine, *Pinus banksiana* Lamb. – caribou lichen, *Cladina mitis* (Sandst.) Hale & W. Culb.) sites. The mountain ecotype of woodland caribou achieves this through spending a considerable portion (spring through late autumn) of the year in high elevation tundra site types, which are unfavourable to other high-elevation species.

Courtois et al. (2004) suggest joint management of caribou, moose, and wolves as a management scale (3,000 – 7,000 km<sup>2</sup>) strategy. Understanding woodland caribou habitat use and the importance of predation in limiting woodland caribou recovery has led to an emphasis on managing habitat to reduce predator – prey interactions. One means of reducing predator – prey interaction is to provide woodland caribou with large, contiguous areas of habitat unattractive to other ungulates – thereby substantially reducing total ungulate population density and hence attractiveness to predators. To this end a number of very large cutblocks have been harvested in the boreal Lower Foothills ecoregion (Beckingham et al. 1996) caribou management zone. The area of

these large cutovers ranges from slightly larger than 100 ha to approximately 350 ha. It is presumed that the large size of these areas will reduce their appeal to large ungulates (moose, *Alces alces andersoni*) which will, in turn, reduce wolf use of these areas (Anonymous 2002).

If these areas are managed for reduced appeal to browsing ungulates, management techniques to reduce browse development after harvesting may be of potential value. This would be especially appealing if major components of the diet of woodland caribou were less affected than moose browse. The authors identified the possible need for browse management in 1997 and assessed several options for longer-term browse reduction.

Broadcast herbicide application appeared to offer the most cost effective (Biring et al. 1996) means, and least disruptive to caribou calving, of managing browse – due to treatment occurring several months after calving and occurring quickly with minimal human access on the ground during treatment. Glyphosate is the most commonly used herbicide for forest management in Canada – approximately 94% of forest management herbicide use is glyphosate (CCFM 2004). Approximately 38% of all forest stand tending in Canada is with glyphosate herbicide. Glyphosate is chosen for its effectiveness in controlling a broad spectrum of competing species (Biring et al. 1996). Glyphosate is classed as moderately persistent material in Canadian soils (Willis and MacDowell 1983, Tortenson 1985) with a half-life in soil of 20 – 100 days depending on soil conditions. Health Canada in the 1987 decision document on glyphosate registration for forestry deemed glyphosate to be a non-leaching (i.e., not soil mobile) based on an Agriculture Canada study of potential for soil mobility of pesticides (Agriculture Canada 1986). Lautenshlager and Sullivan (2002) recently reviewed the ef-

fects of herbicide treatments (primarily with glyphosate) on the biotic components of regenerating northern forests – they concluded that herbicides are a safe, effective tool for restoring conifers to previously conifer – dominated systems which have otherwise been replaced with hardwoods since Europeans began harvesting those systems.

Oberg (2001) cites several articles that demonstrate terrestrial lichens (species not given) comprise the major component of the caribou winter diet. The case is made that both ecotypes of caribou in west-central Alberta rely on caribou lichen as their primary winter food source. However, no data could be found on effects of broadcast glyphosate application, for browse management, on terrestrial lichens (caribou lichens) that form such a significant part of the woodland caribou's diet. Therefore the authors set up two experiments to examine the impact of broadcast glyphosate herbicide treatment on caribou lichen.

### STUDY AREA

A lodgepole pine (*Pinus contorta* var. *latifolia*) stand harvested and replanted to lodgepole pine 2 years prior to treatment was selected as a study site. Located approximately 80 km southeast of Grande Prairie, Alberta the site is located on a sandy soil. Moisture regime is sub-mesic and soil nutrient levels appear to be low as key understory plants in the uncut stand were caribou lichens, bearberry (*Arctostaphylos uva-ursi*), and scattered Canada wild rye (*Elymus canadensis*).

### METHODS

Two small-plot herbicide treatment trials were installed – one in the cutover and reforested area and a second in an adjacent uncut portion of the original lodgepole pine stand.

