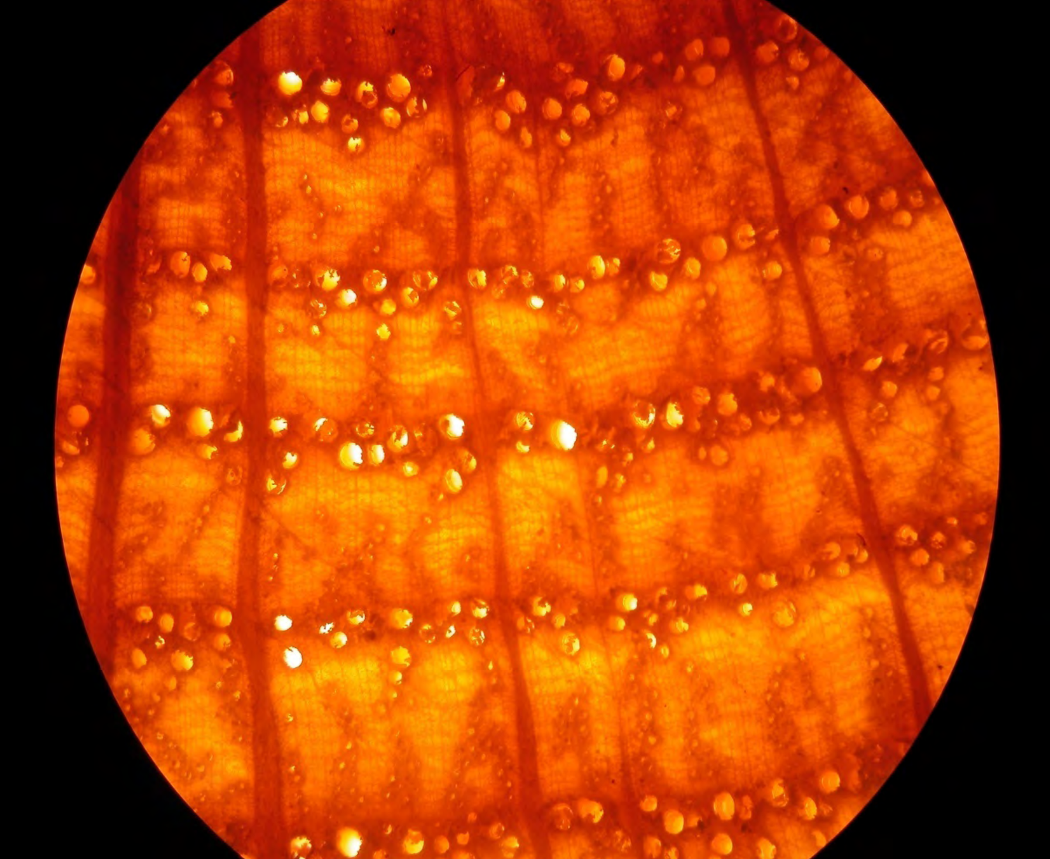

CAUTION
THIS SIGN HAS
SHARP EDGES
DO NOT TOUCH THE EDGES OF THIS SIGN
ALSO, THE BRIDGE IS OUT AHEAD

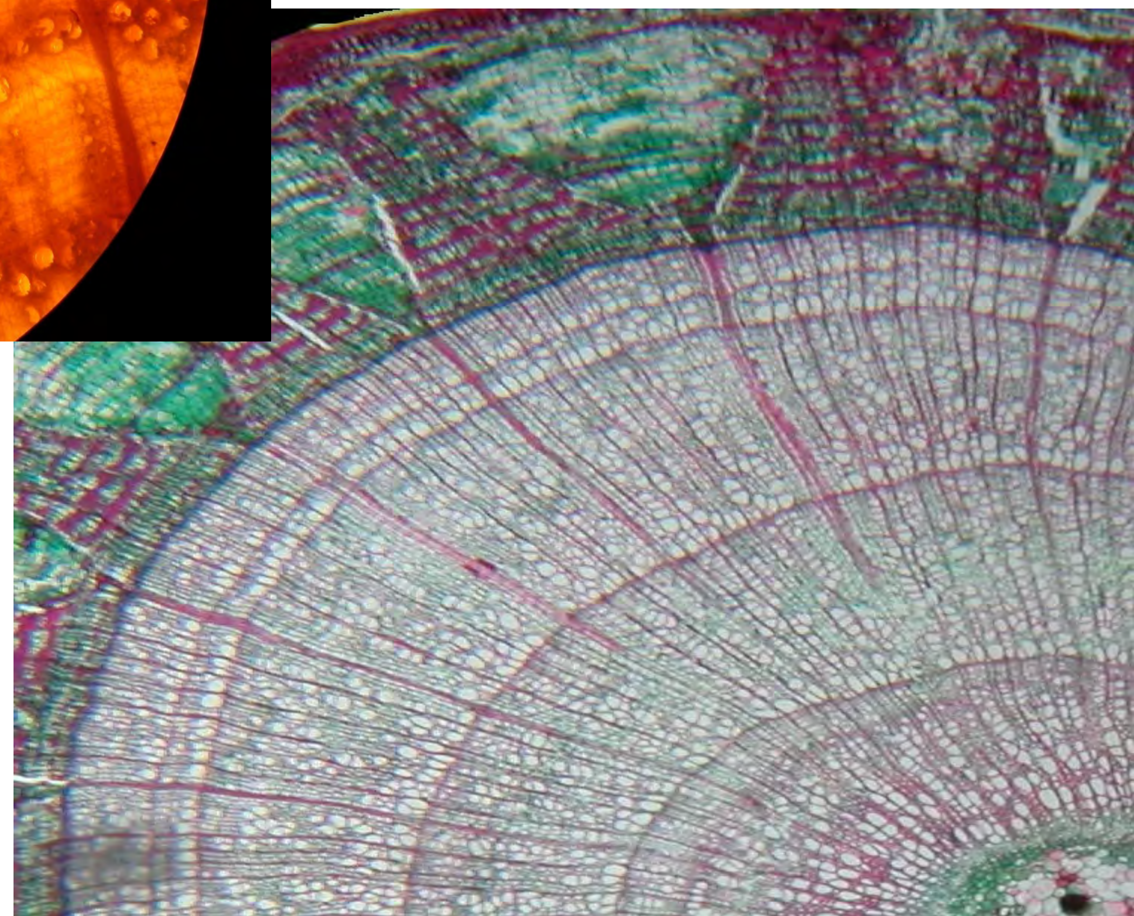
Setting ground rules in changing systems

- Trees take time and are linked to their surrounding environment when healthy, and will grow in response to their environment as possible.
- If the environment changes faster than the plant can grow, the plant is considered “stressed”.
- Urbanized environments often exaggerate abiotic variables, and add additional challenges such as salt,
- Most text evaluation criteria use trees growing in non-stressed situations.



The tree must constantly balance and adapt to its environment.

STRESS is ANY time the environment changes faster than the plant can grow



The balance is reflected in anatomy, morphology and physiology within the limits of physical and chemical law.

The usual currencies are carbon and water

Setting ground rules in changing systems

- Species and communities of species adapt for recurring events (disturbances or re-setting events), but are either temporarily or permanently displaced as the baseline environment//site // competitive pressure changes.
- As the environment changes, the tree often adapts as an individual, but the changing linkage to habitat suitability might limit regeneration and competitive success.
- Species have provenances and meta-populations, influencing where you might choose source materials.

Predictions of the future

- Scenario-based predictions on emissions are fraught with uncertainty by the nature of modeling and contingency.

- But we can agree on increasing temperatures.
  - As goes temperatures, so comes wind
  - Weather patterns shifting with winds patterns
- Earlier springs contribute to earlier leaf expansion/flowering at a greater risk for late freezes.
- Trees do not read books or keep up with the news.

Photosynthesis
Energy balance

$$6CO_2 + 12H_2O \text{ ------> } C_6H_{12}O_6 + 6O_2 + 6H_2O$$

Sunlight energy

As the environment will change, so too will plant communities and niches change

- There are opportunities to influence the trajectory of the plant community change (a human filter in community assemblage theory)

- Trees take time, selections should be based on the site of today, with an eye for fitness in the expected environmental site parameters of 2070…fitness rather than aesthetics in design function

- ***Our designs will need to become more water-savvy.***

- So we might think of what is changing (and maybe by how much) and what is not changing so much.

We are still in a seasonal temperate climate and the axis has not shifted (that much). Light

Photoperiod

Solar Intensity

Drought-heat severity

Invasive species cycles, movements to new areas, introductions

We could consider the role of abscission in storm damage profiles

There is a potential for novel communities and novel disturbance regimes

There are bound to be new diseases and pests moving into Mid-Atlantic landscapes…..

As an example: Roving herds of the vicious Eurasian tree-dwelling goat.

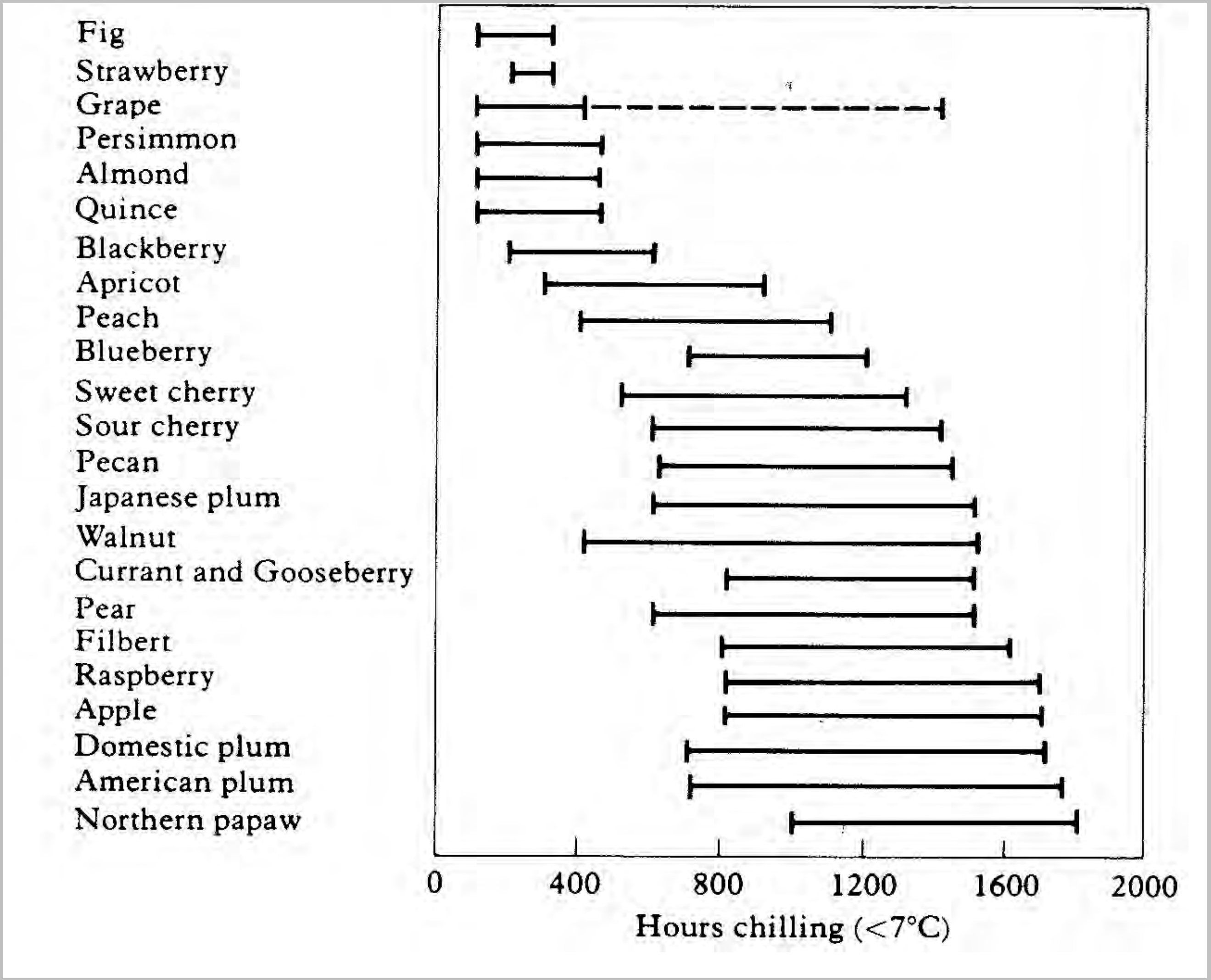
Some perennials could benefit from warmer winters,. . .

while for others there is evidence of *reduced* yields following warmer winters.

