

Mixed Oak – Hickory History, Silvics, and Stand Dynamics



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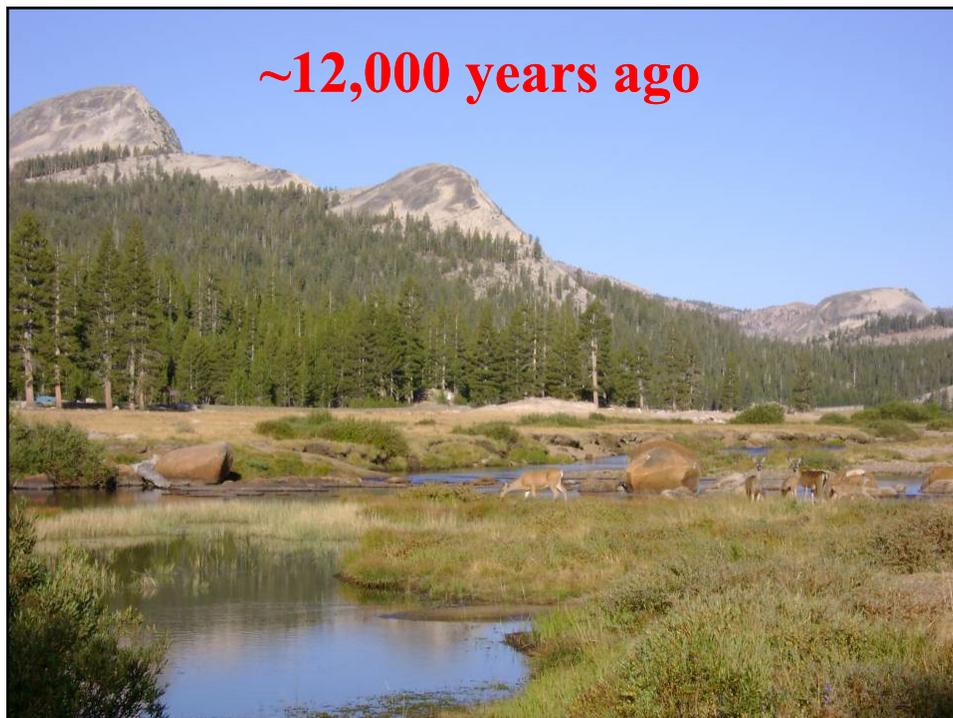


A short history our forests – Or why so many darn oaks

Jeffrey S. Ward, Ph.D.

Chief Scientist – Station Forester

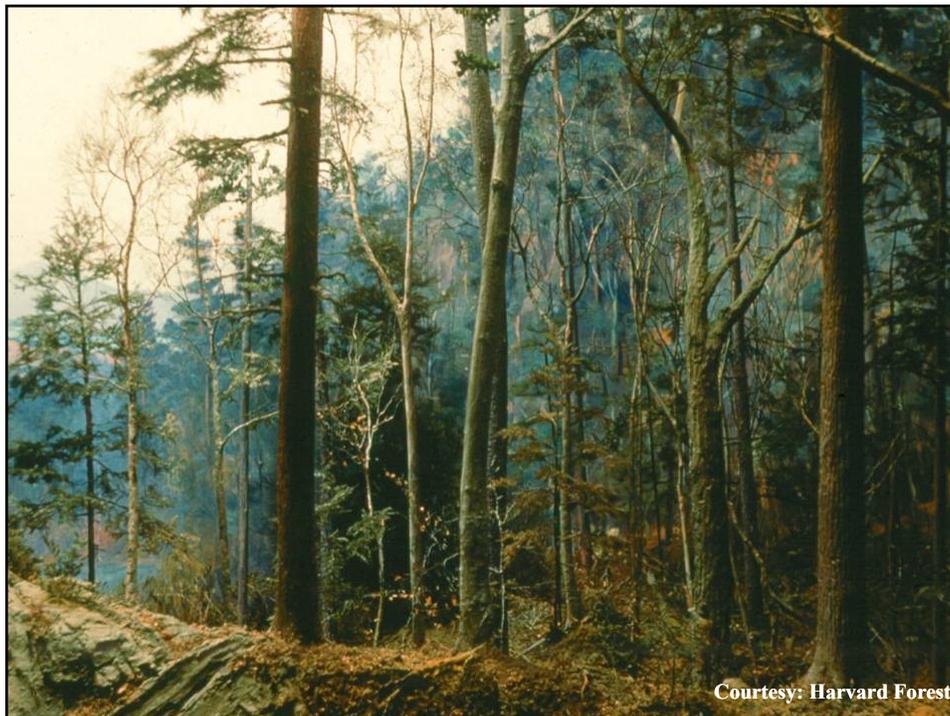
Forestry & Horticulture
The Connecticut Agricultural
Experiment Station



