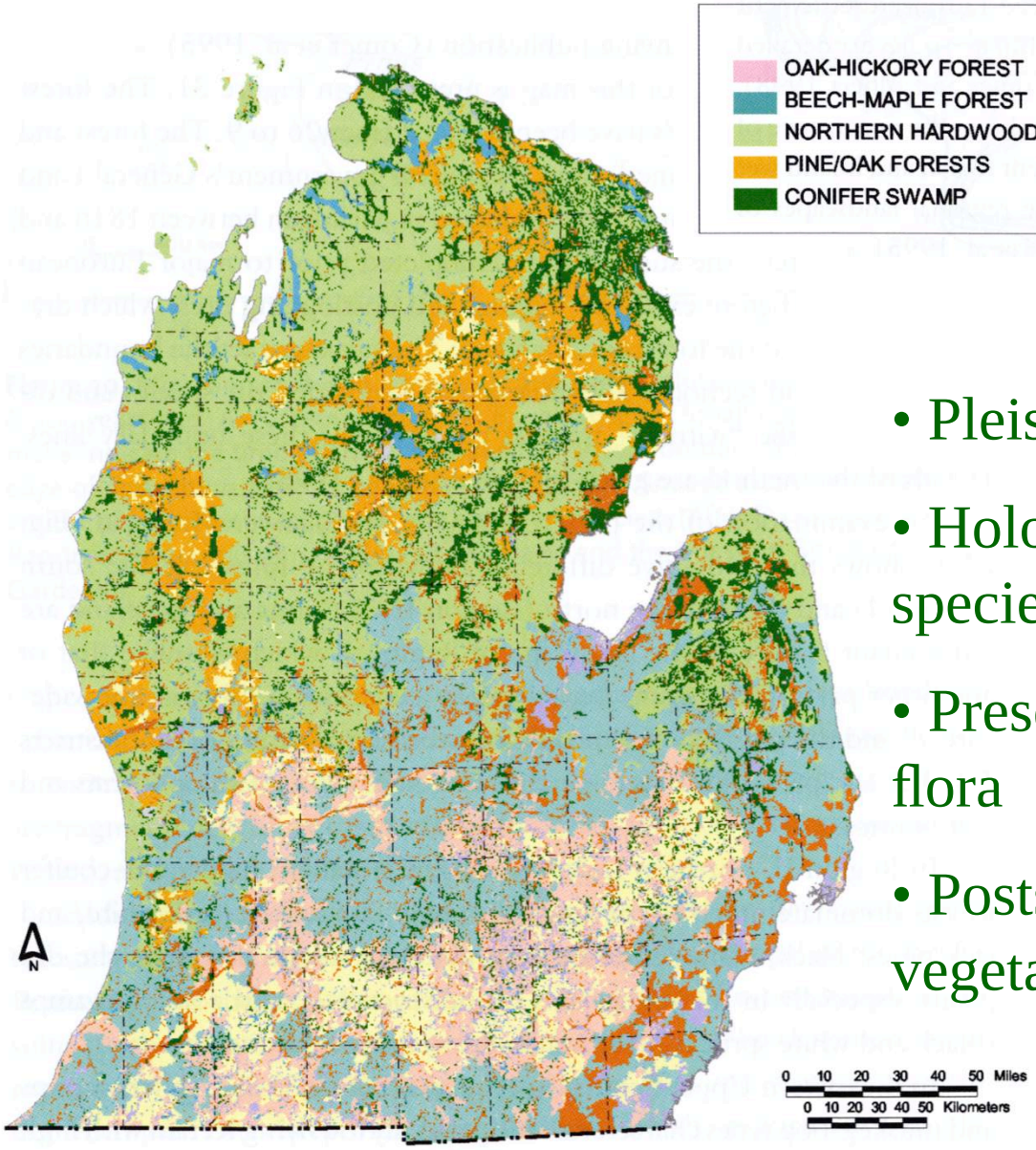


Michigan Forests

- Pleistocene glacial history
- Holocene movement of species and vegetation
- Presettlement vegetation and flora
- Postsettlement changes to vegetation and flora

Continental glacial history of Michigan

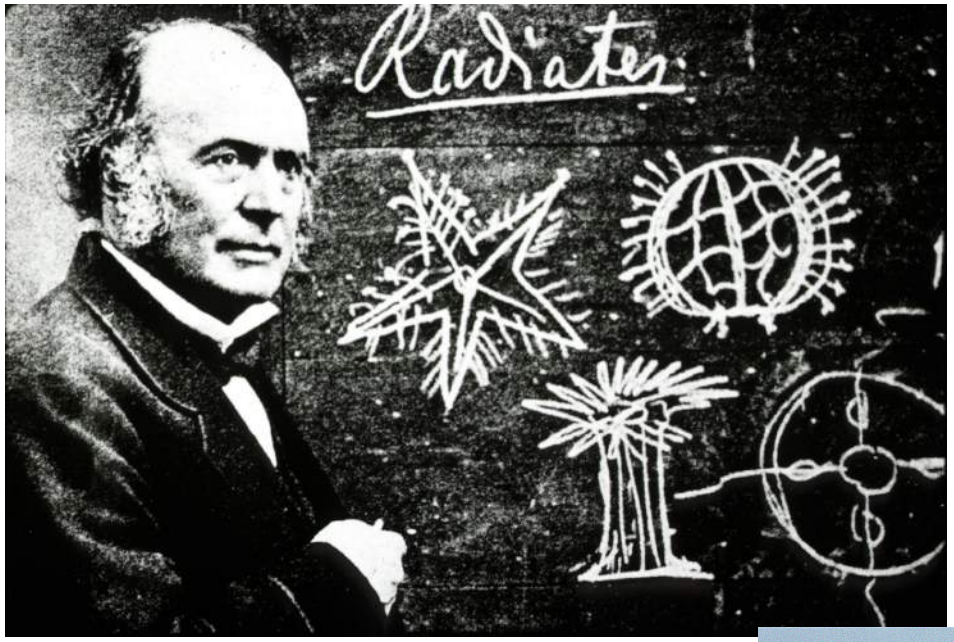
- Vegetation and ecology of Great Lakes region impacted by Pleistocene glaciation over last 2-2.3 million years

Continental glacial history of Michigan

- Vegetation and ecology of Great Lakes region impacted by Pleistocene glaciation over last 2-2.3 million years
- Wisconsin glaciation (last epoch) most important

Continental glacial history of Michigan

- Assembly of **flora** (species composition) and **vegetation** (ecological community types) of most Great Lakes was during end of last glacial and the Holocene (18,000 years ago to present)



Louis Agassiz [1807-1873]

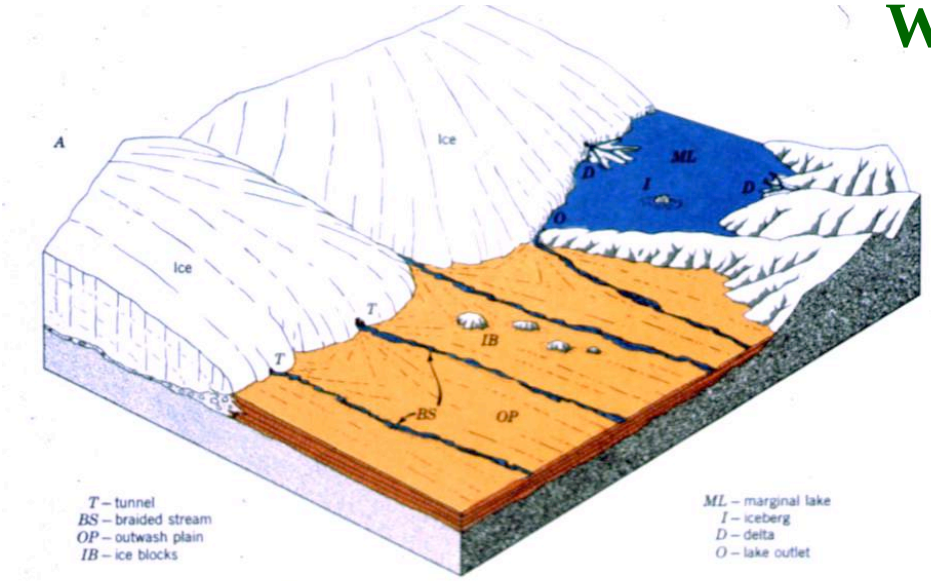
Christian Swiss geologist who studied mountain glaciation

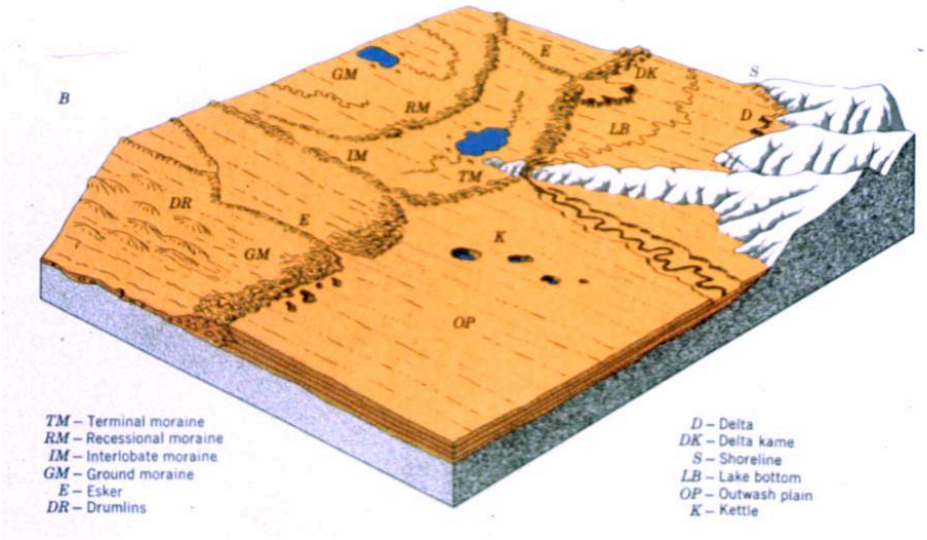
First scientist to articulate continental glaciation in the northern hemisphere

His subsequent studies of North American glacial began the study of the field of continental glaciation

“God did not allow glaciation without a purpose”

What evidence did Agassiz see?





- ice scouring
- glacial outwash till
- drainage channels
- temporary glacial lakes
- kettle lakes
- moraines
- perched dunes
- plant and animal “disjunct” distributions

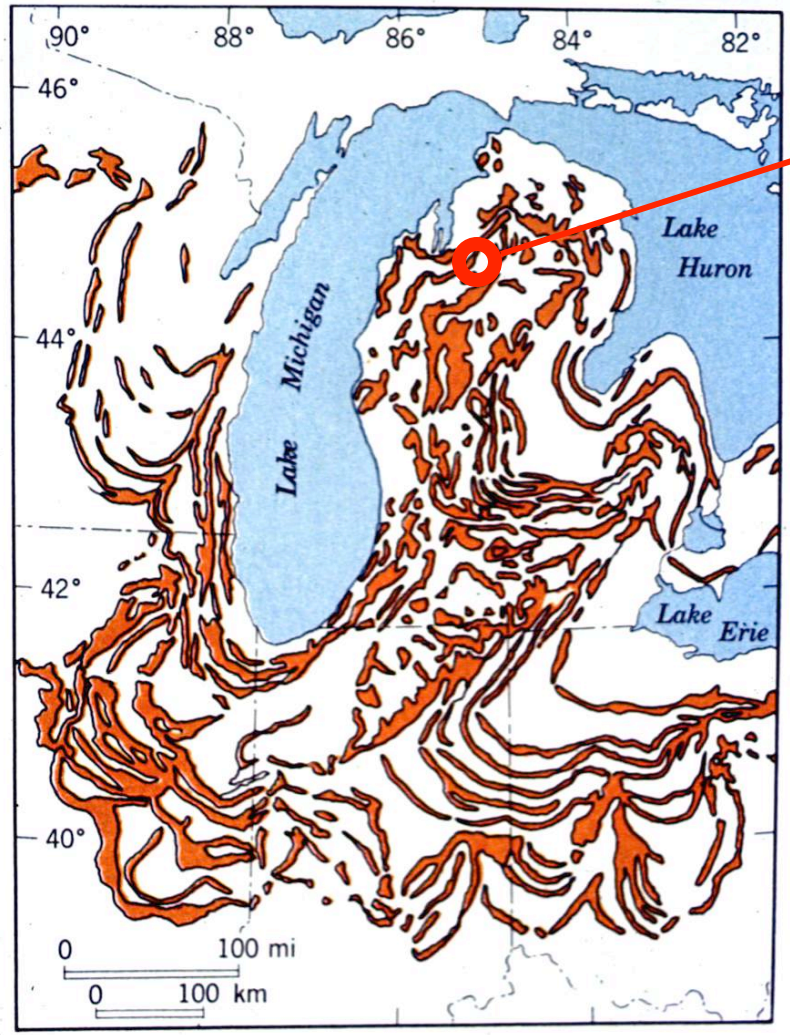


FIGURE 18.22 Moraine belts of the north-central United States have a festooned pattern left by ice lobes. (After R. F. Flint and others, *Glacial Map of North America*, Geological Society of America.)

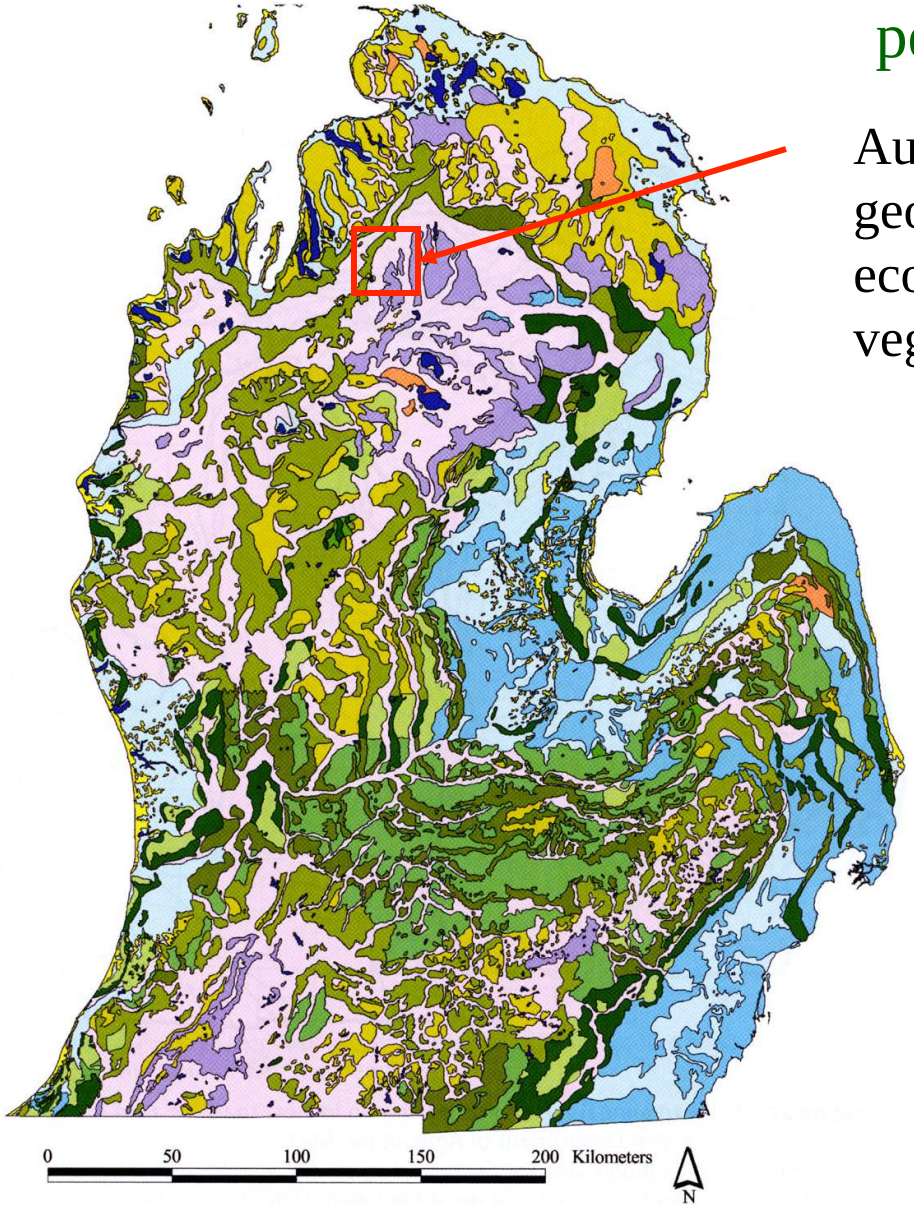
Au Sable

End moraines are some of the most visible "footprints

Formed as ice front "stagnated" for a time and deposited large amounts of unsorted rock, pebbles, sand, and clay

