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RESTORING THE PRE-SETTLEMENT LANDSCAPE IN STANLEY COUNTY, SOUTH DAKOTA

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Abstract. *Settlement of the western United States resulted in clearing and degradation of many wooded areas. The loss of biodiversity and erosion of soil which followed produced a landscape which is still being restored. The first section of the paper reviews the settlement history of western South Dakota, describing the ecological effects of rapid population growth upon the landscape. The second part focuses on a smaller area, that of a family's ranch, which has undergone land management changes and woodland restoration since 1950. Studies which document an increase in woody species diversity and abundance, the population structure of trees, and the area occupied by woody vegetation are summarized. Sampling included measurements of woody vegetation in the field and of riparian and scarp woodland cover from 1956 and 1991 aerial photography.*

Re-creating the pre-settlement landscape has become the goal of an increasing number of landowners in the Great Plains as they attempt to rejuvenate degraded range. Though determining how that landscape appeared is not an easy task, it is generally accepted that trees were an integral component of some Great Plains ecosystems (Wells 1965, 1970). Riparian (lowland) and scarp (upland) woodlands are present today in the Great Plains and were noted in the journals of many early explorers (McFarling 1955; McKelvey 1991). The boundaries of these wooded areas fluctuate under the influence of fire, drought, grazing, and other factors (Axelrod 1985).

An important goal of many restoration projects in the Great Plains today is thus to rejuvenate former woodlands (Chaney, Elmore, and Platts 1990). Many scarp woodlands and riparian areas were cleared at the time of settlement, resulting in severe land degradation. The benefits of tree re-establishment are numerous: tree cover reduces erosion by intercepting rainfall, slowing runoff, and binding the soil. Woodland provides shelter and food for resident wildlife and furnishes important breeding habitat for migratory songbirds (Faanes 1984).

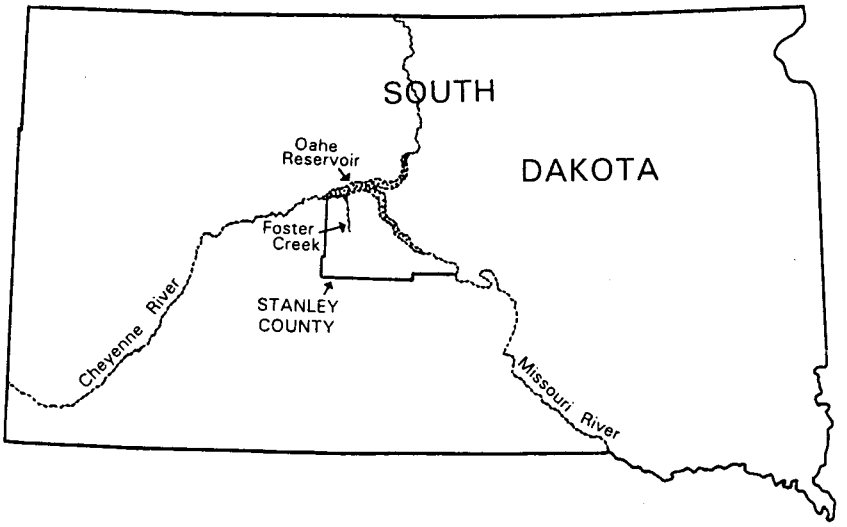

Figure 1. Location of Stanley County, South Dakota. Mortenson property is bounded by Oahe Reservoir and Foster Creek.

Presented here is the story of a Great Plains resident who became committed over four decades ago to restoring trees to his western South Dakota ranch. His goal was to re-create the original landscape, thus repairing unintentional damage caused by early settlement. To understand why and how he proceeded, it is helpful to begin with an investigation of how land degradation took place. The first part of the paper thus presents a brief historical background of settlement by Europeans in western South Dakota and its consequences for the rangeland ecosystem. The second part documents changes in woody vegetation resulting from improved range management on the Mortenson ranch in Stanley County, South Dakota.

