Evolution of North American Vegetation and Flora
The study of the North American flora, vegetation, and fauna - its history and assembly - begins in the late Cretaceous with the major events staged later in the Tertiary of the Cenozoic.
The final shaping of North American (and Great Lakes) flora and vegetation occurs during the Recent Epoch (Holocene) following the glaciation of the Pleistocene.

North American Flora - the Fossil Record
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To understand North American biogeography, follow it through the end of Paleozoic and Mesozoic.

Permian North America
260 mya

- N. America near equator
- Appalachian Mountains well developed
North American Flora - the Fossil Record

To understand North American biogeography, follow it through the end of Paleozoic and Mesozoic

Triassic North America
230 mya

- N. America moves north
- Extensive volcanic activity in oceanic western N. America
North American Flora - the Fossil Record

To understand North American biogeography, follow it through the end of Paleozoic and Mesozoic

**Jurassic North America 170 mya**

- N. America moves north
- Appalachians eroding
- Western mountain building begins
- Interior sea forms
North American Flora - the Fossil Record

To understand North American biogeography, follow it through the end of Paleozoic and Mesozoic

**Cretaceous North America 100 mya**

- Interior Seaway from Gulf of Mexico to Arctic Circle
North American Flora - the Late Cretaceous

The end of the Cretaceous and beginning of the Tertiary (100-50 mya) saw the warmest temperatures since the PreCambrian

Effect was widespread over latitudes
Cosmopolitan floras existed despite Pangaea breakup
Contributing to this moderation of climate were the large epicontinental seas that existed in North America and Eurasia in the Late Cretaceous due to high sea levels.
North American Flora - the Late Cretaceous

- Water bodies absorb more heat than land and release it more slowly
- These inland seaways lowered the intensity of seasonality - "lake effect" - as did the Tethys Sea during the Mesozoic
- More temperate / subtropical to higher latitudes

An aerial view of the eastern coast line of western North America and the Interior Cretaceous Seaway, some 75 million years ago.
North American Flora - the Late Cretaceous

Also contributing to the warm and wet climate of much of North America was that low relief existed in much of North America.

The Rockies form a mountain barrier that stretches from Canada through central New Mexico but were only of moderate relief in the Late Cretaceous.

Uplift of the present Rockies occurs 70-40 mya.
North American Flora - the Late Cretaceous

Also contributing to the warm and wet climate of much of North America was that low relief existed in much of North America.

Sierra Nevada were only a series of low foothills in the Late Cretaceous.

Sierra Nevada 65 mya

Uplift and tilting of the Sierra Nevada range begins 25 mya.
North American Flora - the Late Cretaceous

Also contributing to the warm and wet climate of much of North America was that low relief existed in much of North America.

High Cascades would not appear until the Pliocene around 10 mya.
North American Flora - the Late Cretaceous

Floristic exchange was widely possible between Eastern Asia and Western North America via Beringia.

Floristic exchange was also widely possible between Eastern North America and Western Eurasia via the North Atlantic Land Bridge.
With the North American continent subdivided by the Interior Cretaceous Seaway, two distinct floristic regions are evident in the pollen fossil record (*palynofloras*).

**Aquillapolles**: western N. Am. - Asia via Beringia (sandalwood and mistletoe families)

**Normapolles**: eastern N. Am. - western Eurasia via North Atlantic (walnut and sycamore families)
North American Flora - the Tertiary

Paleocene of the Tertiary 65-66 mya

- warm temperatures, inland seas, and low relief
- tropical, subtropical, and temperate climates from southern United States to the Arctic

Paleothermometers indicate:

- temperature gradient
  - $0.3^\circ C / 1^\circ$ latitude (Paleocene)
  - $1.0^\circ C / 1^\circ$ latitude (today)
- $30^\circ N$ it was $5-10^\circ C$ warmer
- $80^\circ N$ it was $30^\circ C$ warmer
The end of the Cretaceous and beginning of the Tertiary (100-50 mya) saw the warmest temperatures since the PreCambrian.

Effect was widespread over latitudes.

Cosmopolitan floras existed despite Pangaea breakup.

Worldwide cooling then commenced during the Tertiary and culminated in the Pleistocene glaciations.
Tertiary Period

Major points about the Tertiary - 1st half

1. subtropical (or temperate evergreen) forests up to 50° N latitude through Eocene
North American Flora - the Tertiary

Major points about the Tertiary - 1st half

2. Araucariaceae type conifers go extinct in North America, but redwoods and dawn redwoods become dominant conifers

Redwood forest in CA

Metasequoia glyptostroboides

Distribution of Redwoods
North American Flora - the Tertiary

Major points about the Tertiary - 1st half

3. Grasses evolve and appear at the Paleocene/Eocene border (54 mya)

*Sorghastrum nutans* - Indian grass
North American Flora - the Tertiary

Major points about the Tertiary - 1st half

4. Major radiation of deciduous forest families [Arcto-Tertiary Flora]

Deciduous Forest worldwide

Fagaceae - beeches

but also rose, walnut, and maple families
North American Flora - the Tertiary

Major points about the Tertiary - 1st half

5. Montane regions become dominant in western North America; pine family diversifies

Ponderosa pine

Canadian Rockies
North American Flora - the Tertiary

Major points about the Tertiary - 1st half

6. Epicontinental sea in North America retreats to Gulf of Mexico; interior dries out
North American Flora - the Tertiary

Major points about the Tertiary - 1st half

7. Euramerica separated by North Atlantic widening by 55 mya
North American Flora - the Tertiary

Major points about the Tertiary - 2nd half

1. Significant cooling worldwide from late Eocene - Oligocene - Miocene

![Graph showing temperature changes over time in the Tertiary period.]
North American Flora - the Tertiary

Major points about the Tertiary - 2nd half

1. Significant cooling worldwide from late Eocene - Oligocene - Miocene

Gondwanan events affects Northern Hemisphere heat budget via ocean currents

- Tasman Passage
- Drake Passage
North American Flora - the Tertiary

Major points about the Tertiary - 2nd half

1. Significant cooling worldwide from late Eocene - Oligocene - Miocene

Central American closure affects Northern Hemisphere heat budget via ocean currents
Sequoia, now confined to coastal California and adjacent Oregon, had a Holarctic Tertiary distribution as indicated by some of its fossil sites (●).

North American Flora - the Tertiary

Major points about the Tertiary - 2nd half

2. Cooling and drying of central North America forces the fragmentation and decline of the Arcto-Tertiary flora.
North American Flora - the Tertiary

Major points about the Tertiary - 2nd half

2. Cooling and drying of central North America forces the fragmentation and decline of the Arcto-Tertiary flora

and the beginning of the four areas of forest endemism
Rainshadow caused plains and prairie formation and the diversification of ungulates.

Major points about the Tertiary - 2nd half

3. Rocky Mountain uplift finished by the Miocene (10 mya) and beginning for Sierra Nevada (25 mya) provided significant barriers to moisture.

Missouri, Pliocene 5-10 mya