Contain forests that are on richer soil types (nutrients held in clay) with good water retention — mesic forests

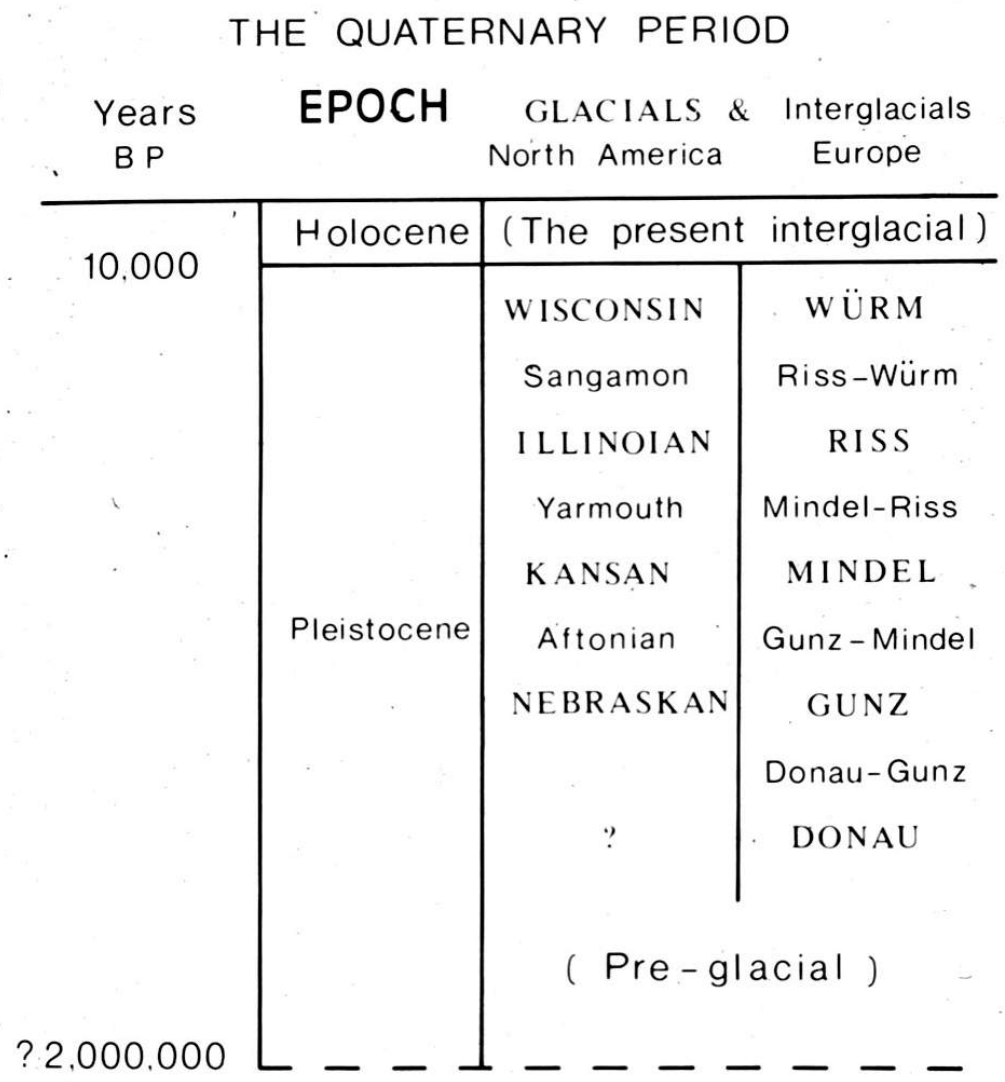
A summary of Michigan's lower peninsula glacial geology



Au Sable is in an unique region geologically that exhibits many different ecological conditions and thus plant vegetation types

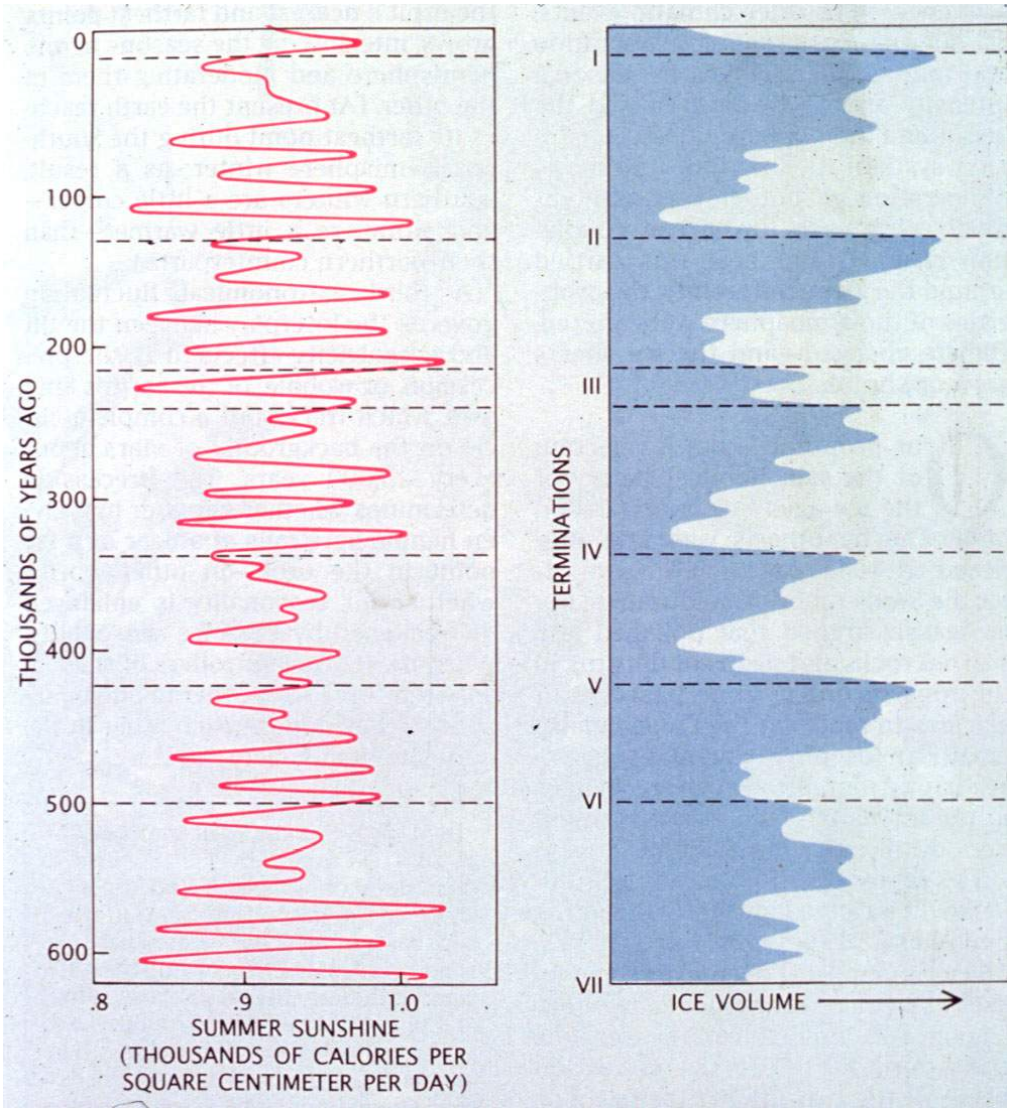
- Outwash Plain
- Ice-Contact Terrain
- Sand Lake Plain
- Clay Lake Plain
- Dune
- Organic Deposits
- Lake
- Fine End Moraine
- Medium End Moraine
- Coarse End Moraine
- Fine Ground Moraine
- Medium Ground Moraine
- Coarse Ground Moraine
- Thin Till Over Bedrock

Great Lakes Region during the Quaternary



The ice-ages (Pleistocene Epoch) included about 20 glacial advances followed by 20 interglacials over the last 2 million years

We are now in the last interglacial called the Holocene Epoch, which followed the most recent glacial ice age called the Wisconsin

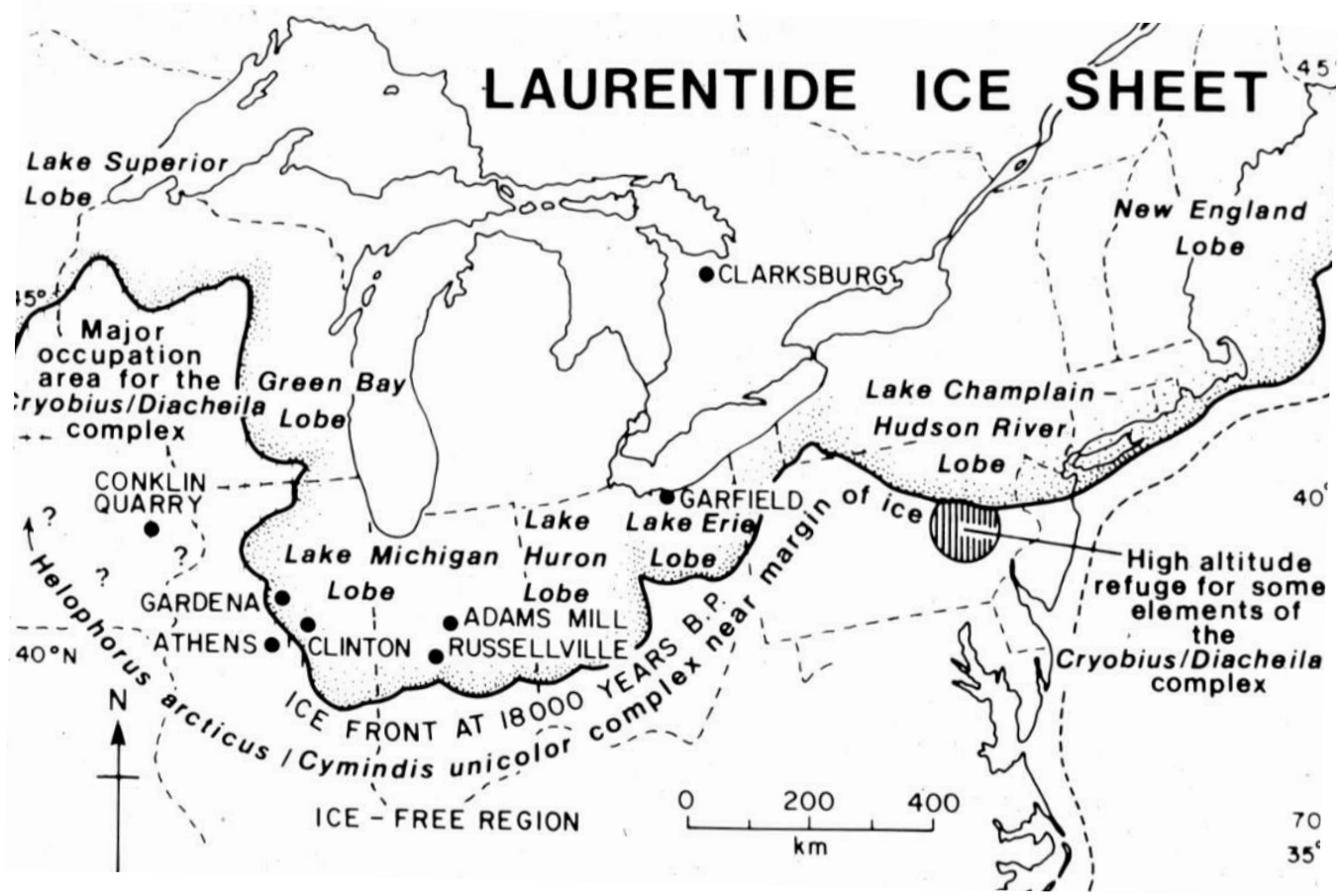


Great Lakes Region during the Quaternary

The ice-ages (Pleistocene Epoch) included about 20 glacial / interglacials over the last 2 million years

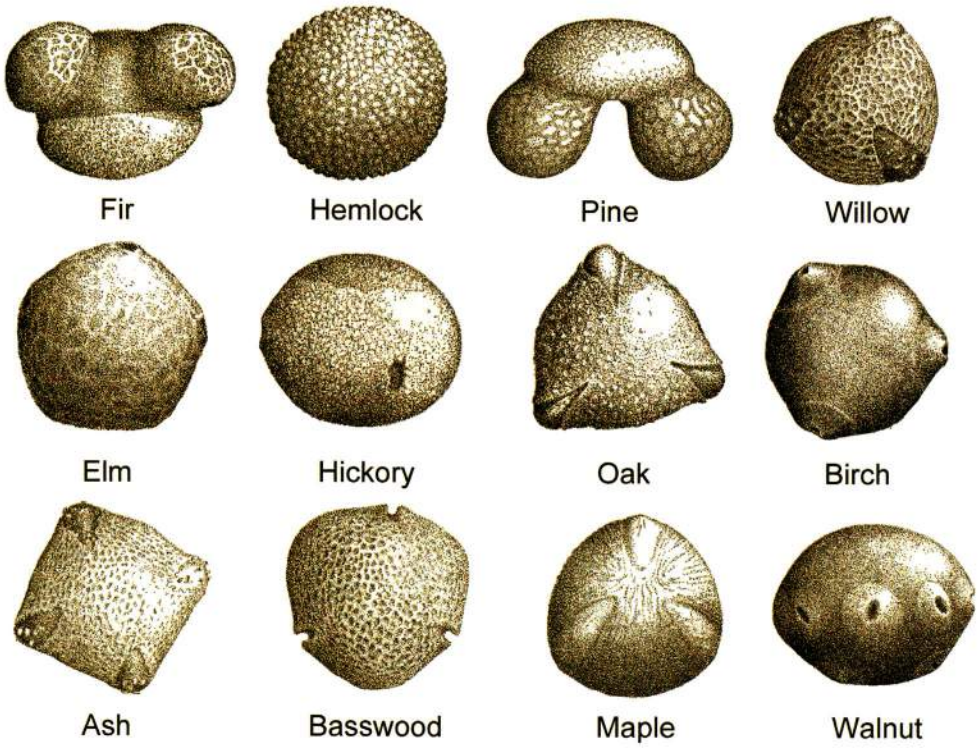
Last interglacial called the Holocene Epoch and followed the last glacial - Wisconsin

"Paleothermometers" indicate that these ice ages occurred on a cycle about 100,000 years



Wisconsin glaciation reached a climax at 18,000 years ago

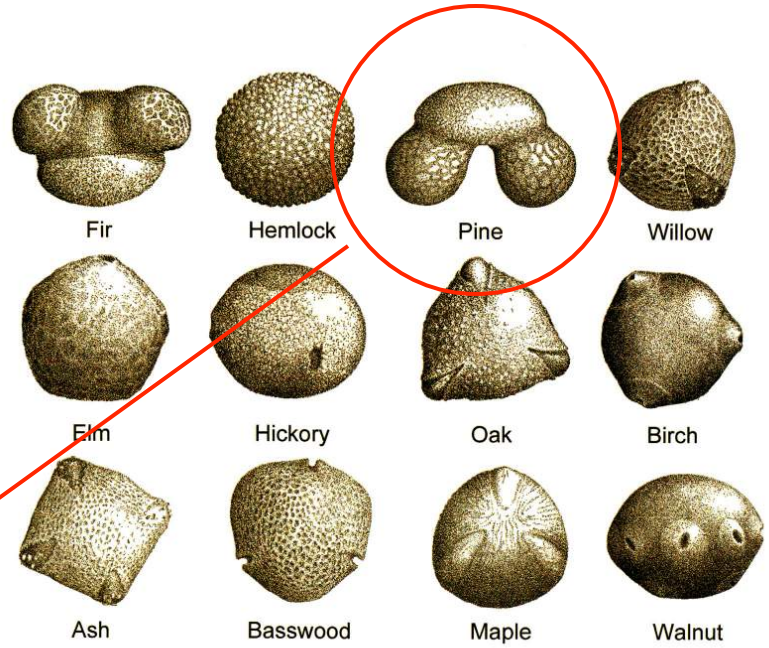
Tundra conditions existed at the margins of ice lobes. How do we know what vegetation and flora occurred further south of the ice?



