

Native Vegetation of the Northern Plains

The Northern Plains are part of the North American Interior Plains that extend from the foot of the Rocky Mountains eastward to the Canadian Shield and Appalachian Provinces and extend from the Athabasca River on the Alberta Plateau southward to the Gulf Coastal Plains (Fenneman 1931, 1946; Hunt 1974; Goodin and Northington 1985). The Interior Plains are divided east and west into the Great Plains and the Central Lowland Physiographic Provinces (Fenneman 1931, 1946). The Northern Plains are separated from the Southern Plains by the North Platte-Platte-Missouri River Valleys (Raisz 1957). The portions of the Great Plains and Central Lowland Provinces that exist in the Northern Plains are separated in North and South Dakota and Saskatchewan by an eroded east facing escarpment at the eastern extent of the Tertiary sedimentary deposits of material eroded from the Rocky Mountains that form a fluvial plain overlaying the Cretaceous bedrock (Hunt 1974). The surface landform feature that shows the location of this boundary is the east escarpment of the Missouri Coteau (Fenneman 1931). In eastern Nebraska, the separation of the Great Plains and Central Lowland Provinces is the western limit of older pre-Wisconsin glacial drift which has a mantle of loess (wind deposited silt) (Fenneman 1931).

The Northern Plains has a continental climate with cold winters and hot summers. Mean air temperatures increase from north to south changing from about 35° - 40° F (1.7° - 4.4° C) in the north to about 48° - 51° F (8.9° - 10.6° C) in the south. Most of the precipitation occurs during the early portion of the growing season. Total annual precipitation fluctuates greatly from year to year. Periods of water deficiency during the growing season occur more frequently than growing seasons without deficiencies. Drought conditions are common. Mean annual precipitation increases from west to east and increases from north to south. In the northern portion, precipitation ranges from about 12 inches (304.8 mm) in the west to about 24 inches (609.6 mm) in the east. In the southern portion, precipitation ranges from about 14 inches (355.6 mm) in the west to about 32 inches (812.8 mm) in the east.

Evapotranspiration affects the quantity of moisture in the soil and the duration infiltrated water remains available for plant growth. The potential evapotranspiration for most of the Northern Plains is greater than annual precipitation. Potential evapotranspiration demand increases from north to south, and increases from east to west. Along the

eastern edge of the Northern Plains, the precipitation is greater than potential evapotranspiration during most years. The region also has several local areas where the combination of stored soil water, precipitation, plus water runoff is greater than evapotranspiration. Subirrigated soils where the rooting zone is moist for most of the growing season would be comparable to conditions with greater precipitation than evapotranspiration.

Soil development is effected by climate, parent material, topography, living organisms, and time (Brady 1974). The main climatic factors that affect soil development are temperature and precipitation. Climate determines the type and rate of weathering that occurs. The rates of biogeochemical processes in soil are effected by soil temperature and soil moisture. Climate determines the type of native vegetation and the quantity of biomass production. There is a relationship between the type of native vegetation and the kind of soil that develops. Increases in soil moisture, increase the biomass production and tend to increase organic content of soils. Increases in soil temperature, increase the rate of decomposition and tend to decrease organic content of soils (Brady 1974).

Classification of soils into principal suborders is based on differences caused by climate and associated native vegetation. The biological processes in soil are effected by soil temperature and soil moisture. The different climatic characteristics important in soil development are separated into specific soil temperature regimes and soil moisture regimes.

The Northern Plains has two soil temperature regimes based on mean annual soil temperature. The mean annual soil temperature is considered to be the mean annual air temperature plus 1.8° F (1° C) (Soil Survey Staff 1975). The Frigid soil temperature regime has mean annual soil temperatures of less than 47° F (8° C). The Mesic soil temperature regime has mean annual soil temperatures higher than 47° F (8° C) and lower than 59° F (15° C) (Soil Survey Staff 1975). The separation between the Frigid and Mesic soil temperature regimes occurs along a wide irregular belt that extends eastward from central Wyoming along its north border with Montana and continues to north central South Dakota just south of its north border with North Dakota, then extends at a southeasterly diagonal to about the center of South Dakota's east border with Minnesota, and then

extends at a northeasterly angle to the boundary of the Oak Forest.

