Prairie Nat. 19(3):189-198. 1987.

Factors Influencing Woodlands of Southwestern North Dakota

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ABSTRACT – Literature pertaining to woodlands of southwestern North Dakota is reviewed. Woodland species composition and distribution, and factors influencing woodland ecosystems such as climate, logging, fire, and grazing are described. Potential management and improvement techniques using vegetation and livestock manipulation have been suggested.

Native woodlands are a unique and diverse ecosystem of the northern Great Plains. Although woodland distribution is limited, their value both economically and ecologically is great. Woodlands provide important habitat for a number of wildlife species, shade and shelter for livestock, biomass production, watershed maintenance, species diversity, and firewood (Severson and Boldt 1978). The value of woodlands for wildlife and firewood production on the northern High Plains has been estimated at $38 million annually (Bjugstad and Sorg 1984).

Precipitation is limited in southwestern North Dakota, and woodlands occur only where there is sufficient soil moisture: north-facing slopes, intermittent drainageways, creeks, springs, floodplains, and the Killdeer Mountains. While moisture is probably the most important factor governing the distribution of woodlands, other factors such as microenvironment, competition with grasses, control of prairie fires, grazing, and woodcutting have also influenced woodland distribution. Many of the tree species are at the outer limits of their ranges, resulting in an unusual combination of eastern and western species.

Woodlands pose difficult management questions. Woodlands are usually stringers or patches only a few hectares in size, surrounded by grasslands. Hence, these "mini-forests" are usually incorporated into livestock pastures and managed as rangelands.

Several manuscripts deal with woodland composition and distribution, factors that influence woodlands, and management and improvement techniques. This paper is a review of the literature available on factors influencing woodlands of southwestern North Dakota, to provide habitat managers with information on how to protect and manage our valuable woodland habitat.

THE AREA

Southwestern North Dakota is part of the Missouri Plateau, which is subdivided into badlands, unglaciated, and glaciated regions with drift remains
neman 193 1). Geological material is primarily of sedimentary layers of shales, silts, clays, sandstone, and lignite veins of the Tongue River, Golden Valley,

and Sentinel Butte Formations of the Fort Union Group (Bluemle 1980). The topography is of rolling plains, dissected buttes, and broad floodplains. Most soils developed from residium (material weathered from rocks in place). The soils range from Mollisols under well-developed plant communities to Entisols where less development has occurred (Omodt et al. 1968). Alfisols and Inceptisols have also been mapped (Wright et al. 1982).

The vegetation is a mosaic of different plant communities made up of a number of grassland, shrubland, and woodland types. The predominant vegetation is broadly classified as mixed-grass prairie (Kuchler 1964). Nine grassland vegetation types have been described based on dominant species, soils, and topography (Hanson and Whitman 1938). Other descriptions have dealt with the composition, production, and dynamics of the grasslands (e.g. Bjugstad and Whitman 1970, Redmann 1975, Whitman 1979, Brand and Goetz 1986).

The distribution of woodlands is limited, as is information on their composition and ecology. *Populus deltoides, Fraxinus pennsylvanica,* and *Juniperus scopulorum* woodlands were first studied by Nelson (1961). Vegetation – environment relationships of woodland and shrub communities were described by Wali et al. (1980); nine major types were described. Habitat types-dominated by *F. pennsylvanica, Populus tremuloides, J. scopulorum, Quercus macrocarpa, Pinus ponderosa,* and *Pinus flexilis* have been classified for this area, southeastern Montana, and northwestern South Dakota (Hansen et al. 1984, Girard 1985, Hansen 1985).

DISTRIBUTION

Native woodlands occur as isolated islands, pockets, or stringers throughout North Dakota. Woodlands make up about 1% of the total ground cover of North Dakota (Jakes and Smith 1983), and from 5 to 7% of the total ground cover of southwestern North Dakota (Hopkins 1983). The woodlands of southwestern North Dakota are dominated by a mixture of northern, eastern, and western tree species (Nelson 1961, Wali et al. 1980, Hansen et al. 1984, Girard 1985). *Fraxinus pennsylvanica* and Quercus *macrocarpa* are eastern species that reach the western edge of their range in western North Dakota and eastern Montana. The distribution of *Populus deltoides* var. *occidentalis* as described by Little (1971) is restricted to the Great Plains. *Populus tremuloides* has the largest range of any of these native North American tree species. *Betula papyrifera* is a northern species. Both *P. tremuloides* and *B. papyrifera* occur as fragmented, isolated types on the northern Great Plains. The western coniferous species of *Juniperus scopulorum, Pinus ponderosa,* and *Pinus flexilis* also illustrate disjunct distributions and northeastern extensions of their ranges in southwestern North Dakota.