(less vine and root damage in European wine grapes with less frequent -12 F winter temps)

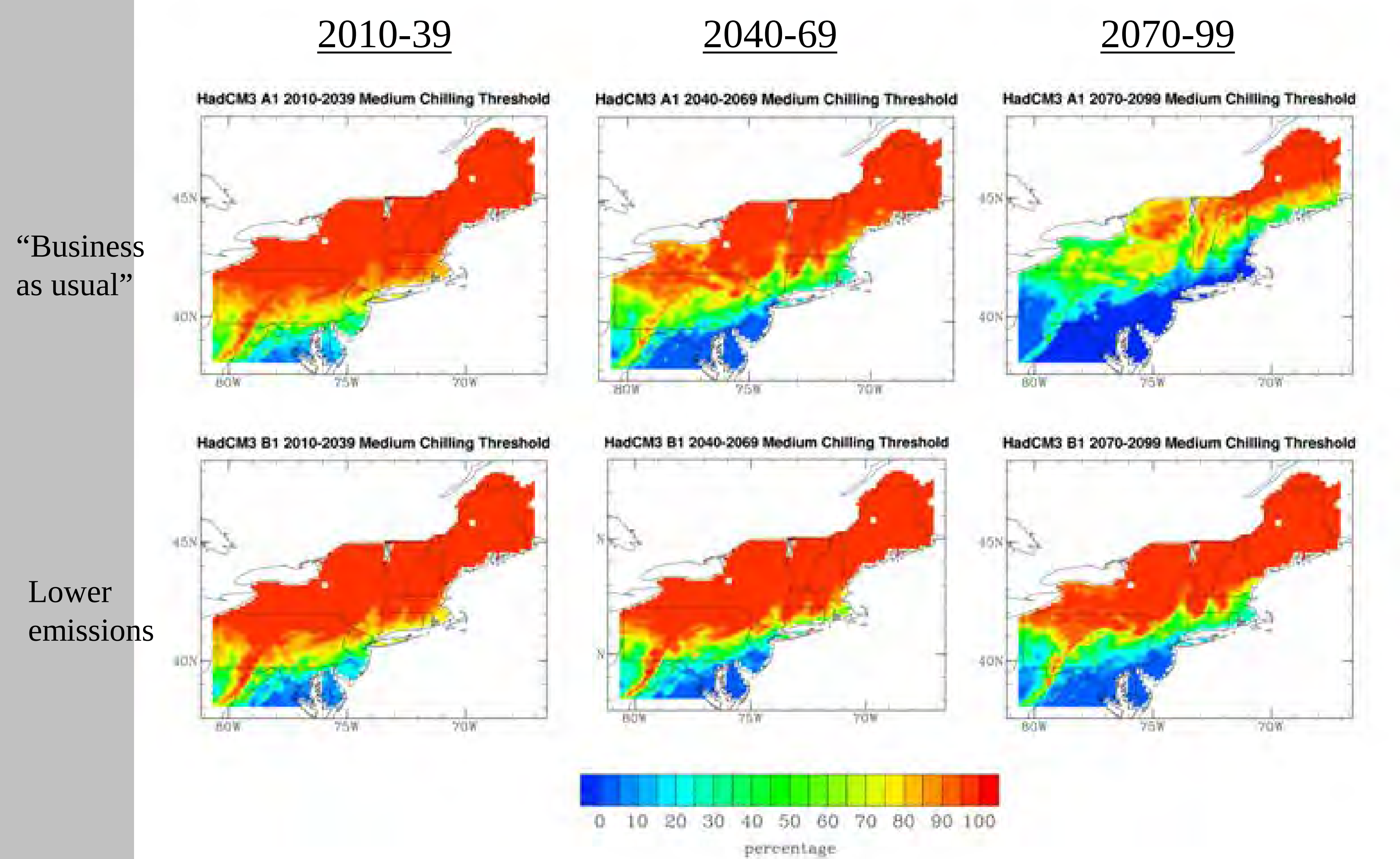
(inadequate “winter chill” period (cumulative hours < 45 F), and poor fruit development in apples)

Winter Chill (< 45 F) Hour Requirements



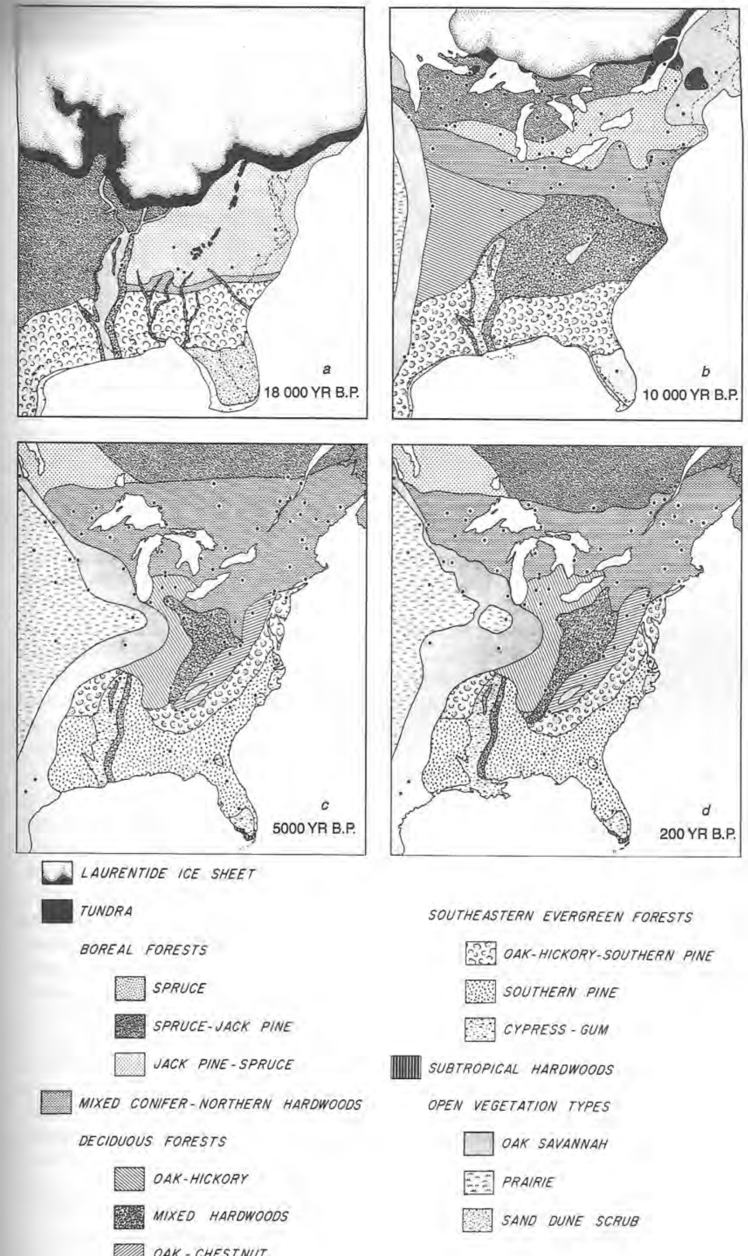
Source: Westwood MN. 1988. Temperate Zone Pomology. p. 386.

Percent Years Meeting 1000-hr Winter-Chill Requirement
(dark orange= most years meet requirement)



RUTGERS
New Jersey Agricultural
Experiment Station

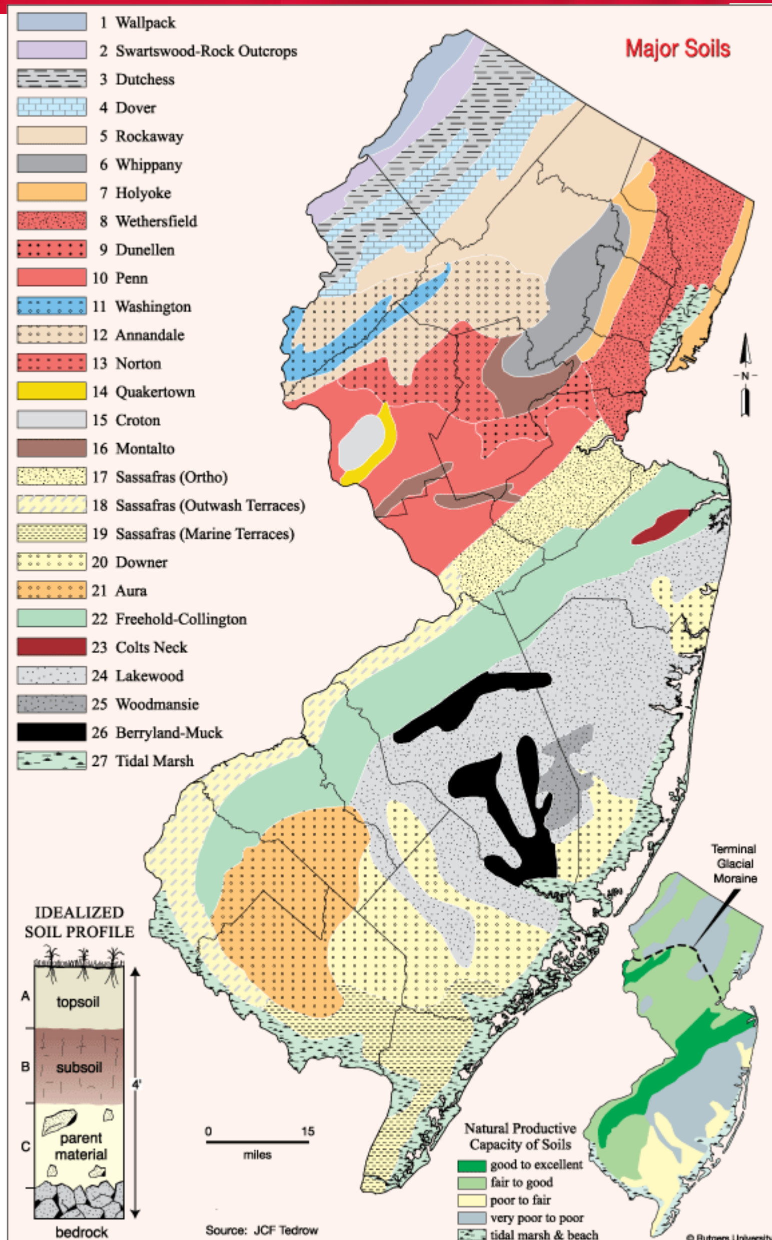
Figure from Forest Ecology 4th Ed. Barnes, Zak,Denton, and Spurr