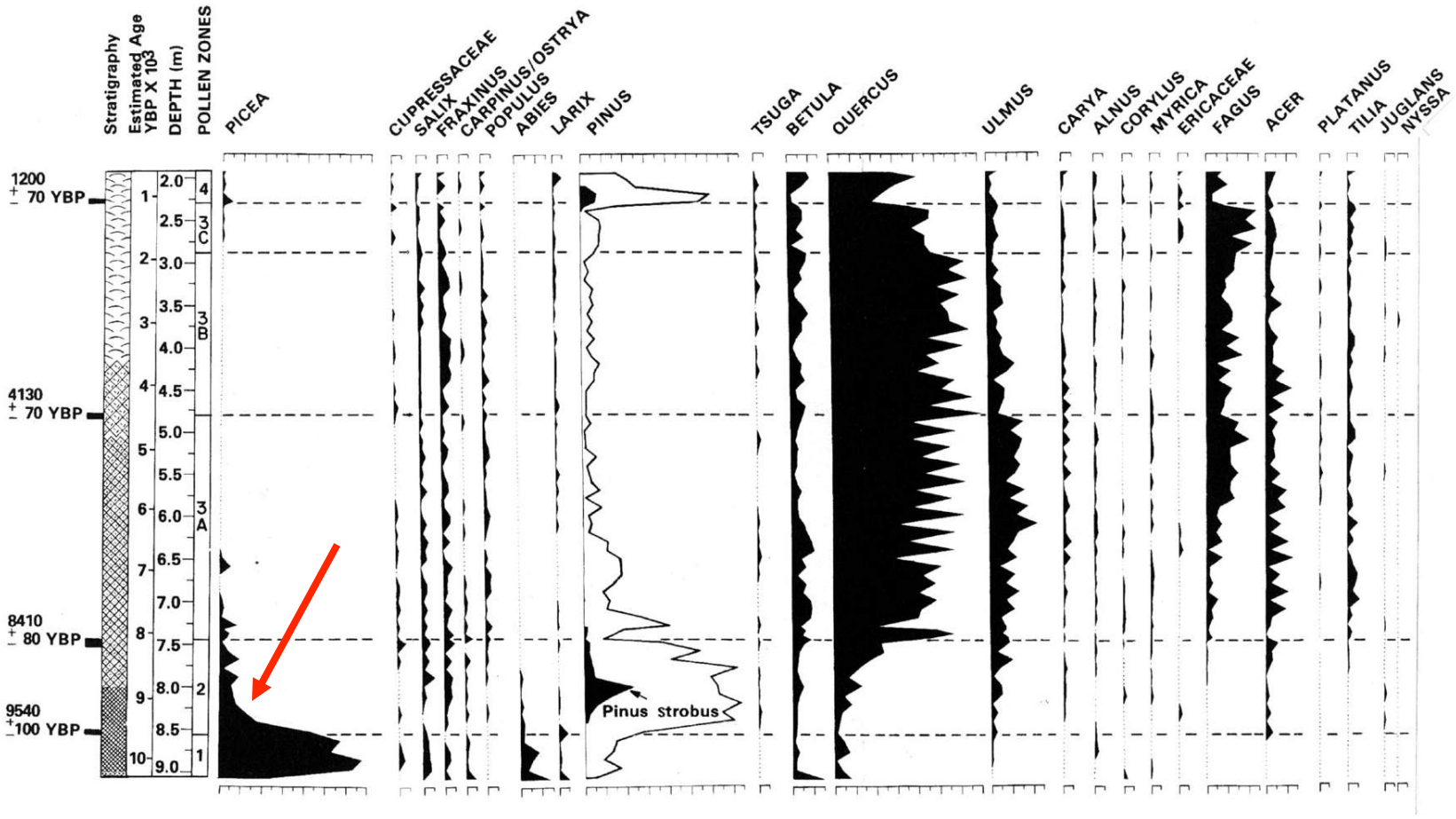
Paleobotanists have been aided by the record of plant remains in lakes and bogs. Pollen (especially from trees) is the single most important record that has been used to track vegetation changes following ice retreat.

Yearly deposits accumulate in lake bottoms to be covered by silt in layers, or in bog peat.

pine pollen from Big Twin Lake



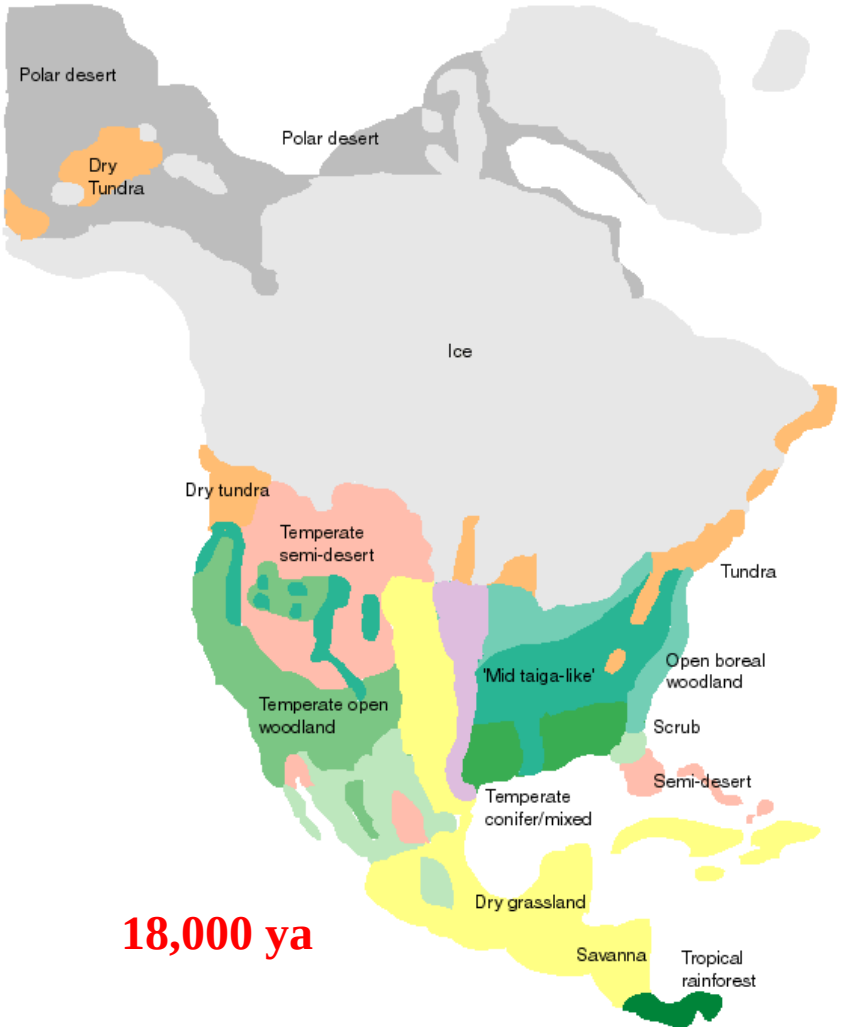
Pleistocene - the Ice Ages



- Pollen record of White Pond, South Carolina
- Note boreal elements (spruce) early in the record

Pleistocene - the Ice Ages

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

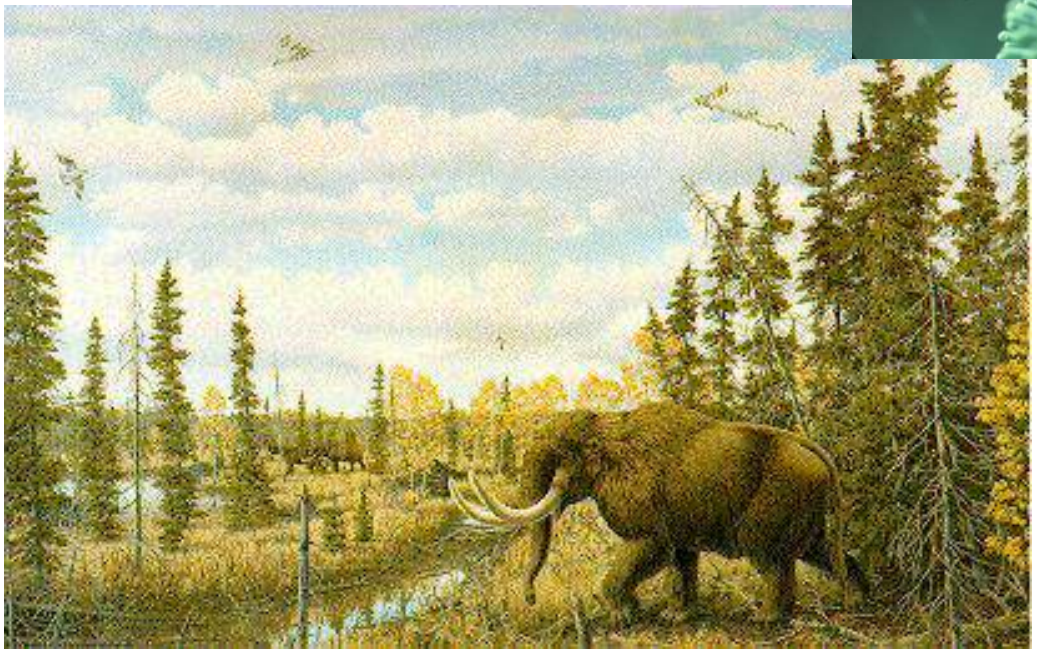


18,000 ya

28 - 25,000 ya

Pleistocene - the Ice Ages

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



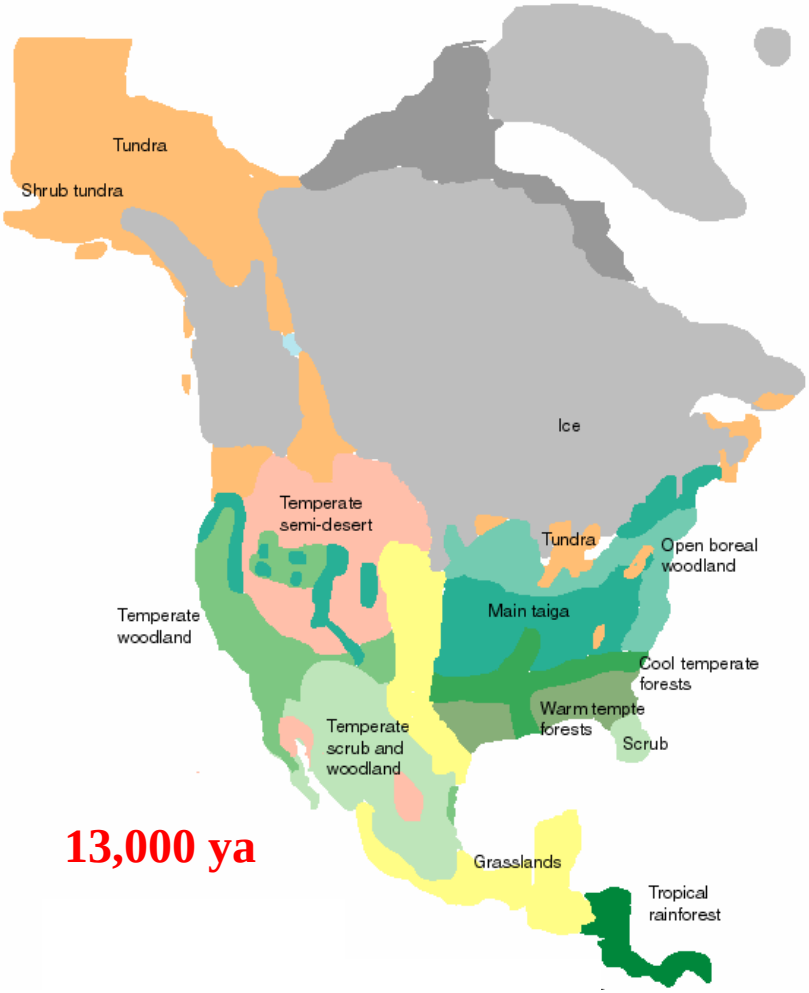
White spruce - *Picea glauca*

Most widespread tree in North America

Illinois 16K

Pleistocene - the Ice Ages

- 14,000 ya ice begins retreat
- Vegetation units move north

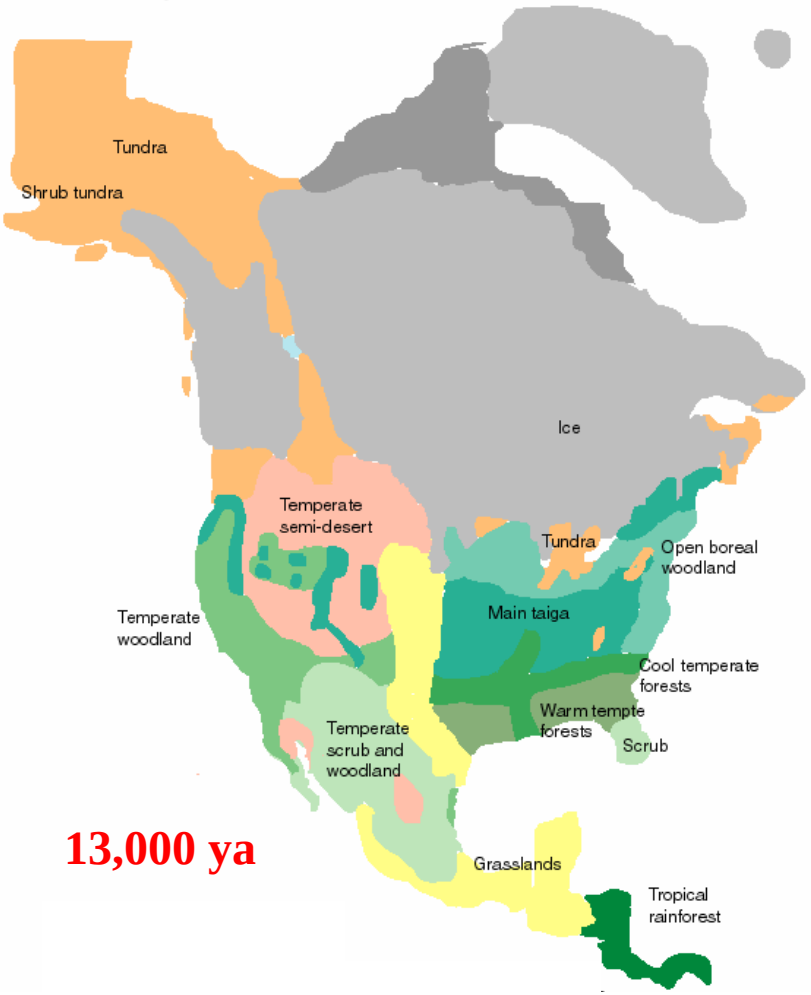


13,000 ya

Holocene - the Ice Retreats

- 14,000 ya ice begins retreat
- Vegetation units move north

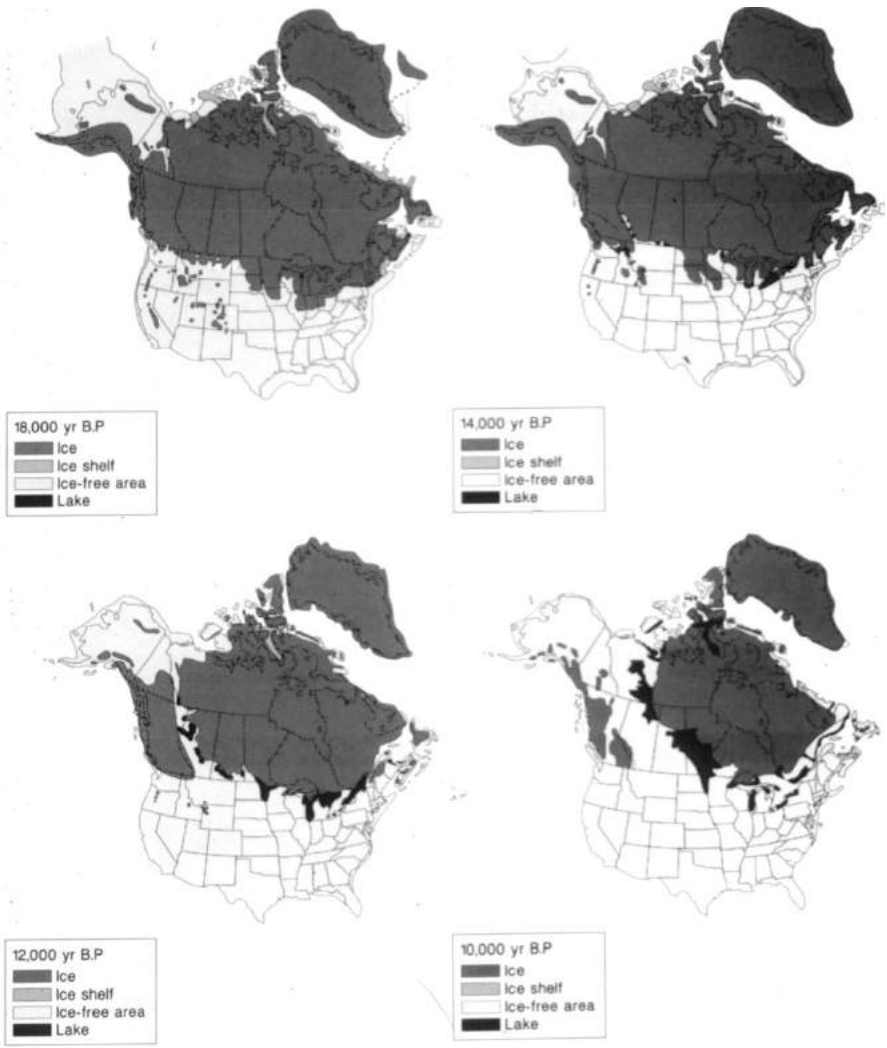
- Proglacial lakes form
- St. Lawrence Seaway exposed