FACTORS INFLUENCING THE WOODLAND ECOSYSTEM

Climate

The northern Great Plains have been described as a marginal environment for tree growth, with size, growth rate, and longevity all tending to decrease as environmental conditions become less favorable (Albertson and Weaver 1945).

The combination of low precipitation and cold winters followed by hot windy summers results in high evapotranspiration rates. These factors, together with a short growing season, form a harsh environment for tree survival. The climate of southwestern North Dakota is semi-arid continental and is characterized by wide daily and seasonal fluctuations in temperature and erratic precipitation (Jensen 1972). Mean temperatures range from 21 ^{o}C in July to – 13^{o} C in January, and the long-term precipitation average is 33-41 cm annually (Jensen 1972). Moisture is often limited during the growing season and the area is subject to recurrent drought. Killing frosts are frequent in late spring and early fall; frost-free days range from 110 to 135 per year, averaging 125 days.

Albertson and Weaver (1945) reported overall tree survival of 43.1% in North Dakota following the drought of the 1930's. Injury and death of wooded species was often the result of continuous adverse climatic conditions over extended periods of time, which culminated during the 1930's drought. Death was actually a gradual process that began long before the 1930's drought, due to a progressive weakening of the trees from recurrent, less severe droughts.

Logging

Commercial logging was conducted in the early 1900's in what was then known as the Dakota National Forest, now a part of the Little Missouri National Grasslands, Slope County, which is characterized by *Pinus ponderosa* woodlands (Green 1960). Logging on private land resumed in 1983.

Juniperus scopulorum stands were heavily cut over beginning in the 1880's, concurrent with the end of the open range and the erection of fences (Ralston 1960). Cutting reached its peak in the 1930's when the Works Progress Administration and the Civilian Conservation Corps cut trees to provide fenceposts to enclose the newly established Little Missouri National Grasslands (Ralston 1960).

Fire

Fire has played an important role in the maintenance of the grassland ecosystem (Stoddart et al. 1975). Fire no doubt was also influential in the woodlands, but its exact role has not yet been reported. Severson and Boldt (1978) pointed out the controversy that continues over whether woodlands have expanded or declined since settlement in the late 1800's. Lack of data on the relative size of pre- and post-settlement woodlands leads to subjective speculation. Many believe the suppression of fire that accompanied homesteading has allowed woodlands to expand. Others argue that woodlands often escaped fire and many of the woody species are adapted to fire.

Higgins (1984) reported that the frequency of fire in portions of the northern Great Plains would favor grasslands over woodlands except in areas of rough, dissected topographies. The Badlands of southwestern North Dakota are composed of rough breaks and steep buttes; hence, the fires probably were not as influential or detrimental to woodlands of the area. Many of the woodlands occur on topographies that are so deep and steep-sided that rapidly moving grass fires may skip over them (Severson and Boldt 1978).

Many woody species found in the woodlands are stimulated to sprout following fire. *Fraxinus pennsylvanica, Symphoricarpos occidentalis, Amelanchier alnifolia, Shepherdia argentea,* and *Prunus virginiana* demonstrate good tolerance to fire (Wasser 1982). Fire tolerance, coupled with the sprouting response to fire, may have allowed for regeneration of stands by destroying old growth and favoring new sprouts. A wildfire through a *Fraxinus pennsylvanica* woodland on the Little Missouri Grasslands increased shrub densities on burned plots contrasted to adjacent unburned plots (Zimmerman 1981).

Grazing

Severson and Boldt (1976) theorized that large bison herds on the Great Plains may have had a great impact on the vegetation of the wooded draws. Free-roaming bison herds in Theodore Roosevelt National Park, North Dakota, restricted their use primarily to paths through wooded draws and areas near water, and a few of the trees were used for rubbing (Norland and Marlow 1984). Very little feeding by bison occurred in the wooded draws.

The North Dakota Badlands have been used for livestock grazing for more than 100 years. Mattison (1969) wrote of the long cattle drives that began in the late 1880's as cattlepersons learned of the rich rangelands of the north that could fatten their cattle easier than the southern plains. These were the days of the open range and most of the ranchers owned little land. Livestock have impacted the woodlands in two ways: (1) livestock would concentrate in the woodlands with surface water, as no other water developments were available, and (2) too many cattle were present in some years (Mattison 1969).