Pleistocene

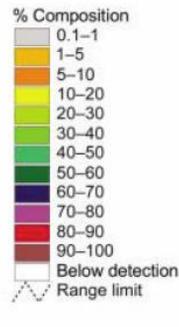
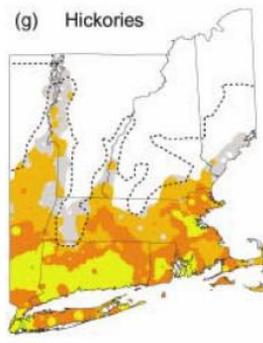
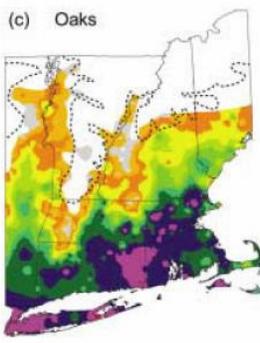


North American Pleistocene Mural, Mammoth detail, copyright by Karen Carr



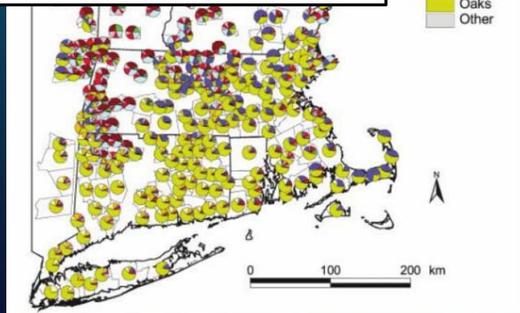
Courtesy: Harvard Forest

Native Americans

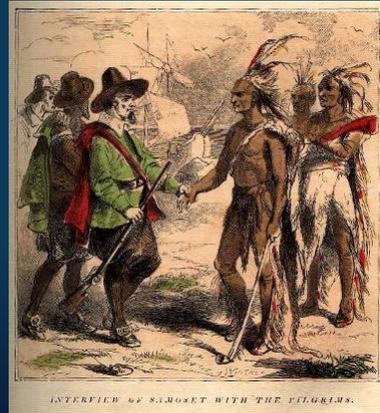


Pre-European forests

Source: Cogbill et al. 2002



European arrival



The last virgin stand in Connecticut, located in Colebrook, was harvested in 1912.

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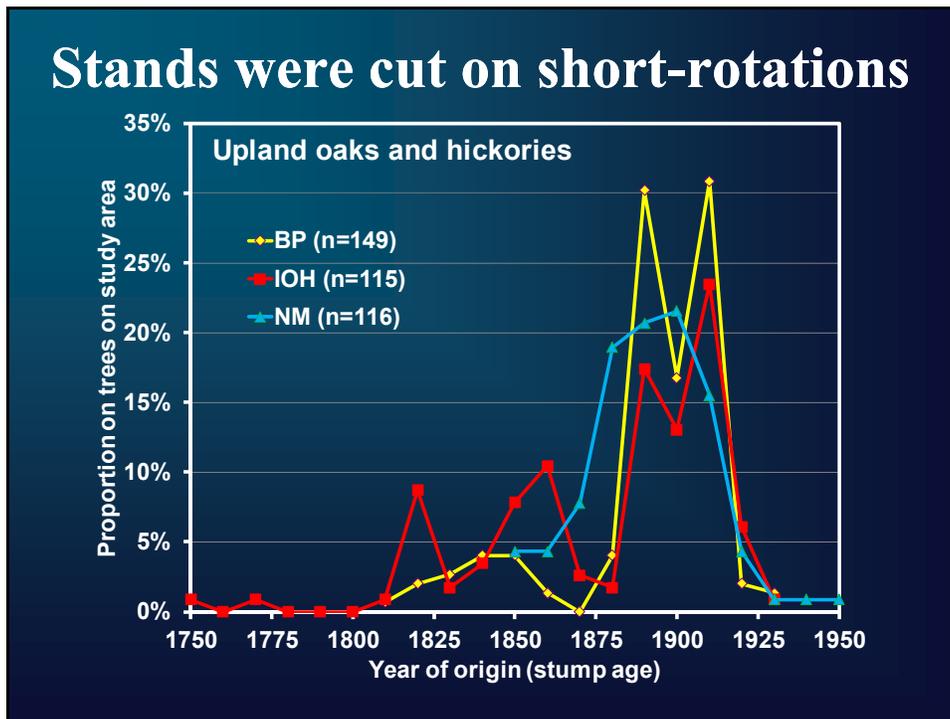