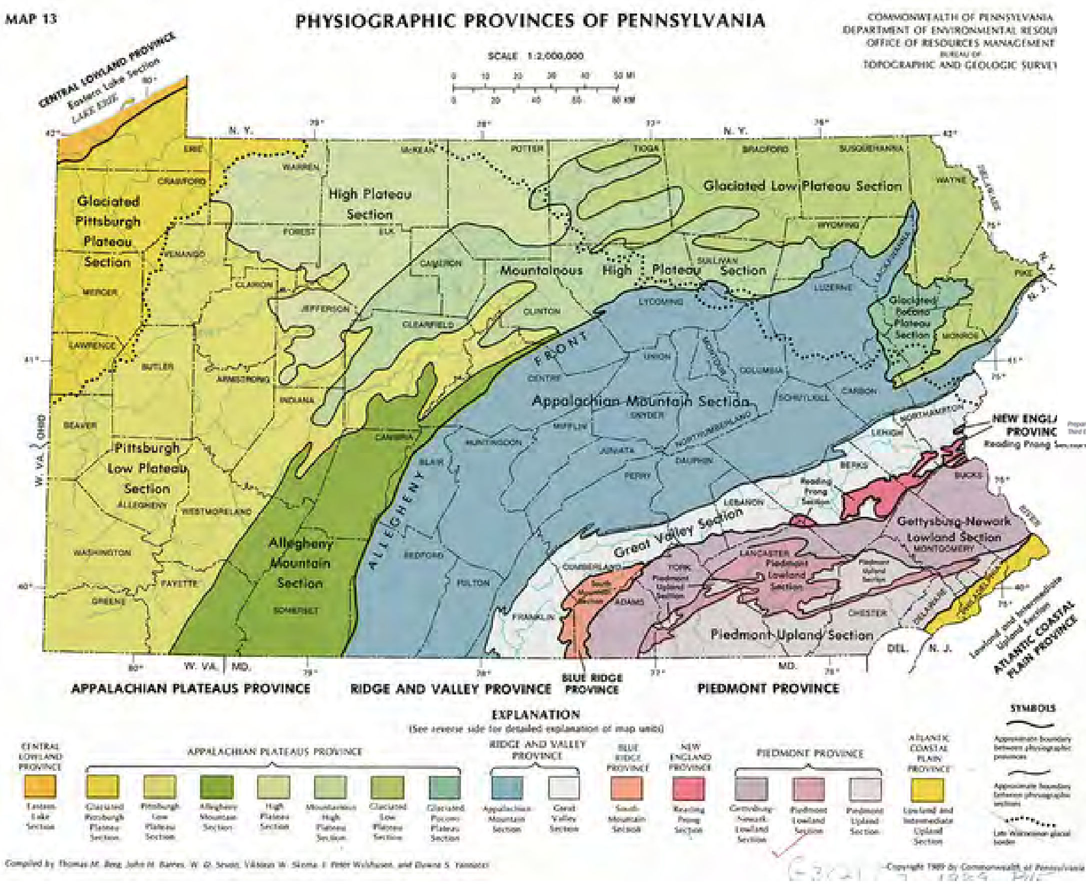
Our underlying geology has not changed, and soils change slowly.

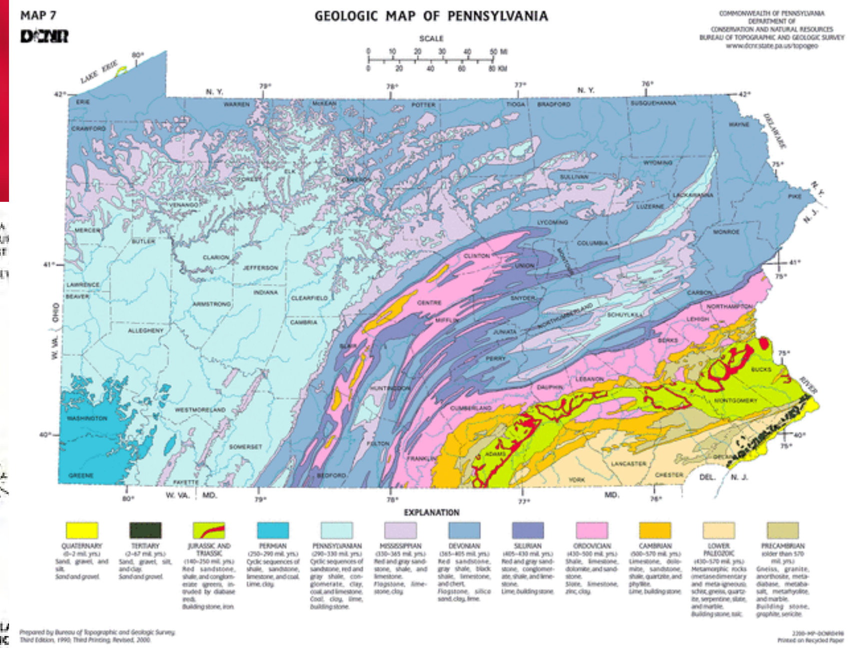
Mineral cycles will change with changing snow cover and growing season.

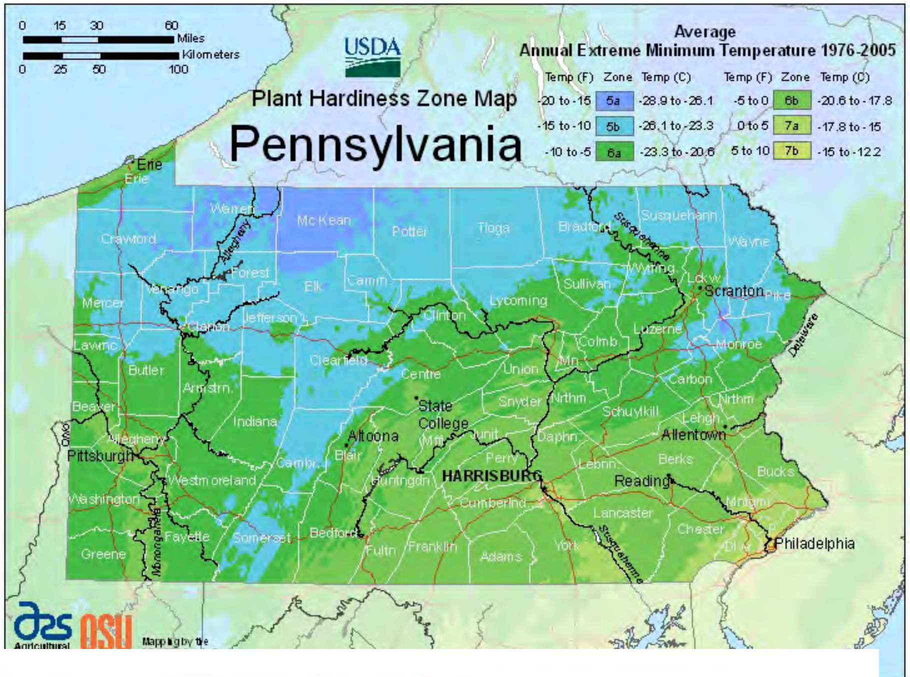
Construction damage happens quickly, impacting hydrology in a changing storm profile



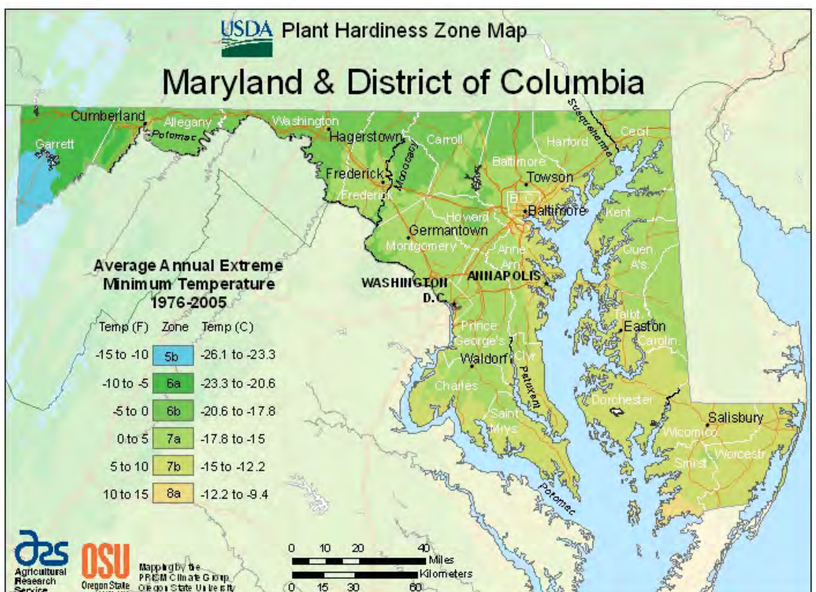
RUTGERS
New Jersey Agricultural Experiment Station







USDA
Plant Hardiness Zone Map
Pennsylvania
Average
Annual Extreme Minimum Temperature 1976-2005
Temp (F) | Zone | Temp (C)
-20 to -15 | 5a | -28.9 to -26.1
-15 to -10 | 5b | -26.1 to -23.3
-10 to -5 | 6a | -23.3 to -20.6
-5 to 0 | 6b | -20.6 to -17.8
0 to 5 | 7a | -17.8 to -15
5 to 10 | 7b | -15 to -12.2
0 15 30 60 Miles
Kilometers 0 25 50 100
Erie
Warren
McKean
Potter
Tioga
Bradford
Susquehanna
Wayne
Crawford
Forest
Elk
Cameron
Sullivan
Wyoming
Scranton
Pike
Mercer
Venango
Lycoming
Clinton
Jefferson
Clarion
Luzerne
Lawrence
Columbia
Monroe
Clearfield
Centre
Union
Butler
Armstrn.
Carbon
Beaver
State College
Snyder
Nrthm
Schuylkill
Nrthm
Indiana
Altoona
Lehigh
Allentown
Allegheny
Pittsburgh
Blair
Dauphn
Berks
Westmoreland
Cambria
Perry
Lebnn
Bucks
Huntngdn
HARRISBURG
Reading
Washington
Cumberlnd
Lancaster
Chester
Montgm
Fayette
Somerset
Bedford
Greene
Fultn
Franklin
Adams
York
Philadelphia
Susquehanna
Delaware
Allegheny
Monongahela
Ohio
Mapping by the



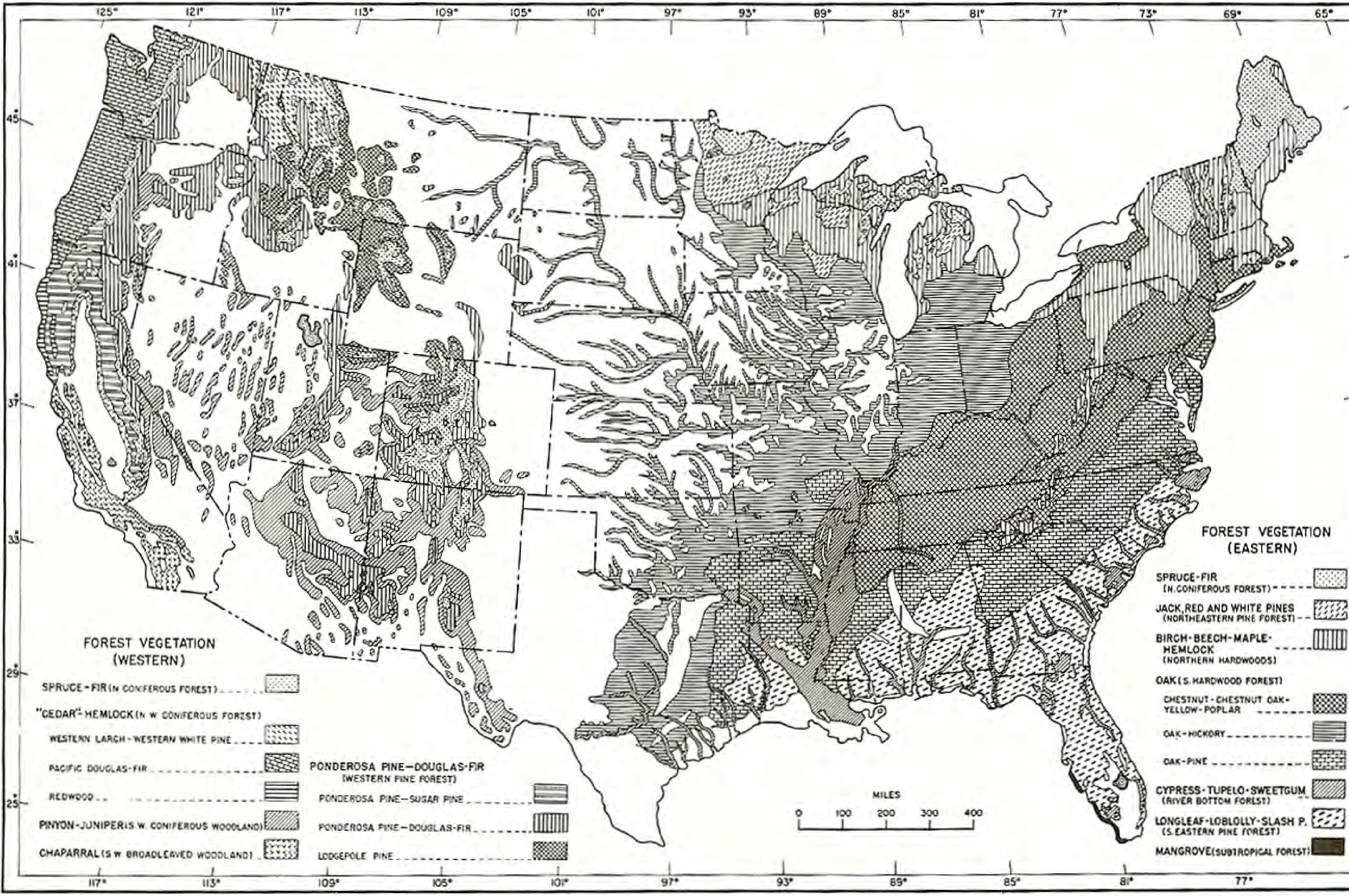
USDA Plant Hardiness Zone Map
Maryland & District of Columbia
Average Annual Extreme
Minimum Temperature
1976-2005
Temp (F) | Zone | Temp (C)
-15 to -10 | 5b | -26.1 to -23.3
-10 to -5 | 6a | -23.3 to -20.6
-5 to 0 | 6b | -20.6 to -17.8
0 to 5 | 7a | -17.8 to -15
5 to 10 | 7b | -15 to -12.2
10 to 15 | 8a | -12.2 to -9.4
Cumberland
Allegany
Garrett
Potomac
Washington
Hagerstown
Carroll
Harford
Cecil
Susquehanna
Frederick
Frederick
Baltimore
Towson
Baltimore
Howard
Kent
Germantown
Montgomery
Anne Arundel
Queen Anne's
WASHINGTON D.C.
ANNAPOLIS
Talbot
Easton
Caroline
Prince George's
Waldorf
Calvert
Charles
Patuxent
Dorchester
Saint Marys
Salisbury
Wicomico
Worcester
Somerset
Potomac
0 10 20 40 Miles
Kilometers
0 15 30 60
Agricultural Research Service
OSU Oregon State
Mapping by the PRISM Climate Group Oregon State University

