# TWO YEAR RESPONSE OF WOODY PLANTS TO LETOURNEAU TREE CRUSHERS ON THE KENAI NATIONAL MOOSE RANGE*

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Moose are creatures of secondary plant succession; they thrive after disturbance. One of the most important disturbances is fire, and changes in moose populations after fire have been well documented. In Michigan (Krefting 1974) and Alaska (Lutz 1956) and Spencer and Hakala (1964) moose populations increased and remained higher for 10-20 years after fire before declining due to changes in vegetative composition and to hardwood saplings growing beyond normal browsing height.

Logging is another important disturbance factor that influences moose populations. Studies in Canada (Telfer 1972) and Minnesota (Peek et al. 1976) reported moose populations respond to changes after logging in a manner similar to changes after fire. However, in colder regions, one might expect the response of vegetation after logging to be somewhat faster than after fire because there may be less destruction to the total plant community and to the upper soil layers.

The Kenai National Moose Range on the Kenai Peninsula, Alaska has a fire history recorded back to the mid 1800's. Major fires this century occurred in 1926, 1947, and 1969. Moose populations reached high levels in the mid-1930's and the late 1960's in response to the two earlier fires. The population is presently 3,500-4,500 moose, about one half the 1971 level.

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METHODS

In 1975 and 1976 experimental programs to create major plant disturbance for improving browse composition . . . were conducted on the Kenai National Moose Range in a part of the 1947 Burn and interspersed unburned forest. From January-March 1975 Moose Range staff used LeTourneau tree crushers to crush vegetation on about 460 ha in the Willow Lake area in the northern part of the Moose Range. The project was designed to crush a dougnut-shaped area, with plans to burn the 150 ha doughnut hole the next spring. Unfortunately, it has been either too wet or too dry to burn successfully, and this phase has not yet been completed. Our objective was to study the vegetational changes resulting from crushing and fire with the hope that white and black spruce (Picea glauca and P. mariana) density would be reduced while density and richness of hardwood browse species would be increased.

From January-March 1976 approximately 520 ha were crushed in the 1947 Burn south of the Kenai Moose Research Center (MRC) and about 8 km from the Willow Lake area.

The stands sampled in the two areas had similar woody species composition (Tables 1 & 2). Mature timber in the area of the white spruce-paper birch (Betula papyrifera) - aspen (Populus tremuloides) type and regrowth of paper birch and black spruce. The MRC area, however, is a more general black spruce type as shown by stands 5-21 and 5-24 in Table 2.

Ten sample stands were selected at Willow Lake to represent the variety of vegetation types in that area. Seven of the nine sample stands at MRC had been part of an ongoing study at MRC (Oldemeyer 1975) and had been selected because of their similarity to stand within the MRC. The other two stands were selected in the wide belt of black spruce that occurs south of the MRC.

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In each stand, woody plant density was sampled in 25, 1 x 5 randomly located quadrats. A 2 x 5 quadrat was nested within each larger quadrat and cover of all plants shorter than 40 cm estimated using modified classes of the method described by Daubenmire (1959). A soil pit was dug in each stand and depth to the A, B, and C horizons measured. A soil sample was removed from the A and B horizons for determination of pH and of rock, sand, silt and clay. Vegetation surveys were conducted before and two growing seasons after crushing, except that the 2 x 5 dm survey of cover was not conducted prior to crushing at MRC.

## RESULTS AND DISCUSSION

Black Spruce. Black spruce occurred in five stands at Willow Lake and in eight stands at MRC. Effects of crushing were similar in both areas with 77.5- and 83.1 percent reduction in density, respectively, and reduction in height from about 150 cm to 70 cm. The reduction in black spruce density and height benefit browse species because of reduced competition for water, nutrients, and sunlight.

Paper Birch. In all mature stands (C-1, C-3, C-7, C-8, and 5-06) paper birch density was low before crushing. After crushing, birch density increased in the mature stands at Willow Lake and decreased at MRC. Density increased or remained the same in the six regrowth stands at Willow Lake but decreased significantly in six of eight MRC stands. Birch heights were similar to spruce heights both before and after crushing.

Aspen. Aspen density increased after crushing in all mature stands, significantly so in three of them. Response of aspen to crushing in regrowth stands was poor; density in all but one stand remained similar to pre-crushing density. [Root suckering was the probable cause of increased density.]