Ranching was quite profitable until 1886, when a harsh winter in the south forced cattledrovers to drive even more cattle to the north, which was experiencing a drought. Theodore Roosevelt, in an interview with the Mandan Pioneer, stated, “There are too many in the business. In certain sections of the West the losses this year are enormous, owing to the drought and overstocking. Each steer needs from 15 to 25 acres, but they are crowded on very much thicker. . . " (Brooks and Mattison 1958).

Modern ranching practices – fences, salting, water developments, grazing rotation, and other management techniques – have helped improve the density and distribution of livestock. However, a number of factors are still impacting the woodlands. Herbivores often tend to be concentrated in woodlands for forage, shelter, and shade (Bjugstad and Girard 1984). Consumption and trampling of the vegetation occurs (Nelson 1961, Severson and Boldt 1978, Butler et al. 1986) as does soil compaction (Mc Comb and Loomis 1944, Albertson and Weaver 1945). These effects have been attributed to both native and domestic herbivores. However, in some instances the hoof action of herbivores may serve to improve the woodlands by opening up the sod, thereby allowing seed germination (Severson and Boldt 1978).

Differences in grazing use have been shown to change the floristics and species composition of woodlands (Nelson 1961, Butler et al. 1986). *Poapratensis, Taraxacum officinale, Symphoricarpos occidentalis,* and *Rosa* woodsii occur more abundantly on grazed *Fraxinus pennsylvanica* sites, while *Carex sprengelii,* boreale, and *Prunus virginiana* were more abundant on ungrazed sites (Nelson 1961). Butler et al. (1986) reported tall shrubs and saplings increase in density with a decrease in grazing use in *Fraxinus pennsylvanica* wooded draws. In the herbaceous layer, graminoid cover was highest on the heavily grazed site, shrub cover was greatest on the moderately grazed site, and forbs were most abundant on the lightly grazed site. *Poa pratensis* increased and *Carex sprengelii* decreased with an increase in grazing. *Fraxinus pennsylvanica, Ulmus americana, Prunus americana,* and *Crataegus rotundifolia* were reported to be highly susceptible to trampling and rubbing. The mean height of many wooded species, including *F. pennsylvanica* and *P. americana,* was greater on the lightly grazed site,

POTENTIAL MANAGEMENT AND IMPROVEMENT TECHNIQUES

Vegetation and Livestock Manipulation

The only comprehensive management and improvement study on *Fraxinus pennsylvanica* woodlands in south western North Dakota was by Boldt et al. (1978). Treatments to test the response of wooded species were (1) installing a cattle-proof fence; (2) installing a cattle-proof fence, partial cutting of trees, and underplanting; (3) partial cutting and underplanting, no fence; and (4) a control with no fencing, cutting, or planting. Plots were evaluated six years after treatment by Uresk and Boldt (1986) and results showed that partial felling and removing of decadent trees will stimulate sprouting of *Fraxinus pennsylvanica* and *Ulmus americana* after five years, and plantings and sprouts of most species had greater survival and attained taller heights when excluded from grazing. Treatment response was slow or nonexistant for some species.

Vegetation Manipulation

Burning. The use of fire as a management tool on grasslands has gained popularity in recent years, and it may also be a useful technique in woodlands. A wildfire through a *Fraxinus pennsylvanica* wooded stand in the Little Missouri National Grasslands increased biomass, density, and cover on burned sites compared to similar, adjacent unburned sites (Zimmerman 1981). The vigorous sprouting demonstrated by many of the shrubs after burning may make it a practical tool for improvement.

Cutting. Fraxinus pennsylvanica and *Ulmus americana* can sprout if the top growth is removed; selective cutting may help regenerate woodlands (Uresk and Boldt 1986). Research on the proper selective cut techniques will be necessary to determine proper tree densities and age. The age of the trees is important, as the ability to sprout decreases with age and diameter of the parent (Kramer and Kozlowski 1960).