Attempting the Impossible

In Clarence Mortenson's words, "On a quarter-section (160 acres) in this country, no one could've or *should've* been expected to make a living." A lifelong resident of Stanley County (Fig. 1), Clarence recalls a day in 1942 when he visited with a settler who had homesteaded in the area of

Foster Creek before 1900. The man's description of a tree-lined grassy-bottomed waterway that never went dry was an enormous contrast to the dusty, barren gully in view.

The change can be understood, in part, by a map of the area in 1889 just after it was newly homesteaded (Fig. 2). At that time, approximately forty families lived on a portion of the area now owned almost entirely by the Mortensons. Though there was some skepticism that 160 acres of land west of the 100th meridian could adequately support a farm family (Herndon 1977), this was the amount that had been offered to settlers under the Homestead Act of 1862. It was thought to be large enough for farming, yet not so large that slavery would be practical (Herndon 1977; Parrow 1991).

Initially, homesteaders were somewhat hesitant to settle in the western Dakotas due to drought and depression (Nelson 1996). By 1900 however, the Homestead Act had resulted in a large influx of people to the western Dakotas. Stanley County, for example, had 1,341 residents in 1900, 2,649 residents when railroad construction began in 1905, and 14,975 residents in 1910. In four years' time during that decade, 63 new school districts were formed and 132 schoolhouses were built in the county. Land values rose from an average of $1.91 per acre in 1900 to $14.09 per acre in 1910 (Nelson 1986).

One homesteader in the area was Bruce Siberts whose memoirs are recorded in the book *Nothing But Prairie and Sky*. Siberts (1954:94) relates, "Up on Foster Creek I found a good spring and a nice level flat not far from some draws full of ash and cedar trees and decided to file a homestead claim. I dragged logs over to the spring and built a ten-by-eighteen cabin." The following spring, 1894, Siberts "cut enough posts to fence [his] 160 acres" (Siberts 1954:96). In country of relatively sparse timber with trees located principally in scattered breaks and side draws of the Cheyenne River, woodland must have been depleted rapidly. As Nelson (1986:121) writes of the time just prior to 1910, "In five short years, the region had been transformed from open range into intensively cultivated, geometrically subdivided farmland."

The Homestead Act caused inadvertent abuse of the land by **requiring** its cultivation. Pastureland farming did not meet the regulations; the Act required the homesteader to break the sod on a minimum of one-eighth of his claim (Herndon 1977; Anonymous 1995). In Stanley County, 47,209 acres of corn alone were planted in 1909 and 1910, more than any other cultivated crop (Nelson 1986:199). Because of low precipitation combined with considerable runoff and evaporation, many South Dakota soils are