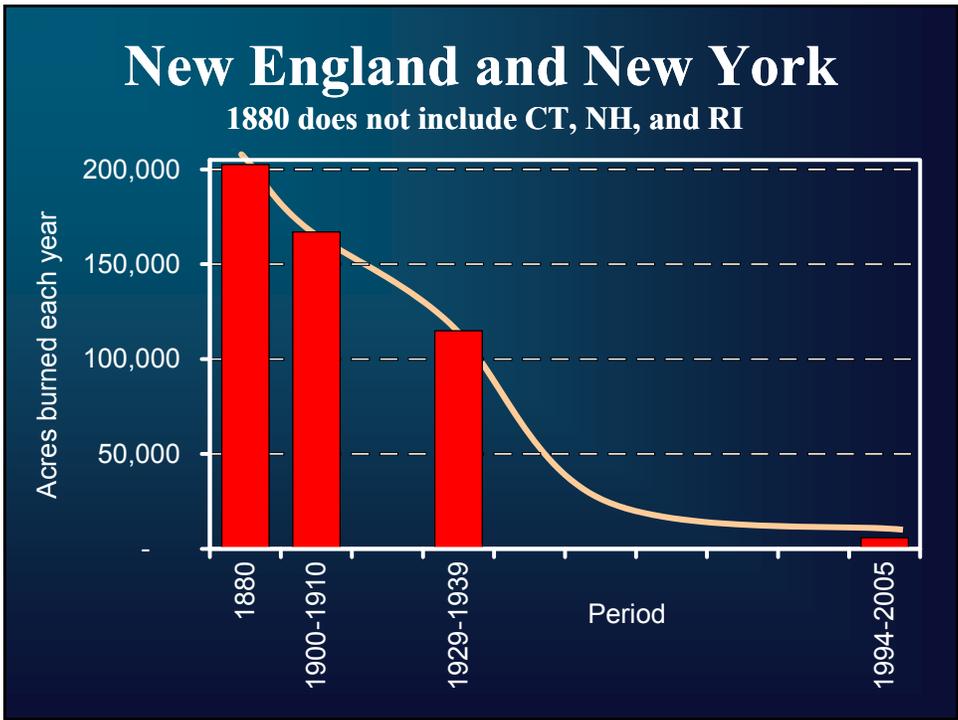
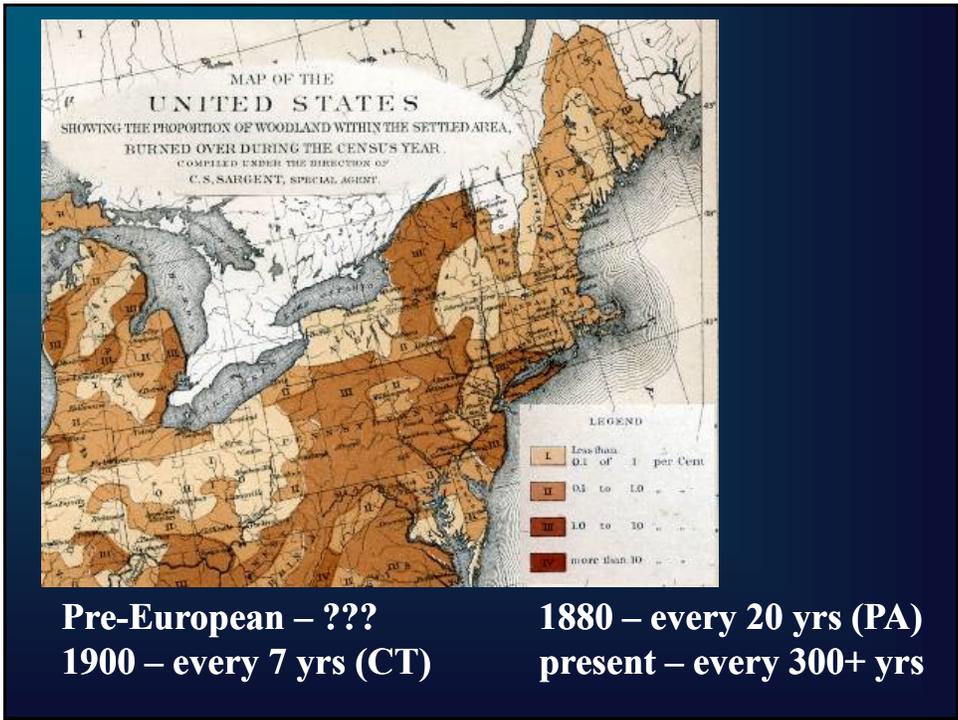


