



Michigan Department of Natural Resources
Wildlife Division

Northern White Cedar Regeneration in Menominee County, Michigan

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The northern white cedar (*Thuja occidentalis*) forest type currently occupies approximately 920,000 acres in Michigan's Upper Peninsula (Schmidt 1993, Leatherberry 1994). Cedar is generally associated with wetlands but may occur as a component in upland forest types. Cedar was abundant in uplands at the time of European settlement (Curtis 1944, Godman 1958, Johnston 1977, Scott and Murphy 1987). Historical evidence suggests that cedar formed all-age stands by regenerating vegetatively on wetland sites, or from seeds on decaying logs or exposed soil within tree fall gaps in old-aged stands (Curtis 1944, Nelson 1951, Godman 1958, Verme and Johnston 1986, Scott and Murphy 1987). Even-aged stands originated following catastrophic fire and windfall (Curtis 1944, Scott and Murphy 1987).

The cedar forest type is increasing in acreage in the UP (Leatherberry 1994, Schmidt 1993), due to shorter-lived tree species dying and the longer-lived cedar persisting on low site index wetland sites. However, the amount of cedar in younger age classes (<40 years old) is declining which raises concern for the long-term viability of cedar (Grossman and Witter 1990). Deer browsing and inappropriate silvicultural techniques are frequently implicated in the failure of cedar to regenerate (Godman 1958, Johnston 1977, Nelson 1955, Pregitzer 1990).

Strip clear-cutting and prescribed burning are silvicultural techniques that have been recommended to promote cedar regeneration (Johnson 1977, Verme and Johnston 1986). Browsing by herbivores, primarily white-tailed deer (*Odocoileus virginianus*) and snowshoe hare (*Lepus americanus*), has been implicated in the failure to successfully regenerate cedar (Aldous 1941, Nelson 1951, Johnson 1977, Krefting 1975, Alverson et al. 1988). The objectives of this investigation were to determine the impact of prescribed burning on regeneration of a typical cedar strip-cut and to evaluate the impact of herbivore browsing on cedar reproduction.

STUDY AREA

The study area was located within Ecological Management Unit-30 of the Escanaba River State Forest. EMU-30 is a glacial lakeplain lying between the cities of Escanaba and Menominee, MI (ERSF Management Plan 1990). EMU-30 is approximately 49% upland forest, 33% lowland forest, 3% agriculture and 15% classified as non-stocked (water, lowland brush, etc.).

The study site was a 25 acre mixed conifer stand located in the NE1/4 NW1/4 Section 8, T36N, R24W. The stand occurs on Johnwood-DeTour soils, which are moderately to poorly drained mineral soils formed in cobbly and gravelly glacial till on till or lake plains (Schwenner 1989). Site index for cedar is approximately 35. In 1964-65 a preparatory cutting removed balsam poplar (*Populus balsamifera*, 280 cords), aspen (*Populus spp.*, 25 cords), white birch (*Betula papyrifera*, 31 cords) and cedar (32 cords) from the stand. Between 1975 and 1978, five, 130 ft X 1300 ft east to west oriented strips were clear-cut.

Cedar (267 cords), balsam fir (*Abies balsamea*, 174 cords), and mixed hardwood (88 cords) were the dominant species removed. Advance cedar reproduction was not present prior to, or following, timber harvesting operations.

Deer numbers have fluctuated within EMU-30, as indexed by deer pellet group surveys (Hill 1994), from 1959 - 1994. Population lows occurred in the late 1960's and population highs occurred in the mid-1970's and mid-1980's (Figure 1). EMU-30 provides winter thermal cover for resident deer as well as deer that move from their summer range within EMU-29 (MDNR unpub. data). Increasing deer numbers are associated with increases in the acreage of corn grown for grain in EMU-29, and increased timber harvest a series of mild winters for both EMU-29 and EMU-30.