Soil moisture regimes are based on the soil moisture conditions in the soil. The Northern Plains has four north-south zones of soil moisture regimes that increase in soil moisture from west to east. The soils in the Aridic and Torric soil moisture regime, typically of arid climates, are dry in all parts for more than half the time and the soils are never moist for as long as 90 days during the growing season (Soil Survey Staff 1975). The soils in the Ustic soil moisture regime, typically of semi arid climates, are dry in some or all parts for 90 or more days in most years, but not dry in all parts for more than half the time, and are not dry for as long as 45 days during the 4 months that follow the summer solstice in 6 or more years out of 10 years (Soil Survey Staff 1975). The soils in the Udic soil moisture regime, typically of sub humid climates, are not dry for as long as 90 days. During the summer, the amount of stored moisture plus rainfall is approximately equal to or exceeds the amount of evapotranspiration (Soil Survey Staff 1975). The soils in the Perudic soil moisture regime, typically of humid climates, are rarely dry. During the summer, the precipitation is greater than the evapotranspiration (Soil Survey Staff 1975).

The combination of four soil moisture regimes (Aridic, Ustic, Udic, and Perudic) and two soil temperature regimes (Frigid and Mesic) results in eight distinct soil moisture-temperature regimes in the Northern Plains. The soils in the Aridic-Frigid soil moisture-temperature regime are primarily Aridic Borolls (arid cool Mollisols) and Torriorthents (hot dry recently eroded medium to fine textured Entisols) and support vegetation of short grasses with some mid grasses. The soils in the Ustic-Frigid soil moisture-temperature regime are primarily Typic Borolls (semi arid cool Mollisols) and support vegetation of mid and short grasses. The soils in the Udic-Frigid soil moisture-temperature regime are primarily Udic Borolls (sub humid cool Mollisols) and support vegetation of mid grasses with some tall grasses. The soils in the Perudic-Frigid soil moisture-temperature regime are primarily Aquolls (humid cool Mollisols that are saturated and absent of oxygen at times for unknown lengths) and support vegetation of tall grasses. The soils in the Aridic-Mesic soil moisture-temperature regime are primarily Argids (arid warm Aridisols with thin horizons, dry for long periods, and have a clay layer) and Aridic Ustolls (arid warm Mollisols) and support vegetation of short grasses. The soils in the Ustic-Mesic soil moisture-temperature regime are primarily Ustipsamments (semi arid warm Entisols that are well sorted wind

deposited sands) and Typic Ustolls (semi arid warm Mollisols) and support vegetation of mid and short grasses with lower topographic slopes supporting tall grasses. The soils in the Udic-Mesic soil moisture-temperature regime are primarily Udic Ustolls (sub humid warm Mollisols) and support vegetation of mid grasses and tall grasses. The soils in the Perudic-Mesic soil moisture-temperature regime are primarily Udolls (humid warm Mollisols that do not have a calcium carbonate layer) and support vegetation of tall grasses.

Development of plant communities and vegetation types is effected by the climatic characteristics of temperature, precipitation, and evapotranspiration demand; the soil characteristics of texture, structure, and chemical and mineral composition; and the landform topographic characteristics of slope, aspect, and elevation. Vegetation of the Northern Plains separates into 10 grassland vegetation types and 7 grassland with woodland or forest vegetation types. The vegetation of the Northern Plains map (figure 1) developed by Dr. W.C. Whitman (Barker and Whitman 1989) is a compilation of information from several sources supplementary to the basic map of potential natural vegetation by Kuchler (1964). Modifications to vegetation type designations, distributions, and boundaries were conflated into the base map from state vegetation maps for Montana (Ross and Hunter 1976, Hacker and Sparks 1977), Nebraska (Kaul 1975, Bose 1977), North Dakota (Shaver 1977), South Dakota (Baumberger 1977), and Wyoming (Shrader 1977). Vegetation type designations and distributions from scientific papers were added for Canada (Clarke, Campbell, and Campbell 1942; Moss and Campbell 1947; Coupland and Brayshaw 1953; Coupland 1950, 1961). A new concept of a plains rough fescue mixture along a portion of the northern border of North Dakota was introduced to the map details by Whitman and Barker (1989).

No living plant species are known to have originated in the Northern Plains. All plant species considered to be native to the Northern Plains originated and developed in other regions and sometime later migrated into the Northern Plains. The plant communities and vegetation types, however, are relatively young and began development in place about 5,000 years ago when the current climate with cycles of wet and dry periods began.

The Tall Grass Prairie, Bluestem-Switchgrass-Indiangrass Type, exists on the eastern margin of the Northern Plains Grasslands and extends from southern Manitoba through eastern North and

South Dakota and western Minnesota southward into northwestern Iowa and northeastern Nebraska to the Platte River. The physiography of the region consists of the Manitoba Plain and the Red River Valley Plain of the Small Lakes Section and extends into the Dissected Till Plains Section of the Central Lowland Province. The climate is humid with evapotranspiration lower than precipitation. The soil moisture regime is Perudic and the soil temperature regime is Frigid in the north and Mesic in the south. The soils are primarily Aquolls in the north and Udolls in the south.

