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Prehistorical Conditions of Rangelands in the Northern Great Plains

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An accurate account of the Northern Great Plains rangelands does not match the static romantic image of a vast, ageless, pristine grassland in excellent health, with large herds of free-roaming bison accompanied by elk, antelope, wolves, and grizzly bears in idealistic harmony. The present grassland assemblage of communities and ecosystems in the Northern Great Plains started to develop only about 5,000 years ago, and the plants that migrated into the region respond to environmental changes dynamically, with shifts in species composition and biological status. Populations of plants and animals in grassland ecosystems experience peaks and crashes in cycles of variable highs, lows, and duration, in response to the complex set of interrelated forces in the environment. Grassland ecosystems have never been static nor can they be managed to remain at an idealistic static goal. Most idealistic static management goals for grasslands are based on a perceived image of "presettlement conditions" that evokes strong nostalgia but does not provide a complete set of guidelines on which to base sound grassland management. To formulate an accurate account of the integral parts of the Northern Great Plains grasslands and to develop an understanding of these interrelated processes we must look further back in time at the environmental forces and the processes within the plants and the ecosystems.

Climate

The climate of the Northern Great Plains has changed several times during geologic history. A major climate change resulted when the Rocky Mountains began to uplift about 70 to 80 million years ago, forming a barrier that prevented humid Pacific Ocean air masses from flowing eastward. The Great Plains became much drier. Two million years ago the climate became cooler and more humid, with several periods of glaciation. Glacial advances occurred during periods when the winter snow accumulation on top of the glacier was greater than the amount of ice melted during the summer. The periods of glacial advance were cool and humid, the interglacial periods warmer and drier.

The changes in climate since the last glaciation period, which occurred between 100,000 and 10,000 years ago, have strongly influenced the present conditions of the region. The last ice sheet reached its maximum advance between 14,000 and 12,000 years ago. About 10,000 years ago, a sudden change in the climate to drier and warmer summers but colder winters occurred. This major change accelerated the melting of the glacial ice. A spruce-aspen forest developed in the cool moist conditions at the ice margin; this community

graded into a deciduous forest, which graded into a grassland south of the Northern Great Plains. The climate was much drier and warmer for the period between 10,000 and 5,000 years ago. During the period between 8,500 and 4,500 years ago, the vegetation was a sage and short grass plant community similar to vegetation in parts of Wyoming, and the region experienced frequent summer droughts and extensive soil erosion from wind (Bluemle 1977, Bluemle 1991).

The climate changed about 5,000 years ago to conditions like those of the present, with cycles of wet and dry periods (Bluemle 1977, Bluemle 1991, Manske 1994). The wet periods have been cool and humid, with greater amounts of precipitation. A brief wet period occurred around 4,500 years ago. Relatively long periods of wet conditions occurred between 2,500 and 1,800 years ago and between 1,000 and 700 years ago. Recent short wet periods occurred from 1905 to 1916, 1939 to 1947, and 1962 to 1978. During the wet periods, the vegetation changed, with increases in taller grasses and deciduous woodlands. The dry periods have been warmer, with reduced precipitation and recurrent summer droughts. A widespread, long drought period occurred between 1270 and 1299, and more recent drought periods occurred in the 1860's, and from 1895 to 1902, 1933 to 1938, and 1987 to 1992 (Manske 1994). During the dry periods, the vegetation changed, with decreases in woodlands and increases in grasslands, and the plant composition shifted from taller grass species to shorter grass species. This climatic pattern with cyclical changes in amounts of precipitation oscillating between wet and dry periods has caused noticeable changes in the plant species composition as it shifted from deciduous woodland species to tall grass, mixed grass, short grass, and desert shrub plant communities, then reversed the cycling process, returning to increases in taller grasses and woodland plants.

Vegetation

The plant species in this region originated in other areas and migrated into the Northern Great Plains by different mechanisms and at different times and rates. The present vegetation has plant species with affinities to the tall grass, mixed grass, and short grass prairies, deciduous and coniferous forests, and Rocky Mountain and desert shrub plant communities (Zaczkowski 1972). This wide mix of plant species in the Northern Great Plains formed from remnants of plant communities that reached periods of greater development during the periods of wet and dry cycles when conditions favored these various plant community types. The diversity of plant species in our native plant community permits it to respond dynamically to changes in climatic conditions by increasing the plant species favored by any set of conditions.

The grass plants that migrated into the Northern Great Plains had previously developed biological mechanisms to exist and thrive with defoliation by grazing herbivores. This evolutionary process started millions of years ago. The earliest grass fossils appeared in the late Tertiary Period during the time when the earth's climate was becoming cooler and drier as a result of the build up of an ice cap at the south pole on Antarctica. The earth's lush tropical and subtropical forests diminished and moved southward, and grasslands expanded and moved northward. Grass species evolved quickly during the lower Miocene Epoch, 20 million years ago, developing characteristics that are similar to those of present grasses and that identify these plants to modern genera.

Grass plants and grazing mammals evolved together (Manske 1994). During the period of coevolution with herbivores, grasses developed defoliation resistance mechanisms like hormonal growth regulation and symbiotic soil organism relationships as compensatory processes

to grazing. Close cropping of plants by herbivores exerted selective pressure that improved the survival of grasses over that of other plants and promoted grassland expansion.

