(Dis)Assembly of the Great Lakes Forests

The Questions

- Pleistocene placement of the forests - where did they hang out?
- Holocene migrations - how and when did they assemble into the Great Lakes?
- Recent past, present, and future changes - the dis-assembly?

Vegetation vs. Flora

- Vegetation refers to the physical appearance (physiognomy) of the forest type - ecology driven
- Flora refers to the species (genus, family) composition of any given forest - history driven

Pleistocene - the Ice Ages

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

Northern hardwood forests in WI and MI have sugar maple, but beech co-dominates mainly in MI
In the Tertiary, earth experienced intensification towards climatic cooling.

Culminated with a series of glacial-interglacial cycles in Pleistocene.

North American flora and vegetation profoundly influenced by these "ice-age" events.

Wisconsin glaciation (last epoch) most important - maximum at 18,000 ya.

Assembly of flora and vegetation of most Great Lakes was during the late Pleistocene and Holocene - (14,000 ya to present).

Ice-free Areas

Southern North America of glaciers

Beringia, much of Alaska, Siberia

Coastal plains, steep coastlines of Pacific northwest

Wisconsin Driftless Area - never completely surrounded by ice.
**Pleistocene - the Ice Ages**

**Ice-free Areas**
- North America south of glaciers
- Beringia, much of Alaska, Siberia
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- Wisconsin Driftless Area - never completely surrounded by ice

**What was happening south of the glacial maxima?**

**Pleistocene - the Ice Ages**

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

- Paleobotanists are aided by the pollen record (especially trees) in lakes and bogs to understand Pleistocene vegetation and flora

**Assembly of Flora & Vegetation**

Importantly, the different species of trees (and herbs) entering the Great Lakes region after the glaciers retreated entered via different routes - that is, they came from different refugia or survivia

**White pine from the Alleghenian refugium and present distribution**
Importantly, the different species of trees (and herbs) entering the Great Lakes region after the glaciers retreated entered via different routes—that is, they came from different refugia or survivia.

**Assembly of Flora & Vegetation**

Bur oak from the Ozarkian refugium and present distribution.

**Pleistocene - the Ice Ages**

- Much of eastern North America outside these refugia would have looked like this boreal scene.

**Assembly of Flora & Vegetation**

- How and when did this assembly in the Great Lakes happen?

**The Questions**

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• Pollen record shows waves of species over time
• Boreal elements (spruce) early in the Holocene, followed by pines, then oaks, maples and lastly beech

Coniferous species migrated into the Great Lakes region in waves (flora): Boreal species like spruce & tamarack arrived first.
Assembly of Flora & Vegetation
Coniferous species migrated into the Great Lakes region in waves (flora): Boreal species like spruce & tamarack arrived first, and later balsam fir followed by more mesic loving white pine.

Hemlock, characteristic of mesic Northern Hardwood forests, arrived last.
**Dis-assembly of the forests?**

*Pinus strobus* - white pine  
*Tsuga canadensis* - hemlock

**Assembly of Flora & Vegetation**

Angiosperm hardwoods migrated into the Great Lakes region in waves towards the end of conifer migration:  
Oaks arrived first from the south - 11,000 ya

Elms arrived at about the same time from the southeast - 11,000 ya

Hickories arrived shortly thereafter from the southwest - 10,500 ya
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Angiosperm hardwoods migrated into the Great Lakes region in waves towards the end of conifer migration: Followed by mesic-loving maples . . .

Assembly of Flora & Vegetation

The flora of the Great Lakes can be divided into a number of elements, each of which shares a common geographical origin (refugia).

Closely related species (such as oaks) can often be part of different floristic elements.

This is due to both different ecological preferences (such as hydric vs. mesic vs. xeric) and to geographical origin.

Quercus - the oaks

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Angiosperm hardwoods migrated into the Great Lakes region in waves towards the end of conifer migration: . . . and finally American beech last

Assembly of Flora & Vegetation

The Questions

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Substantial changes in forest and prairie communities since presettlement times due to urbanization, farming, and forestry

How do we know what presettlement forests or community types were actually present mid-1800s?

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-slashied, identified, and dbh recorded.

Dis-assembly of the forests?

640 acres

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.

Dis-assembly of the forests?

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

Hartwick Pines State Park, MI – logging museum

Witness trees used to define forest types:
- Jack pine forest
- Hemlock, yellow birch forest
- White pine, maple forest

Small forest regions remain & these are different today.

Historical distribution of 3 important tree species – already impacted by humans:
- American beech
- Eastern hemlock
- Balsam fir

Future distribution of 3 important tree species? – climate change, disease, invasives
Dis-assembly of the forests?

- Pleistocene oscillations
- Global temperature increase and climate change
- CO$_2$ concentration (showing annual cycle) increasing from 315 ppm to 415 over last 60 years
- Last 4 years' CO$_2$ concentration increasing from 402 ppm to 415 ppm
- Measured at top of Mauna Loa, Hawaii
- 1. Climatic shifts in Great Lakes region
Dis-assembly of the forests?

1. Climatic shifts in Great Lakes region

2. Forest biome shifts in Great Lakes region

3. Individual species shifts in Great Lakes region
Wisconsin phylogenetic tree - genealogy of all species


3. Individual species shifts in Great Lakes region

DNA Barcode tree

increased suitable habitat by 2070

decreased suitable habitat by 2070

Impacts of climate change on suitable habitat

Current Species Distribution

North of Tension Zone

North and South of Tension Zone

South of Tension Zone

% of range remaining climatically suitable in 2070

Net loss

Net gain

3. Individual species shifts in Great Lakes region

Dis-assembly of the forests?

American beech – model species

1989 Science paper based on CO2 doubling


3. Individual species shifts in Great Lakes region

Dis-assembly of the forests?

American beech – model species

3. Individual species shifts in Great Lakes region
Dis-assembly of the forests?

American beech – model species:

3. Individual species shifts in Great Lakes region

3. Individual species shifts in Great Lakes region

No matter what model of global warming is used, whole vegetation units need to migrate. Beech drops must track beech migration or go extinct.

Beech drops must track beech migration or go extinct.

Epifagus virginiana
Beech drops
(root parasite only on American beech)

American beech – model species:

Dis-assembly of the forests?

American beech – model species:

Dis-assembly of the forests?