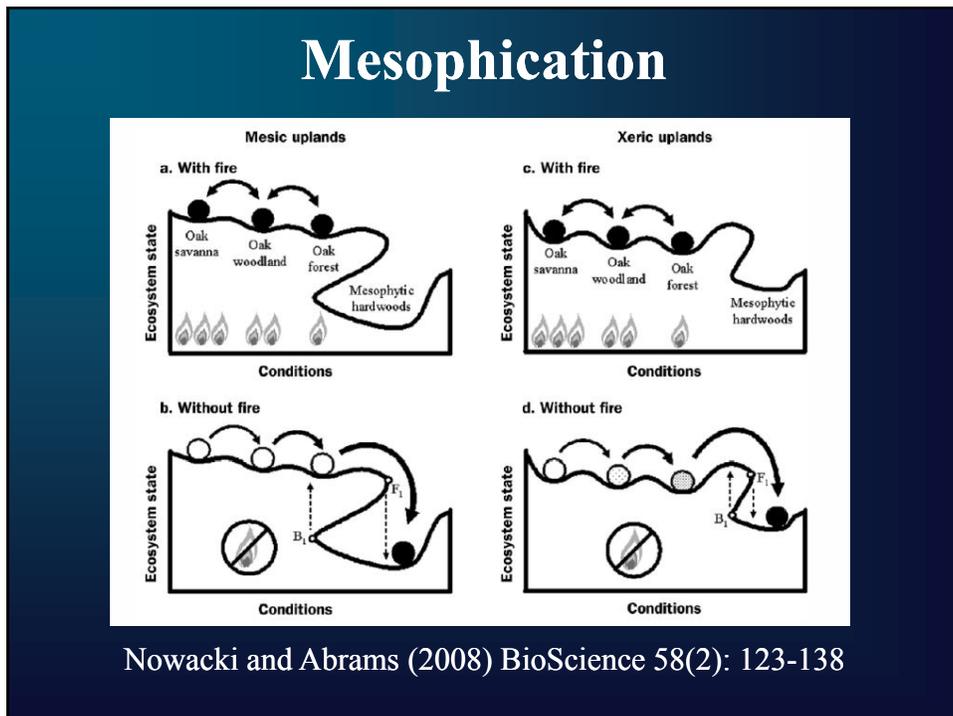
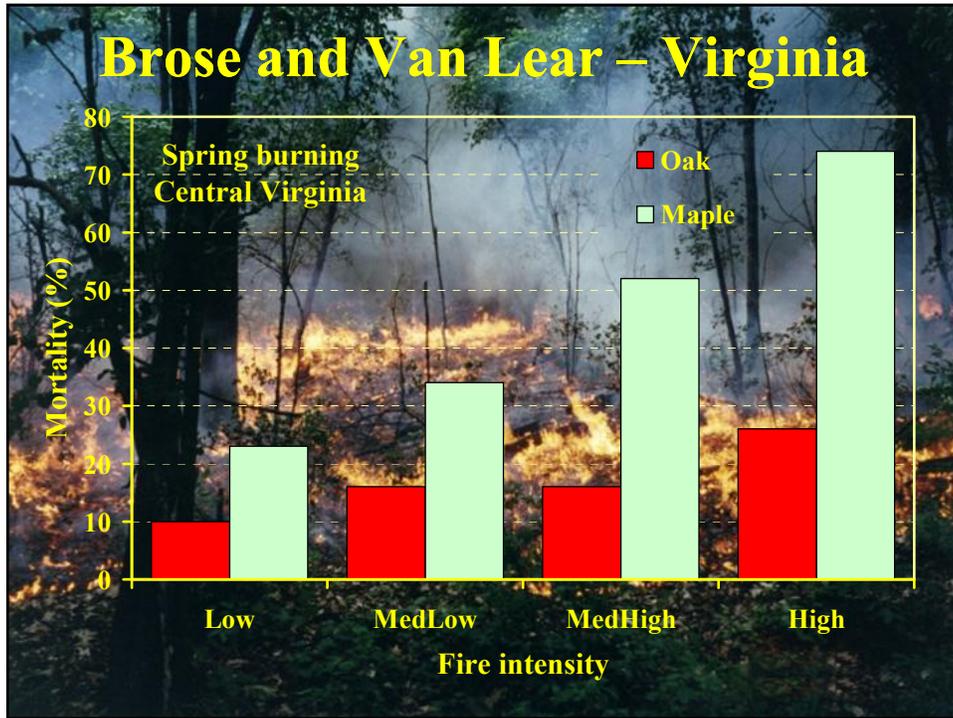