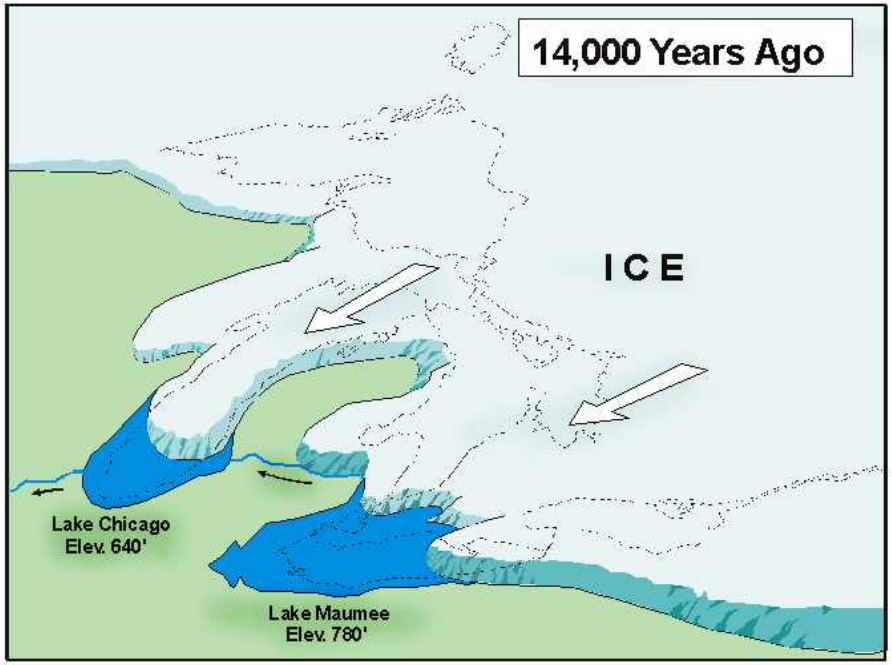
13,000 ya

11,000 ya

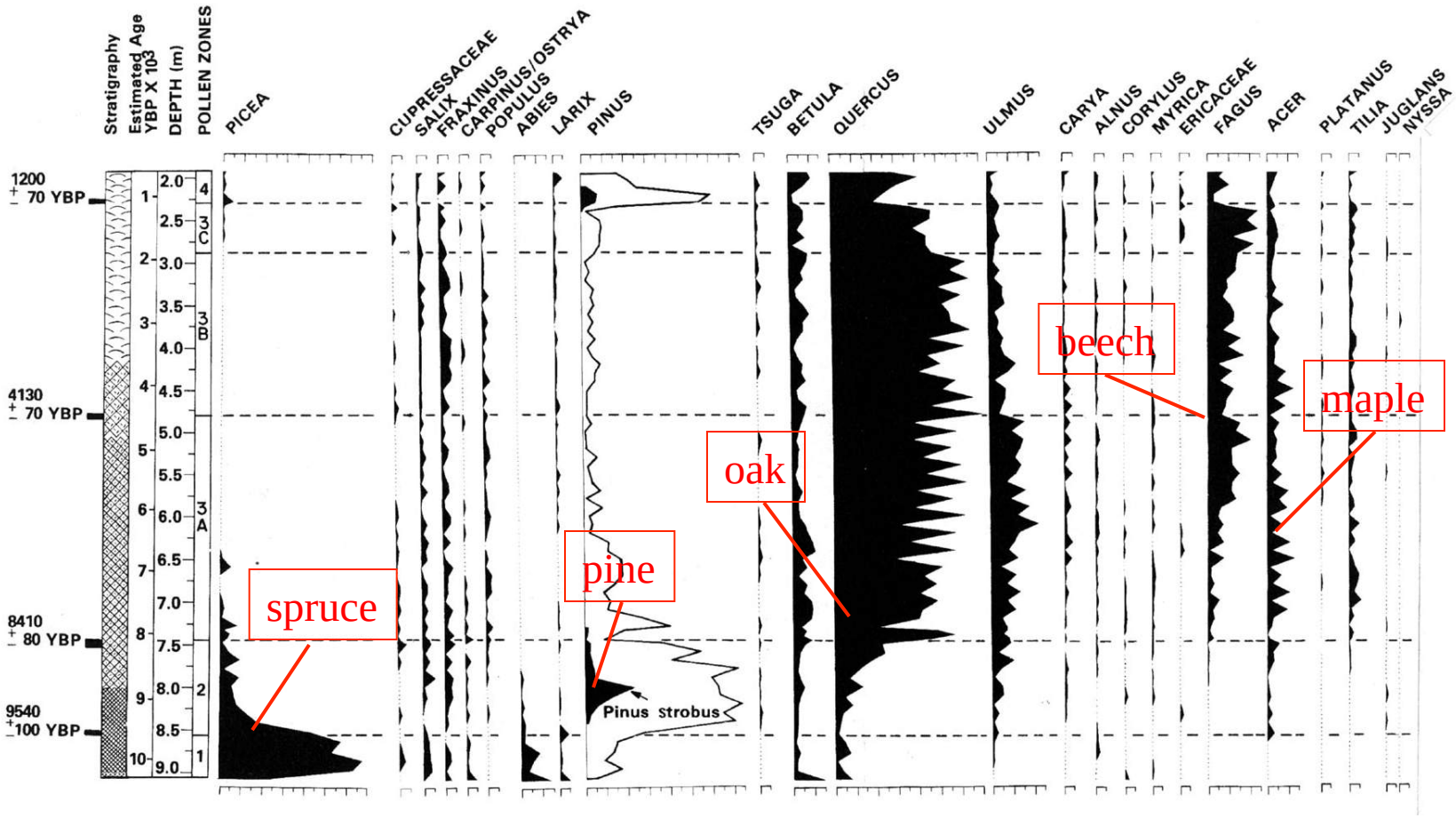
Holocene - the Ice Retreats



Formation of extensive pro-glacial lakes; drainage first through Grand River, Lake Chicago, and Mississippi River; later through St. Lawrence Seaway

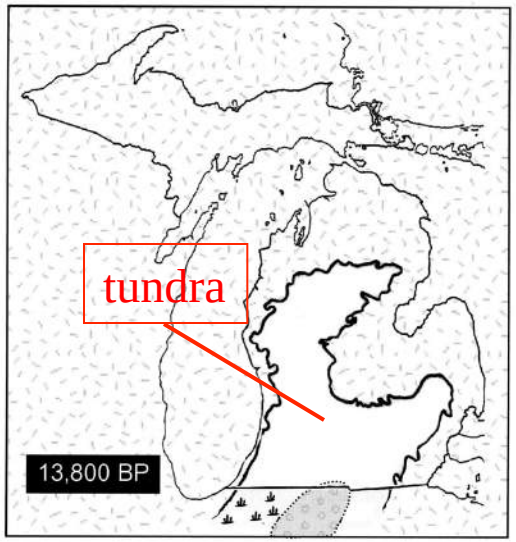


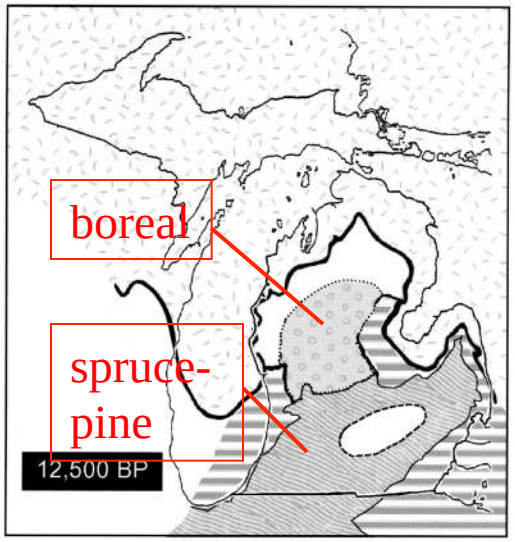
Assembly of Great Lakes Flora

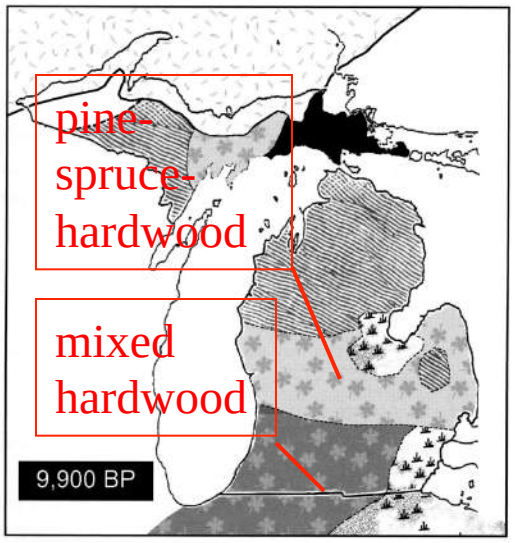


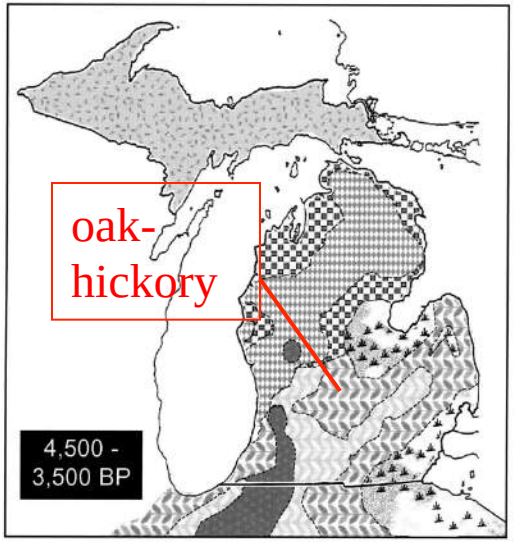
- Pollen record shows waves of vegetation over time
- Boreal elements (spruce) early in the Holocene, followed by pine communities, and then oak, maple, and other hardwoods

Assembly of Great Lakes Flora



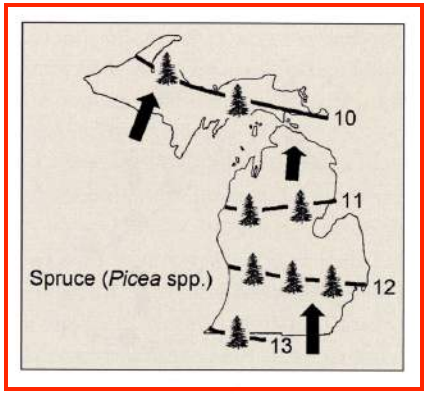


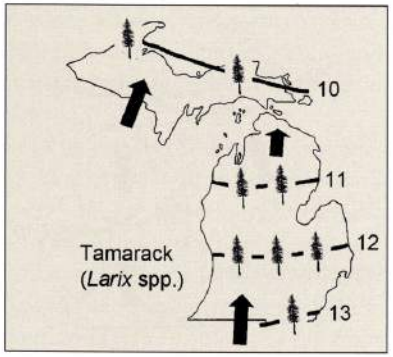


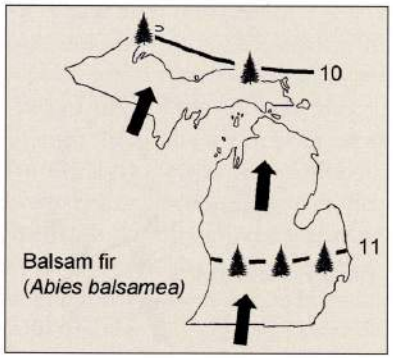


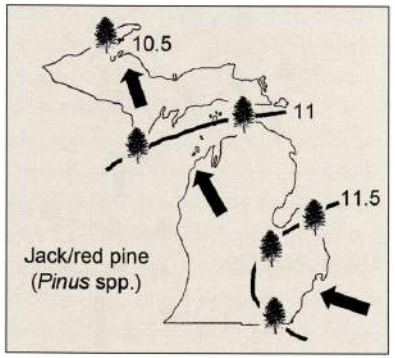
Shifts of vegetation belts starting at about 13,000 ya

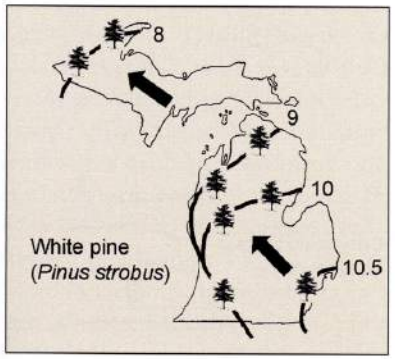
Assembly of Great Lakes Flora

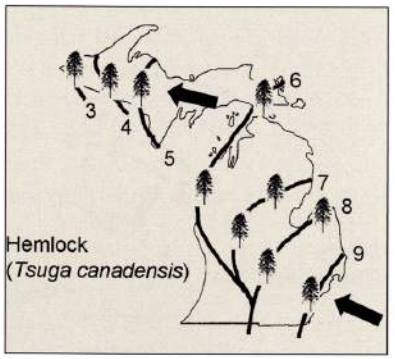








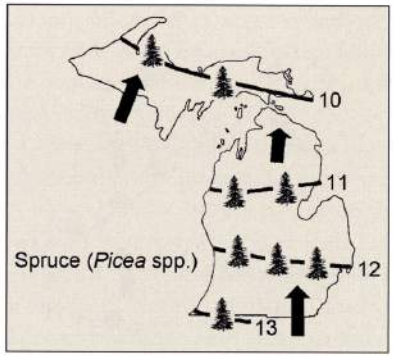


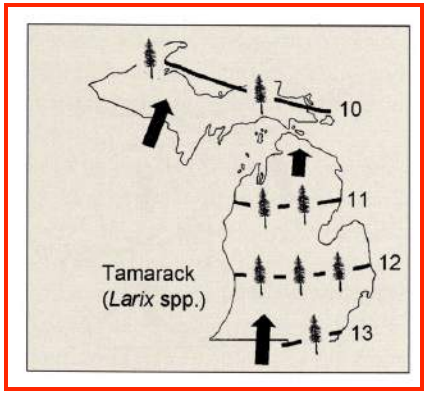


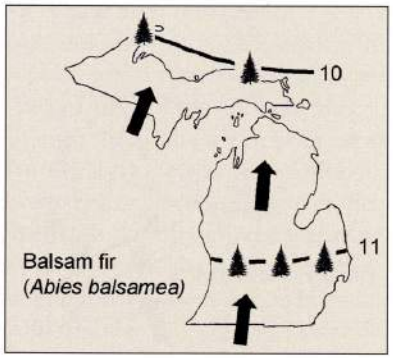
Coniferous species migrated into the Great Lakes region in waves:

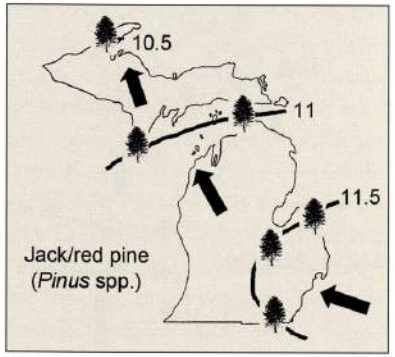
Boreal species like spruce, tamarack, and balsam fir arrived first