Willow. Willow density increased in all Willow Lake stands but decreased in all but one MRC stand. At Willow Lake, willow occurred in samples in three stands after crushing where it had not been detected before crushing. At MRC, decreases in two of the stands were statistically significant. Heights of willow and aspen were similar before and after crushing in both areas and averaged about 52 cm. Both species are heavily browsed each year, and this browsing over the 30-year period since the fire may be the factor causing low density.

Aerial Cover Survey at Willow Lake. Significant changes occurred in aerial cover of several herbaceous and low-growing woody species. Fireweed (Epilobium angustifolium) increased in six of ten stands; however, four of those six were mature stands. Because fireweed is known as an invading species after disturbance, this observation was expected.

Aerial cover of grasses tended to increase after crushing. Five of seven stands showed increases, but the change was statistically significant in only one stand. The fern, Gymnocarpium dryopteris, decreased in all four of the stands where it occurred. Three of those were mature stands and the fourth was a paper birch regrowth stand adjacent to mature timber. Prickly rose (Rosa acicularis) decreased in seven of nine stands where it occurred. Rose reproduces by seed, so reestablishment would be slow if killed by the crushing. Starflower (Trientalis europaea) cover increased in all six of the stands in which it occurred. It reproduces from rhizomes and perhaps was stimulated by crushing.

Aerial cover of lowbush cranberry (Vaccinium vitis-idaea) decreased in eight of ten stands. Those decreases were statistically significant in seven of the stands. Large circular areas of dead lowbush cranberry are commonly observed during the summer and appear to be where moose have dug through the snow to eat the plant. Plant mortality in these areas is probably due to freezing rather than overbrowsing by moose. Crushing exposes bare ground and compacts snow, reducing its insulation capacity; thus, the decrease observed in lowbush cranberry aerial cover in our study stands may well be due to freezing.

At MRC, aerial cover in uncrushed stands adjoining stands 5-05, 5-21, and 5-24 were sampled. Differences between the crushed and uncrushed stands were similar to the responses observed at Willow Lake. Fireweed cover was greater while prickly rose and lowbush cranberry cover was less in the crushed than uncrushed stands. Grass cover was lower at MRC crushed plots in contrast to the higher cover at Willow Lake. Lichen response at MRC was different than Willow Lake. Peltigera sp. was significantly lower in two of three crushed stands and Cladonia sp. was significantly higher in two of three crushed stands. At Willow Lake opposite responses were observed.

Soils. Physical characterists of soils in the two areas are not strikingly different (Tables 4 & 5). At MRC, pH and percent clay were significantly higher than at Willow Lake. Thicknesses of horizons were not different between the two areas.

CONCLUSIONS

Crushing has not been totally effective in achieving all the desired changes in vegetation composition. Spruce density was successfully reduced and should not provide a major competitive factor for 15-20 years.

Aerial cover of fireweed, grasses, starflower, and Peltigera lichens increased in most of the stands where they occurred. Cover of the fern (Gymnocarpium dryopteris, rose, and lowbush cranberry decreased after crushing. Lowbush cranberry is an important winter food plant for moose in this area (Le Resche and Davis 1973, Oldemeyer et al. 1977). While aerial cover of lowbush cranberry was significantly reduced by crushing, it should recover rapidly because of its high seed production and mat forming characteristics. One objective of the tree crusher program is to create a multi-species browse range for moose. If we succeed in this objective, decreased cover of lowbush cranberry will not be important. However, when there is only a single browse species, lowbush cranberry becomes an important second forage in the winter for moose.

Table 2. Woody plant density before and after crushing at the Moose Research Center.

| Stand | Betula papyrifera | | Populus tremuloides | | Salix sp | | Picea muriana | |
|---|---|---|---|---|---|---|---|---|
| | Before | After | Before | After | Before | After | Before | After |
| 5-01 | 5,200 | 800* | 800 | 400 | 800 | 600 | 8,000 | 800* |
| 5-02 | 43,600 | 2,400* | 600 | 200 | 1,400 | 400 | 6,200 | 800* |
| 5-03 | 25,600 | 3,200* | 800 | -- | 1,600 | 400* | 7,800 | 800* |
| 5-04 | 10,000 | 3,800* | -- | -- | 1,400 | 1,000 | 12,000 | 5,400* |
| 5-05 | 9,600 | 1,400* | 1,400 | -- | 5,000 | 1,400* | 15,800 | 2,400* |
| 5-06 | 600 | 200 | 4,600 | 11,800 | 400 | -- | 600 | 400 |
| 5-07 | 28,200 | 7,000* | -- | 1,800 | 1,600 | 3,200 | 19,800 | 1,800*[W] |
| 5-21 | 4,200 | 3,400 | 400 | 400 | 800 | 200 | 11,000 | 2,000* |
| 5-24 | 400 | 200 | -- | -- | -- | -- | 12,400 | 1,600 |

[W]White spruce

*The probability of the before density being different from the after density is $\geq 0.90$.