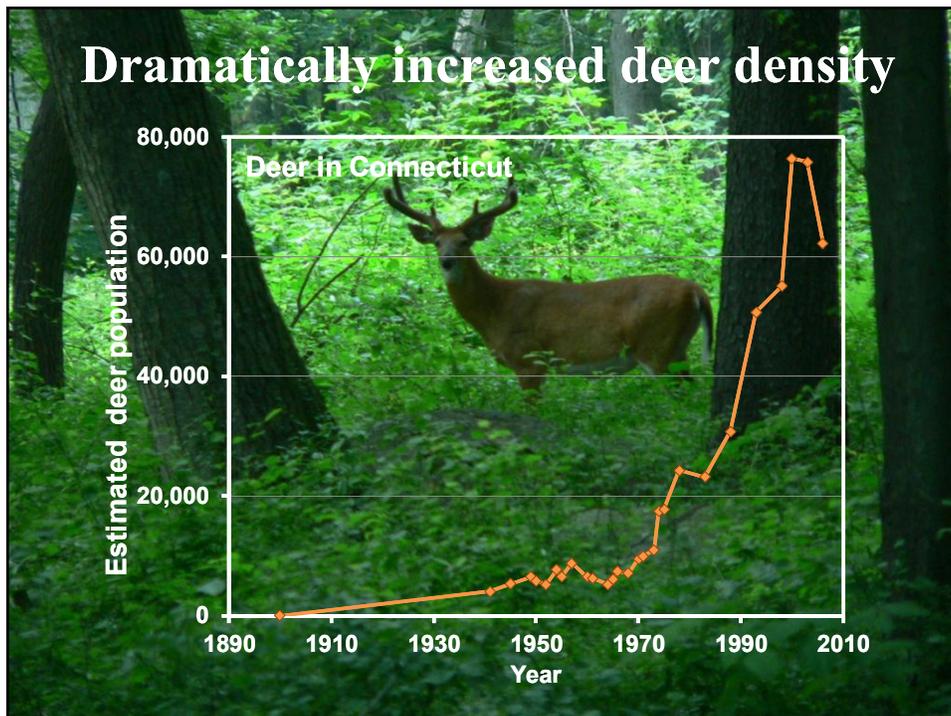
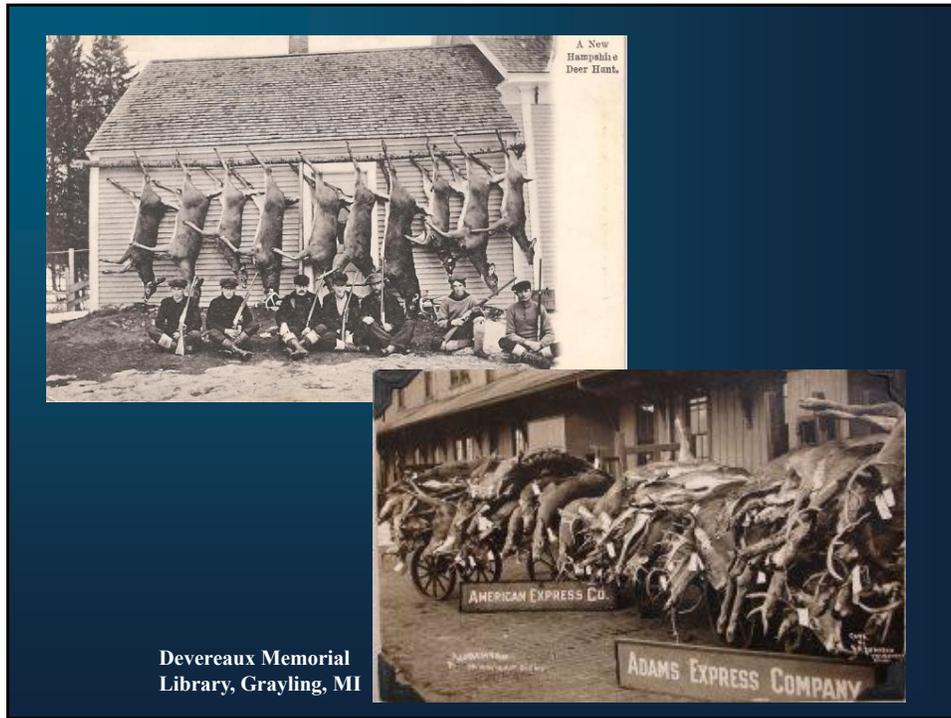