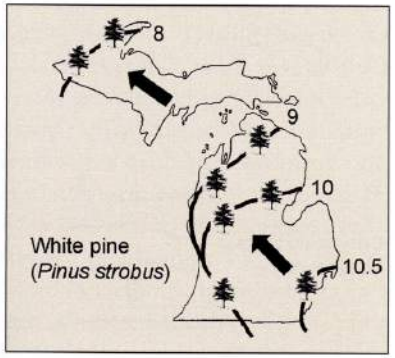
Assembly of Great Lakes Flora

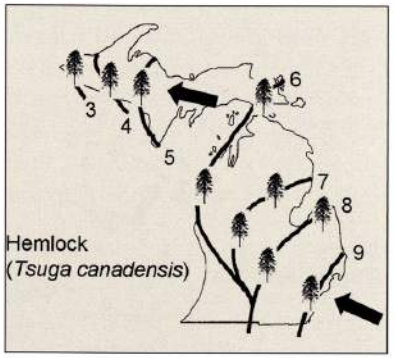








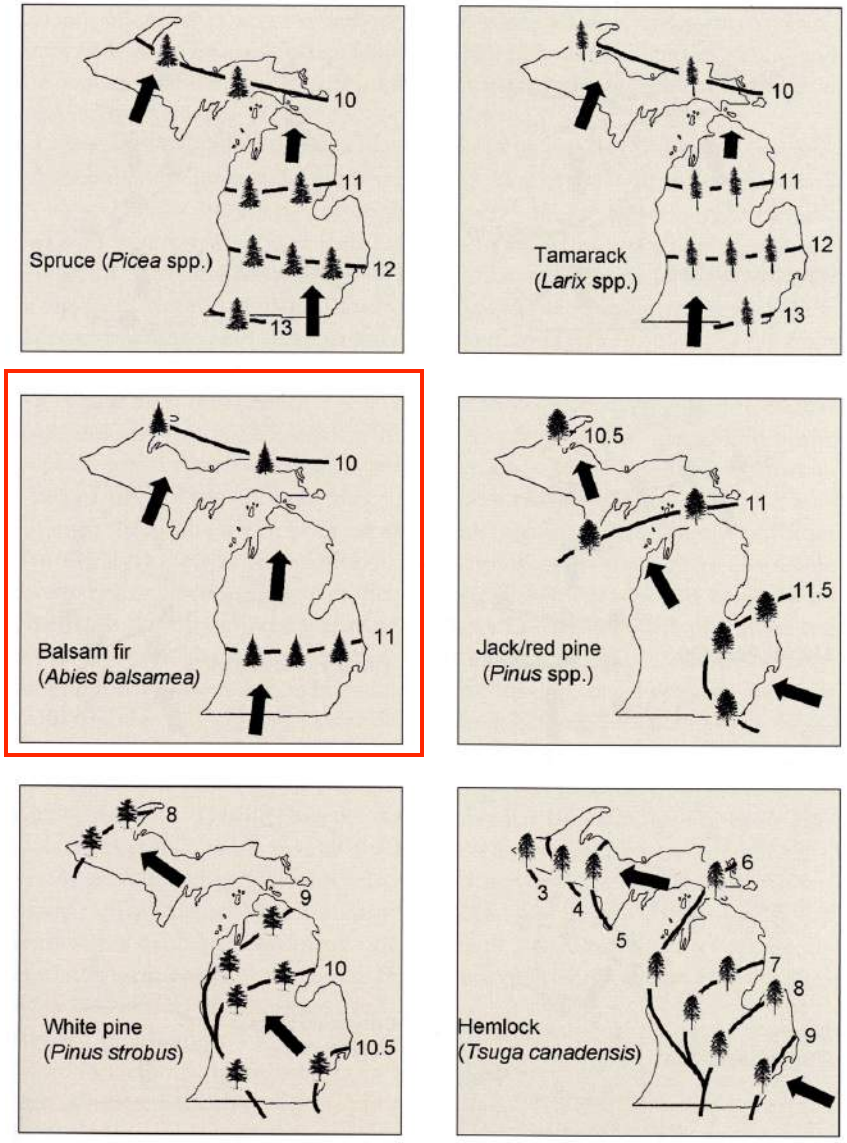




Coniferous species migrated into the Great Lakes region in waves:

Boreal species like spruce, tamarack, and balsam fir arrived first

Assembly of Great Lakes Flora



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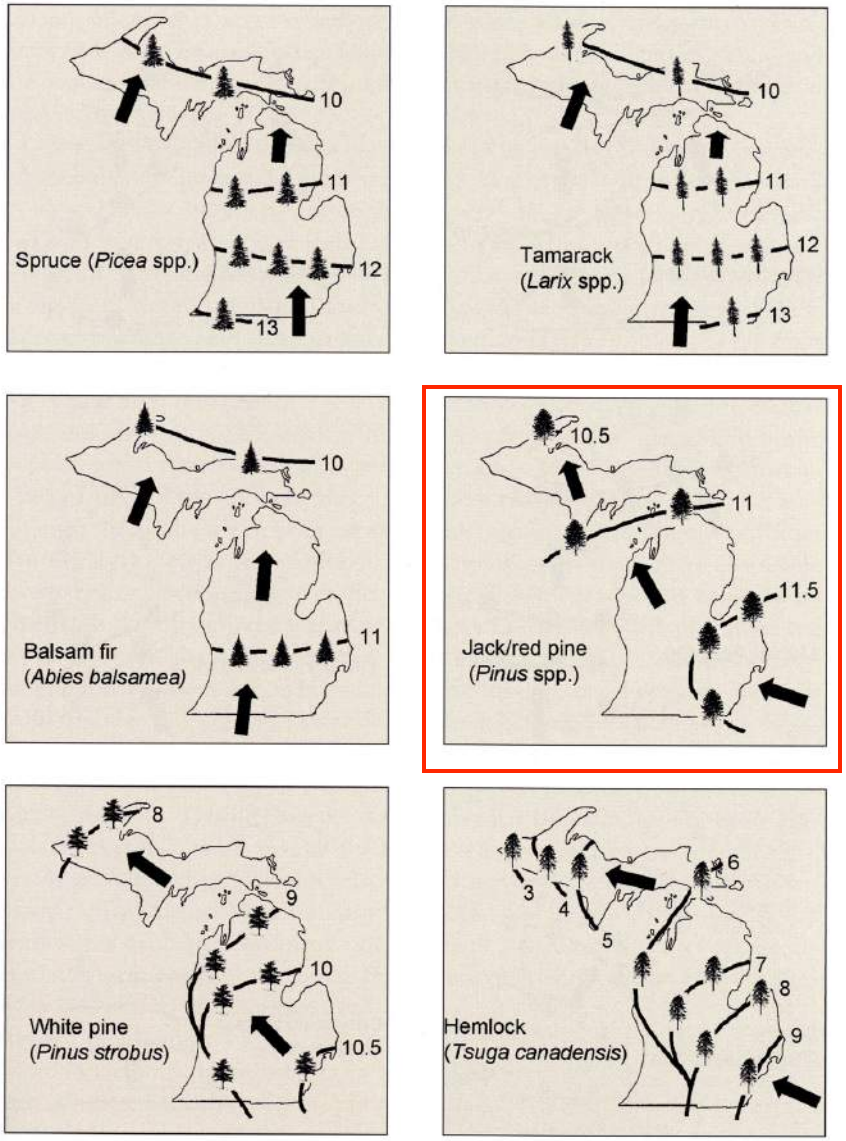
Boreal species like spruce, tamarack, and balsam fir arrived first

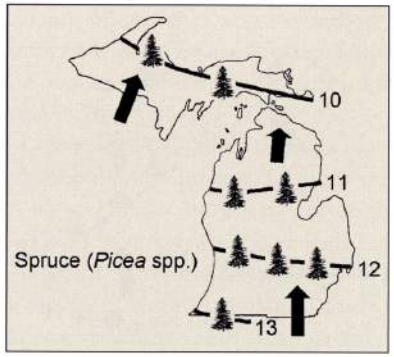
Assembly of Great Lakes Flora

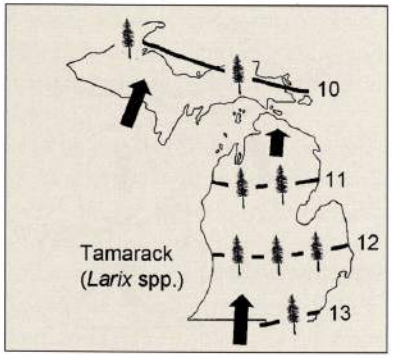


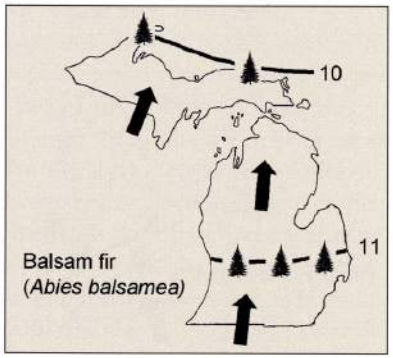
Coniferous species migrated into the Great Lakes region in waves:

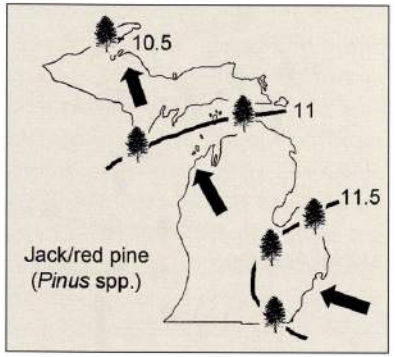
Xeric pine species like jack pine and red pine arrived next

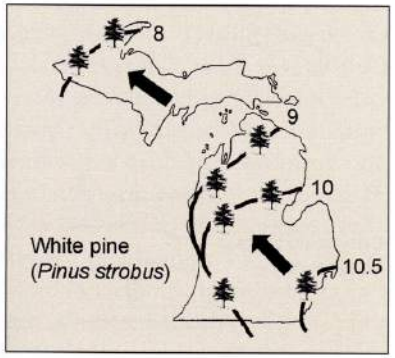
Assembly of Great Lakes Flora

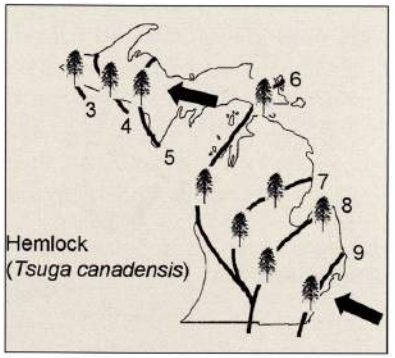








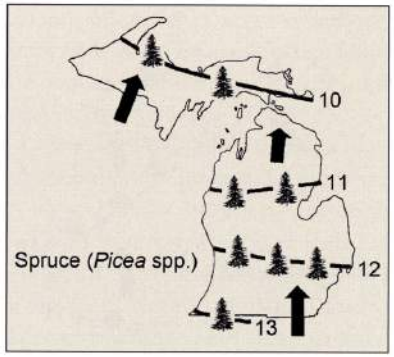


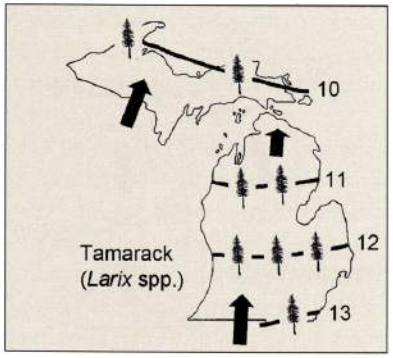


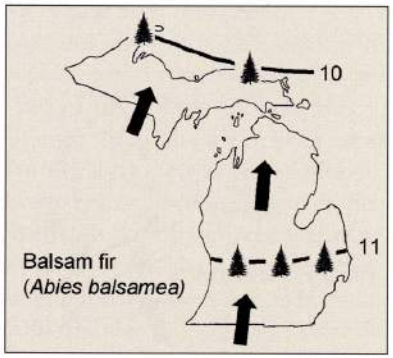
Coniferous species migrated into the Great Lakes region in waves:

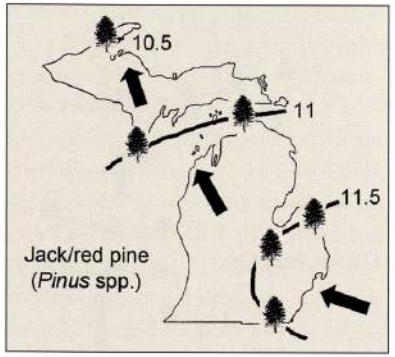
. . . followed by more mesic white pine

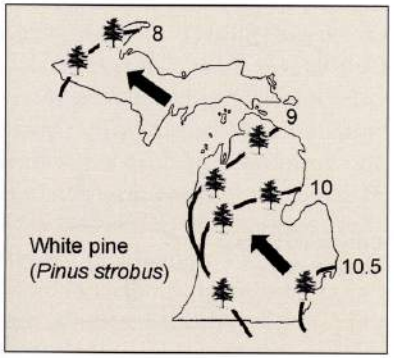
Assembly of Great Lakes Flora

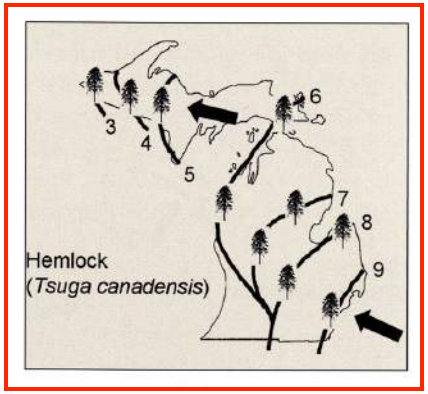








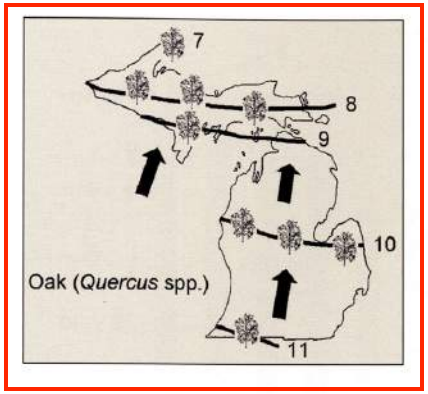


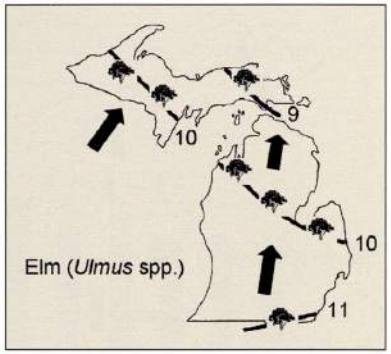


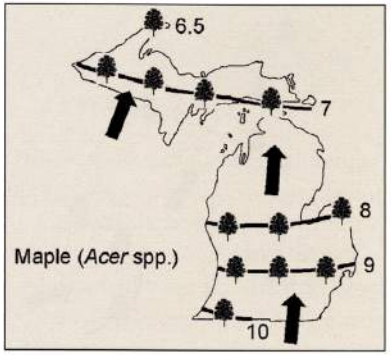
Coniferous species migrated into the Great Lakes region in waves:

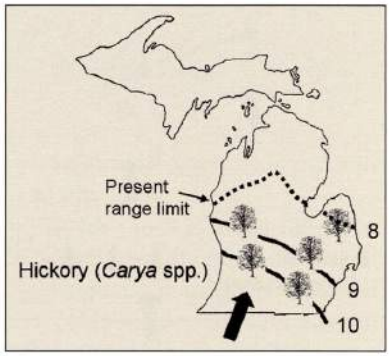
Hemlock, characteristic of mesic Northern Hardwood forests, arrived last

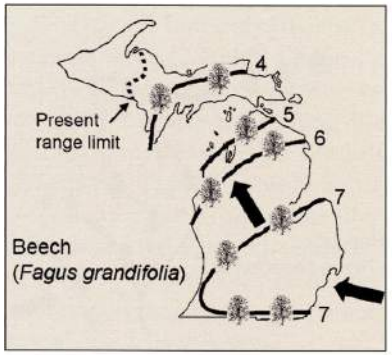
Assembly of Great Lakes Flora

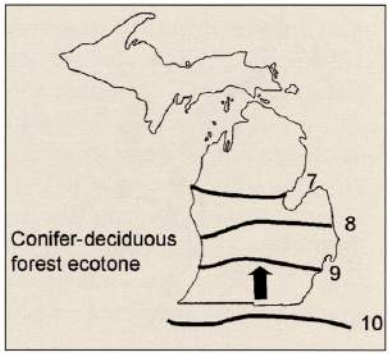








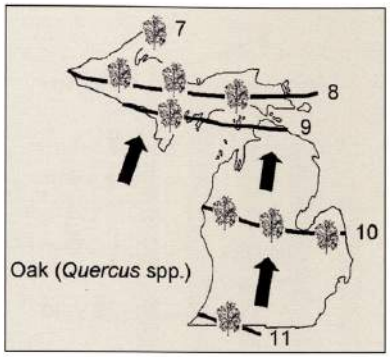


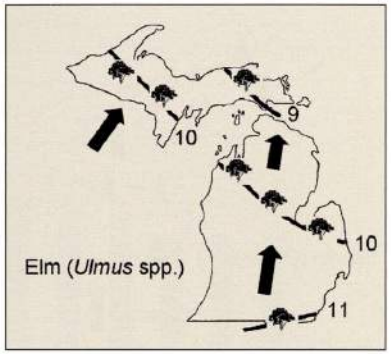


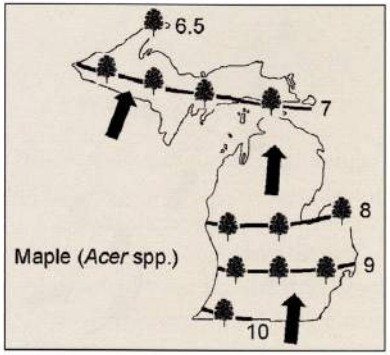
Angiosperm hardwoods migrated into the Great Lakes region in waves

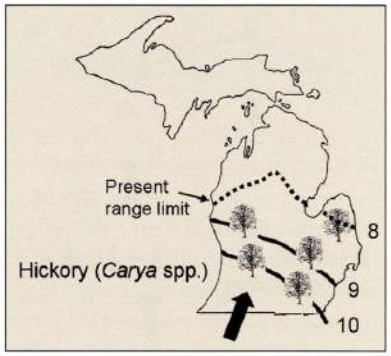
Oaks, hickories and elms arrived first - 11,000 ybp