METHODS

In May 1978, four of five clear-cut strips were burned, resulting in approximately 50% of each burn strip actually being burned (J. Noasconi, MDNR, unpubl. report). The experimental units consisted of two clear-cut strips: one randomly-selected burned strip (treatment) and an unburned (control) strip. The control and treatment strips were separated by two well-stocked, 80 - 90 year old cedar dominated leave strips, each approximately 66 ft X 1300 ft in size, and one clear-cut strip, 132 ft X 1300 ft. The burned strip was approximately 3 acres and the unburned strip 1.8 acres in size. Approximately 40% of the unburned leave strip occurred on different soils (Cathro-Ensley) and was excluded from the study.

The treatment and control strips were divided into 66 ft X 66 ft square blocks. Blocks were randomly selected, and in 1980 exclosures 3.3 ft X 3.3 ft (1-m²) were randomly placed within a block. Exclosures were constructed with fine mesh chicken wire. In addition, a strip of hardware cloth 12 in high was attached to each exclosure flush with the ground. Exclosures prevented browsing by white-tailed deer and snowshoe hares. Browsing by small mammals such as southern red-backed voles (*Clethrionomys gapperi*) was hindered but not eliminated. Control plots (no exclosures) were located immediately adjacent, in a random cardinal direction, to the exclosures. Eleven exclosure and control plots were located in the burned strip and 5 exclosure and control plots were located in the unburned strip. Differences in sample size were due to acreage differences between the strips, and 2 plots on the unburned strip fell on sites not representative of the study area and were excluded. Field work was conducted from 1982 to 1993.

Cedar seedlings were counted on control and treatment plots during spring (mid -late May) and fall (October, before leaf-fall) from 1982 through 1993. Beginning in 1986, cedar seedlings 12 in. or greater in height were counted in an attempt to identify seedling recruitment.

Wilcoxon Matched Pairs Test was used to compare within treatment counts and the Mann-Whitney U Test was employed to test differences between treatments (Zar 1984).

RESULTS AND DISCUSSION

Burned (Treatment) Strip Compared with Unburned (Control) Strip

A clear difference existed between the number of cedar seedlings counted on the burned strip compared to the unburned strip during the early years of the study (Figure 2). Within exclosures (protected), counts of cedar seedlings were higher on burned strips in both spring and fall for 11 of 12 years ($P < 0.10$). On seasonally wet mineral soil sites, as represented in this study, burning increased the number of cedar seedlings. These results are consistent with Nelson (1955), Johnston (1977), and Verme and Johnston (1986) who reported increased numbers of cedar seedlings following burns on lowland sites.

Over the 12 years of study, counts of cedar seedlings declined approximately 50% within exclosures on the burn strip (Figure 2), but remained significantly greater than the number of seedlings counted on unprotected plots in the burned strip ($P < 0.10$) and protected and unprotected plots in the unburned strip ($P < 0.10$). By spring 1988, counts of seedlings in unprotected plots on the burn strip approximated counts of seedlings in exclosures on the unburned strip (Figure 2). Herbivore browsing appeared responsible for the reduced number of cedar seedlings.

Burned Strip: Exclosure Plots Compared with Control Plots

Significant differences were not observed between spring counts of cedar seedlings on protected and unprotected plots on the burn strip between 1982 and 1987 ($P > 0.10$), however, for each year between 1988 and 1993, protected plots contained significantly more seedlings than unprotected plots ($P < 0.10$). A similar pattern was observed in fall counts, with no differences noted between seedling counts on protected and unprotected plots between 1982 and 1985 ($P > 0.10$), however, for 7 of the 8 years between 1986 and 1993, seedling counts within exclosures were higher ($P < 0.10$). Browsing by herbivores appeared to reduce the number of cedar seedlings on the unprotected plots, with statistically significant differences expressed 7-9 years following burning.

A few cedar seedlings in exclosures had grown to 12" in or greater in height when we began recording seedlings 12"+ in height in 1986, 8 years following burning (Figure 3). Differences in the number of cedar seedlings 12"+ in height between exclosure and control plots are probably due to browsing by herbivores. Browsing was reducing the number of seedlings reaching 12" in height by 7 years following burning.