The Transition Mixed Grass Prairie, Wheatgrass-Bluestem-Needlegrass Type (figure 1), exists between the Tall Grass Prairie on the east and the Mixed Grass Prairie on the west and extends from east central Saskatchewan and southwestern Manitoba through east central North and South Dakota and east central Nebraska to the Platte River. The physiography of the region consists of the Saskatchewan Plain and the Glaciated Plains (Drift Prairie) of the Small Lakes Section of the Central Lowland Province and extends into the eastern portion of the High Plains Section of the Great Plains Province. The climate is sub humid with evapotranspiration greater than precipitation over most of the area except for subirrigated soils and topographic slope positions with water runoff. The soil moisture regime is Udic and the soil temperature regime is Frigid in the north and Mesic in the south. The soils are primarily Udic Borolls in the north and Udic Ustolls in the south.

The Mixed Grass Prairie has a high mid grass component with some short grasses and some tall grasses present and is separated into three vegetation types based on differences resulting from soil texture and soil temperature regime.

The Mixed Grass Prairie, Wheatgrass-Needlegrass Type (figure 1), exists on semi arid cool soils between the Transition Mixed Grass Prairie on the east and the Short Grass Prairie on the west and extends from mid Saskatchewan through western North Dakota and eastern Montana to north central and northwestern South Dakota. The physiography of the region consists of the eastern portions of the Glaciated and Unglaciated sections of the Missouri Plateau Section, including the Alberta Plain, of the Great Plains Province. The climate is semi arid with evapotranspiration greater than precipitation. The soil moisture regime is Ustic and the soil temperature regime is Frigid. The soils are primarily Typic Borolls.

The Mixed Grass Prairie, Wheatgrass-Grama Type (figure 1), exists on semi arid warm clay soils south of the Wheatgrass-Needlegrass Type and is in southwestern South Dakota. The physiography of the region consists of the southeastern portion of the Unglaciated section of the Missouri Plateau Section of the Great Plains Province. The climate is semi arid with evapotranspiration greater than precipitation. The soil moisture regime is Ustic and the soil temperature regime is Mesic. The soils are primarily clay textured Typic Ustolls.

The Mixed Grass Prairie, Wheatgrass Type (figure 1), exists on semi arid warm dense clay soils south of the Wheatgrass-Needlegrass Type and is in northwestern South Dakota. The physiography of the region consists of the central portion of the Unglaciated section of the Missouri Plateau Section of the Great Plains Province. The climate is semi arid with evapotranspiration greater than precipitation. The soil moisture regime is Ustic and the soil temperature regime is Mesic. The soils are primarily dense clay textured Typic Ustolls.

The Northern Short Grass Prairie, Grama-Needlegrass-Wheatgrass Type (figure 1), exists on the western side of the Northern Plains Grasslands and extends from southeastern Alberta and southwestern Saskatchewan through central Montana and southward into northeastern Wyoming. The physiography of the region consists of the western portions of the Glaciated and Unglaciated sections of the Missouri Plateau Section of the Great Plains Province. The climate is arid with evapotranspiration greater than precipitation. The soil moisture regime is Aridic and the soil temperature regime is Frigid in the north and Mesic in the south. The soils are primarily Aridic Borolls and Torriorthents in the north and Argids and Aridic Ustolls in the south.

Dr. Whitman (Barker and Whitman 1989) continued the separation of this vegetation type from the Wheatgrass-Needlegrass Type because of the notable increase in the shortgrass component and the relative decrease of western wheatgrass and needle and thread. Cool-season grass species increase towards the northern portions and warm-season grass species increase towards the southern portions. The needlegrasses increase in the north. Blue grama and buffalograss increase in the south. Because of the presence of mid cool-season grasses, the Northern Shortgrass Prairie has sometimes been combined with the Northern Mixed Grass Prairie. However, these two vegetation types are distinct and should remain separated. The Grama-Needlegrass-Wheatgrass Type has the appearance of a shortgrass prairie and has an

arid soil moisture regime, less soil horizon development, shallower soil depth to the accumulating soluble salts and developing argillic (clay) layer, shallower rooting depth, lower soil water holding capacity, greater evapotranspiration potential, and generally more xeric than the Wheatgrass-Needlegrass Type.