Treatments were glyphosate, applied as Vision Silviculture Herbicide, at rates of

2, 4, and 6 L ha<sup>-1</sup> (0, 712, 1424, and 2136 g (ae) glyphosate isopropylamine ha<sup>-1</sup>) with an untreated control (Table 1). All treatments were applied using a carbon dioxide propelled small plot sprayer. Application volume was 75 L ha<sup>-1</sup>, using 110015 flat fan nozzles. Applications were made on September 9, 1997 during the typical season when herbicides might be applied for browse management – a time when browse may be controlled without negatively affecting conifer regeneration. Weather conditions at treatment were: wind west at 2 km h<sup>-1</sup>, temperature 23°C, and relative humidity 58 percent.

Treatment plots were laid out prior to treatment. A single, fixed 0.25 m<sup>2</sup> subplot for repeated assessment of subject plant cover was established and marked in each treatment plot. Subplots were randomly located in each treatment plot and were used to overcome variability in cover and extent of subject plants. Cover was assessed by ocular estimate. All estimates were by the same investigator and were made blind (without knowledge of the treatment being assessed). Subject species were caribou lichen (a complex of *Cladina cenotea*, *C. rangiferana*, and *C. stellaris*) and blueberry (*Vaccinium myrtilloides*); bearberry was present but was not suffi-

ciently uniform in distribution to provide an evaluation of treatment impact. Caribou lichen cover was assessed 10 months after treatment (MAT), blueberry cover was assessed 10 and 22 MAT.

A randomized, complete block experimental design was used. Treatments were replicated 4 times. All comparisons were based on means of the 4 replicates. One-way analysis of variance was used to test for significant differences ( $P = 0.05$ ) within a subject species, time period, and locale. If differences were found, Tukey's Honestly Significant Difference separation of means test (University of Missouri - Rolla 2002) was used to elucidate differences between treatments at that time period and locale.

## RESULTS

Results of cover assessments, at 10 and 22 months after treatment (MAT), are given in Table 2. Broadcast glyphosate treatment, regardless of application rate did not significantly affect caribou lichen cover in either area (cutover and uncut). No visual symptoms of glyphosate activity were noted on the caribou lichen. Sub-lethal glyphosate symptoms on susceptible species typically include: stunting (reduced elongation) of new stem or branch growth, dwarfing of new foliage, yellow or white color of new foliage, and clustering of foliage at branch tips.

Blueberry cover was reduced significantly, at both 10 and 22 MAT by all glyphosate rates in both the cutover area and the uncut stand. Cover reduction was directly related to glyphosate application rate with the two labelled application rates (4 and 6 L of product ha<sup>-1</sup>) resulting in greater reduction in cover than the lowest rate examined (2 L of product ha<sup>-1</sup>). Reductions in blueberry cover were greater in the uncut area than in the cutover area (significance not tested).

Table 1. Browse control treatments evaluated.

Treatment Number	Description	Application Rate (L ha <sup>-1</sup> )	Active Ingredient Rate (g ha <sup>-1</sup> )
1	Untreated control	0	0
2	½ nominal brush rate	2	712
3	Nominal brush rate	4	1424
4	Maximum labeled rate	6	2136

Table 2. Changes in plant cover, 10 and 22 months after treatment.

Locale	Glyphosate (g ha <sup>-1</sup> )	Lichen Cover <sup>1,2</sup>			Blueberry Cover <sup>2</sup>				
		At Treatment	10 MAT	% Change 10 MAT <sup>3</sup>	At Treatment	10 MAT	% Change 10 MAT <sup>3</sup>	22 MAT	% Change 22 MAT <sup>3</sup>
Cutover	0	71	77	8.5	16.7	16.7	0	18.3	9.6
	712	75	89	18.7	20	8.3	<b>-58.5</b>	15	<b>-25</b>
	1424	80	83	3.8	11.7	3.3	<b>-71.8</b>	10	<b>-14.5</b>
	2136	78	80	2.6	13.3	0	<b>-100</b>	3.3	<b>-75.2</b>
Uncut	0	77	77	0	10	11.7	17	13.3	<b>33</b>
	712	85	80	-5.9	11.7	4	<b>-65.8</b>	8.3	<b>-29.1</b>
	1424	88	87	-1.1	16.7	2	<b>-88</b>	6.7	<b>-59.9</b>
	2136	83	82	-1.2	13.3	0	<b>-100</b>	4	<b>-69.9</b>

<sup>1</sup> Lichen was a complex of *Cladina rangiferana*, *C. cenotea*, and *C. stellaris*.

<sup>2</sup> Cover values are averages of ocular estimates of cover in 4 – 0.25 m<sup>2</sup> permanent sub-plots established prior to treatment in each plot. Thus each cover represents the average of a total of 16 cover assessments.

