

HABITATS

South Dakota Forests

PRAIRIE FORESTS

Has South Dakota Always Been A Prairie?

Fifty million years ago, during the Eocene Epoch, the climate and vegetation of what was to become South Dakota was much different from today. There were no large mountains to the west, so rainfall was more plentiful and uniform across the center of the North American continent. Since it was much warmer, tropical and subtropical vegetation extended into the Dakotas.

About 30 million years ago, during the Oligocene Epoch, the climate began to cool. During the same period, the Rocky Mountains began to form. This upheaval created a rain shadow to the east and the South Dakota climate not only became cooler (though still warmer than today), but drier. Grasses were more tolerant of this semiarid environment, and the first prairie began to form.

By the middle of the Pliocene Epoch, about 5 million years ago, the South Dakota vegetation looked similar to today's. Grasses were the dominant plants, with trees restricted to river valleys. The climate was to change again, however, this time becoming cooler.

Beginning about 2 million years ago, there were five glacial periods. The last, the Wisconsin glacial period, reached its peak about 20,000 years ago. At its farthest extent, the glaciers covered South Dakota east of the Missouri River

(See Figure 1). Most of the land east of the river was buried beneath hundreds of feet of ice. South of the glaciers spruce and fir trees grew. The glaciers stagnated and began to melt about 13,000 years ago as the climate became warmer. By about 8,500 years ago, the prairie had displaced the spruce forest in South Dakota. While South Dakota has remained a prairie since that time, the border between the prairie and the eastern forest has migrated as the climate became slightly warmer and cooler. The prairies reached their farthest extent about 1000 years ago, then the climate cooled reaching its lowest mean temperature during the "Little Ice Age" of the 1600's. As the climate cooled, the forest extended into the prairie. The situation has reversed again, and as the climate warms, the prairie is once again invading the forest.

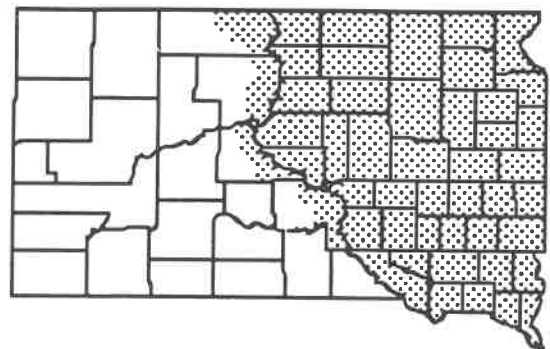


Figure 1: The Approximate Extent Of Glaciation In South Dakota.

Why Are There Grasses Instead Of Trees?

While the border between the forest and the prairie has moved back and forth through the last few centuries as the climate warmed and cooled, the center of the North American continent has remained grassland rather than forest. There are a number of factors that have prevented trees from displacing the grasses. Trees are rare due to the combined effect of these factors: low precipitation, temperature extremes, fire and grazing animals.

The climate is the dominant reason for the development of the prairie. Most of the trees native to eastern North America, such as sugar maple and white pine, require more than 30 inches of annual precipitation to reach their best development. Precipitation levels alone would restrict the majority of tree species to southeast South Dakota and the Black Hills.

While the annual precipitation is very low in many areas of South Dakota, only 15 to 25 inches per year, there are forested regions that have similar low precipitation levels. However, these other regions, such as the boreal forests of northern Canada, have much cooler summers. In cool summers trees lose less moisture to evaporation and *transpiration*. Evaporation losses are from water being removed from the soil and returning to the air. *Transpiration* losses are from water being removed from tiny pores in the leaves and returning to the air. The combined effect is called *evapotranspiration*. In temperate regions, grasslands dominate when more water may be lost through *evapotranspiration* than occurs as precipitation.

The longer climatic cycles add to this problem. Since the end of the last glacial period, the prairie has experienced extremely severe droughts about every 500 or so years. There have also been severe droughts about every 25-30 years. These periodic droughts are

devastating to trees. Many are killed, and for those that survive, recovery is very slow. For example, during the 1930's drought, in some areas of South Dakota, over 90% of the elms and cottonwoods were killed by the combination of high summer temperatures and low precipitation.

Fire has played a major role in perpetuating the grasslands. Even light burns are fatal to willows and cottonwoods. Most of the prairie forests have established themselves in areas protected from fires. River flood plains and upland ravines are usually spared from prairie fires, as slopes serve as a natural fire break. Trees also established themselves in fire shadows on the leeward sides of lakes, ponds and marshes. Lightning is a major cause of natural fires. The incidents of lightning fires have been estimated at 6 fires per year for every 3,600 square miles. Prior to European settlement, the American Indians started fires for hunting purposes, either to direct game or improve grazing land.

The large herds of grazing animals were once a detriment to tree establishment on the prairie. Bison fed on the tender young seedlings and compacted the soil, preventing seedlings from developing into mature trees. Sapling and mature bur oaks were killed when grazing animals compacted the ground beneath them. The compacted soil has less air which limits root growth. The trees often die during a drought because their root system can not absorb enough water.