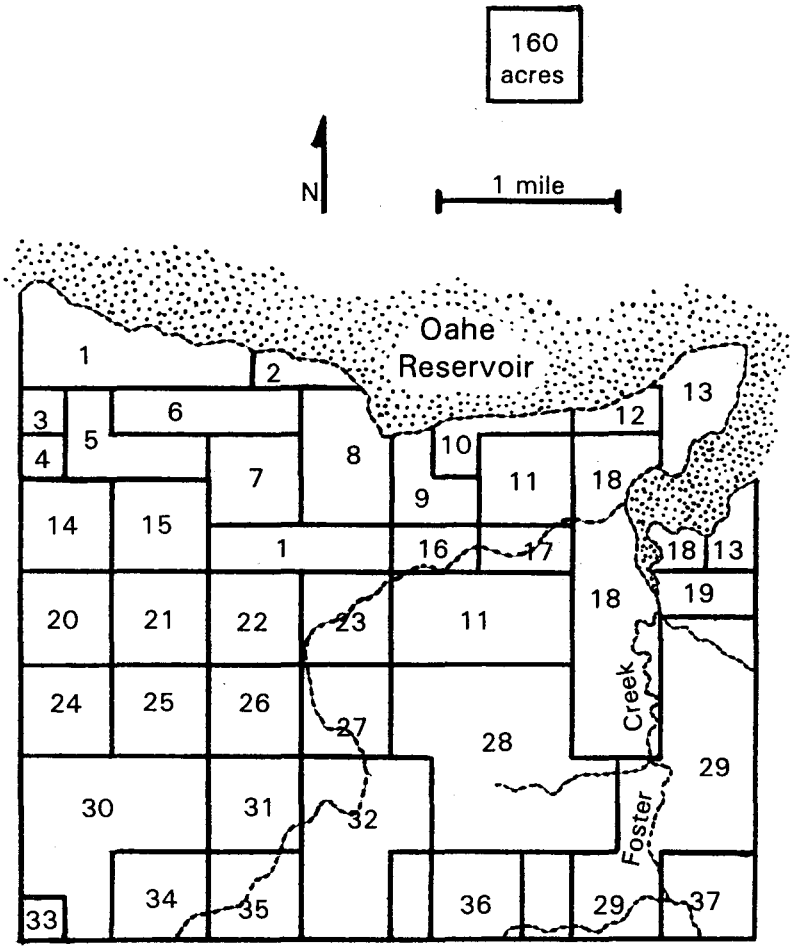

Figure 2. A portion of Spring View Township in Stanley County, South Dakota, showing settlement in 1890. Each number represents the name of a homesteader. The majority of the area shown (approximately 8,300 acres) is currently managed by Todd Mortenson.

The map shows the present-day boundary of Oahe Reservoir. In 1890 an additional five homesteads were located on land that is now flooded.

Redrawn from Centennial Atlas of Stanley County, 1989.

susceptible to serious moisture depletion (Westin and Malo 1978). Stanley County is located in the Pierre Hills Section of the Missouri Plateau Division which is underlain by shale bedrock of the Pierre Formation. This material breaks down into a sticky clay, giving the region the name of "gumbo area" (Rothrock 1943). The fragility of these soils coupled with the dry climate produce conditions that can not successfully support a high moisture and nutrient demanding crop such as corn. Thus, the tremendous influx of settlers, their subsequent clearing of trees, and their cultivation of the soil made unrealistic demands upon the semi-arid country. Homesteaders were of course not the first people to impact the landscape; trappers, traders, soldiers, and Native Americans had long influenced it. New, however, was the presence of an agricultural population of such large numbers. The inevitable result was severe erosion and depletion of resources. What happened next accelerated and worsened the process.

During the years of 1910 and 1911, a severe drought occurred in the upper Midwest including western South Dakota. For example, at Cottonwood, sixty miles to the southwest of the Mortenson ranch and Foster Creek, only 9.95 inches of rain were received in 1910 (National Climatic Data Center 1910). Current normal precipitation for this location is 16.46 inches annually. As Nelson (1986:120-21) wrote:

> The drought of those years desiccated the once-thriving immigration and drastically altered the meaning of the homesteading experience. . . Many homesteaders abandoned their claims, while those who stayed were forced to struggle for mere survival. . . Although the drought lessened somewhat in 1912, the optimism and energy of the boom years vanished. The remaining settlers recognized that the country would not yield easily to their efforts.

The residents of Stanley County voted to divide, becoming three counties in 1914. The same area that had a population of 14,975 in 1910 had only 7,881 residents in 1915 and 2,627 in 1925 (Holden 1981; Nelson 1986). Those people who remained made use of the abandoned fields by grazing their cattle on them, cutting hay, and harvesting anything they could find to subsist (Nelson 1986).

These initial experiences prompted passage of an Enlarged Homestead Act in 1909 which gave settlers a homestead of 320 acres. Promoters of South Dakota were concerned that this new policy might label the region as too dry, and they did not participate until 1915 (Nelson 1996). In 1916, the

Grazing Homestead Act was passed, increasing the offer to 640 acres. In western South Dakota however, most land had already been claimed by 1916. Even before the drought of the 1930s brought economic and environmental ruin, the process of degradation was well underway.