USDA
Plant Hardiness Zone Map
Delaware
0 5 10 20 Miles
Kilometers
0 5 10 20
Elsmere
Wilmington
New Castle
Middletown
Smyrna
DOVER
Kent
Milford
Georgetown
Seaford
Sussex
Average Annual Extreme
Minimum Temperature
1976-2005
Temp(F) | Zone | Temp(C)
0 to 5 | 7a | -17.8 to -15
5 to 10 | 7b | -15 to -12.2
Agricultural Research Service
OSU Oregon State

Air quality

- Expecting increased concentration of CO_2
- O_3 formation in smog is a temperature dependant process

- Plant productivity can go up if other aspects not limited
- Allergens rise with plant growth, as do the biotic aspects of ozone upwind from urban centers
- Root turnover up as growth rate increases with seasonal turnover conditions.
- Soil macroporosity (Soil air) seen to increase over time in SE US enrichment study



FOREST VEGETATION (WESTERN)
SPRUCE-FIR (N. CONIFEROUS FOREST)
"CEDAR"-HEMLOCK (N W CONIFEROUS FOREST)
WESTERN LARCH-WESTERN WHITE PINE
PACIFIC DOUGLAS-FIR
REDWOOD
PINYON-JUNIPER (S.W. CONIFEROUS WOODLAND)
CHAPARRAL (S.W. BROADLEAVED WOODLAND)
PONDEROSA PINE—DOUGLAS-FIR (WESTERN PINE FOREST)
PONDEROSA PINE—SUGAR PINE
PONDEROSA PINE—DOUGLAS-FIR
LODGEPOLE PINE
MILES
0 100 200 300 400
FOREST VEGETATION (EASTERN)
SPRUCE-FIR (N. CONIFEROUS FOREST)
JACK, RED AND WHITE PINES (NORTHEASTERN PINE FOREST)
BIRCH-BEECH-MAPLE-HEMLOCK (NORTHERN HARDWOODS)
OAK (S. HARDWOOD FOREST)
CHESTNUT-CHESTNUT OAK-YELLOW-POPLAR
OAK-HICKORY
OAK-PINE
CYPRESS-TUPELO-SWEETGUM (RIVER BOTTOM FOREST)
LONGLEAF-LOBLOLLY-SLASH P. (S. EASTERN PINE FOREST)
MANGROVE (SUBTROPICAL FOREST)

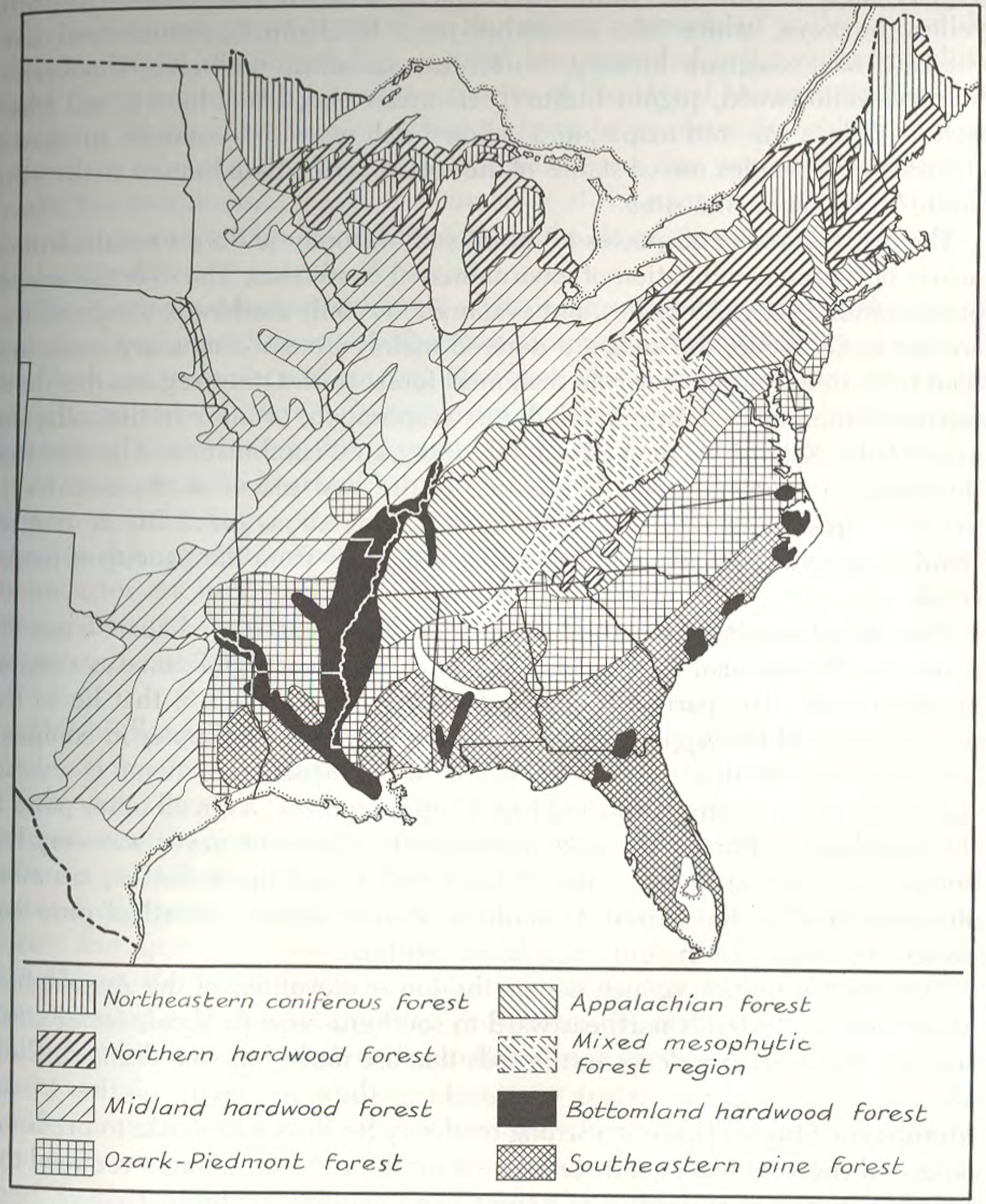
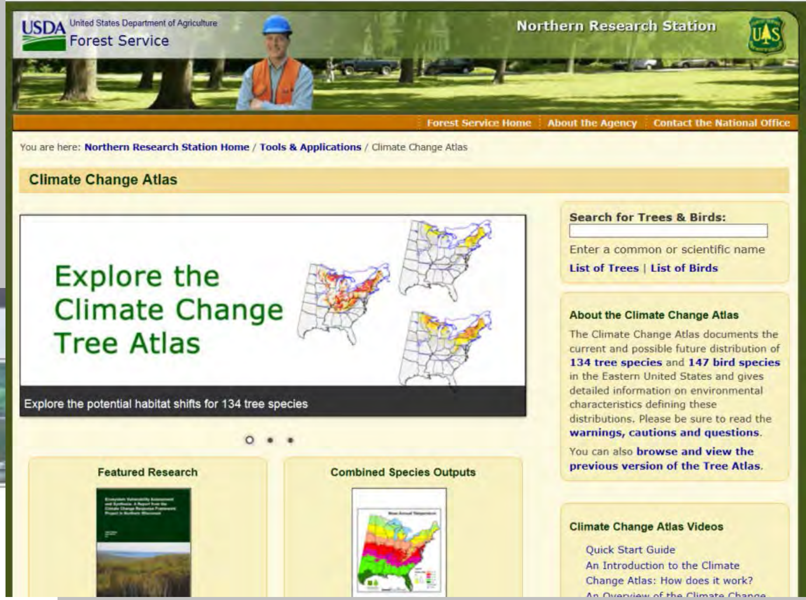


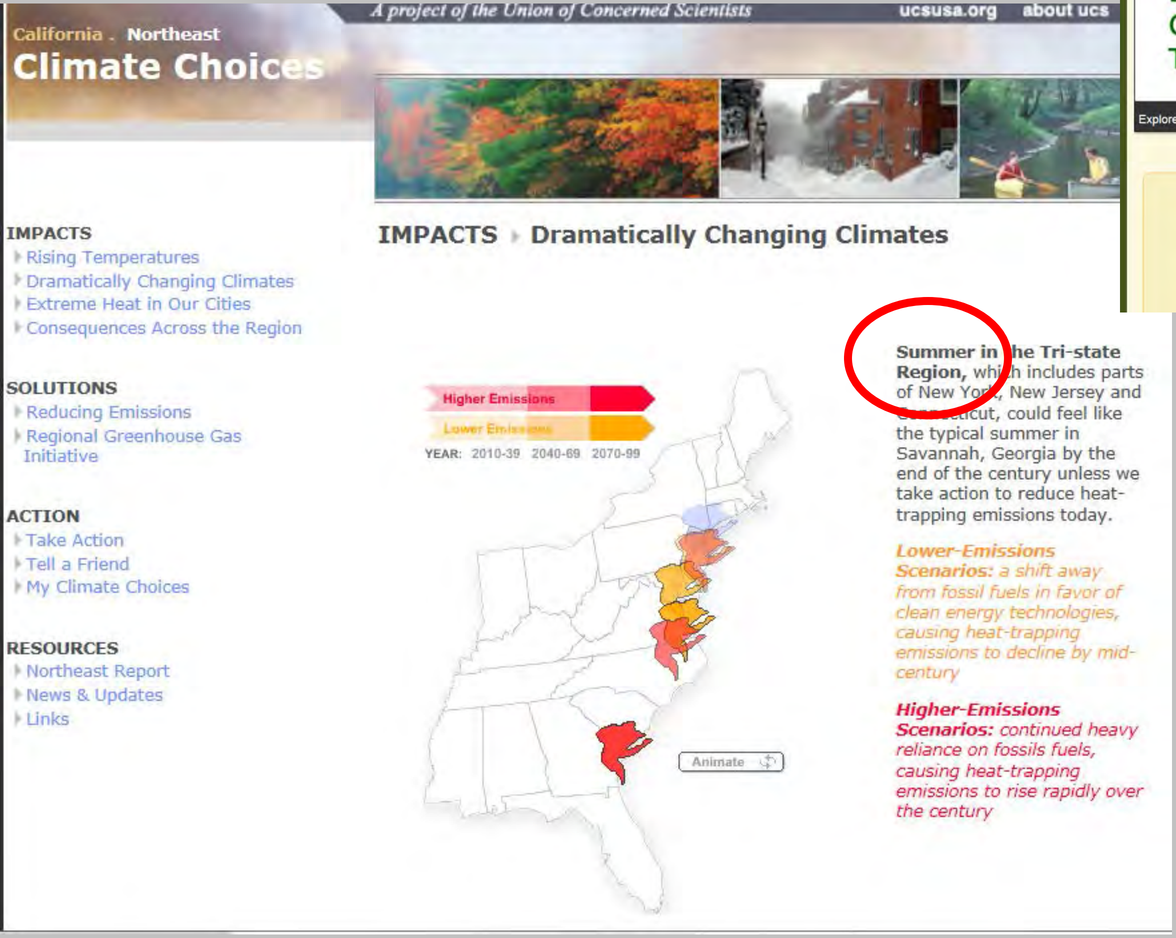
Figure 1-5. The major subdivisions of the Eastern Deciduous Forest as it existed in the original vegetation of the eastern United States. The Mixed Mesophytic Forest Region is shown as part of the Appalachian Forest. Only the broadest belts of the Bottomland Hardwood Forest are shown (adapted from Shantz and Zon, 1924; Braun, 1950).

