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The vegetation of the Little Missouri Badlands of North Dakota

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Abstract:

The landscape of southwestern North Dakota is a collection of rugged, spectacular landforms bordering the Little Missouri River. This region, called the badlands, encompasses abrupt changes in substrate, slope, soils and salinity. The result is a fragmented collection of habitats supporting a patchwork of plant communities. Many western North Dakota species have broad ecological amplitudes and grow in more than one plant community. Only a few species are limited to narrowly defined habitats. However, habitat diversity translates into floristic diversity as demonstrated by floristic studies, which have documented the presence in the badlands of a least half of the 1300 species present in the flora of North Dakota.

The Little Missouri Badlands of western North Dakota is a collection of rugged and spectacular landforms bordering the Little Missouri River. These badlands extend from the South Dakota border to the point where the Little Missouri joins the channel of the 'Big' Missouri at Lake Sakakawea. They vary from 10 to 25 miles in width.

Locally the badlands are often referred to as "The Hills" but rather than looking up at them when you approach, you look down into them. The change from the gently rolling plain immediately behind you is dramatic. The difference in topography is the result of erosion. Running water from rain and melting snow, frost, wind and other erosion processes sculpted the land into a collage of beautiful and fantastically shaped forms.

The exposed rock layers in most of the Little Missouri Badlands are between 55 and 65 million years old. They were deposited during the Paleocene Epoch. At that time the newly-formed Rocky Mountains were very high and being eroded rapidly. Swift streams transported large amounts of eroded material. Coarse materials were deposited near the

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mountains. Finer materials like silt, clay and fine sand were carried all the way to the Dakotas (Blumle, 1975).

Beds of light, yellowish-colored soft sandstone of the Bullion Creek Formation are exposed along creek valleys and at lower elevations near the Little Missouri River. Layers of the younger Sentinel Butte Formation lie above the Bullion Creek Formation and are generally more somber in color. Its bluish gray layers consist mostly of silt and clay (Blumle, 1981). Variations in color in both formations reflect differences in the deposited sediment. Brownish gray layers are composed of beds of sand that contain orange, iron-rich bands only a few inches thick.

Black layers are formed by beds of lignite coal and can be found in both the Bullion Creek and Sentinel Butte formations.

Sometimes trees were buried before they had time to decay and were petrified instead of turning to lignite. Bones of prehistoric animals can also be found protruding from eroded banks.

One the more outstanding visual features of the Little Missouri Badlands are the colorful layers of clinker or "scoria". Scoria, or porcelinite, is formed when burning lignite beds bake the adjacent clay layers into a bright colored, natural brick material. Since "scoria" is harder and more resistant to erosion than the surrounding Paleocene layers it commonly remains as a cap on many of the hills. The red color, especially after a rain, is attention getting and is, to a large measure, responsible for the distinctive appearance of the Little Missouri Badlands.

Despite the fact that the exposed Paleocene layers are over 50 million years old the badlands themselves of are far more recent origin. Their formation began about 60,000 years ago during the Pleistocene Age. Before the ice age water from the Little Missouri River flowed northward through a broad, gentle valley and ultimately into Hudson Bay. But, when massive continental glaciers blocked this route the river was diverted eastward and then south. This new course was shorter and had a steeper gradient. Erosion increased and the down-cutting responsible for the formation of the badlands began (Blumle, 1972).

Southwestern North Dakota has a typical continental climate: long, cold winters; short, hot summers; warm, sunny days; cool nights; low rainfall and low humidity. The yearly precipitation averages 15-16 inches, three-quarters of which falls during the growing season that extends roughly from mid-May to mid-September. Daytime temperatures over 100º F. are fairly common in July and August. Winter lows sometimes exceed -40º Fahrenheit. The January mean temperature is about 10º F. The July mean is about 70º F. During most winters there is only a thin snow cover (less than one foot). However, strong winds usually redistribute the snow cover so that large drifts accumulate in sheltered areas to the obvious benefit of some plant communities (Lee, 1983).

Extensive erosion that began in the Pleistocene has continued up to the present. The effect of this erosion into varying geological deposits has been to produce a highly dissected topography that, in turn, provides a wide variety of conditions for plant growth. The result is a complex patchwork of vegetation types related to soil, slope and moisture availability.