<sup>3</sup> Percent change values shown in **bold** font are “honestly significantly different” from pre-treatment cover values using Tukey’s Honestly Significant Difference (HSD) test.  $\alpha = 0.05$ .

## DISCUSSION

Browse management to reduce use of recently reforested cutovers may be a means of limiting use of these areas by moose. It has been postulated that a reduction in moose utilization will, in turn, reduce the attractiveness of recent cutovers to predators (James 1999, Courtois et al. 2004) thereby reducing predator impact on woodland caribou populations.

Herbicide use for browse reduction on large cutovers may be a feasible means of maintaining low browse densities (Biring et al. 1996). Results of this experiment suggest broadcast application of glyphosate herbicide for browse reduction would not negatively impact the supply of caribou lichen (and hence caribou forage) on treated areas. However, herbicide treatment would result in some reduction of blueberries thus reducing forage for species other than woodland caribou.

## CONCLUSION

Broadcast application of glyphosate herbicide for browse management should not negatively impact caribou lichen extent on treated areas.

## ACKNOWLEDGEMENTS

The authors wish to thank Dr. Tom Sullivan of the Applied Mammal Research Institute for his review and comments; Canadian Forest Products Limited for their support of this research; and two anonymous reviewers for their comments and suggestions.

## REFERENCES

- AGRICULTURE CANADA. 1986. Pesticide priority scheme for Water Monitoring Program. Unpublished report, Pesticide Directorate, Food Production and Inspection Branch, Ottawa, Ontario, Canada.
- ANONYMOUS. 2002. Threatened Wildlife. Alberta Sustainable Resource Development, Natural Resource Services, Edmonton, Alberta, Canada.
- BECKINGHAM, J., I. G. W. CORNS, and J. H. ARCHIBALD. 1996. Field guide to ecosites of west-central Alberta. Natural Resources Canada, Canadian Forest Service, Northwest Region, Northern Forestry Centre, Special Report 9. Edmonton, Alberta, Canada.
- BIRING, B. S., P. G. COMEAU, and J. O.

- BOATENG. 1996. Effectiveness of vegetation control methods in British Columbia. Canadian Forestry Service and British Columbia Ministry of Forests. Victoria, British Columbia, Canada.
- (CCFM) CANADIAN COUNCIL OF FOREST MINISTERS. 2004. Pest control product use. [http://nfdp.ccfm.org/compendium/pest/index\\_e.php](http://nfdp.ccfm.org/compendium/pest/index_e.php).
- CHOWNS, T. J. 2003. State of the Knowledge of Woodland Caribou in Ontario. Forestry Research Partnership. [http://www.forestryresearch.ca/product\\_catalogue/reports.htm](http://www.forestryresearch.ca/product_catalogue/reports.htm).
- COURTOIS, R., J.-P. OUELLET, C. DUSSAULT, and A. GINGRAS. 2004. Forest management guidelines for forest-dwelling caribou in Québec. *Forestry Chronicle* 80:598-607.
- JAMES, A. R. C. 1999. Effects of industrial development on the predator-prey relationships between wolves and caribou in northeastern Alberta. Ph.D. Thesis, Department of Renewable Resources, University of Alberta, Edmonton, Alberta, Canada.
- LAUTENSCHLAGER, R. A., and T. P. SULLIVAN. 2002. Effects of herbicide treatments on biotic components of regenerating northern forests. *Forestry Chronicle* 78:695-730.
- OSBERG, P. R. 2001. Responses of mountain caribou to linear features in a west-central Alberta landscape. M.Sc. Thesis, Department of Renewable Resources, University of Alberta, Edmonton, Alberta, Canada.
- TORTENSSON, L. 1985. Behaviour of glyphosate in soils and its degradation. Page 137 in E. Grossbard and D. Atkinson, editors. *The Herbicide Glyphosate*. Butterworths, London, U.K.
- UNIVERSITY OF MISSOURI – ROLLA. 2002. Virtual statistician website. Accessed 2002. <http://web.UMR.edu/~psyworld/tukeys4mean.htm>.
- WILLIS, G. H., and L. L. MCDOWELL. 1983. Pesticides in agricultural runoff and their effects on downstream water quality. *Environmental Toxicology and Chemistry* 1:267.