The academic exercise

- Look to define a future environment, then find analogues to our designed communities in functioning ecological systems of today sharing environmental loadings and development context.
- Then testing/trying/observing to suggest what works within the local landscape context (urban core, city park, rural, wildland, timber or biofuel cropping)
- Plant species migrate on glacial timelines, but the environment is shifting by decade. As we enable migrations, there are certainly larger questions as humans become both recruitment filter and enablers of refuge.
- We tend to only plant to preferences in the “garden”

Future Climate Change for the Northeast (www.climatechoices.org/ne)





- Temperature highs and lows
- Seasonality and natural ranges within species
- Moisture
- Soils
- Providing context of the urban within the selection based on exaggerated abiotic filters
- Designed wide diversity with a structured evenness in occurrence, with hopes for age stratification over time

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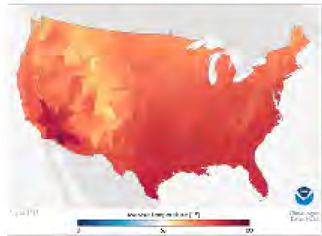
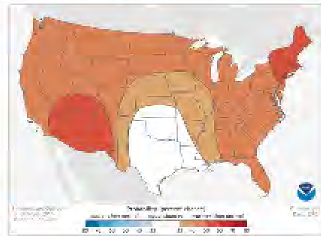
Easy access to climate data, products, and services

Data Snapshots | Dataset Gallery | Climate Data Primer | Climate Dashboard

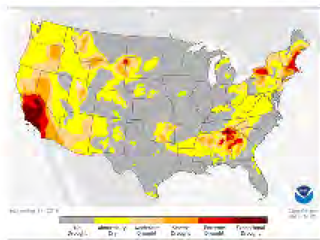
Data Snapshots: Reusable Climate Maps



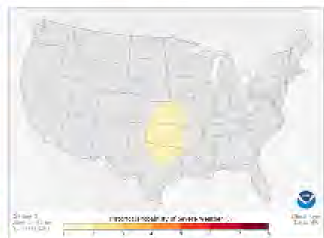
Average Monthly Temperature



Temperature Outlook



Drought Monitor



Severe Weather Climatology

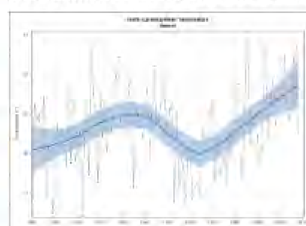
Explore a range of easy-to-understand climate maps in a single interface. Featuring the work of NOAA scientists, each "snapshot" is a public-friendly version of an existing data product.

Launch Data Snapshots

Dataset Spotlight: U.S. Climatological Rankings - Ranking Chart

When you hear or see news that a region had its hottest or wettest month since records began, you can check the climatological

See Climate Trends in Your State



View graphs of historical average temperature for any of the 48 contiguous United States.

View Temperature Trends by State

Browse the Dataset Gallery

This visual catalog with convenient filtering options can help you find the climate data you need. How-to instructions can help you navigate data access tools.

Enter the Dataset Gallery

GIS Data Locator (Advanced Users)

Launch Map Application

Climate Data Primer

Ready to learn some of the basics about climate data? Find out about measuring, modeling, and predicting climate and ways to find and use climate data.

The Primer includes information on instruments used to measure weather and climate; how weather observations relate to climate products; how climate scientists check the quality of observations, and tools you can use for exploring climate data

Open the Primer's table of contents

Recently Updated Datasets

- El Niño-Southern Oscillation Indicators
- Past Weather by Zip Code - Data Table
- Record-setting weather - Charts and Maps
- Global Vegetation Health - Images

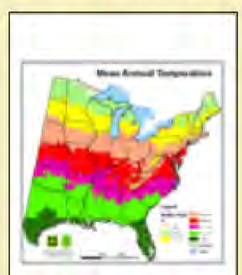
Go to the Dataset Gallery

Climate Change Atlas

Explore the potential habitat shifts for 134 tree species

Featured Research

Combined Species Outputs



Search for Trees & Birds:

Enter a common or scientific name

List of Trees | List of Birds

About the Climate Change Atlas

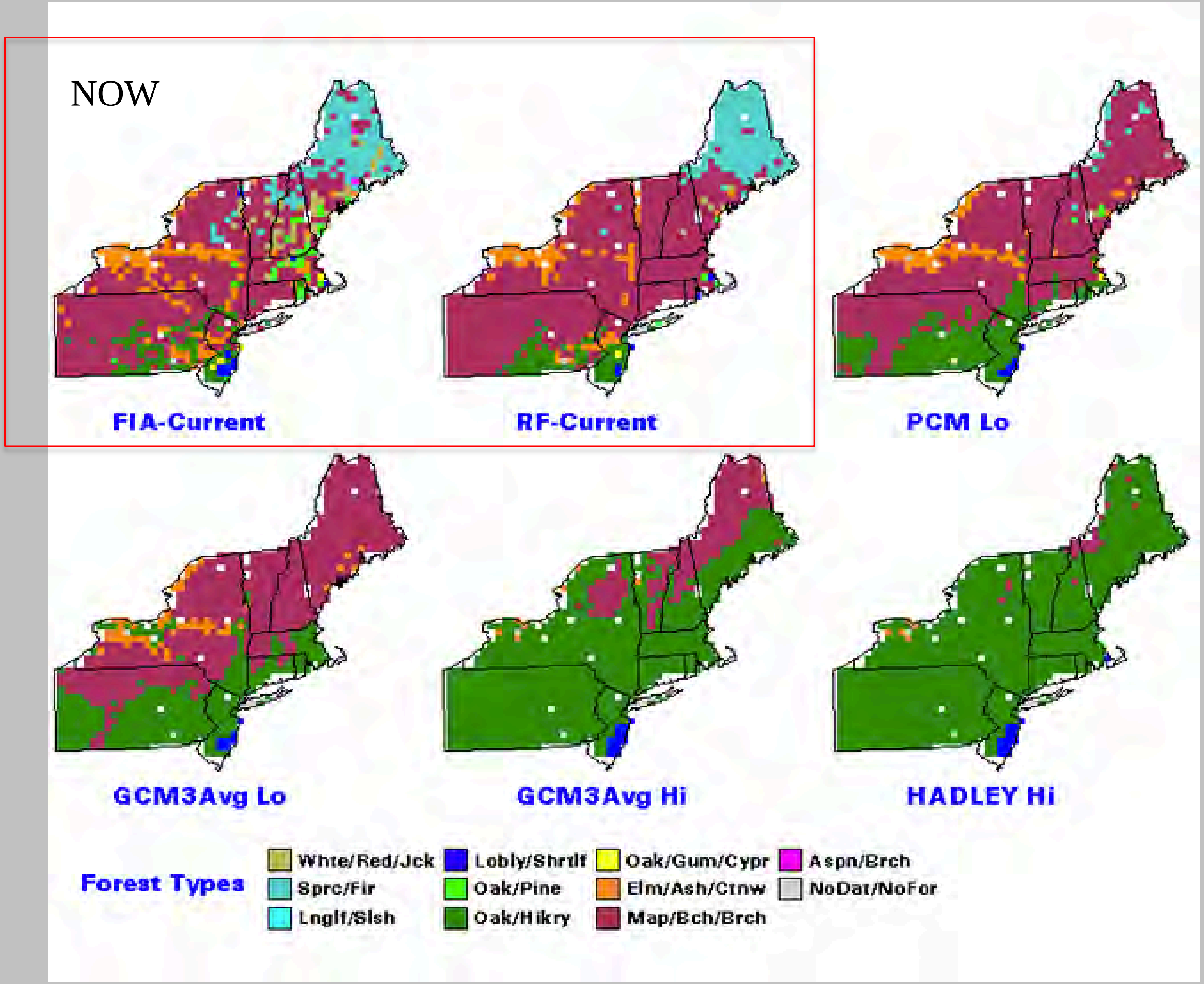
The Climate Change Atlas documents the current and possible future distribution of **134 tree species** and **147 bird species** in the Eastern United States and gives detailed information on environmental characteristics defining these distributions. Please be sure to read the **warnings, cautions and questions**.

You can also **browse and view the previous version of the Tree Atlas**.

Climate Change Atlas Videos

- Quick Start Guide
- An Introduction to the Climate Change Atlas: How does it work?
- An Overview of the Climate Change

Forest Type Changes (4 models)



USDA United States Department of Agriculture Forest Service

Climate Change Tree Atlas

Northern Research Station

You are here: NRS Home / Tools & Applications / Climate Change Atlas / Tree Atlas

Climate Change Tree Atlas (A Spatial Database of 134 Tree Species of the Eastern USA)

Anantha M Prasad, Louis R Iverson, Steve Matthews, Matt Peters

NRS-4151, USDA Forest Service, Northern Research Station, Delaware, Ohio

Atlas Background | What's New | Citations | Credits | Atlas Help | Other Links (DropDownMenu)

Table of 134 Tree Species:

(Click Table-Header-Link to Sort by that Column - Ascending/Descending)

Model Reliability: High Medium Low

Reliability	Spp. #	Common Name	Scientific Name
Medium	951	American basswood	*Tilia americana*
High	531	American beech	*Fagus grandifolia*
Medium	421	American chestnut	*Castanea dentata*
Medium	972	American elm	*Ulmus americana*
High	591	American holly	*Ilex opaca*
Medium	391	American hornbeam:musclewood	*Carpinus caroliniana*
Medium	935	American mountain-ash	*Sorbus americana*
Low	43	Atlantic white-cedar	*Chamaecyparis thyoides*
Low	808	Durand oak	*Quercus durandii*
Medium	356	Serviceberry	*Amelanchier spp.*
Medium	311	Florida maple	*Acer barbatum*
Low	571	Kentucky coffeetree	*Gymnocladus dioicus*
Low	828	Nuttall oak	*Quercus nuttallii*