Coming Full Circle

Economic decline, severe drought, and depletion of resources are what Clarence Mortenson remembers from the 1930s and 1940s. One day in 1942 he was told that the barren and eroded landscape surrounding him had once been vegetated. He found this difficult, if not impossible, to believe. A few years later, while completing a land survey, Clarence read in surveyors' notes from the 1890s a description that matched the one he had been given in 1942. This gave Clarence the idea that "if it was this way once, maybe it could be this way again. That more or less gave me an idea of what we could work back to—with no knowledge, of course, of how to get back there."

The restoration efforts began with Clarence's planting of native tree species in the 1950s. Though these first attempts were not successful, more ideas emerged. Eventually, a lengthy trial-and-error process of re-creating the original condition was underway. It involved first recharging groundwater with a series of dams, then establishing native vegetation from local seed sources. This was achieved by encouraging natural regeneration of tree and shrub species in woody draws (Fig. 3) rather than by hand planting. The final step was adopting a flexible grazing rotation plan. Further detail of the entire process is presented in Boettcher, Johnson, and Gartner (1995) and Mortenson and Boettcher (1993). Today, Clarence's son Todd manages a cattle operation in a landscape resembling the one of a hundred years ago. Without any blueprint or guidebook, the Mortensons have come full circle; one can find a description of the present scene by reading from notes first written more than a century ago.

In the spring of 1890, surveyor Miles Woolley recorded the presence of "deep ravines with timber, principally ash and cottonwood" (U.S.General Land Office 1890:266). He noted that "the country is well adapted to grazing" (U.S.General Land Office 1890:379). These notes were written as Woolley surveyed the area presently managed by Todd Mortenson. In 1811, the explorers Bradbury and Brackenridge wrote of "trees of different kinds, shrubs, plants, flowers, meadow, and upland" when visiting the region (Thwaites 1966:108). Their journals mention cottonwood, elms, ash, buffalo berry, gooseberry, currant, rose, and grape (Bradbury 1966; Thwaites 1966).

Figure 3. Trees, mostly ash, on floodplain and side draws of the Foster Creek watershed on the Mortenson ranch. Smaller trees were established naturally by seed production of the larger trees.

All these species are present today on the Mortenson ranch and in increasing numbers.

Documenting the Changes

How does one document the effects of changes in range management? In other words, can restoration success be quantified? For this purpose, measurements were taken which are useful for describing the vegetation composition, the structure of tree populations, and the change in amount of woody cover present at the Mortenson ranch.

Vegetation Composition

The age and size (basal or cross-sectional area at breast height) of trees, the density of seedlings, saplings, and mature trees, and the percent cover of shrub and vine species were sampled at the Mortenson ranch during 1992-94. Five sites spread throughout the ranch were inventoried. A detailed

TABLE 1
OCCURRENCE OF TREES AT FIVE WOODED DRAWS, 1992-94, AT THE MORTENSON RANCH, STANLEY COUNTY, SOUTH DAKOTA
Taxonomy follows Great Plains Flora Association, 1986

SPECIES	OCCURRENCE[1]
Hackberry (*Celtis occidentalis*)	2
Green ash (*Fraxinus pennsylvanica*)	5
Rocky Mountain juniper (*Juniperus scopulorum*)	1
Cottonwood (*Populus deltoides*)	1
Peachleaf willow (*Salix amygdaloides*)	2

[1]Number of sites (of 5 possible) at which species occurred.