The interaction of these factors has restricted the number of tree species that can grow in South Dakota. On the South Dakota prairie most trees occur along rivers and streams. The flowing water assures a more adequate supply of water than occurs from precipitation alone. The ravines and valleys carved out by the flowing water also provide a more protected environment. High summer temperatures are moderated along the north-facing slopes. The valleys also serve as natural fire breaks and provide

protection from the drying winds.

Some typical flood plain tree species, such as basswood and hackberry, occur in *coulees*. At first glance it may seem unusual for trees to be able to survive in these upland depressions. The soils in these depressions are usually moist throughout the growing season since the water from the surrounding uplands flows to these areas. On the flood plains these same trees receive moisture during the spring floods, but quite often the same soils dry out by mid-season. The depressions also protect the trees from fire and drying winds.

Where Do Prairie Forests Grow?

Tree species occur in particular sites and occupy these sites in a particular order. This process of one group of trees sequentially replacing another over time is known as *forest succession*. There are two types of succession, primary and secondary. *Primary succession* is the development of a forest beginning with an unoccupied site and proceeding to a self-perpetuating forest. An example of this might be a new sand bar that starts as a willow thicket. As the water flow changes and the soil builds up, a cottonwood forest develops on the higher, drier, ground. This forest is gradually replaced by green ash and American elm and eventually becomes mostly elm. In the absence of a catastrophic disturbance, elm will dominate the forest indefinitely. Why does this sequence occur? Cottonwood and willows are considered *pioneer species*. *Pioneer species* are the first trees to occupy a site. They usually have light seeds that can be carried long distances by the wind or running water. *Pioneer species* typically form pure even-age forests. They can not survive competition from other trees. This inability to withstand competition is called *intolerance* and primarily applies to *shade intolerance*. Tree species that are intolerant are not usually found in the understory, only the upperstory. The upperstory of a forest is the level of trees

whose crowns are exposed to the sunlight. The understory exists beneath the canopy of the taller trees. As cottonwoods grow, they cast shade upon the forest floor. The shade they cast is too heavy for their own seedlings to develop. It's not too shady for all trees however. Green ash and elm seedlings will tolerate the shade and begin to grow as the understory in the cottonwood forest. Eventually the cottonwoods die and the ashes and elms assume dominance. Elm, being the most tolerant, will continue to come up in its own shade. In an elm-ash forest you can find elm in the understory and upperstory. On flood plain sites along prairie rivers and streams, elm is considered a *climax species*. This means it creates a stable, self-maintaining, and self-reproducing forest.

Rarely does a site develop that never undergoes any changes. Usually a disturbance occurs that disrupts rather than destroys an existing site. The disturbance usually sets back succession and the cycle begins again. This is known as *secondary succession*. With the above example, imagine the green ash-elm site flooded for a long time during a spring. This disturbance kills many of the ash and elm and cottonwoods once again occupy the site. The cycle begins again.

How Are Trees Distributed In Prairie Forests?

If you were to walk along a river in eastern South Dakota, you would notice that the composition of the forest changes as you walked from the river edge along the flood plain to the ridge above the terraces (See Figure 2). Each tree species has particular needs and competitive abilities that limit its development to specific sites. A typical walk would find willows along the water's edge. As the ground becomes slightly higher, cottonwoods begin to dominate. If the cottonwoods are mature, perhaps there are young green ashes and boxelders beginning to grow. On slightly higher, more fertile, ground the large, old

cottonwoods are being replaced by young green ashes and elms. As you reach the upper terraces, particularly along the upland ravines, bur oaks are found. Finally, at the top of the ridges stand a few stunted bur oaks and the prairie begins.

The composition also changes as you follow rivers upstream from the southeast corner of the state. At the extreme southeastern corner of the state, the Missouri river flood plain has more tree species along its banks. The lowest levels are still composed of willows and cottonwoods, but as you climb to the higher terraces you'll find silver maples, black walnuts, honeylocusts, basswoods, and hackberries associated with the green ashes and elms. Many of these species fade out beyond Bon Homme County. As you progress up the river,

the diversity of the flood plain forest decreases, sometimes limited only to willows and cottonwoods in places.

Why Are Prairie Forests Important?

Because prairie forests are usually associated with flood plains or waterways, they are prime habitat for wildlife. Prairie forests contain a diverse community of animals and plants. The plants of the forest provide protection, food, and reproductive habitat for a wide range of animals. These forests are particularly important for amphibians, such as salamanders and frogs, that must return to water to lay their eggs. Other cold blooded *vertebrates* such as lizards, turtles, and snakes are common inhabitants of the prairie forests.