134 Species Combined/Compared

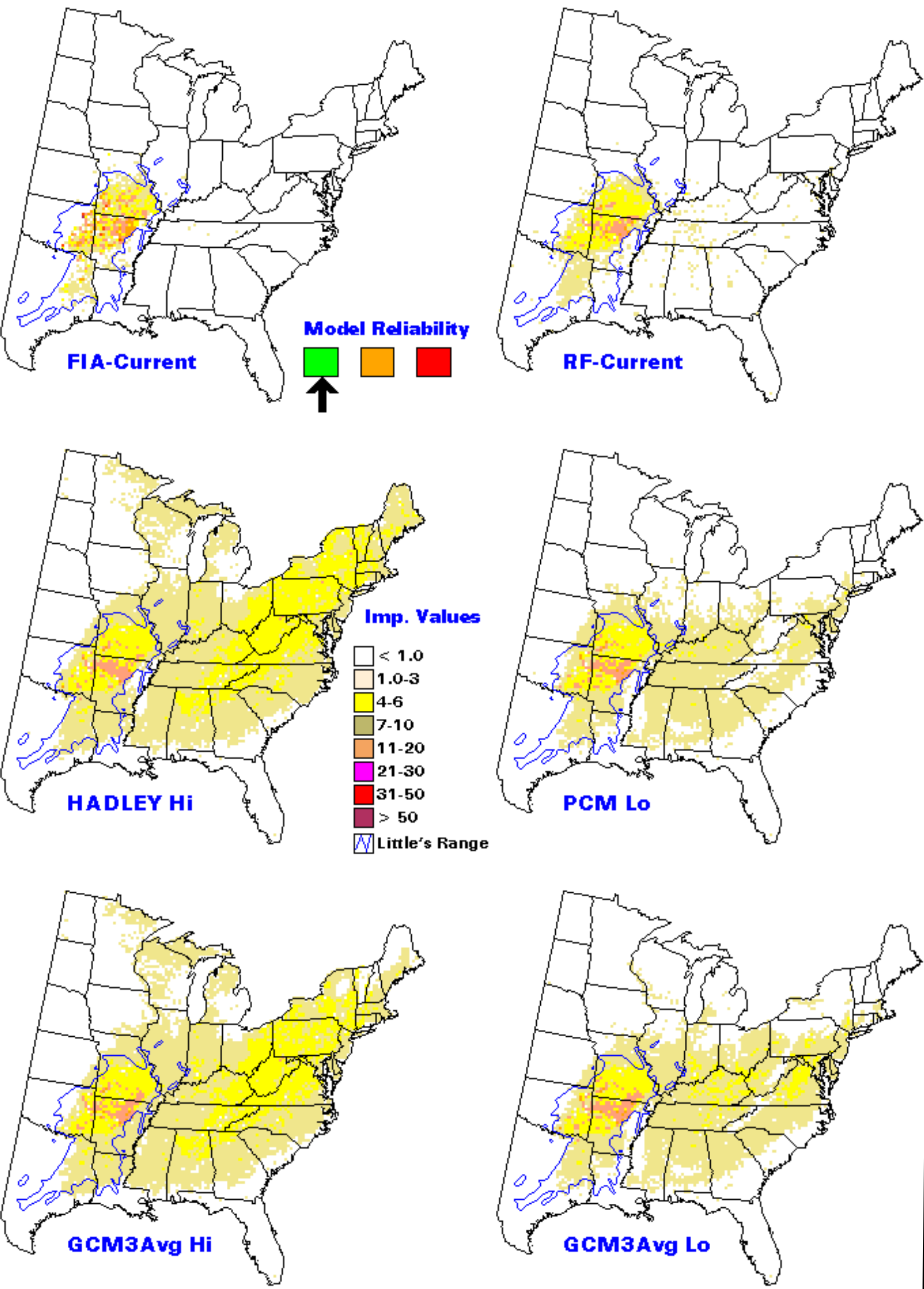
Combined Species Outputs

Summary of Predictors

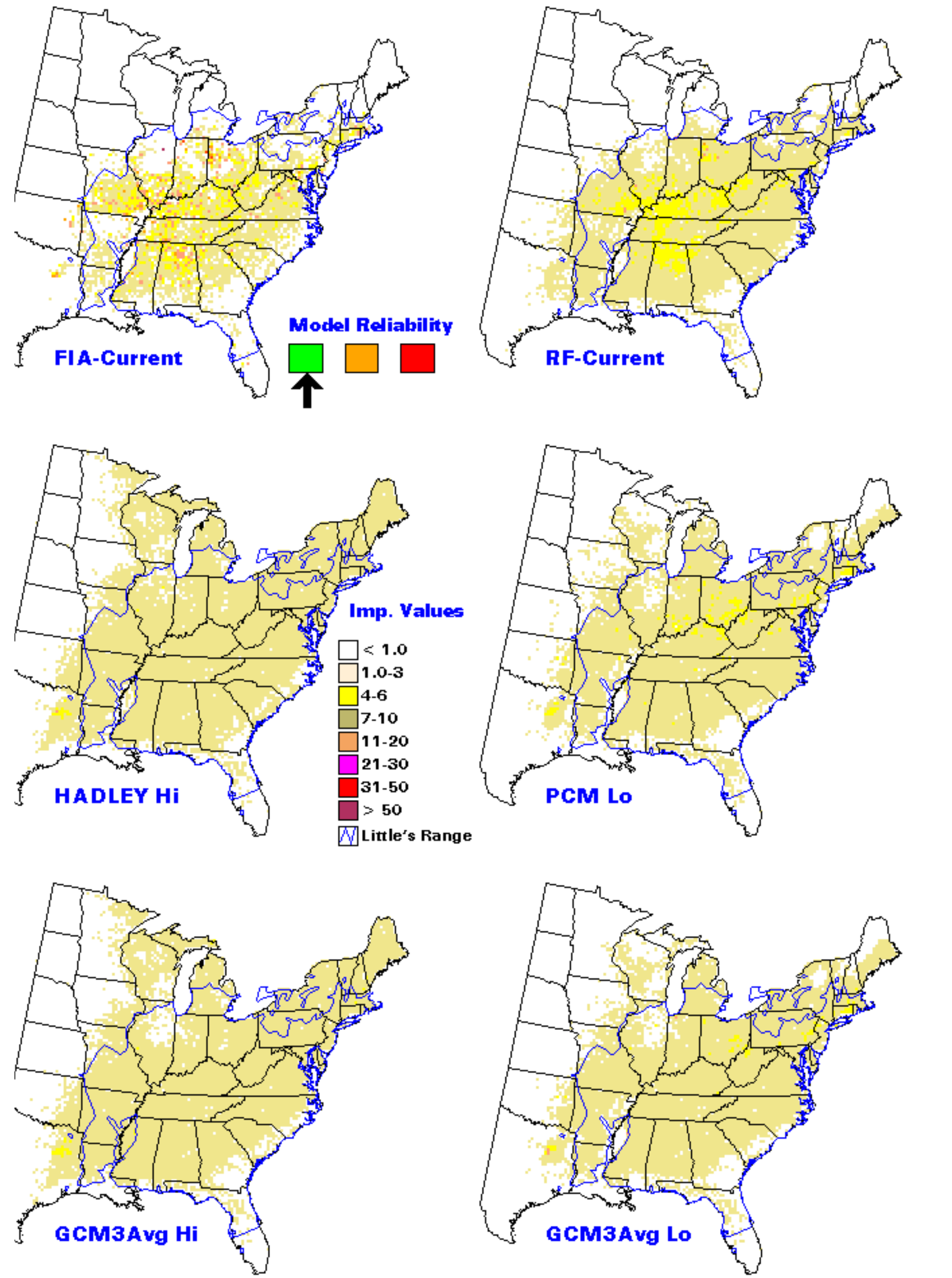
Google Earth Maps

The following maps show habitat suitability in 2100; not arrival dates of migrating species

black hickory - Carya texana - (408)



pignut hickory - Carya glabra - (403)



pignut hickory *Carya glabra* **Model Reliability: High**

Select Maps and Options for pignut hickory *Carya glabra* **Model Reliability: High**

Available Maps

- [x] Current FIA
- [x] Current Modelled
- [ ] HadleyCM3 – A1FI (High, "Harsh")
- [ ] HadleyCM3 – B1 (Low)
- [ ] PCM – A1FI (High)
- [ ] PCM – B1 (Low, "Mild")
- [ ] GFDL – A1FI (High)
- [ ] GFDL – B1 (Low)
- [x] Avg. of 3 GCMs – A1FI (High)
- [x] Avg. of 3 GCMs – B1 (Low)