The most conspicuous pattern exhibited is the difference between the vegetation on north and south slopes. Steep north slopes are often covered by Rocky Mountain juniper making them quite distinct even from a distance. Facing away from direct rays of the sun, the surface receives less insolation, conditions are cooler, snow remains longer in spring and moisture doesn't evaporate as readily. Even though the slopes are steep and the soils poorly developed these sites are able to support dense stands of juniper. Small seeded ricegrass (*Oryzopsis micrantha*) is characteristic of this habitat type, but where growth is very thick there are few species in the understory except mosses and lichens. Woody plants like skunkbush (*Rhus trilobata*), dwarf juniper (*Juniperus communis*), creeping juniper (*Juniperus horizontalis*), woods rose (*Rosa woodsii*) and chokecherry (*Prunus virginiana*) are commonly associated with openings. Bluebell (*Campanula rotundifolia*), northern bedstraw (*Galium boreale*), and false solomon's seal (*Smilacina stellata*) are common in juniper woodlands. Green ash (*Fraxinus pensylvanica)* is present in many stands, particularly where depressions provide extra moisture. Wooded north facing slopes have been reported on by Ralston (1960) and Hansen *et al*. (l984).

In contrast to wooded north facing slopes, steep, south facing, clay slopes are nearly devoid of vegetation. High insolation causes the surface to become very hot in summer. Little moisture is able to penetrate the clay so most precipitation runs off. Erosion is so severe there is no true soil development. All these factors result in an extremely harsh environment. Not surprisingly, vegetation is sparse. The predominant species, rabbitbrush (*Chrysothamnus nauseosus*), longleaf sage (*Artemisia longifolia*), and greasewood (*Sarcobatus vermiculatus*), are shrubby and exist only as scattered individuals on the face of the slope. The same species can also be found on the clay outwash fans at the base of the slope. Semiwoody species include broomweed (*Gutierrezia sarothrae*), woody sea blite (*Suaeda moquina*) and winterfat (*Ceratoides lanata*). Forbs are not common in this habitat, however some that can be found include buckwheat (*Eriogonum multiceps*), phlox (*Phlox hoodii*), gumbo lily (*Oenothera caespitosa*), butte candle (*Cryptantha celosoides*), stemless hymenoxys (*Hymenoxys acaulis*), red mallow (*Sphaeralcea coccinea*) and prickly pear (*Opuntia polycantha*). A study by Flesland (1964) details the ecology of the salt-desert shrub type in the Little Missouri Badlands.

Broad level deposits of alluvium adjacent to the Little Missouri River and its major tributaries are dominated by silver sage (*Artemisia cana*) with western wheatgrass (*Agropyron smithii*) as the predominant grass species. Soils are typically alluvial and vary from clay loam to sandy loam.

A different sagebrush community occurs on narrow terraces or benches above the valley floor. Black sage (*Artemisia tridentata*) is the dominant species in these sites. However, in the southern part of the badlands the distribution of black sage is more widespread. The distribution of both black and silver sage in western North Dakota is described by Hazlett (1975).

In addition to the silver sage/western wheatgrass habitat type, floodplains of the Little Missouri also support a community dominated by cottonwood (*Populus deltoides*). Cottonwood develops extensive stands on the floodplain because its seedlings favor fresh alluvium for establishment. It's common to find thick rows of young trees marking the course of flood deposits. Narrow bands of mature cottonwoods bear record to former, but now abandoned channels. Green ash (*Fraxinus pensylvanica*) is the typical understory

tree and, as cottonwood requires an open substrate for establishment, will eventually replace cottonwood. Ultimately, both species may be replaced by juniper. Buckbrush is the most common shrub species but woods rose and skunkbush sumac, are also present. Clematis (*Clematis ligusticifolia*) and woodbine *(Parthenocissus vitacea*) often climb over the other woody vegetation.