Burned Strip: Spring Counts Compared with Fall Counts

The number of cedar seedlings counted on exclosure plots increased from spring to fall from 1982 through 1986. Fall counts of seedlings in unprotected plots on the burned strip were significantly greater than spring counts for three of the initial four years. These results are similar to those reported by Nelson (1955) and suggests recruitment of seedlings from spring to fall is greatest during early post burn years, probably when site conditions are optimal for seed germination. During the first six years of the study, seedling counts on exclosure plots were significantly greater ($P < 0.10$) than control plots for only one year (1985), however, exclosure counts were greater than controls for 5 of the last 6 years of the study ($P < 0.10$). This suggests browsing reduced the number of cedar seedlings, and browsing was occurring between the two count periods, and before snow was present.

Burned Strip: Fall Counts Compared with Succeeding Year Spring Counts

The number of cedar seedlings in exclosures on the burned strip declined significantly from fall to the succeeding spring for five of the initial six years ($P < 0.05$) suggesting factors other than browsing by white-tailed deer or snowshoe hare were operating. Brown, dead, but still rooted, seedlings were observed on exclosure and control plots. Nelson (1951) indicated desiccation was an important mortality factor for cedar seedlings. Evidence of small mammal browsing was noted inside and outside of the exclosures. During the last five-years of the study, only one fall-to-succeeding spring comparison of exclosure plots (Fall 1990 vs Spring 1991, $P < 0.10$) exhibited a significant difference. Overwinter mortality of cedar seedlings in exclosures declined and became less variable, approximately 10 years following the burn (Figure 2). This may be the result of less predation pressure from small mammals, or more likely, ameliorated microclimate conditions for seedlings due to re-vegetation of the site following timber harvesting and burning. Coincident with improved site conditions for seedling development, the site became less suitable for cedar seed germination, resulting in reduced numbers of seedlings.

MANAGEMENT IMPLICATIONS

In the Upper Peninsula of Michigan, many cedar stands have been strip clear-cut to promote cedar regeneration. This study found clear-cutting of cedar on a seasonally wet mineral site failed to regenerate cedar, unless it was followed with a burn. Zasada (1952) and Nelson (1951) reported poor cedar reproduction following clear-cutting, without burning, on poorly drained mineral soil sites and suggested an increase in hardwood reproduction was at the expense of cedar.

Cedar seedlings were abundant on the burned strip, however, browsing by herbivores, probably white-tailed deer, reduced the number of cedar seedlings on unprotected plots. Differences in the number of cedar seedlings between protected and unprotected plots were statistically significant 7-9 years following burning. Strip clear-cuts juxtapose food (clear-cut strip) with shelter (leave strip) for species such as deer and snowshoe hare, and may exacerbate the impact of browsing on reproduction. In addition, the presence of abundant cedar seedlings in exclosures, immediately adjacent to control plots, may attract deer to the exclosures and intensify browsing pressure on controls.

Given the existing habitat conditions, deer population density and distribution, and behavioral patterns of deer, it seems prudent to delay efforts to regenerate cedar in EMU-30. The mean number of deer pellet groups deposited per pellet course ranged from 17-32 over the course of this study. Efforts to regenerate cedar may be fruitless if regeneration efforts are undertaken in other areas with deer pellet group indices approximating those in this study, if the impact of browsing found in this study is representative.

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Figure 1. Mean (± 1 SE) number of deer pellet groups/deer pellet course within Ecological Management Unit-30 (EMU-30), Menominee County, Michigan, 1959-1994.