Table 2. Woody plant density before and after crushing at the Moose Research Center.

| Stand | Betula papyrifera | | Populus tremuloides | | Salix sp | | Picea muriana | |
|---|---|---|---|---|---|---|---|---|
| | Before | After | Before | After | Before | After | Before | After |
| 5-01 | 5,200 | 800* | 800 | 400 | 800 | 600 | 8,000 | 800* |
| 5-02 | 43,600 | 2,400* | 600 | 200 | 1,400 | 400 | 6,200 | 800* |
| 5-03 | 25,600 | 3,200* | 800 | -- | 1,600 | 400* | 7,800 | 800* |
| 5-04 | 10,000 | 3,800* | -- | -- | 1,400 | 1,000 | 12,000 | 5,400* |
| 5-05 | 9,600 | 1,400* | 1,400 | -- | 5,000 | 1,400* | 15,800 | 2,400* |
| 5-06 | 600 | 200 | 4,600 | 11,800 | 400 | -- | 600 | 400 |
| 5-07 | 28,200 | 7,000* | -- | 1,800 | 1,600 | 3,200 | 19,800 | 1,800*[W] |
| 5-21 | 4,200 | 3,400 | 400 | 400 | 800 | 200 | 11,000 | 2,000* |
| 5-24 | 400 | 200 | -- | -- | -- | -- | 12,400 | 1,600 |

[W]White spruce

*The probability of the before density being different from the after density is $\geq 0.99$.

Table 3. Cover of important understory plants and of debris after crushing at Willow Lake and the Moose Research Center.

| Species | Willow Lake | | Moose Research Center | |
|---|---|---|---|---|
| | No. Stands | Mean Cover | No. Stands | Mean Cover |
| Betula papyrifera | 9 | 1.0 | 6 | 0.5 |
| Cladonia sp. | 8 | 1.2* | 9 | 3.5* |
| Cornus canadensis | 10 | 3.7* | 9 | 2.1* |
| Debris | 10 | 5.9 | 9 | 4.3 |
| Epilobium angustifolium | 10 | 2.0 | 9 | 1.9 |
| Graminae | 6 | 0.6 | 7 | 0.4 |
| Linnea borealis | 8 | 1.2* | 6 | 0.4* |
| Lycopodium sp. | 7 | 1.0 | 9 | 1.1 |
| Mosses | 10 | 3.8 | 9 | 4.2 |
| Peltigera sp. | 7 | 2.7 | 8 | 4.6 |
| Vaccinium vitis-idaea | 10 | 2.7 | 9 | 6.7 |

*The probability that the mean cover at Willow Lake is different from the Moose Research Center is $\geq 0.90$.

Table 4. Organic and A Horizon Parameters at Willow Lake And the Moose Research Center.