The Northern Short Grass Prairie, Saltgrass Type, exists on salt affected soils distributed in local areas across the Northern Short Grass Prairie region. Few plant species can tolerate the harsh environmental conditions of salt-affected areas. The tolerant species have mechanisms to exclude uptake of salts, or physiologically separate and discharge the undesired salts.

The Southern Short Grass Prairie, Bluegrama-Buffalograss Type (figure 1), exists in northwestern Nebraska and extends into east central Wyoming north of the North Platte River. The physiography of the region consists of a small western portion of the High Plains Section of the Great Plains Province. The climate is arid with evapotranspiration greater than precipitation. The soil moisture regime is Aridic and the soil temperature regime is Mesic. The soils are primarily Argids and Aridic Ustolls.

The Sandhills Prairie, Bluestem-Sandreed-Grama-Needlegrass Type (figure 1), exists in the north central portion of Nebraska south of the Niobrara River and north of the Platte River. Other Sandhills Prairie areas exist scattered throughout the Northern Plains. Many areas are too small to map. A large area of Sandhills Prairie exists along the Sheyenne River in southeastern North Dakota and another large area exists near Swift Current, Saskatchewan. The physiography of the Nebraska Sandhills consists of the Sand Hills region of the High Plains Section of the Great Plains Province. The climate is semi arid with evapotranspiration greater than precipitation. The soil moisture regime is Ustic and the soil temperature regime is Mesic. The soils are primarily Ustipsamments.

The Foothills Prairie, Plains Rough Fescue Type (figure 1), exists as a fringe along the montane forest of the Rocky Mountain foothills from Alberta to south central Montana and along the aspen groveland and aspen parkland bordering the boreal forest zone in Alberta and Saskatchewan and the type mingles with the Wheatgrass-Bluestem-Needlegrass Type extending across Saskatchewan and southwestern Manitoba and into northern North Dakota. Plains Rough Fescue has continued to move

south in the Transition Mixed Grass Prairie and the Mixed Grass Prairie of North Dakota. The physiography of the region consists of the northern portion of the Glaciated section of the Missouri Plateau Section of the Great Plains Province and the northern portion of the Small Lakes Section of the Central Lowland Province.

The Pacific Bunchgrass Prairie, Bluebunch-Fescue Type (figure 1), exists in the south central portion of Montana. Numerous other areas too small to map exist within the Great Plains. The physiography of the region consists of the Unglaciated section of the Missouri Plateau Section of the Great Plains Province.

The Badlands and River Breaks, Woody Draw and Savanna Types (figure 1), exist in central Montana along the Missouri and Musselshell Rivers, in western North Dakota along the Little Missouri River, and in southwestern South Dakota along the White River. The physiography of the region consists of the Unglaciated section of the Missouri Plateau Section of the Great Plains Province.

The Pine Savanna, Pine-Juniper-Bluebunch Type (figure 1), exists on rough uplands in south central and southeastern Montana, north central Wyoming, western South Dakota, and southwestern North Dakota. The physiography of the region is the Unglaciated section of the Missouri Plateau Section of the Great Plains Province.

The Black Hills Pine Forest, Pine-Spruce-Aspen Type (figure 1), exists in southwestern South Dakota and northeastern Wyoming. The physiography of the region consists of the Black Hills section of the Missouri Plateau Section of the Great Plains Province.

The Montane Forest, Pine-Fir-Spruce Type (figure 1), exists on the Sweetgrass Hills, and the Highwood, Bearpaw, Little Rocky, Moccasin, Judith, and Big Snowy mountains in Montana and the Cypress Hills in Saskatchewan. The physiography of the region consists of the laccolithic domed mountains in the Unglaciated section and the erosional upland remnant in the Glaciated section of the Missouri Plateau Section of the Great Plains Province.

The Upland Woodlands, Aspen-Ash-Oak-Juniper Types (figure 1), exist as scattered areas with various types of trees, shrubs, and grasses in North Dakota, Manitoba, and Saskatchewan. The physiography of the region consists of upland

positions of the Small Lakes Section of the Central Lowland Province and of upland positions of the Unglaciaded section of the Missouri Plateau Section of the Great Plains Province.

The Riparian Woodlands, Cottonwood-Ash-Elm Type (figure 1), exists along the floodplains of the larger rivers and streams and as small groves along minor drainage ways located throughout the Northern Plains.