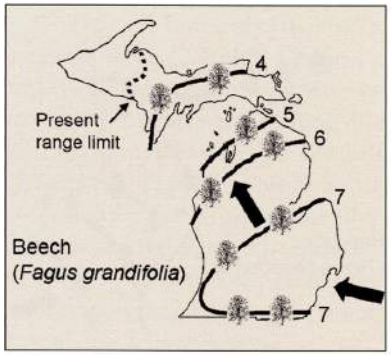
Assembly of Great Lakes Flora

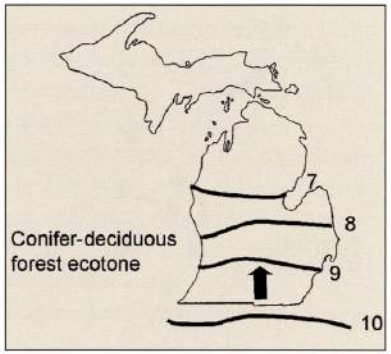






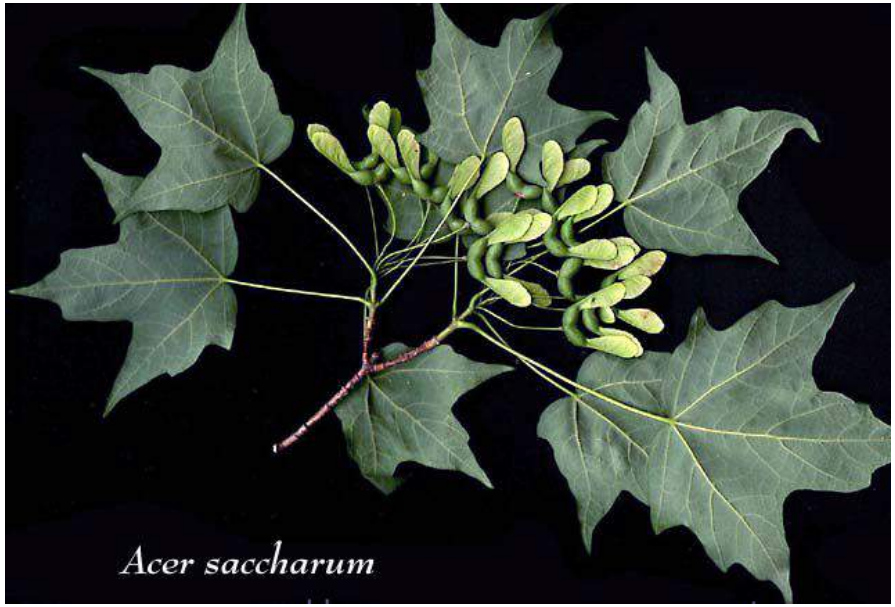




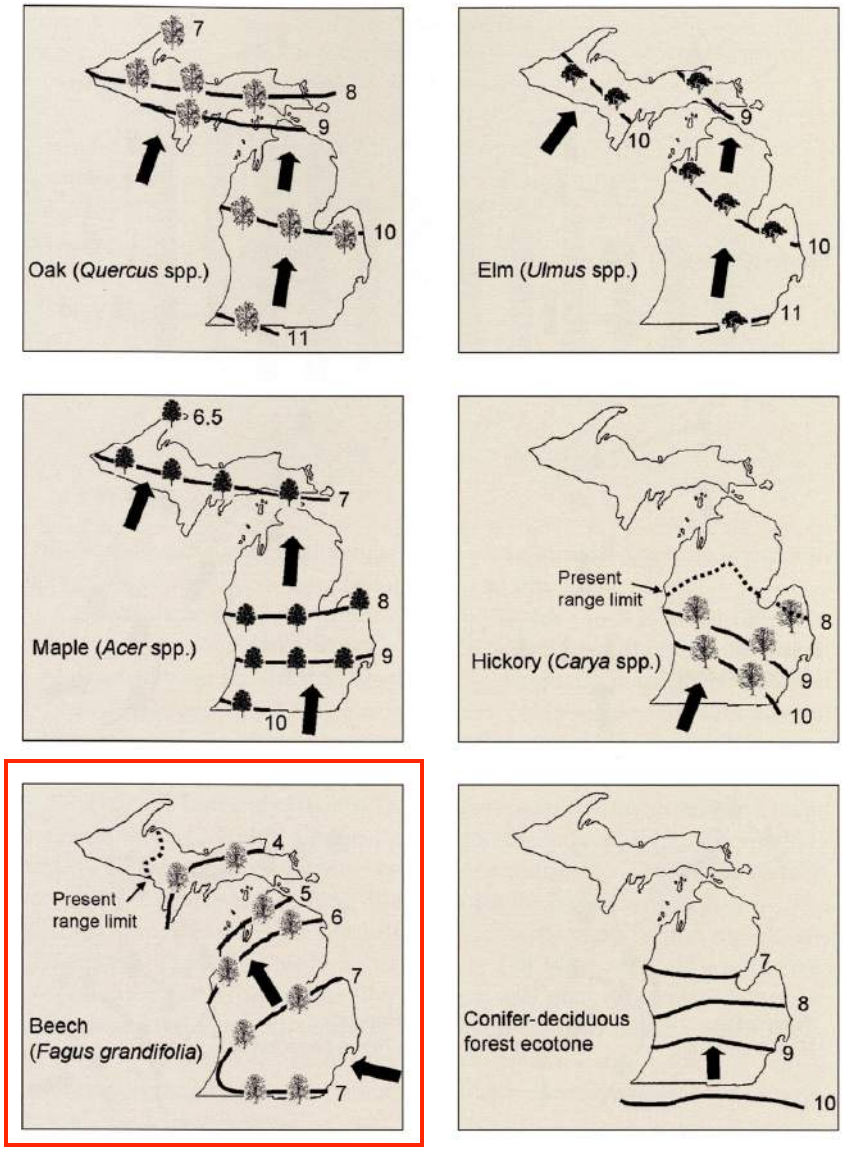


Angiosperm hardwoods migrated into the Great Lakes region in waves

Followed by mesic-loving maples



Assembly of Great Lakes Flora

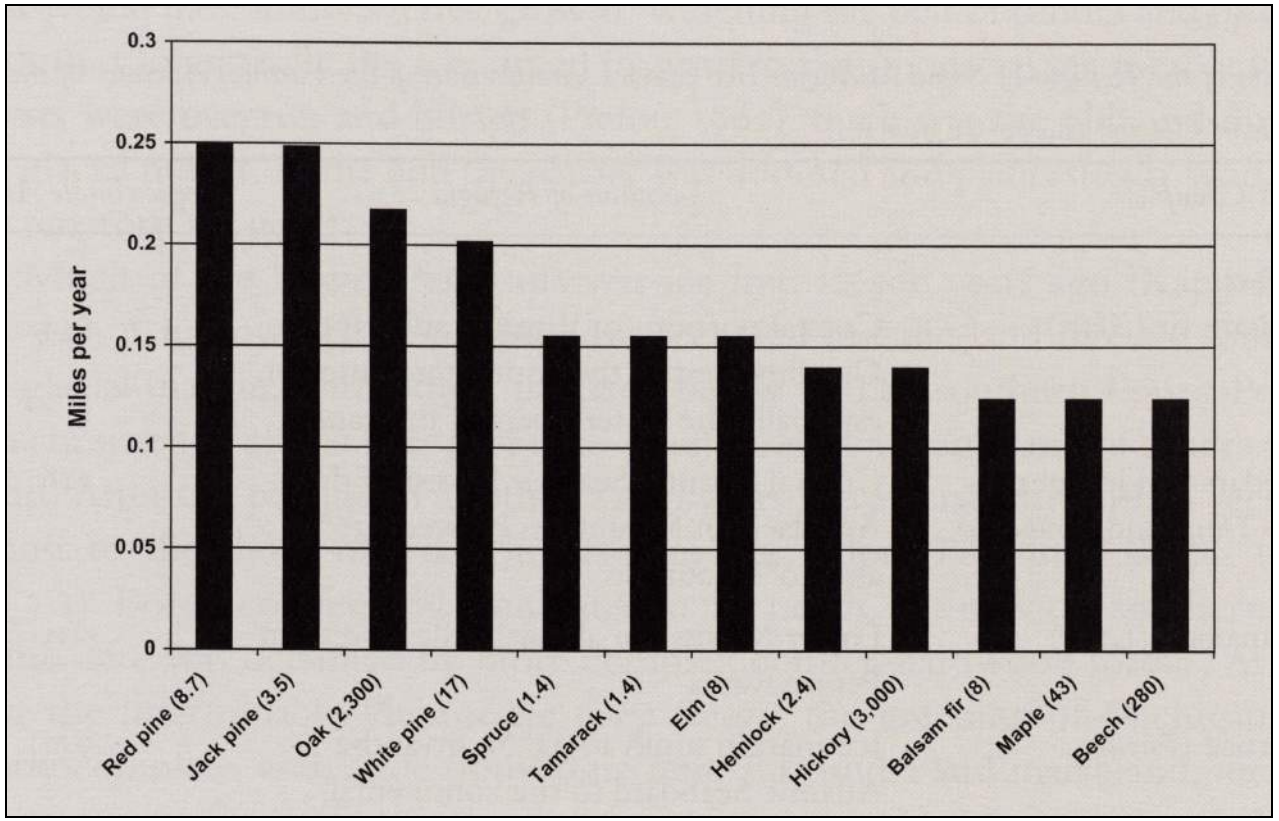


Angiosperm hardwoods migrated into the Great Lakes region in waves

And finally American beech last

Assembly of Great Lakes Flora

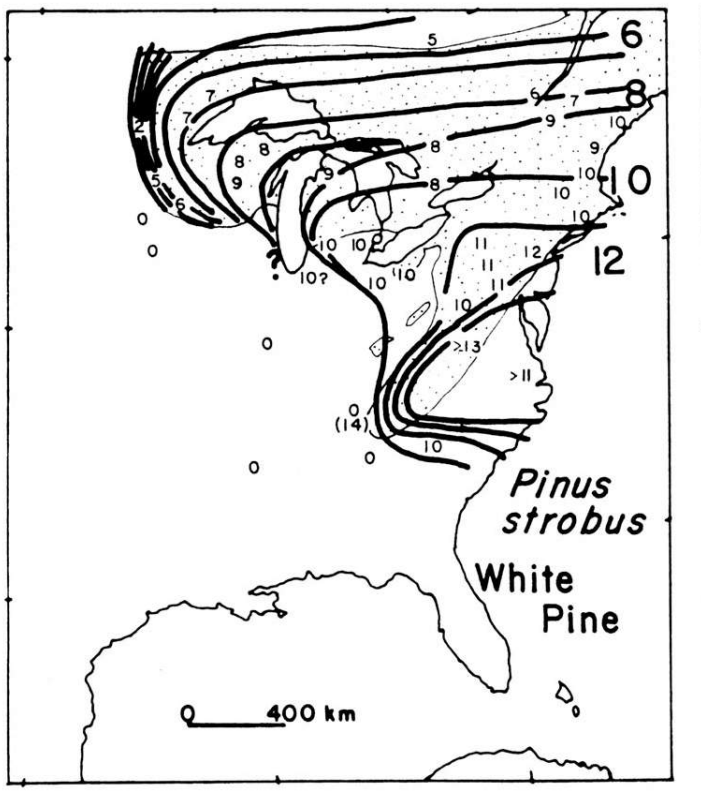
Rate of species migration (shown in the chart below as miles per year) is dependent on a number of factors:



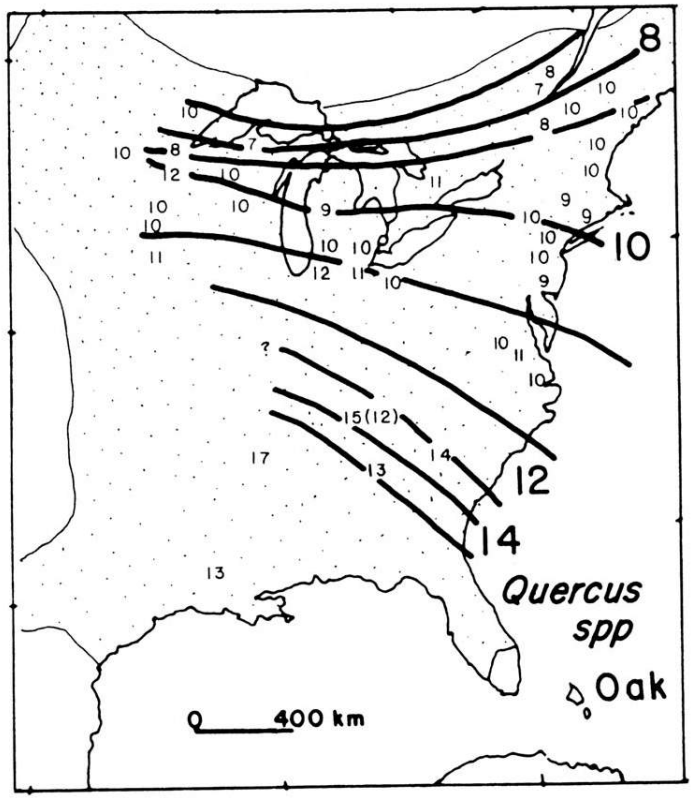
- location during Pleistocene
- ecological climate envelope of each species
- type of seed/ fruit dispersers
- seed dispersal rate (seed/fruit weight given in milligrams)

Assembly of Great Lakes Flora

Importantly, the different species of trees (and herbs) entering the Great Lakes region after the glaciers retreated entered via different refugia or survivia



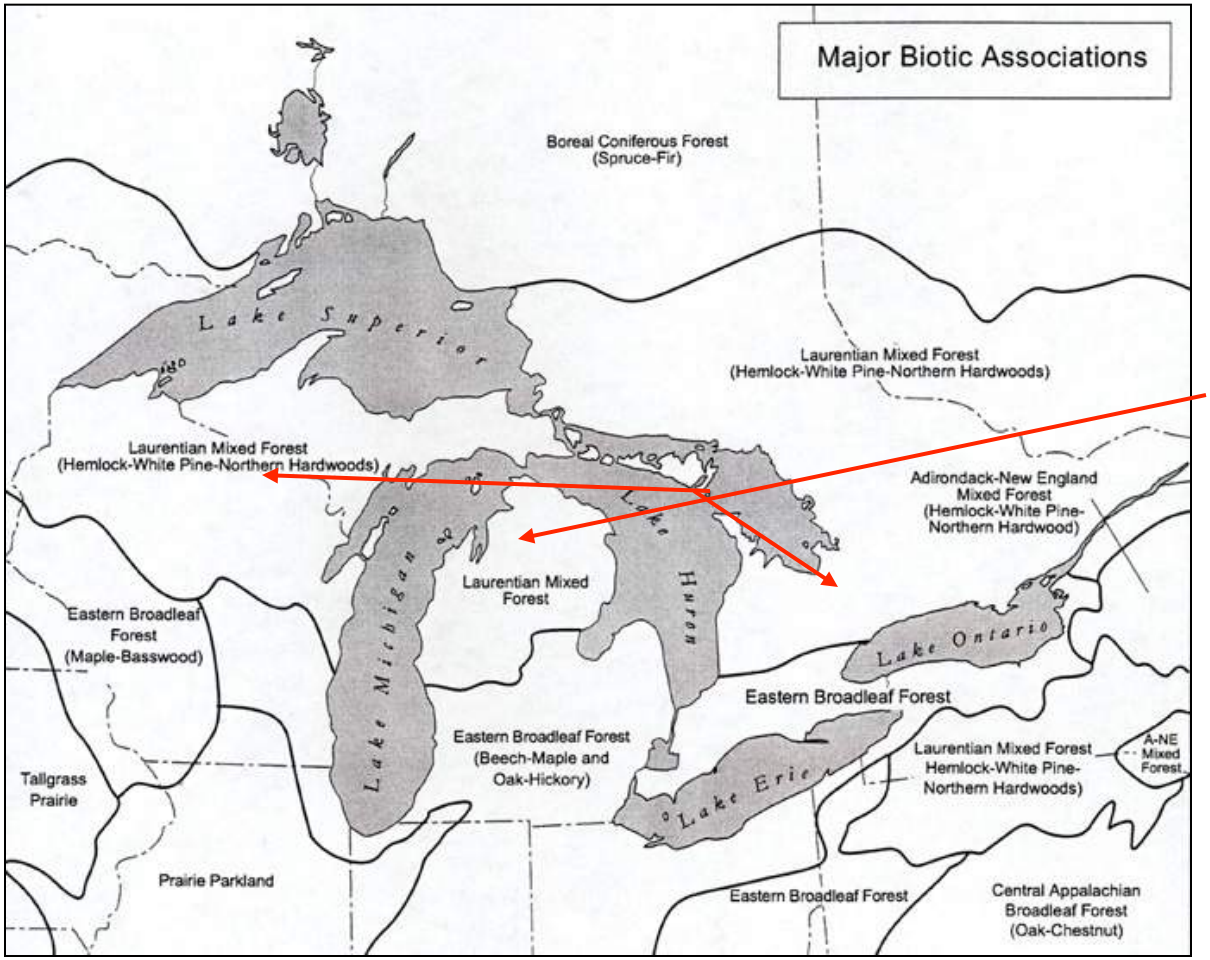
White pine from the Alleghenian refugium



Oaks from either the Alleghenian (white oak) or Ozarkian (black oak) refugia

Assembly of Great Lakes Flora

Species migrating into the Great Lakes region ended up in specific regions and associated with specific groups.