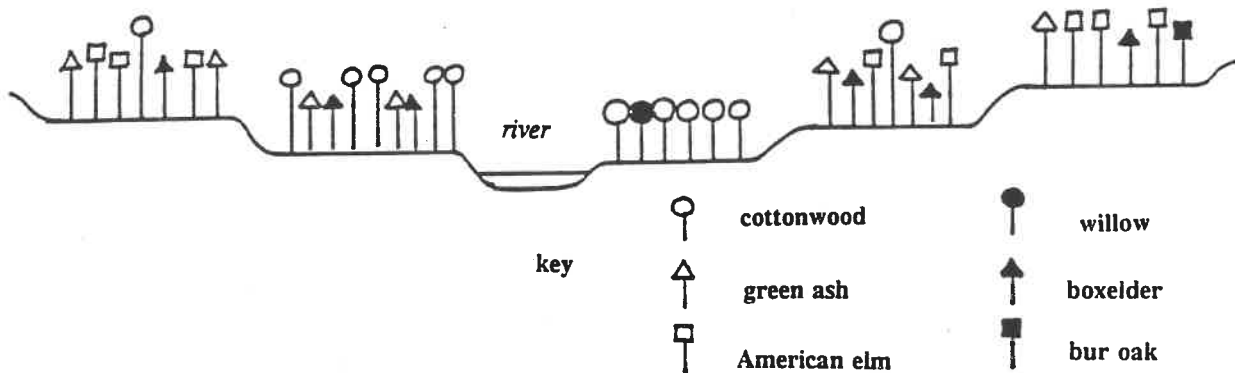


Figure 2: Cross Section of a River Flood Plain Showing The Distribution of Important Tree Species. For a more detailed diagram see Johnson, C.W., R.L. Burgess and W.R. Keammerer, 1976. Forest Overstory Vegetation and Environment on the Missouri River Flood plain in North Dakota. Ecological Monographs 46(1):59-84.

Birds rely heavily on the prairie forest habitat for food, shelter and nesting areas. Flood plain forests serve as colonial *rookeries* for many tree-nesting water birds, such as herons and cormorants. Waterfowl, such as wood ducks whose young drop from nesting cavities high in the trees and must quickly find water, are also dependent on flood plain forests. Prairie forests are heavily used by the many migratory songbirds that pass through our state during the spring and fall. Many summer resident birds, including woodpeckers, blue jays, doves, and turkeys, nest in these forests. The flood plain forests along the Missouri River are important winter *roosting* sites for bald eagles, a federally listed endangered species.

Mammals that depend on flood plain forests include deer, squirrels, fox, and beaver. The abundance of fur bearing animals, such as beaver whose valuable pelt was prized by fur traders in the 1800's, was a principal stimulus to early European exploration and settlement of the prairie.

Will Prairie Forests Remain As They Are Today?

Disturbances are a natural part of the forest ecosystem; nothing remains the same forever. During the past seventy or so years, many changes have occurred that have far reaching impact on forest succession. These changes include the elimination of most large fires, dam construction, introduction of exotic diseases, and timber harvesting.

As Europeans began settling the prairies in permanent dwellings, fires became a liability rather than an asset. While fires were an important mechanism for perpetuating grasses and providing fresh

pasture for the native grazing animals, it was a danger to dwellings and agriculture. With the elimination of fire, several tree species extended their range. For example, eastern redcedar, once a relatively uncommon prairie species, now occurs throughout South Dakota.

Dams have had a major impact on the flood plain forest. The reservoirs behind dams eliminated about 86,000 acres of bottomlands. Dams have much more impact than just flooding areas behind them. Dams also regulate river levels downstream. This has reduced the frequency and severity of floods. By checking the meandering action of the river and reducing spring flooding, the conditions necessary for willow and cottonwood establishment have been eliminated.

The introduction of Dutch elm disease into South Dakota has had a great effect on the composition of the flood plain forests. This disease, which was introduced from Europe, is deadly to most elms. Dutch elm disease has greatly reduced the number of American elms in the climax flood plain forest. Green ash has become the dominant tree species in many of these forests.

Timber harvesting has also changed the composition of the flood plain forest. Beginning with the early European settlers, forests have been heavily cut. The most valuable species such as oak and elm have been harvested and used for fuel and as building materials. In eastern South Dakota, trees are being lost faster than new ones grow. Over the last 50 years, we have lost about half our native woodlands, about 210,000 acres. In their place are housing developments, fields and lakes.

Glossary

- Climax species** - the plant species that is part of the stable forest community where a tree species is replaced by itself.
- Coulee** - a deep depression or ravine in the land that is usually dry in the summer.
- Evapotranspiration** - the combination of water loss resulting from evaporation from the soil and surface of the plant and water loss from the small pores in the plant leaves.
- Forest succession** - the general trend in plant invasion, replacement and dominance of a site.
- Pioneer species** - the first plant species to colonize an area.
- Primary succession** - a development of a forest community from an unoccupied site.
- Rookeries** - breeding areas or colonies where large groups of birds nest.
- Roosting site** - an area where birds perch to rest or sleep.
- Secondary succession** - the development of a forest community from a disturbed site.
- Shade intolerance** - inability to grow in areas shaded by other plants.
- Shade tolerance** - the ability of a plant to grow in areas shaded by other plants.
- Transpiration** - the loss of water through the small openings in leaves of plants.
- Vertebrates** - those animals with a backbone such as fish, amphibians, reptiles, birds, and mammals.

References

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Resources for Teachers

South Dakota's Forests, a video by the South Dakota Society of American Foresters, Spearfish, SD, grades 4-12.

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