Herbivores

Grazing mammals appeared in the fossil record at about the same time as grass plants. The early grazing mammals had cecal fermentation digestive systems (small horses, rhinoceroses, tapirs, brontotheres, and chalicotheres) and primitive ruminant digestive systems (camels and oreodonts). Herbivore characteristics changed and improved in response to changing characteristics in grasses. Grass plants developed a complex chemical composition and deposited silicates in their tissue, rendering it tough and nearly indigestible. Herbivores developed deep hard teeth with enamel ridges on the crowns and digestive systems with improved effectiveness. Increased predatory pressure on open grasslands led to herbivores' development of longer legs with horny hooves, and increases in overall body size. The latest and most successful group of herbivores to evolve during this coevolutionary process was the bovine (deer, sheep, cattle, and antelope), which have advanced true ruminant digestive systems, long legs, and hard moon-shaped cusps on their teeth. Bison are an advanced bovine with a true ruminant digestive system, fast legs, and hard teeth. Early bison migrated to North America from Asia about a million years ago. The early populations remained small in response to competition. Bison have changed form several times with a gradual decrease in body and horn size.

Several large mammals became extinct in North America between 10,000 and 8,000 years ago, after the sudden climatic change that set off ecological changes in the vegetation communities. Most paleontologists believe that these large mammals could have adjusted to the climate change had extra pressure from human hunters not altered the birth-death ratios and had increased competition for forage resources not disadvantaged territorial animals and given herding animals a survival advantage. The mastodon, mammoth, camel, tapir, sloth, horse, large long-horned bison, middle-sized bison, and dire wolf became extinct during this time. Caribou, musk oxen, and the small bison survived the climate change, hunting pressure, and forage competition. The dramatic success of the bison following this period resulted in part from the extermination of its previous prairie competitors. The small bison was the dominant herbivore between 5,000 and 115 years ago (Manske 1994). Domestic cattle have been the dominant herbivore on Northern Great Plains rangelands for over one hundred years.

Humans

The early human inhabitants of the Northern Great Plains were descendants of Asian immigrants who moved across the Bering Land Bridge between 19,000 and 14,000 years ago (Snow 1989, Wormington 1957). They later moved into this region at the time of the retreating ice sheet. These people lived in small family groups, traveled and traded over long distances, and do not appear to have claimed territories. They had fire for warmth and cooking, used well-made stone-tipped spears to hunt large game animals, and conducted hunting as an efficient, coordinated group activity. These people used fire intentionally as a hunting aid to change the vegetation to attract herds of game animals to a desired region (Bryan 1991, Holder 1970). During the early portion of human occupation in the Northern Great Plains, many types of large herbivores roamed the region and were used for food. Following a climate change about 10,000 years ago, the availability of game animals decreased for several thousand years, and the humans made a noticeable shift in their diet by increasing the

use of plants. During this period, humans intentionally distributed seeds of food plants across the territory. Starting around 2,250 years ago, the inhabitants cultivated large plots of arable land for production of domesticated food plants (Manske 1994).

Conclusion

The rangelands of the Northern Great Plains are highly advanced complex ecosystems that function similarly to living organisms, with response and feedback processes. Defoliation by herbivores is a process grass plants require at specific growth stages if healthy productive rangelands are to be maintained. Attempting to develop modern grazing management practices that emulate a perceived model of bison movement is naive. Grass plants developed their biological processes of defoliation resistance mechanisms 20 million years ago in areas outside the Northern Great Plains and in conjunction with early herbivores that are now extinct. Grass plants migrated from numerous types of environments into the Northern Great Plains and initiated development of dynamic plant communities only about 5,000 years ago, when the present climatic pattern started. The modern small bison did not coevolve with the grass species of the Northern Great Plains, but migrated from Asia to North America about a million years ago. The large herds did not develop before 5,000 years ago. The bison has played a role in plant community dynamics and plant species composition, but it was not a part of the fauna when the grasses developed their biological mechanisms in resistance to defoliation. The 5000- year tenure of the bison on Northern Great Plains grasslands has the same relationship to the 20-million-year age of the grass plants as 6.8 days has to the age of a 75-year-old person. In order to be successful and maintain a healthy productive grassland ecosystem in the Northern Great Plains, modern grazing management practices must meet the grass plants biological requirements as the first priority.

Management Implications

A. The present rangeland ecosystems have existed in the Northern Great Plains for only about 5,000 years, and the plant communities are still developing.
B. The normal Northern Great Plains climatic pattern is cyclical between wet and dry periods and causes changes in plant species composition, with periodic increases and decreases in woody plants and increases and decreases in taller and shorter grasses.
C. Plants on the Northern Great Plains rangelands originated elsewhere and migrated into the region, developing dynamic plant communities in place.
D. Plants developed defoliation resistance mechanisms during coevolution with herbivores prior to migration into the region and require defoliation at specific growth stages to remain healthy and productive.
E. The early herbivores that coevolved with grass plants in North America are extinct. All extant herbivores require control of grazing patterns so that plant requirements are met.
F. Humans lived in the Northern Great Plains prior to the development of the present rangeland ecosystems and have used various techniques and practices to manipulate herbivore movement and plant growth. The inhabitants distributed seeds of food plants across the region and cultivated arable land for food plant production from about 2,250 years ago.

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