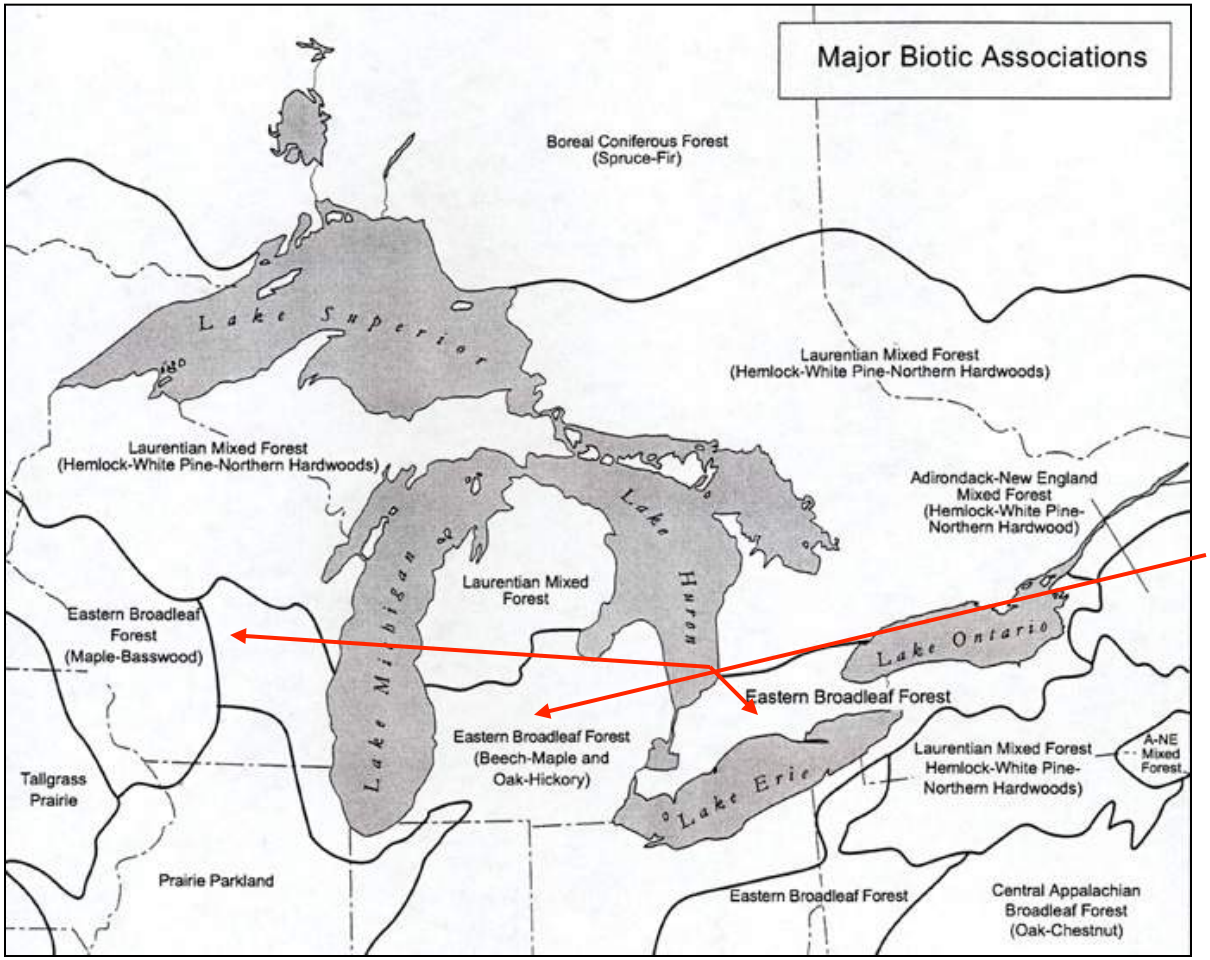


Two major biotic associations exist in the Great Lakes region:

1. northern hardwood-conifer forest

Assembly of Great Lakes Flora

Species migrating into the Great Lakes region ended up in specific regions and associated with specific groups.

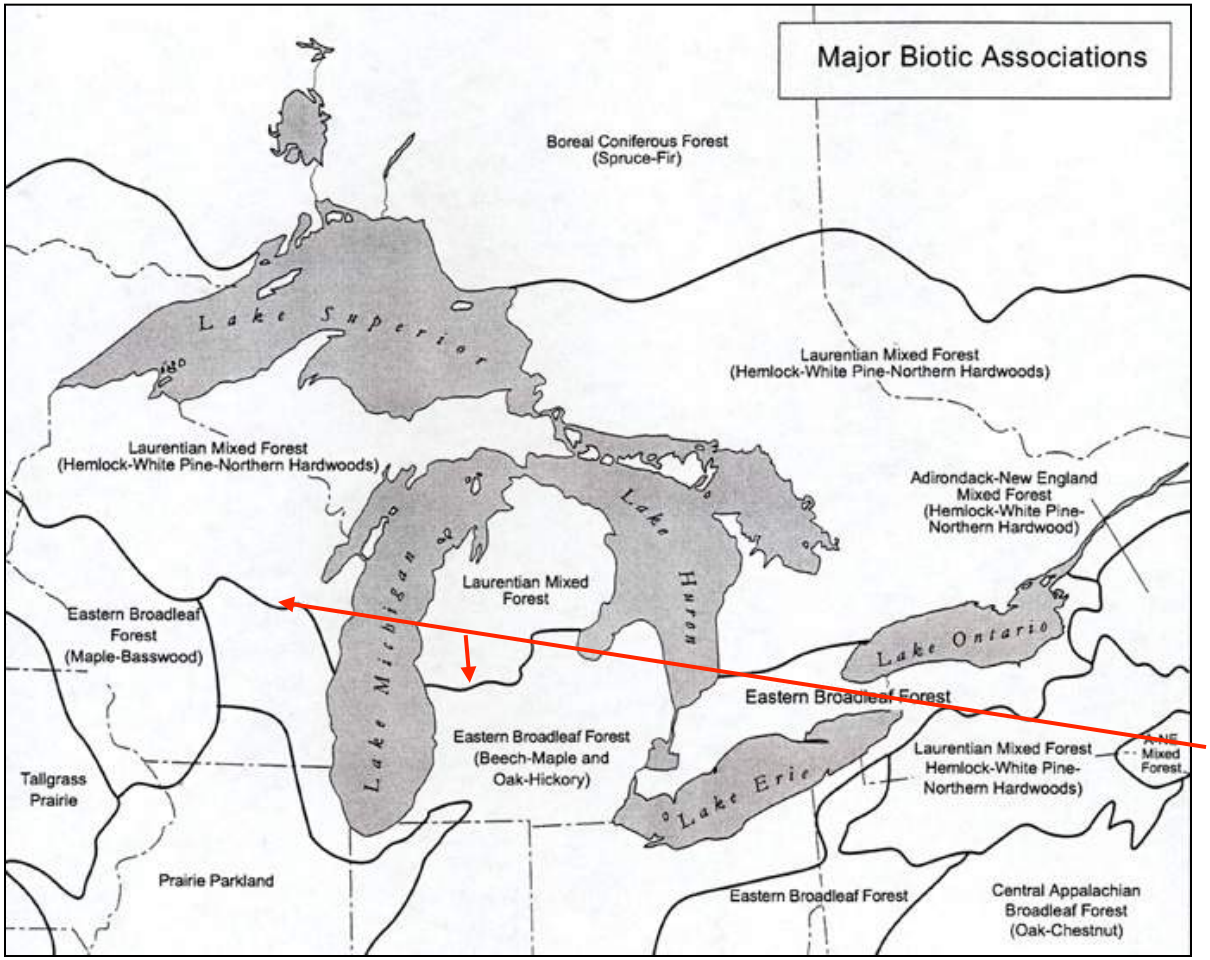


Two major biotic associations exist in the Great Lakes region:

1. northern hardwood-conifer forest
2. eastern deciduous forest

Assembly of Great Lakes Flora

Species migrating into the Great Lakes region ended up in specific regions and associated with specific groups.

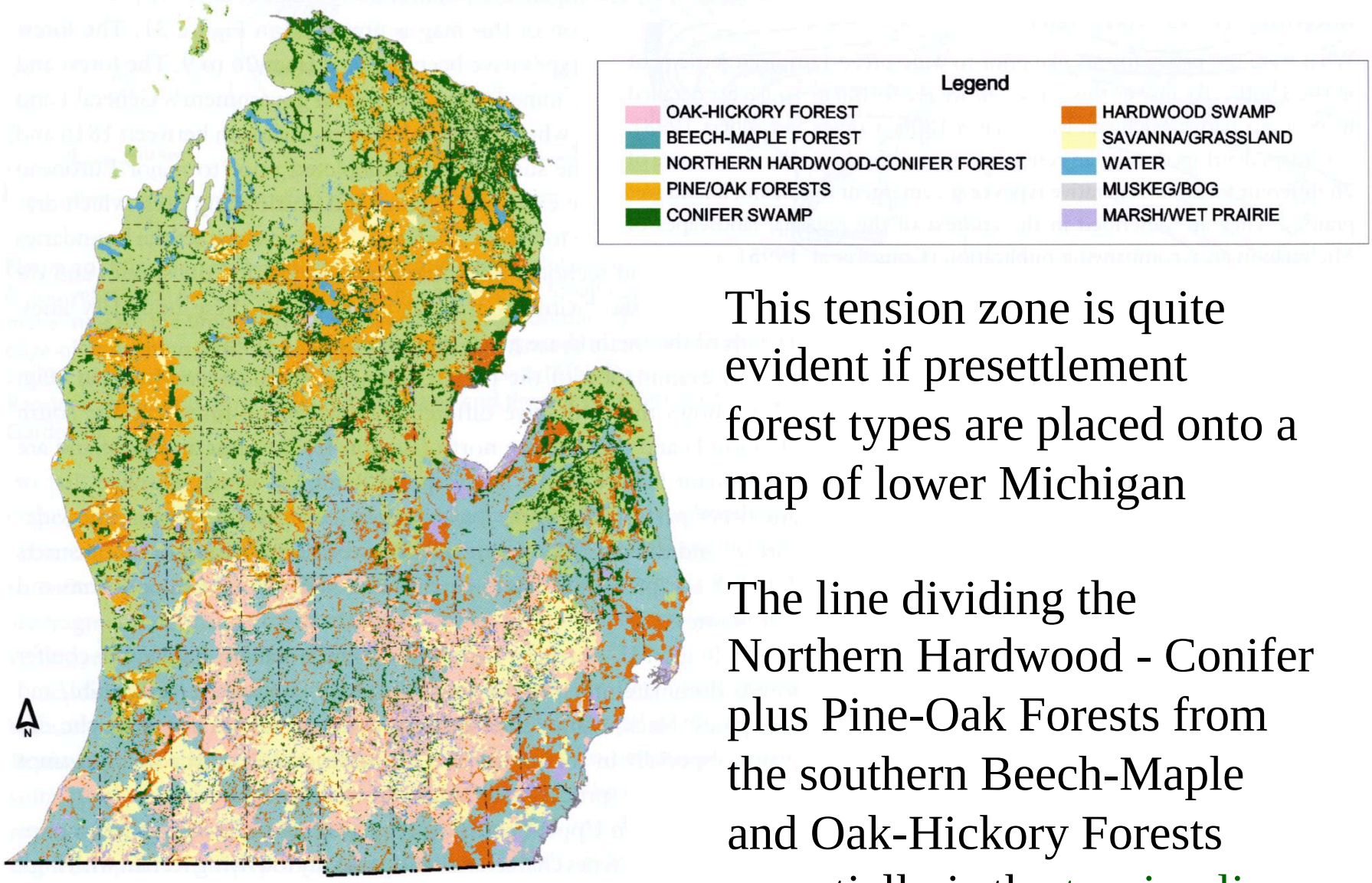


Two major biotic associations exist in the Great Lakes region:

1. northern hardwood-conifer forest
2. eastern deciduous forest

These two associations are separated by a fairly sharp tension line or zone

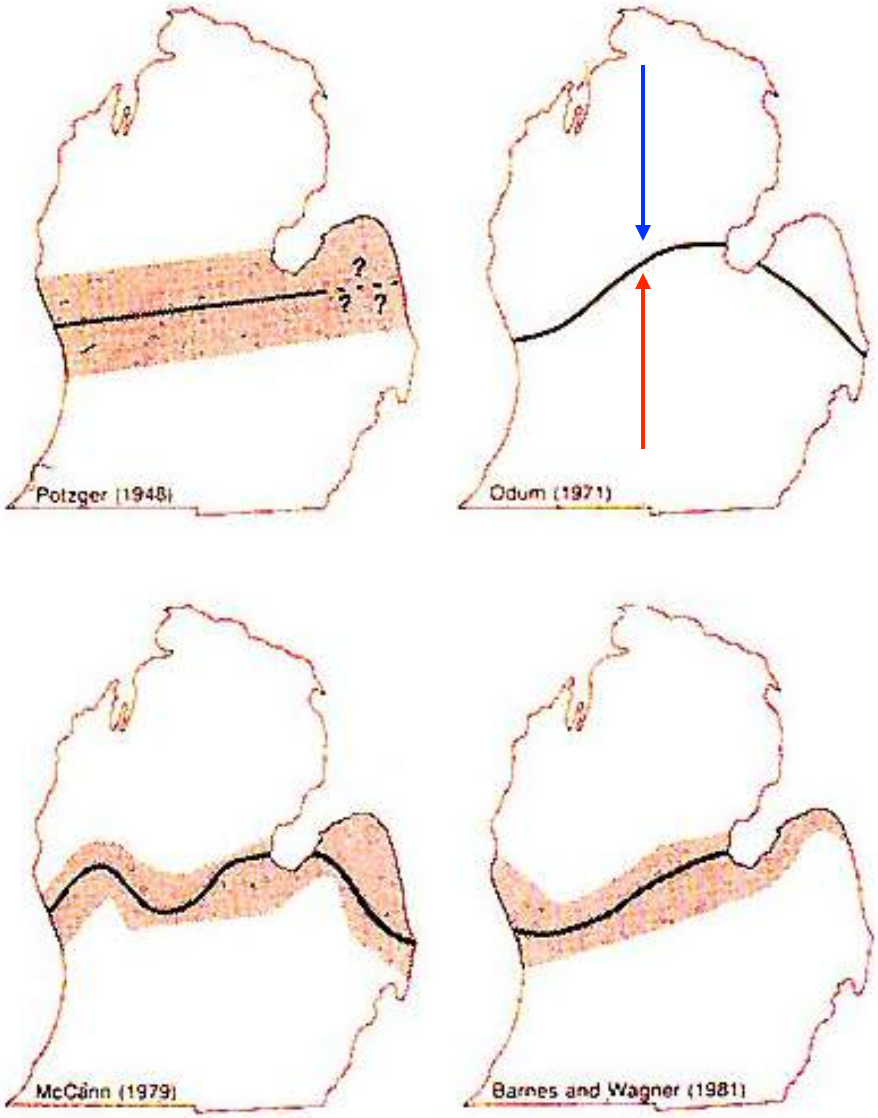
Presettlement forests in the Great Lakes region



This tension zone is quite evident if presettlement forest types are placed onto a map of lower Michigan

The line dividing the Northern Hardwood - Conifer plus Pine-Oak Forests from the southern Beech-Maple and Oak-Hickory Forests essentially is the tension line