Select another tree species

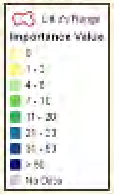
Enter a common or scientific name

Map Size

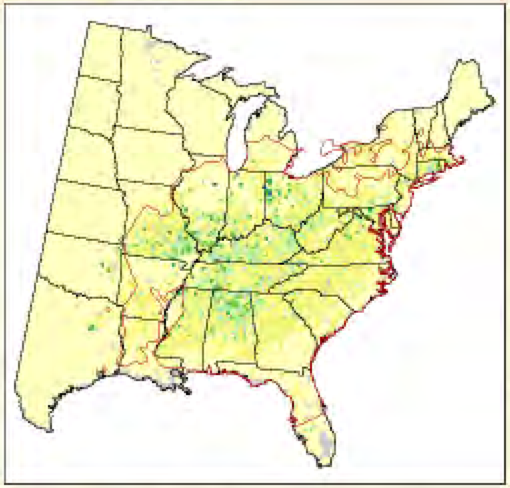
500 pixels

Update Maps

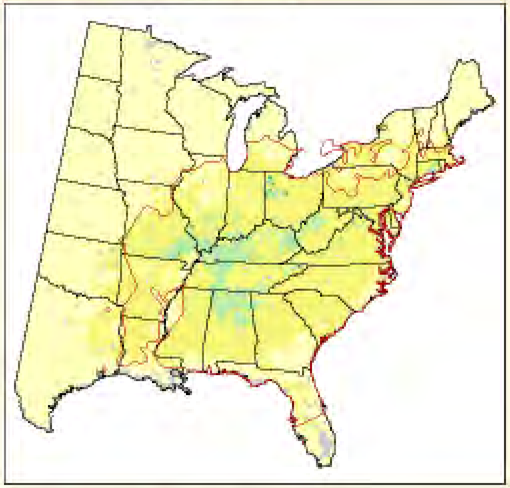
Map Legend



Current FIA for pignut hickory



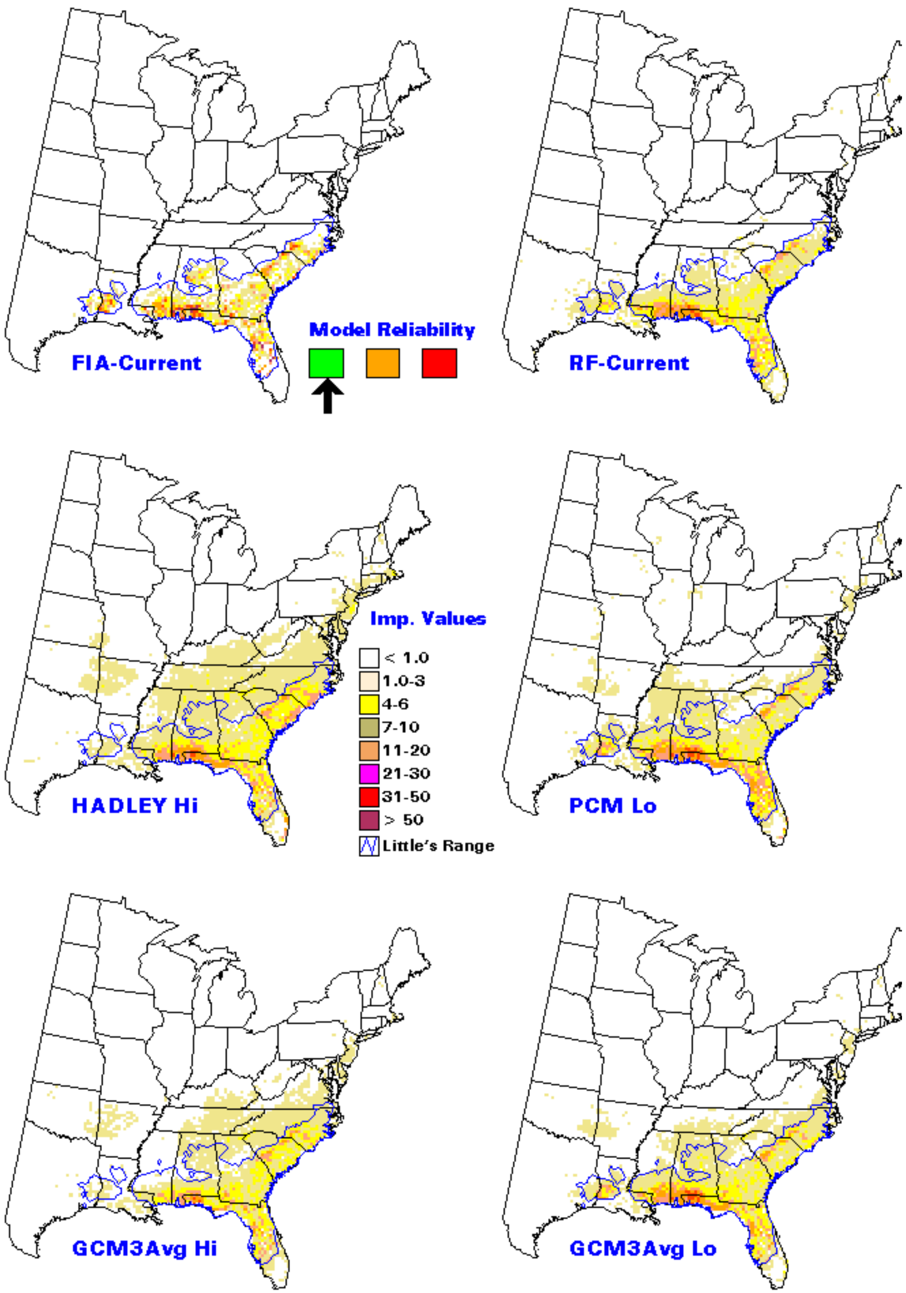
Current Modelled for pignut hickory



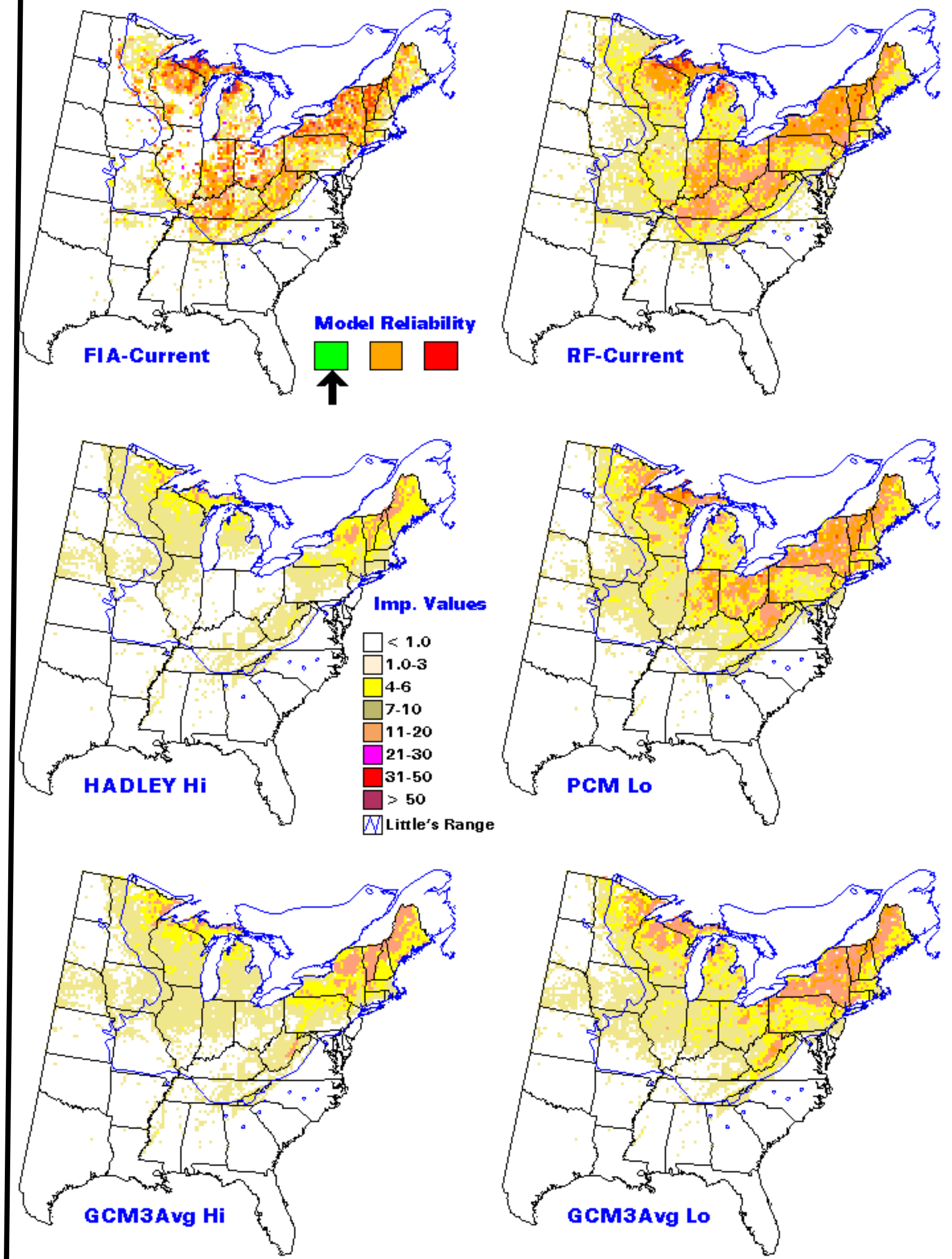
HadleyCM3 – A1FI (High, "Harsh") for pignut hickory

PCM – B1 (Low, "Mild") for pignut hickory

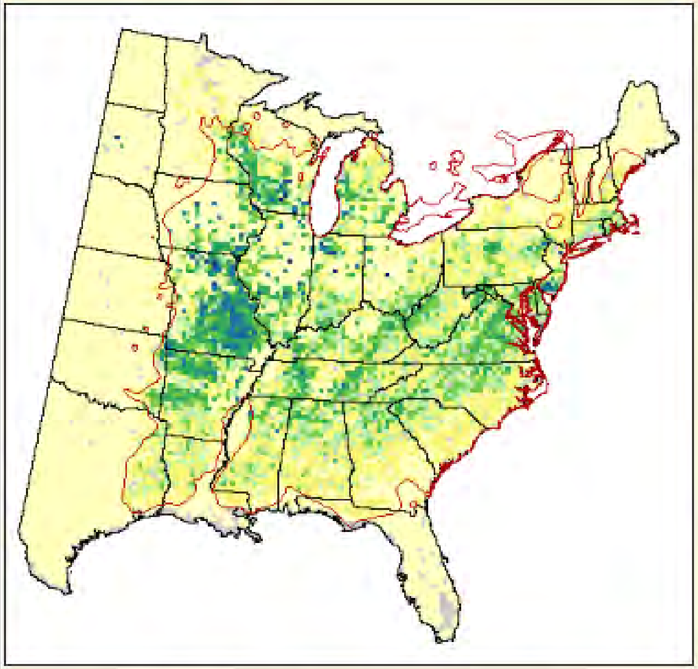
longleaf pine - Pinus palustris - (121)



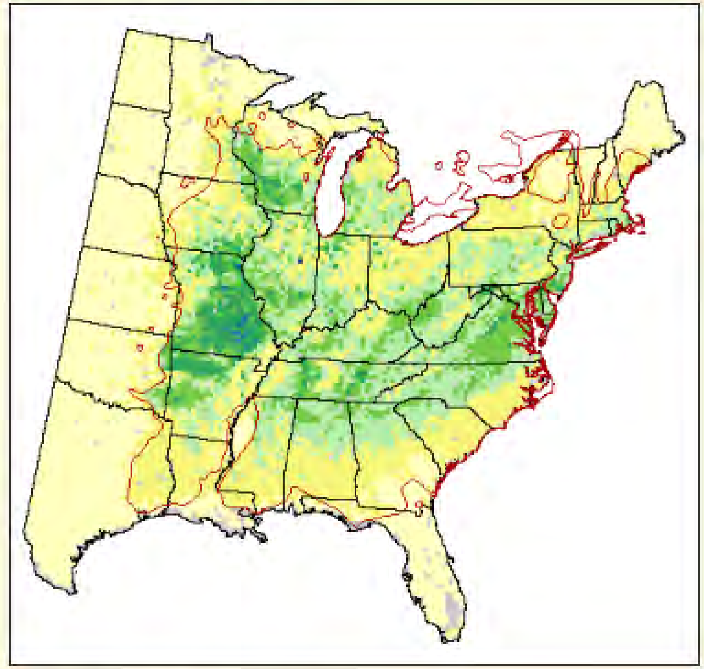
sugar maple - Acer saccharum - (318)