In addition to its importance on the river floodplain, Green ash is the typical woody species in upland draws. Woodlands follow the drainage patterns where runoff from adjacent slopes provides the extra moisture needed for tree growth. Chokecherry (*Prunus virginiana*) is the dominant shrub in the understory but is most abundant near the edges of the stand where the light intensity is greater. Juneberry (*Amelanchier alnifolia*) is also found near the edges of woods but generally only on north facing slopes. Buckbrush (*Symphoricarpos occidentalis*) is also common in the undergrowth, as is woods rose, and poison ivy (*Rhus trilobata*). Common forbs include northern bedstraw (*Galium boreale*), catchweed bedstraw (*Galium aparine*), bergamot (*Monarda fistulosa*), early meadow rue (*Thalictrum venulosum*), spreading dogbane (*Apocynum androsaemifolia*) and false Solomon's seal (*Smilacina stellata*). Disturbance from cattle is common in woody draws and this has allowed for the introduction of weedy species like burdock (*Arctium minus*) and dandelion (*Taraxicum officinale*). Nelson (1960) described the composition and structure of principal woody vegetation types in the North Dakota badlands.

Occasionally you find aspen (*Populus officinale*) growing on north facing slopes above green ash communities. It is not a very widespread community type but occurs sporadically throughout the badlands.

In addition to being part of the understory of ash and cottonwood forests, buckbrush occurs as scattered thickets in which it is the primary species. Buckbrush grows on a variety of soils, from fine textured to coarse, gravely substrates, but in the sites where it grows the moisture situation is more favorable than in the adjacent grassland sites. Buffaloberry (*Shepherdia argentea*) also forms thickets.

Stands of ponderosa pine (*Pinus ponderosa*) occur in the south-central portion of the Little Missouri Badlands. There are scattered populations from near the South Dakota border to about as far north as I-94 east of Medora, but the most extensive forest is in northern Slope County. Pine trees are generally restricted to ridges and knolls, but may extend down the slopes. Bluebunch wheatgrass (*Agropyron spicatum*), plains muhly (*Muhlenbergia spicatum*) and little bluestem (*Andropogon scoparius*) are the principal grasses in the understory (Dodds 1972). The ecology of ponderosa pine in western North Dakota is discussed by Potter and Green (1964).

Scoria hilltops are a unique habitat as well as being visually distinct. It is the primary habitat for a few species, including ten-petal mentzelia (*Mentzelia decapetala*). Weathered and eroded scoria buttes often support a community of creeping juniper and little bluestem (Whitman and Hanson 1939, Hansen *et al*. 1984).

Skunkbush sumac is commonly found on dry hilltops with rocky outcrops (Sanford 1970). Rocky slopes are also typical habitat for yellow wild buckwheat (*Eriogonum flavum*) and bladderpod (*Lesquerella alpina*).

A number of studies have been made which delineated grassland communities in western North Dakota. The major grassland types were first described by Hanson and Whitman (1938). Other important studies of western North Dakota grasslands include those done by Dix (l960), Redmann (1975), Whitman (1979), Hansen *et al*. (1984), Hirsh (1985) and Butler *et al*. (1986). Many grassland communities have species in common. The difference lies in the relative importance of a species in a particular community. Differences in moisture, soil and salinity all affect the abundance of a particular species.

Uplands, plateaus and gentle slopes with deep, well drained sandy loam soils are dominated by needle-and-thread (*Stipa comata*), threadleaf sedge (*Carex filifolia*) and blue grama (*Bouteloua gracilis*). Blue grama occurs as an understory and increases in abundance with heavy grazing.

On gentle slopes with somewhat heavier, finer textured soils, such as a silty loam, western wheatgrass (*Agropyron smithii*) achieves prominence. Needle-and-thread, blue grama and prairie junegrass (*Koeleria cristata*) are also important and green needlegrass (*Stipa viridula*) and plains muhly (*Muhlenbergia cuspidata*) are present.

Heavy, clay soils on level or gently sloping uplands frequently form clay pans at or near the surface. The clay pan largely prevents the infiltration of water and results in sodium affected soils. Sparsely vegetated or bare slick spots are typical. The main species that are found in these areas are western wheatgrass, blue grama and buffalo grass (*Buchloe dactyloide*).

Deep, well-drained sandy soils are especially common on exposures of the Bullion Creek Formation. Sandreed (*Calamovilfa longifolia*) is typical of sandy sites but needle-and-thread and needleleaf sedge (*Carex eleocharis*) are also common. Blue grama is also present. Obviously blue grama is a species with a broad ecological amplitude because it is present to a greater or lesser degree in almost all western North Dakota prairie communities growing in soils that range from sandy to heavy sodium affected clays.