| Stand | Depth of Organic Material | A Horizon Thickness cm | pH | Rocks and Debris | Sand | Silt | Clay |
|---|---|---|---|---|---|---|---|
| C-01 | 5 | 4 | 4.3 | 4.4 | 76.6 | 22.0 | 4.4 |
| C-02 | 9 | 7 | 4.2 | 0.1 | 72.6 | 22.0 | 5.4 |
| C-03 | 7 | 6 | 4.5 | 0.3 | 71.6 | 22.0 | 6.0 |
| C-04 | 5 | 5 | 4.0 | 0 | 72.0 | 22.0 | 6.0 |
| C-05 | 5 | 3 | 4.4 | 0.2 | 77.6 | 17.3 | 5.1 |
| C-06 | 6 | 2 | 4.3 | 0.3 | 58.9 | 35.6 | 5.5 |
| C-07 | 4 | 6 | 3.9 | 0.9 | 71.2 | 24.4 | 4.4 |
| C-08 | 8 | 3 | 4.3 | 5.2 | 82.2 | 15.0 | 2.8 |
| C-09 | 10 | 3 | 4.2 | 0.1 | 74.7 | 19.7 | 5.6 |
| C-10 | 5 | 4 | 4.3 | 0.1 | 76.2 | 18.6 | 5.2 |
| Mean | 64.4 | 43 | 4.2 | 1.2 | 73.4 | 21.9 | 5.0 |
| | | | | | | | |
| 5-01 | 8 | 4 | 4.4 | 0.1 | 68.7 | 25.2 | 6.1 |
| 5-02 | 9 | 2 | 4.8 | 0 | 60.5 | 30.6 | 8.9 |
| 5-03 | 6 | 2 | 4.5 | 0.1 | 55.7 | 33.9 | 10.5 |
| 5-04 | 12 | 5 | 5.4 | 0.2 | 64.8 | 26.7 | 8.5 |
| 5-05 | 8 | 2 | 4.9 | 0.4 | 66.3 | 25.3 | 8.4 |
| 5-06 | 9 | 4 | 4.8 | 0.7 | 77.8 | 16.9 | 5.4 |
| 5-07 | 7 | 6 | 4.6 | 0.2 | 76.8 | 15.2 | 8.0 |
| 5-21 | 5 | 3 | 4.3 | 0.9 | 73.4 | 21.9 | 4.7 |
| 5-24 | 5 | 4 | 3.8 | 0.7 | 78.6 | 17.2 | 4.3 |
| Mean | 7.7 | 3.6 | 4.6* | 0.4 | 69.2 | 23.7 | 7.2* |

*The probability of the Willow Lake value being different from the Moose Research Center value is $\geq 0.90$.

Table 5. B and C Horizon Parameters at Willow Lake and the Moose Research Center.*

| | B Horizon | | | | | | |
|---|---|---|---|---|---|---|---|
| Stand | Thickness cm | pH | Debris | Sand | Silt | Clay | Depth to C Horizon cm |
| C-01 | 34 | 5.6 | 0.2 | 70.1 | 23.9 | 6.0 | 43 |
| C-02 | 64 | 5.9 | 0.5 | 76.3 | 19.3 | 4.5 | 80 |
| C-03 | 76 | 5.2 | 0.1 | 73.3 | 21.3 | 5.4 | 89 |
| C-04 | 35 | 5.4 | 0.1 | 74.0 | 20.2 | 5.8 | 45 |
| C-05 | 60 | 5.6 | 0.6 | 72.8 | 22.0 | 5.2 | 68 |
| C-06 | 24 | 6.3 | 10.9 | 79.7 | 15.7 | 4.6 | 30 |
| C-07 | 56 | 5.0 | 0.5 | 75.2 | 19.2 | 5.7 | 66 |
| C-08 | 59 | 5.2 | 15.2 | 88.5 | 7.4 | 4.1 | 70 |
| C-09 | 25 | 5.5 | 2.2 | 77.1 | 18.0 | 4.9 | 38 |
| C-10 | 21 | 5.6 | 3.2 | 74.6 | 19.1 | 6.2 | 30 |
| Mean | 45.4 | 5.5 | 3.4 | 76.2 | 18.6 | 5.2 | 55.9 |
| 5-01 | 39 | 5.5 | 0.4 | 71.1 | 23.2 | 5.7 | 51 |
| 5-02 | 6 | 5.4 | 16.0 | 86.0 | 9.7 | 4.3 | 17 |
| 5-03 | 25 | 5.6 | 0.1 | 75.4 | 19.4 | 5.2 | 33 |
| 5-04 | 13 | 5.7 | 1.6 | 73.6 | 21.3 | 5.1 | 30 |
| 5-05 | 26 | 5.7 | 3.0 | 82.3 | 13.0 | 4.7 | 36 |
| 5-06 | 76 | 5.8 | 0.9 | 68.7 | 27.3 | 4.0 | 89 |
| 5-07 | 42 | 5.7 | 0.1 | 81.7 | 12.6 | 5.9 | 55 |
| 5-21 | 65 | 5.8 | 2.8 | 75.4 | 19.5 | 5.1 | 73 |
| 5-24 | 33 | 5.8 | 0.7 | 71.8 | 23.5 | 4.7 | 42 |
| Mean | 36.1 | 5.7 | 2.8 | 76.2 | 18.8 | 5.0 | 47.3 |

*The probability of the Willow Lake value being different from the Moose Research Center corresponding value is $\leq 0.90$.

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