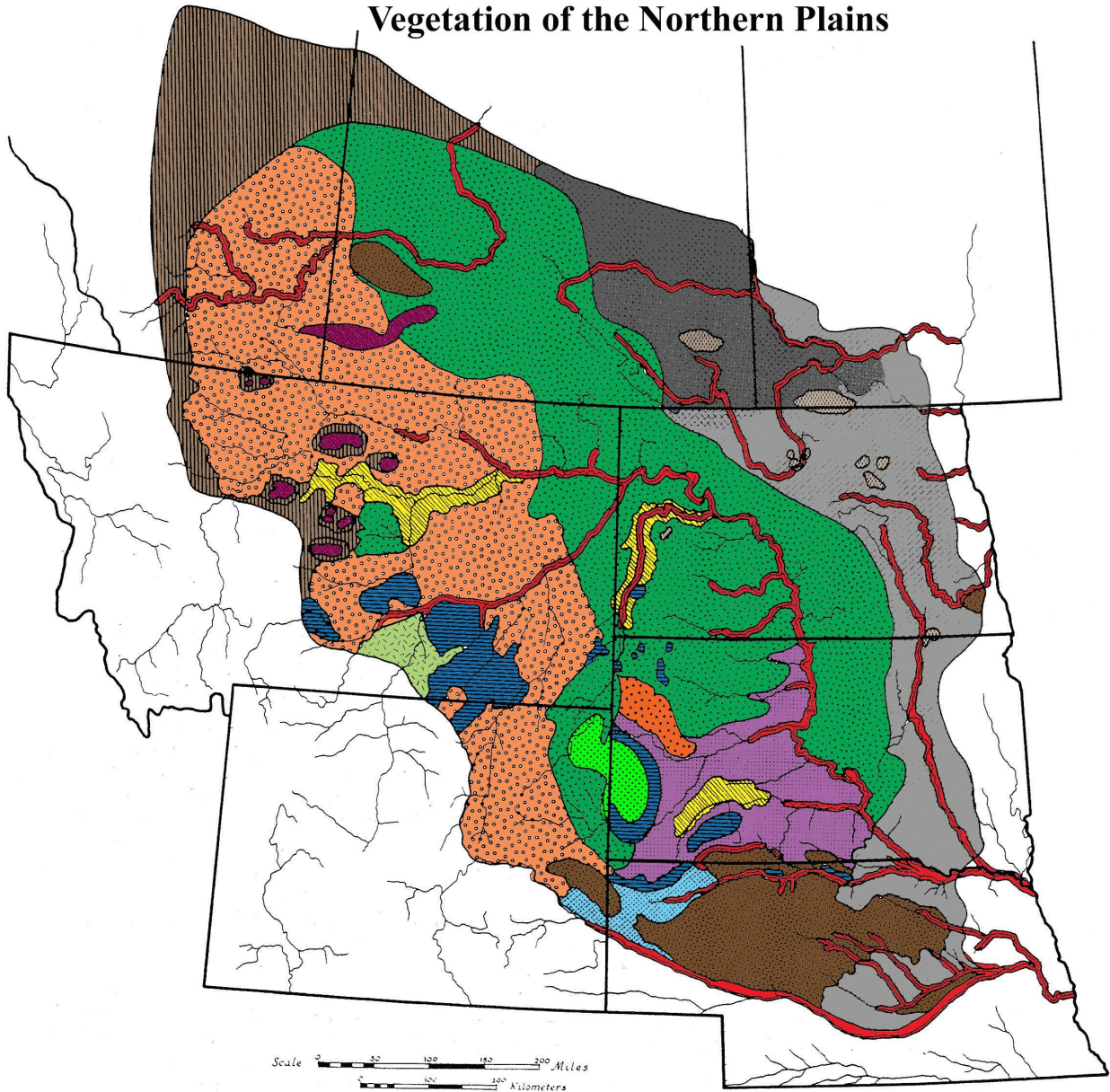
The environmental and biological factors that affect development of plant communities and vegetation types are the same factors that affect soil development. The current climate with wet and dry periods, and the current soil moisture and soil temperature regimes have been operational for about 5,000 years. Soil moisture regimes affect distribution of plant species affiliations. The species affiliations that are the major vegetation types in the Northern

Plains; Tall Grass Prairie, Transition Mixed Grass Prairie, Mixed Grass Prairie, and Short Grass Prairie; coincide with the four soil moisture regimes; Perudic, Udic, Ustic, and Aridic; respectively. The four soil moisture regimes are further separated into two soil temperature regimes; Frigid in the northern portions and Mesic in the southern portions. Soil temperature regimes affect composition and distribution of cool-season and warm-season grasses within the vegetation types. In the northern Frigid temperature regime, warm-season grass species decrease and cool-season grass species increase. In the southern Mesic temperature regime, cool-season grass species decrease and warm-season grass species increase.

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map from Barker and Whitman 1989