methodology and most of the results have been published elsewhere (Boettcher, Johnson, and Gartner 1995). The species richness, density, and coverage of woody vegetation sampled at the five study sites is summarized here (Tables 1 & 2). Twenty-two woody species occurred, including 5 tree, 15 shrub, and 2 vine species. All woody species that occurred were native. Green ash (*Fraxinus pennsylvanica*) was the most ubiquitous species, present on all transects at all sites. The percent cover of shrub and vine species is not indicative of their coverage throughout the entire ranch, but reflects the fact that sampling was conducted in wooded draws. Lead plant (*Amorpha canescens*), for example, occurs only in small amounts at the outer fringe of wooded areas, but is present in greater numbers on uplands. Additional woody species noted at the ranch which did not occur on transects include American elm (*Ulmus americana*), red cedar (*Juniperus virginiana*), creeping juniper (*Juniperus horizontalis*), buffalo berry (*Shepherdia argentea*), and carrion-flower (*Smilax herbacea*). Taxonomy follows *Great Plains Flora Association* (1986).

The Structure of Tree Populations

A commonly used method of describing a population's vigor is to compare the densities of individuals among age classes. A healthy popula-

TABLE 2
RELATIVE COVER OF SHRUBS (S) AND WOODY VINES (V) AT FIVE WOODED DRAWS, 1992-1994, AT THE MORTENSON RANCH IN STANLEY COUNTY, SOUTH DAKOTA
Taxonomy follows Great Plains Flora Association, 1986

SPECIES	RELATIVE COVER (%)
S Wild plum (*Prunus americana*)	31.9
S Western snowberry (*Symphoricarpos occidentalis*)	19.3
S Choke cherry (*Prunus virginiana*)	18.2
S Skunkbush sumac (*Rhus aromatica* var. *trilobata*)	13.5
S Saskatoon service-berry (*Amelanchier alnifolia*)	4.3
S Poison ivy (*Toxicodendron rydbergii*)	4.0
S Prairie wild rose (*Rosa arkansana*)	3.0
V Winter grape (*Vitis vulpina*)	2.6
V Woodbine (*Parthenocissus vitacea*)	1.2
S Buffalo currant (*Ribes odoratum*)	0.6
S Northern hawthorn (*Crataegus rotundifolia*)	0.5
S Dwarf sagebrush (*Artemisia cana*)	0.4
S Western wild rose (*Rosa woodsii*)	0.2
S Lead plant (*Amorpha canescens*)	0.2
S Dwarf wild indigo (*Amorpha nana*)	0.1
S False indigo (*Amorpha fruticosa*)	Trace
S Missouri gooseberry (*Ribes missouriense*)	Trace
	Total = 100.0

tion capable of expansion is characterized by large numbers of individuals in young age classes; these will grow to reproductive age and replenish the population as older individuals die. In contrast, the occurrence of few young individuals even with the presence of mature trees would indicate a population decline.

At the five study sites, tree species were grouped into categories of seedlings, saplings, and mature trees (Table 3). Seedlings were mostly one to two years old. Saplings were approximately ten to twenty-five years old, and mature trees were generally older than twenty-five years of age. Several

TABLE 3
TREE SPECIES DENSITY BY AGE CLASS FROM FIVE SITES

Seedlings (<1m tall)	Saplings (≥1m tall, <6 cm dbh)	Mature trees (>6cm dbh)
115,000/ha	575/ha	264/ha

of the largest trees were aged and found to be survivors of the severe early-century droughts. These parent trees served as a seed source for re-establishing the population. The population's overall structure shows that individuals of all ages are present and that the greatest densities are found in the youngest class. Though only three categories were sampled, a comparison among them indicates that elements characteristic of an expanding population are present.

Assessment of Change in Woody Cover

Areas at the Mortenson ranch capable of supporting woody vegetation, i.e., riparian and scarp woodlands, are a relatively small portion of the total landscape (<10%). Within these areas, the increase in woody cover due to the Mortensons' improved management was assessed by comparing aerial photos taken in 1956 and 1991. Sixteen sites were selected for comparison. A grid of lines spaced at 1/8" intervals was placed over each of the sixteen locations on the 1956 photo. This sampling grid was as wide and perhaps slightly wider than the area capable of supporting trees amidst the surrounding grassland. Of the sixteen sites, half were riparian (wetland) locations. These were flat, lowland areas along relatively permanent streams. The remaining half was in scarp woodland (upland) on side slopes and smaller side drainages. For each location, at each intersection in the grid, the presence or absence of woody cover was recorded. The sixteen sites were located again on a 1991 photo of the same scale as the earlier photo (1:7,920 or 1 in = 660 ft.), and the sampling process of overlaying the grid and assessing cover was repeated.

