Sleeping Bear Dunes National Lakeshore

Pleistocene - the Ice Ages

Stage is now set to understand the nature of flora and vegetation of North America and Great Lakes

- Pliocene (end of Tertiary)
  - most genera had already originated (in palynofloras)
  - Flora was in place
  - Vegetation units (biomes) already derived

In the Pleistocene, earth experienced intensification towards climatic cooling

- Culminated with a series of glacial-interglacial cycles
- North American flora and vegetation profoundly influenced by these "ice-age" events

The vegetation and flora as we see it now (Holocene) was dramatically affected by Pleistocene events
Pleistocene - the Ice Ages

• In the Pleistocene, earth experienced intensification towards climatic cooling
• Culminated with a series of glacial-interglacial cycles
• North American flora and vegetation profoundly influenced by these "ice-age" events
• Wisconsin glaciation (last epoch) most important
• Assembly of flora and vegetation of most Great Lakes was during the late Pleistocene and Holocene - (18,000 years ago to present)

Pleistocene - the Ice Ages

What happened in the Pleistocene?

• Holocene (Recent) - the present interglacial started ~10,000 ya
• Wisconsin - the last glacial (Würm in Europe) occurred between 115,000 ya - 10,000 ya.
• Height of Wisconsin glacial activity (most intense) was 18,000 ya - most intense towards the end of the glacial period

Pleistocene - the Ice Ages

Prior to the Wisconsin glaciation, the evidence for three other glacials are still visible

Pleistocene - the Ice Ages

What happened in the Pleistocene?

Maximum extent of Wisconsin glacial activity at 18,000 ya

• 2-3 mile thick ice causing downwarping on crust
• Northern Canada has risen 300 meters in rebound since end of Wisconsin
• Hudson Bay should eventually disappear before next glaciation as rebounding still occurring
What happened in the Pleistocene?
- slower earth rebound than ice melt
- St. Lawrence Seaway had major invasion of salt water almost into Great Lakes
- allow for coastal maritime species entry into Great Lakes?

What happened in the Pleistocene?
- up to 100 meter drop in sea level worldwide
- coastal plains become extensive

What happened in the Pleistocene?
- up to 100 meter drop in sea level worldwide
- coastal plains become extensive
- continental islands disappeared and land bridges exposed

Malaysia to Asia & New Guinea and New Caledonia to Australia
Pleistocene - the Ice Ages

What happened in the Pleistocene?
- up to 100 meter drop in sea level worldwide
- coastal plains become extensive
- continental islands disappeared and land bridges exposed

Great Britain to Europe

Pre-Pleistocene connection Late Pleistocene English Channel formation

Pleistocene - the Ice Ages

What happened in the Pleistocene?

Ice-free Areas in North America
- North America south of glaciers
- Beringia, much of Alaska, Siberia
- Coastal plains, steep coastlines of Pacific northwest
- Wisconsin Driftless Area - never completely surrounded by ice

What was happening south of the glacial maxima?

Maximum extent of Wisconsin glacial activity at 18,000 ya

What was happening south of the glacial maxima?

Jet stream (and moisture) deflected south of glaciers

Large Pluvial Lakes formed - later disappeared and formed salt flats or deserts
- Lake Bonneville (300 m deep)
- Lake Lahontan
- Lake Manly
Lake Bonneville is now the Great Salt Lake in part.

**Pleistocene - the Ice Ages**

- Jet stream (and moisture) deflected south of glaciers
- Large Pluvial Lakes formed - later disappeared and formed salt flats or deserts
  - Lake Bonneville (300 m deep)
  - Lake Lahontan
  - Lake Manly

Lake Manly is now Death Valley - are the generic endemics to Death Valley of recent origin?

**Oxytropis lutea**
Capparaceae

What was happening south of the glacial maxima?
- Coastal plain (extensive) emerges on continental shelf with sea water drop

Wisconsin glaciation reached a climax at 18,000 years ago

_Tundra_ conditions existed at the margins of ice lobes. *Dryas* (Rosaceae), *Helophorus arcticus* (water scavenger beetle), *Cymindis unicolor* (alpine ground beetle)
Tundra conditions existed at the margins of ice lobes. *Dryas* (Rosaceae), *Helophorus arcticus* (water scavenger beetle), *Cymindis unicolor* (alpine ground beetle).

How do we know what vegetation/flora existed south of the glacial maxima?

Paleobotanists have been aided by the record of plant remains in lakes and bogs. Pollen (especially from trees) is the single most important record that has been used to identify vegetation/flora at a site and track vegetation changes following ice retreat.
Pollen record of White Pond, South Carolina
Note boreal elements (spruce) early in the record

- Extensive boreal forest zone S to 33° N
- Mixed deciduous forest zone near Gulf
- 18,000 ya harshest conditions; zones were further north earlier

18,000 ya
28 - 25,000 ya

Much of eastern North America would have looked like this boreal scene

White spruce - Picea glauca
Most widespread tree in North America

14,000 ya ice begins retreat
Vegetation units move north

13,000 ya
**Pleistocene - the Ice Ages**
- 14,000 ya ice begins retreat
- Vegetation units move north
- Proglacial lakes form
- St. Lawrence Seaway exposed

13,000 ya 11,000 ya

**Holocene - the Recent Times**
- Ice retreats continue into Holocene (10,000 ya)
- Warmest time of Holocene is Hypsithermal - 8,500 to 6,000 ya
- Vegetation units move north
- Prairie peninsula extends east

8,000 ya Present

**Holocene - the Recent Times**
- With 2/3 of this interglacial completed, earth should be cooling
- Last 100 years the average earth temperature is rising dramatically

*Carbon Dioxide (parts per million by volume)*

Temperature [°C]

*Temperature deviation, compared to 1850-1899 average (°C)*

- Annual deviations (land and sea)
- 10-year moving average (land only)
- 15-year moving average (land and sea)