Manipulation of Forage. The herbaceous vegetation of woodlands remains green later in the season than that of most uplands because of the mesic conditions in many woodlands. Woodlands receive additional moisture through overland flow from the uplands, which encourages longer and more intensive use by livestock in the latter part of the summer grazing season (Severson and Boldt 1977). Interseeding of highly palatable species in unused areas would tract livestock and result in less use on areas to be protected. Other management techniques such as burning, spot fertilization, and mowing of the unused areas will increase their green period and palatability (Bjugstad and Girard 1984).

Livestock Manipulation

Shelter. Shelter reduces livestock mortality from extreme temperature changes in both the summer and winter (Johnson et al. 1962, Bjugstad 1977). Cattle change grazing behavior with small changes in air conditions, with a close relationship between time spent grazing and a temperature-humidity index (Ehrenreich and Bjugstad 1966, Bjugstad and Dalrymple 1968). Grazing time increased with increased wind speed on hot humid days. These findings indicate that construction of shelters at strategic locations would be better suited for improved cattle production and more effective grazing distribution than volunteer and/or forced use of wooded areas (Bjugstad and Girard 1984). One limitation may be overuse of range sites adjacent to shelters, but this could be reduced by use of portable structures.

Fencing and Grazing Systems. Fencing and grazing systems are effective management tools. Winter grazing has little effect on the nature of a woodland stand as cattle primarily used sunny south-facing unwooded slopes (Severson and Boldt 1978). In winter, insects were absent, soils were less susceptible to compaction, plants were dormant, and snow limited livestock movement within the woodlands; summer use was detrimental for opposite reasons. Severson and Boldt (1978) also reported that two- and three-pasture systems did not appear to result in wooded species improvement and that the effects of rest-rotation systems were inconclusive.

Planted shelterbelts on rangelands are sometimes protected by fences; however, fencing of woodlands by private landowners is rare. Potential benefits of fencing include provision of (1) a continually reproducing windbreak for cattle; (2) grazing in winter and/ or early spring, or during emergencies; (3) firewood if properly managed; and (4) food and shelter for wildlife.

Cost is the primary limitation to fencing woodlands or to dividing a pasture to implement a grazing system. In a decadent or heavily disturbed woodland, fencing alone may not be sufficient to perpetuate the community (Uresk and Boldt 1986). Several exclosures throughout southwestern North Dakota show differences between grazed and ungrazed woodlands. It is difficult to draw conclusions from these exclosures because no information is available on the vegetation of the woodland at the time of exclusion. Determination of woodland response to exclusion will be necessary for conclusions to be drawn on the effectiveness of fencing. Fencing in conjunction with other rehabilitation techniques may be necessary if the community structure has been altered drastically, if forming grasses dominate the understory, or if the reproductive capacity of the trees has diminished (Girard 1985).

New forms of fiberglass electric fencing may help improve the grazing distribution of livestock. Because the fiberglass electric fences are easy to install and can be easily moved, it is possible to fence woodlands during critical growth periods of the woody species to ensure their survival. When the woody species have attained the desired composition and structure, the fence could be transported to another location.

Water and Supplements. Woodlands are part of the drainage system for the adjacent upland areas and are often selected for construction of ponds, encouraging livestock to linger in woodlands near the water supply. Severson and Boldt (1978) pointed out that if draws cover only a small part of the pasture, the chances of cattle concentrating and placing very demanding use on them are greater. The problem therefore is distribution, not necessarily the stocking rate. Water and salt blocks are strong attractants for livestock and are important in achieving livestock distribution (Valentine 1980). Placement of salt and water away from woodlands may help improve livestock distribution.

The use of browse by cattle increases in late summer and early fall in riparian areas (Uresk 1985), and this time frame is correlated with the decrease of protein in preferred forage species (Heath et al. 1973). Protein supplements might decrease cattle use of woodlands at critical times (Bjugstad and Girard 1984).

Implications of Management

Most of the methods suggested need further testing, because results are too limited and specific to generalize about their effectiveness for woodland improvement. The best responses will probably result from the integration of two or more techniques. Because of the slow growth rate and response of many wooded species, it may be several years before conclusive results are available. However, in grassland situations most of these methods have been proven to be effective in improving range condition and/ or livestock production (Stoddart et al. 1975, Valentine 1980).

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Received 14 January 1987. Accepted 26 May 1987.

Sponsors

The officers of the North Dakota Natural Science Society extend sincere thanks to the following members who as sponsors made a contribution to the Society in 1986 in excess of the normal membership dues. The additional funds are designated for the 0. A. Stevens Fund, which is used to help students and others without research support to meet page charges for their published papers.

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