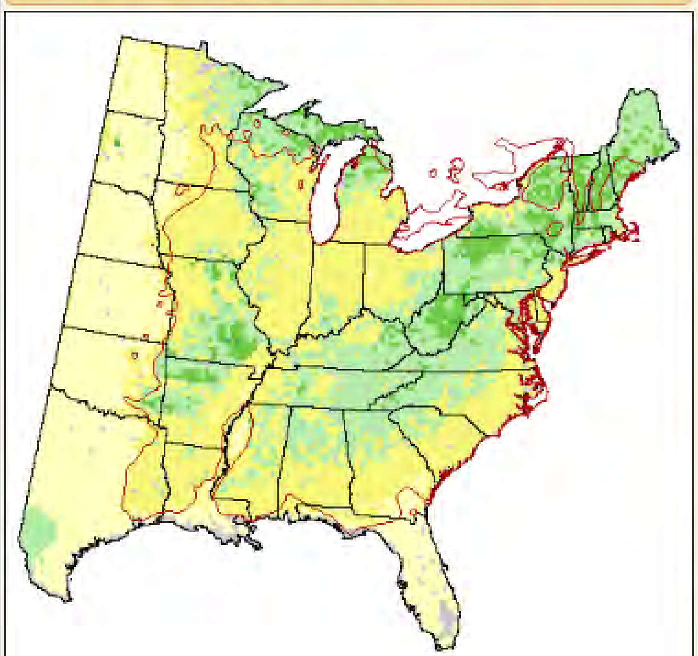
Current FIA for white oak



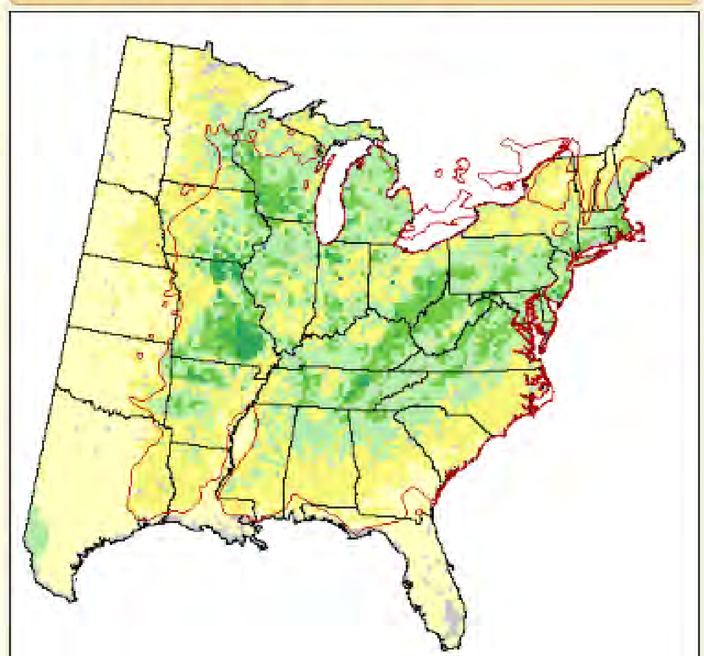
Current Modelled for white oak



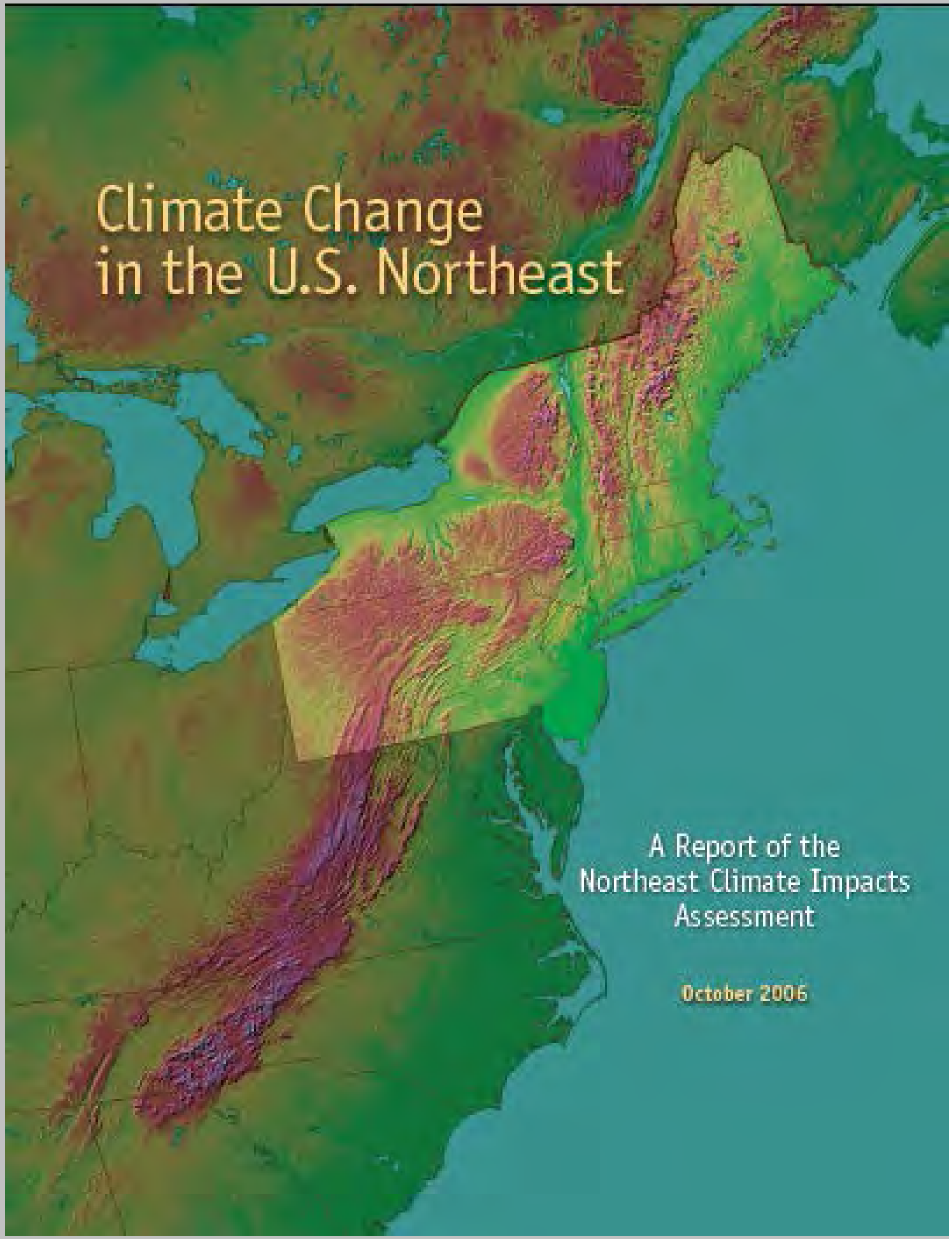
HadleyCM3 – A1FI (High, “Harsh”) for white oak



PCM – B1 (Low, “Mild”) for white oak



- While trees grow in the averages, they die at the extremes
- Cold tolerances might change less than heat loading norms
- Plants might not go through needed acclimatization prior to extreme cold events
- Changes in the periodicity of precipitation (seasonal and days between events) and the intensity of events….. Results in changes in growth season and water availability
- Change in snow-covered days and albedo change mineral cycling in forest soils, more like non-snow soils of similar provenance along Appalachian ridge and Piedmonts



Northern Trees - Microsoft Internet Explorer

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Northern Trees

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- Site Analysis
- Tree Selector

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- Hardiness Zone
- State Trees

Related Sites
- Urban Design
- Nursery Growing

UNIVERSITY OF FLORIDA IFAS

RUTGERS COOPERATIVE EXTENSION

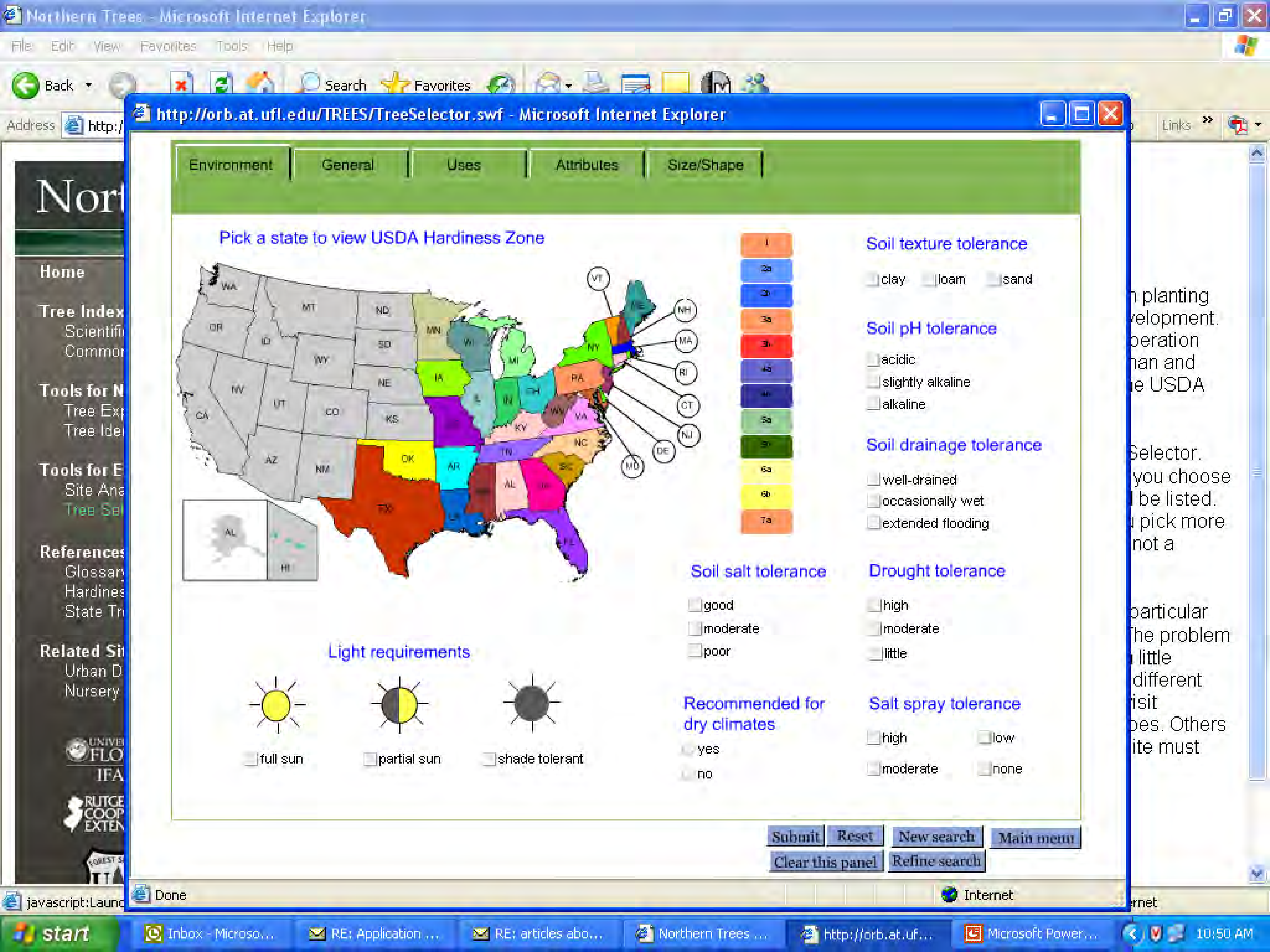
This web site is designed to help guide you through the process of choosing trees for urban and suburban planting sites. Several tools listed on the left side of this screen are available to you now. Others are still under development. This information was assembled through a grant from the USDA Forest Service Northeast Region in cooperation with Rutgers University and University of Florida. The principle authors of this system include Drs. Ed Gilman and Howard Beck, professors at University of Florida and Dr. Jason Grabosky at Rutgers. Robin Morgan at the USDA Forest Service was instrumental in executing the agreements that lead to completion of this project.

Using the Tree Selector: You can mark more than one value of an attribute such as soil pH in the Tree Selector. This chooses trees that can grow in soils with either one of the values of soil pH. On the other hand, when you choose more than one attribute, such as acid soil pH and 25-50 feet tree height, only trees with both attributes will be listed. You may choose as many attributes as you like but remember the list of matching trees diminishes as you pick more attributes. You will find that some planting sites are so harsh no trees are suited for growing there. This is not a shortcoming of this software; it is a shortcoming of the planting site.

More on selecting trees for urban and suburban landscapes: One method of choosing a tree for a particular site is to drive around town to find out which species grow well in landscapes with similar site attributes. The problem with this approach is that most people do not do it, and when they do, it can create urban landscapes with little species diversity. The other problem with this approach is the soil conditions at your planting site may be different from other sites around town. Many professionals who specify trees for urban and suburban landscapes visit arboreta and botanic gardens. This is good because it potentially brings new plants to our urban landscapes. Others rely on books and computer software to choose trees. This is reasonable, however the specific planting site must first be evaluated to determine the cultural and physical attributes required of trees at the site.

Internet

start | Inbox - Microsoft Out... | RE: Application Recei... | RE: articles about urb... | Northern Trees - Micr... | 10:49 AM



Northern Trees - Microsoft Internet Explorer
http://orb.at.ufl.edu/TREES/TreeSelector.swf - Microsoft Internet Explorer
Environment
General
Uses
Attributes
Size/Shape
Pick a state to view USDA Hardiness Zone
Soil texture tolerance
clay
loam
sand
Soil pH tolerance
acidic
slightly alkaline
alkaline
Soil drainage tolerance
well-drained
occasionally wet
extended flooding
Soil salt tolerance
good
moderate
poor
Drought tolerance
high
moderate
little
Light requirements
full sun
partial sun
shade tolerant
Recommended for dry climates
yes
no
Salt spray tolerance
high
low
moderate
none
Submit
Reset
New search
Main menu
Clear this panel
Refine search
Home
Tree Index
References
Done
Internet
start
10:50 AM

Individual trees do not tend to move great distances once planted

- As the temperature and moisture regimes shift, existing trees can fall into the category of species-site disconnect where they previously were apt as a species.
- Others which were questionable choices may come into a stronger species-site match

- The quality of the linkage influences disease-pest and other maintenance expenditures

Creating typologies on site condition groupings

- Often it is challenging, if not impractical at municipal level to derive a species-site matching rubric customized for each planting event.
- Often the stress filters can cluster into a discrete set of site types
- As site types emerge, clusters of species options emerge
- The key is to avoid cross-listing adaptable species into several site types


A gratuitous pretty plant image

Common selection filters

- Soil pH tolerance
- Salt, a companion to pH
- High temperature
  - Above ground
  - Below ground
- Drought-flood-compaction
- Space limits above ground (lines and views)

Microclimate factors (site specific)

- Light levels and shade patterns
- Wind exposure or wind tunnels
- Rain shadows
- Reflected heat loads
- Frost pockets and air drainage

Questions….

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