Presettlement forests in the Great Lakes region



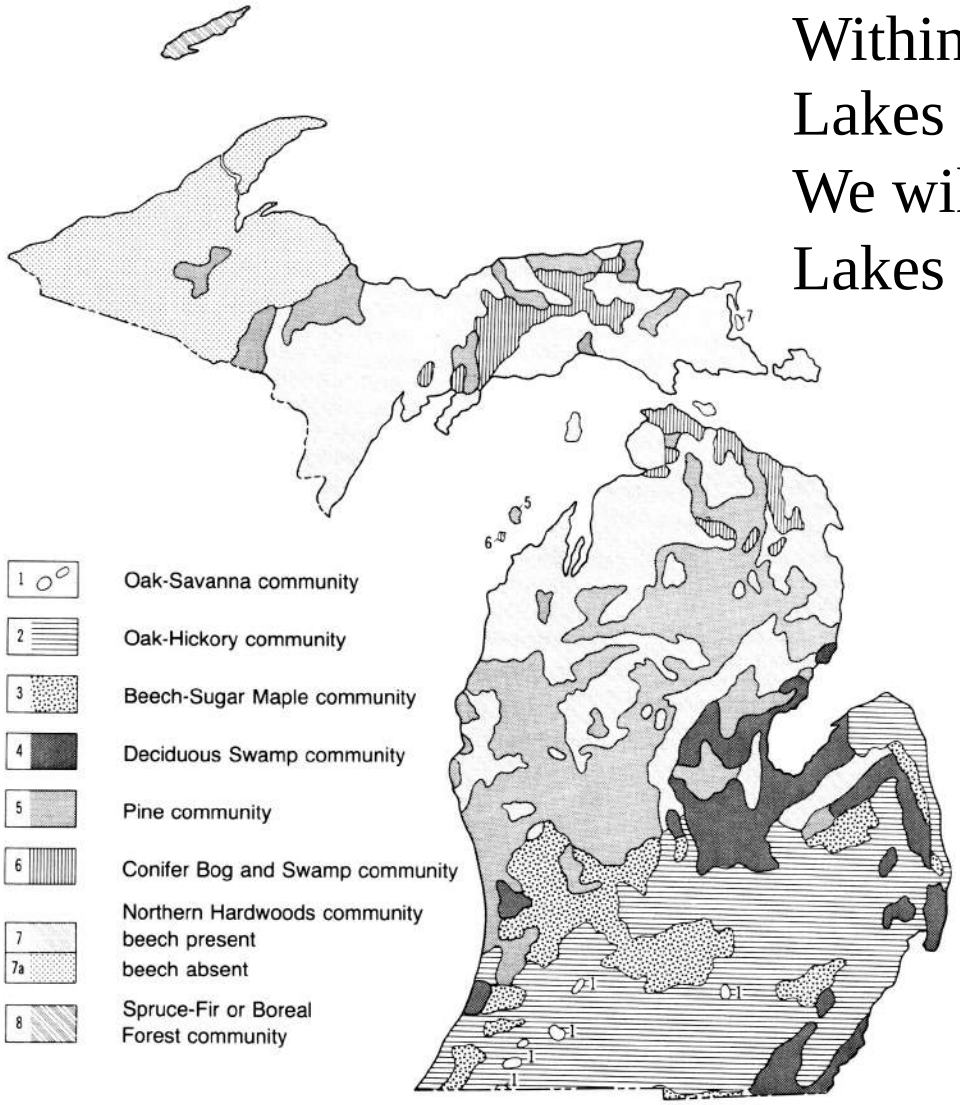
However, the tension line is actually defined on the basis of plant distributions:

the northern limit of southern species,

and the southern limit of northern species

Where exactly this tension line is located has been a source of some contention

Presettlement forests in the Great Lakes region

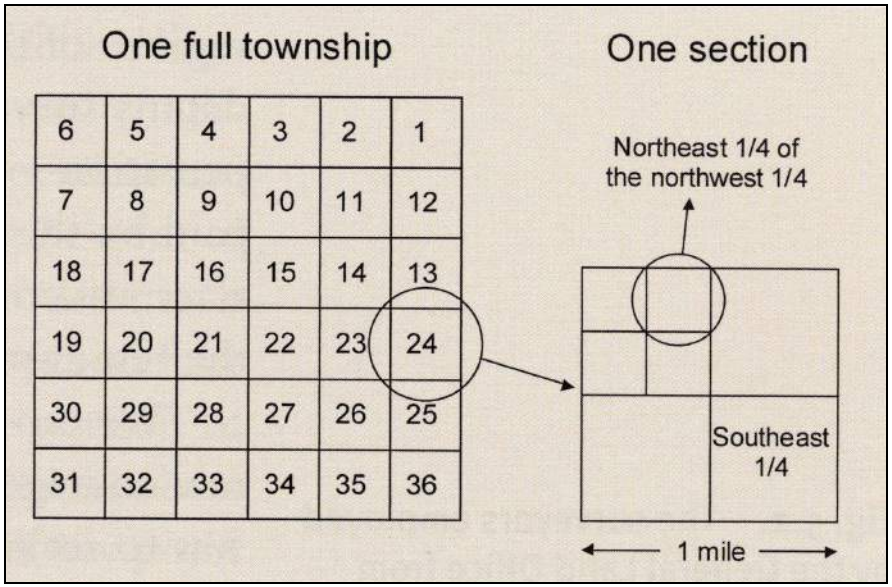


Within each association in the Great Lakes region are plant communities. We will focus our study of the Great Lakes at this level.

We will start today in the Northern Hardwood, but will later examine:

Mixed Pine community
Xeric Pine community
Boreal community
Conifer Bog community
Dune community
Riparian community

Presettlement forests in the Great Lakes region



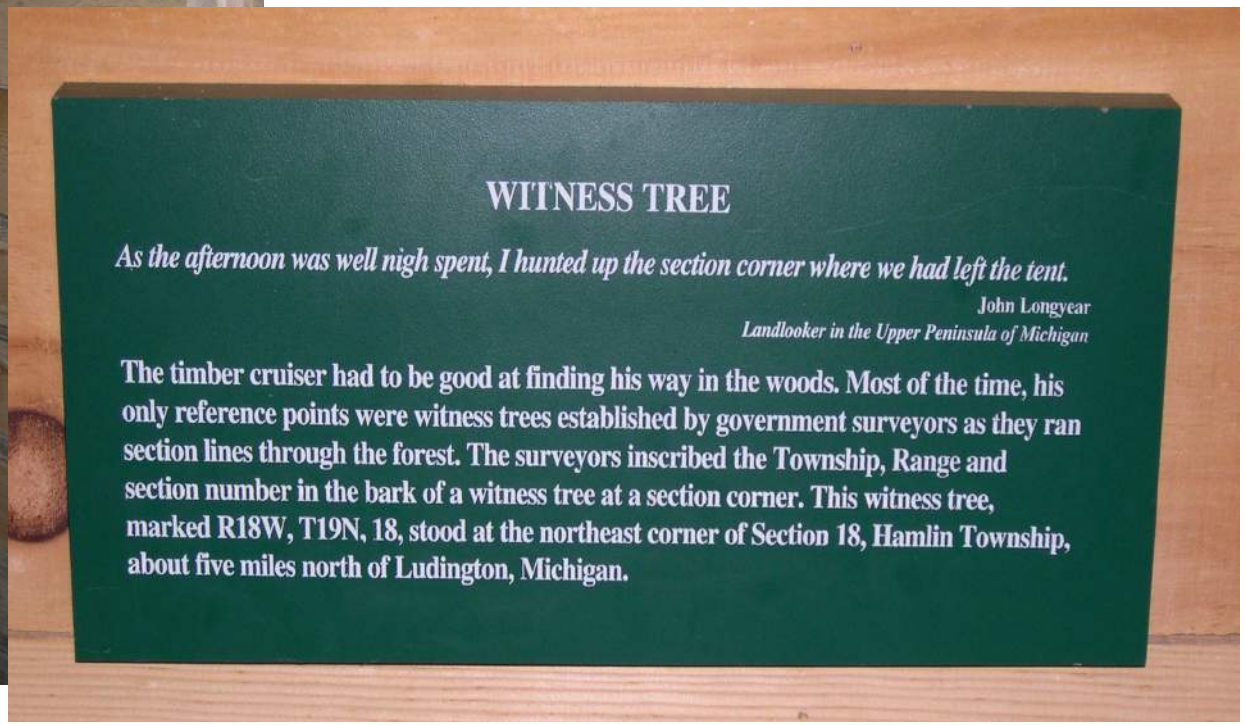
How do we know what presettlement forests or community types were actually present?

The General Land Office surveys of the 1800s required that a rectangular system of land survey be done. Trees nearest each quarter section corner were bark-slashed, identified, and dbh recorded.

Fig. 5.1. The basic units of land division in the rectangular system of land survey. A normal township contains 36 sections of one square mile each. Each section contains 640 acres and can be divided into four quarter sections of 160 acres each or 16 quarter-quarter sections of 40 acres each.

Presettlement forests in the Great Lakes region

Shown here is such a "Witness Tree" from the NE corner of section 18 in Hamlin Township (R18W, T19N) north of Ludington, Michigan.



Presettlement forests in the Great Lakes region

Shown here is such a “Witness Tree” from the NE corner of section 18 in Hamlin Township (R18W, T19N) north of Ludington, Michigan.

A close up of the slashed tree shows the original surveyor’s marks:

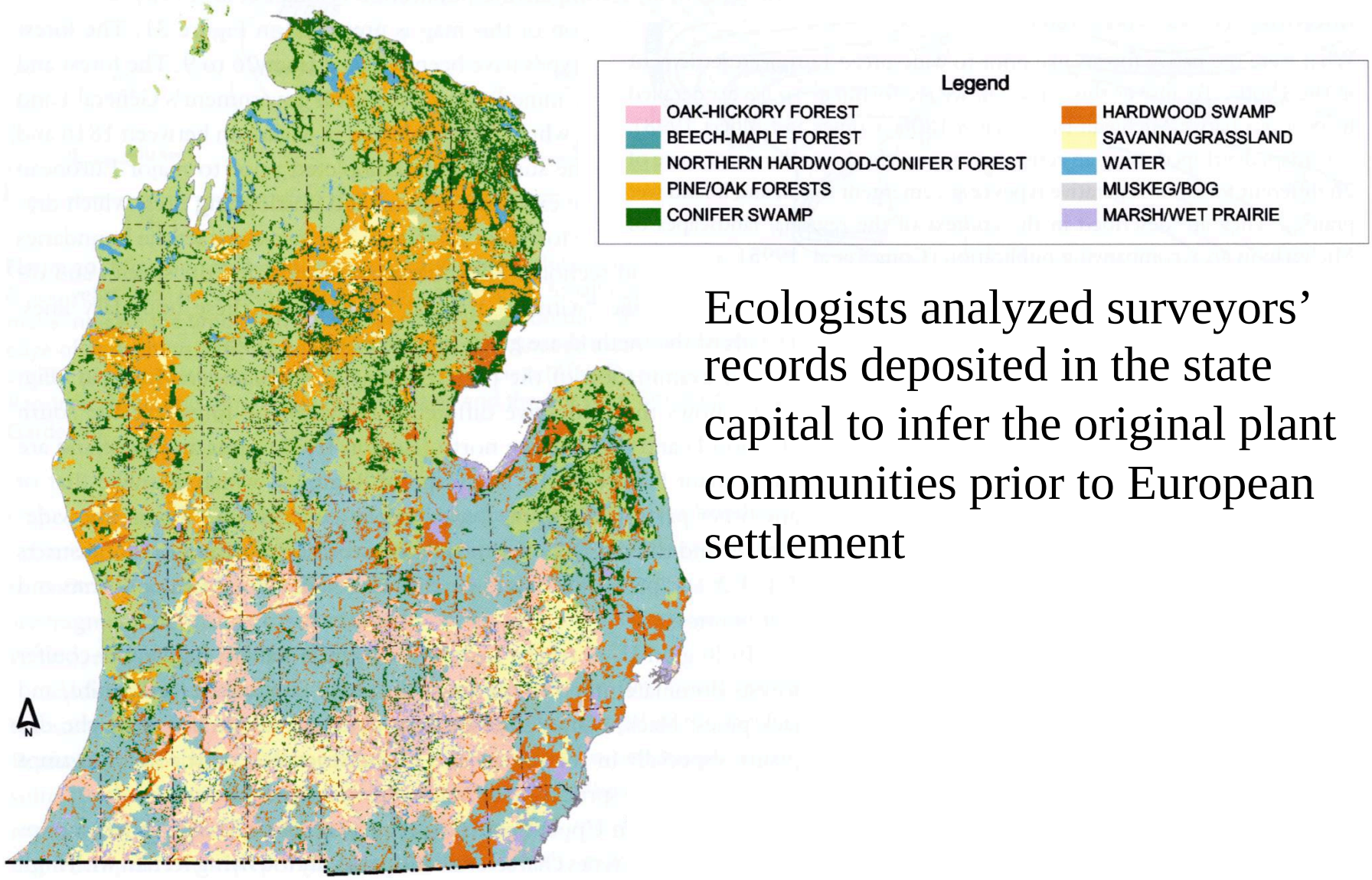
R 18 W

T 19 N 18

Presettlement forests in the Great Lakes region

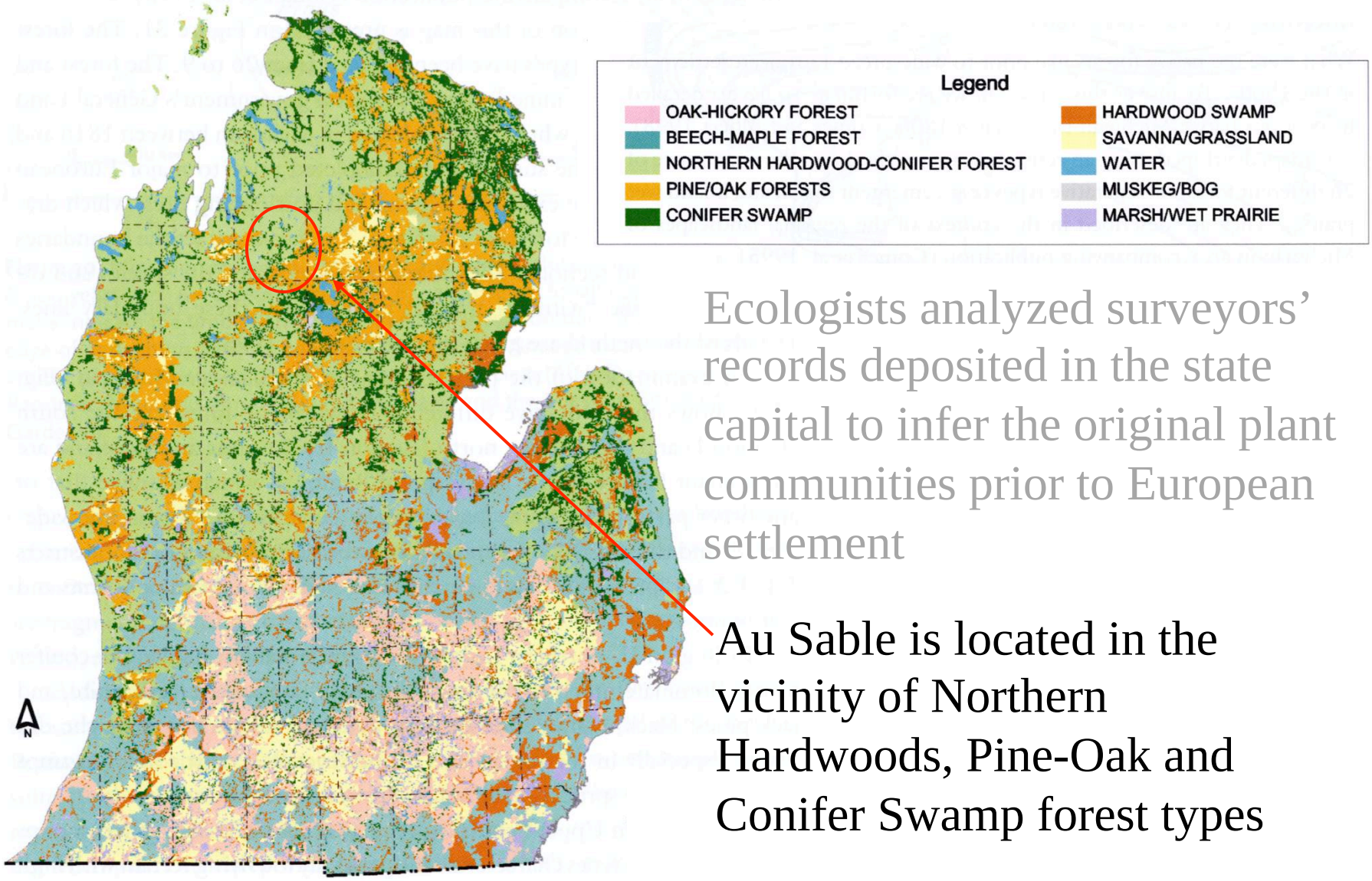
Stakes and witness trees now replaced by permanent sectional markers – here seen during an Integrative Session

Presettlement forests in the Great Lakes region



Ecologists analyzed surveyors' records deposited in the state capital to infer the original plant communities prior to European settlement

Presettlement forests in the Great Lakes region



Ecologists analyzed surveyors' records deposited in the state capital to infer the original plant communities prior to European settlement

Au Sable is located in the vicinity of Northern Hardwoods, Pine-Oak and Conifer Swamp forest types

Presettlement forests in the Great Lakes region

Northern Hardwood forest

Presettlement forests in the Great Lakes region

Northern Hardwood forest - sampled