The only grassland community of which blue grama is not a part is probably the big bluestem community. Big bluestem (*Andropogon gerardii*) has only limited occurrence along some stream courses and along the lower slopes of draws where there are deep, fertile soils and supplemental moisture. Porcupine grass (*Stipa spartea*), prairie dropseed (*Sporobolus heterolepis*), and switchgrass (*Panicum virgatum*) may also occur with big bluestem in these favorable sites.

Communities of little bluestem (*Andropogon scoparius*) are easily recognized after late summer by their reddish autumn color. Little bluestem communities occur on relatively steep slopes and hill crests that have only a thin layer of usually coarse textured soil over sandstone or shale parent material. Little bluestem communities often develop on north or east facing slopes where snow accumulates.

Most grassland forbs are not limited to a particular grassland type even though they may be most abundant in a particular habitat. The inception of flowering of the earliest species is dependent on temperature, however, the first flowers usually appear in April. Pasque flower (*Anemone patens*), buttercup (*Ranunculus glaberrimus*) and pussytoes (*Antennaria parvifolia*) are among the earliest. Prairie phlox (*Phlox hoodii*), wild parsley (*Musineon divaricatum*), yellow wild parsley (*Lomatium foeniculaceum*), prairie smoke

(*Geum triflorum*), locoweed (*Oxytropis lambertii*) and golden pea (*Thermopsis rhombifolia*) are common in May.

Species flowering in June include: arnica (*Arnica fulgens*), butte *candle (Cryptantha bradburniana*), Missouri milk-vetch (*Astragalus missouriensis*), two-grooved vetch (*Astragalus bisulcatus*), prairie turnip (*Psoralea esculenta*), prairie chickweed (*Cerastium arvense*), flax (*Linum lewisii*), fleabane (*Erigeron glabellus*), spiderwort (*Tradescantia occidentalis*), wallflower (*Erysimum asperum*), goatsbeard (*Tragopogon dubius*), Missouri ball cactus (*Coryphantha vivipara*), white beardtongue (*Penstemon albus*), slender beardtongue (*Penstemon gracilis*), prairie ragwort (*Senecio plattensis*), grey ragwort (*Senecio canus*), scarlet mallow (*Sphaeralcea coccinea*) and yarrow (*Achillea millefolium*).

By early July the aspect changes with the appearance of typical mid-summer flowers such as: pink coneflower (*Echinacea angustifolia*), gaillardia (*Gaillardia aristata*), prairie rose (*Rosa arkansana*), purple prairie clover (*Dalea purpurea*), yellow cone flower (*Ratibida columnifera*), silver-leaf scurf pea (*Psoralea argophylla*), skeleton weed (*Lygodesmia juncea*) and whorled milkweed (*Asclepias verticillata*).

By late August the prairie begins to take on an autumnal aspect with the appearance of gumweed (*Grindelia squarrosa*), white sage (*Artemisia ludoviciana*), broom weed (*Gutierrezia sarothrae*), blazing star (*Liatris punctata*) and several asters, including, many-flowered aster (*Aster ericoides*) and aromatic aster (*Aster oblongifolius*).

Wetlands are uncommon in the badlands. Extensive erosion has precluded the natural development of marshes and lakes. However, artificial impoundment for livestock water are present and provide habitat for aquatic species as do springs, creeks and the Little Missouri River. Fulton (1979) provides a discussion of wetland vegetation in southwestern North Dakota.

The previous discussion of typical plant communities of the badlands concentrated on only a few of the common or typical plant species of each habitat. Many other species can be found. Zaczkowski (1972) is his study of the flora of southwestern North Dakota reported 605 species from Billings, Bowman, Golden Valley and Slope counties. Rohde-Fulton (1985) reported 701 species in a floristic study of west central North Dakota, which included the badlands of McKenzie and Dunn counties. The greater number of species in the later study can be at least partially accounted for because that study included the Killdeer Mountains, a floristically unique pair of buttes bordering the badlands in Dunn County. Rohde-Fulton found 49 species growing on the Killdeer Mountains that were not found elsewhere in her three county study area. Since most species growing in the badlands were probably accounted for by Zaczkowski and Rohde-Fulton, it seems likely that least half of the approximately 1300 species that comprise the flora of the North Dakota (William Barker, personal communication) can be found in the Little Missouri Badlands.

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