TABLE 4
NUMBER OF TREES IN TWO WOODLAND TYPES SAMPLED BY OVERLAYING A GRID ON 1956 AND 1991 AERIAL PHOTOS
For each woodland type in each year, n = 8, T = Total

Number of points intersecting woody cover			
Riparian floodplain		Scarp woodland	
1956	1991	1956	1991
3	7	9	9
2	3	16	21
0	7	3	5
2	10	4	6
1	4	0	3
5	11	11	14
5	10	5	7
0	0	9	14
T=18	T=52	T=57	T=79

Data were analyzed as paired comparison t-tests between 1956 counts and 1991 counts for each of the two woodland types (Table 4). Of a possible 360 grid points (45 per sample x 8 locations sampled), there were 18 points (5%) intersecting woody cover in riparian areas on the 1956 photo and 52 points (14%) in 1991. Scarp woodland sites showed an increase from 57 points (16%) in 1956 to 79 points (22%) in 1991. Greater cover in 1991 v. 1956 was significant for both riparian (t significant at 0.004) and scarp woodland areas (t significant at 0.003). This increase is due both to the growth of individual trees and shrubs which were present in 1956 and to a greater number of individuals present at the end of the 35-year interval.

The increase is more evident in the lower-elevation riparian areas than in the higher scarp woodlands. This may be a result of riparian areas being

more affected by severe gully erosion; many of these areas had few trees or none at all following settlement.

Though cover of 14% and 22% in areas of potential woodland seems far from complete, it is unlikely that complete cover could ever be achieved. First, as mentioned previously, the sampling grid used was as wide and perhaps wider than the area capable of supporting trees amidst the surrounding grassland. Secondly, the general structure of riparian and scarp forests consists of sparser cover than that of large closed-canopy forests of the eastern United States, for example (Johnson, Burgess, and Keammerer 1976). For western riparian and scarp woodlands, total cover is not a realistic target, but the potential for additional increase in woody cover nonetheless exists.

Conclusions

The story of the Mortensons' restoration work emphasizes several points. First, given the shortage of knowledge about the fragility of western rangelands at the time of their settlement, the devastation that followed was unavoidable. The rapid depletion of resources by homesteaders was largely unanticipated and certainly not intentional. Second, the resulting damage is not irreparable. Now that the potential effect of human activity on the environment is better known, techniques have been developed to lessen our impact. Farms and ranches of only 160 acres are no longer commonplace in arid rangelands. The average size of a ranch in Stanley County, for example, was 4,566 acres in a recent census (U.S. Bureau of the Census 1994:169). As indicated by the sampling results presented here, restoring a landscape to a condition approaching that of pre-settlement is indeed possible. Third, implementing a recovery plan does not have an immediate obvious outcome. Several decades have passed since Clarence Mortenson first began restoration. Only in recent years has rapid growth of tree and shrub populations resulted. Indeed, the challenge of rejuvenating arid rangelands is especially difficult, requiring more time and effort than other areas (Fleischner 1994).

The need to implement sustainable ranching systems becomes more urgent when one considers that livestock grazing is the most widespread influence on native ecosystems of western North America. As Fleischner (1994) states, the effects of grazing are so pervasive and have existed for so long, they are frequently unnoticed. Improvements in land management which enhance woodland restoration produce numerous benefits for hu-

mans, livestock, wildlife, and the whole ecosystem. We hope that the changes documented here and the story they relate will be an impetus for additional attempts to restore native ecosystems.

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