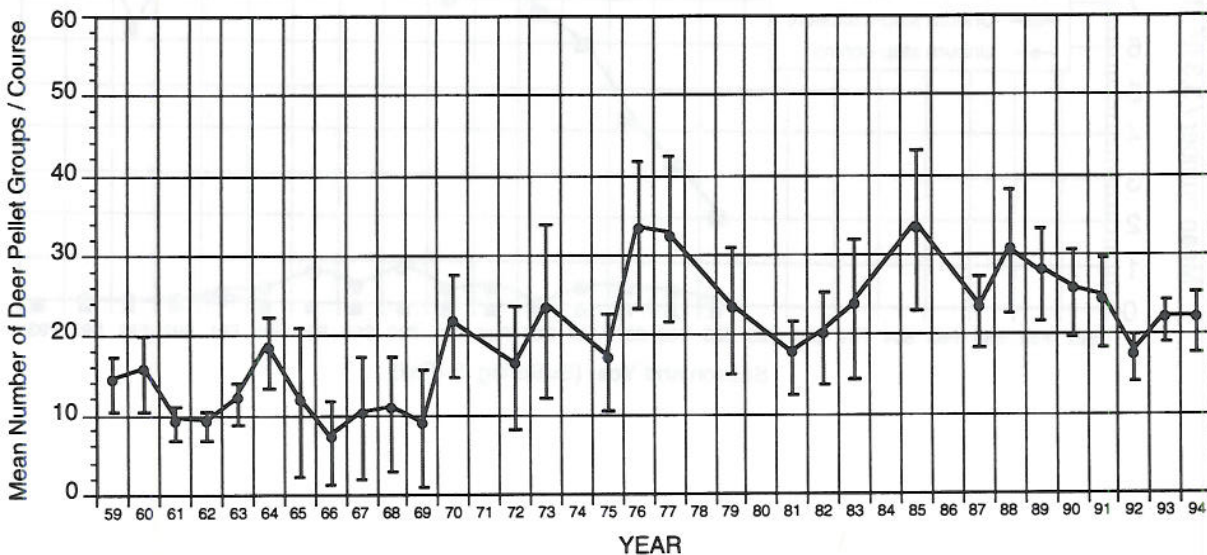


Figure 2. Mean number (± 1 SE) of cedar seedlings counted per 3.3 ft² (1-m²), in clear-cut strips with four different post sale treatments, EMU30, Menominee County, Michigan, 1982-1993.

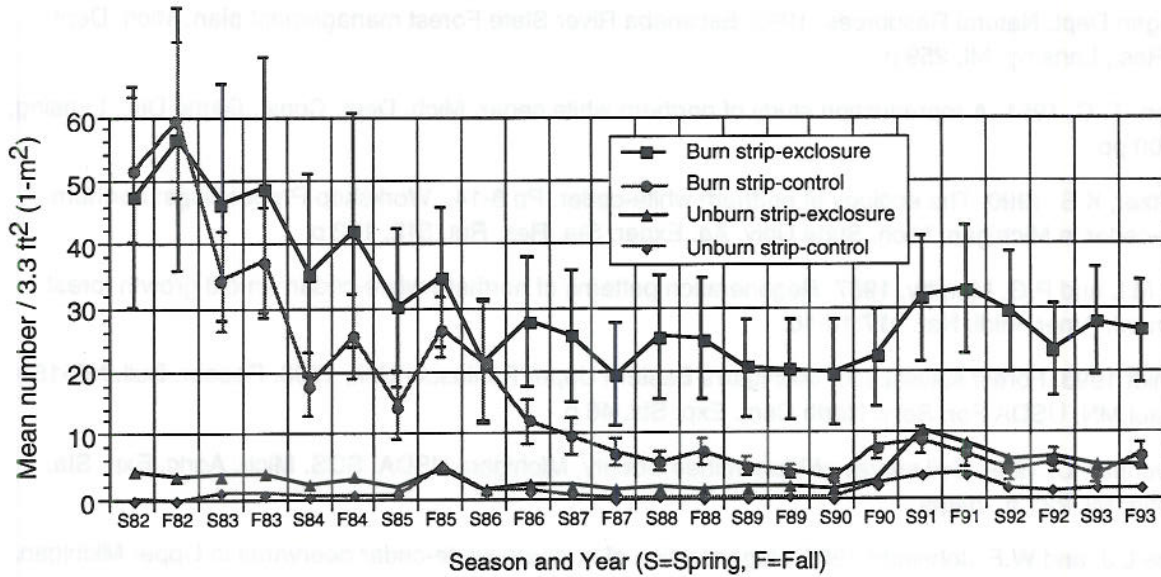


Figure 3. Mean number of cedar seedlings 12 inches or greater in height, per 3.3 ft² (1-m²), in clear-cut strips with four different post sale treatments, EMU-30, Menominee County, Michigan, 1986-1993.