East Hartford 1905



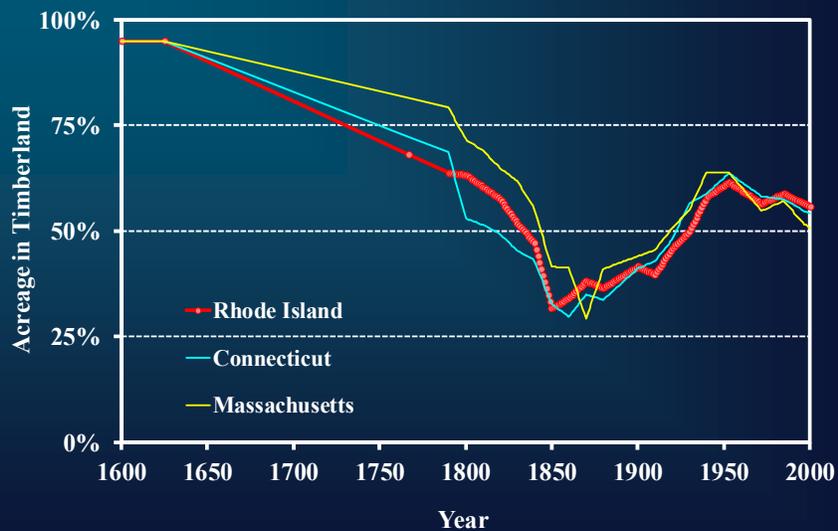




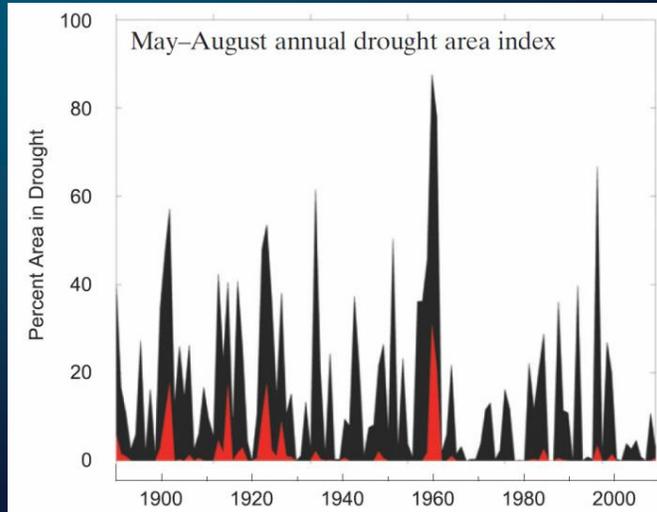
When our oak forests originated

1. Forests were cut more frequently (short-rotation)
2. Forests burned over frequently (and often much hotter)
3. No deer

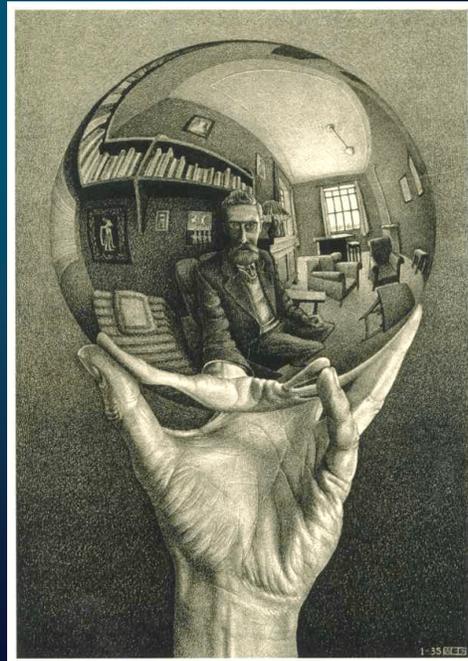
Forest cover plunged, then recovered

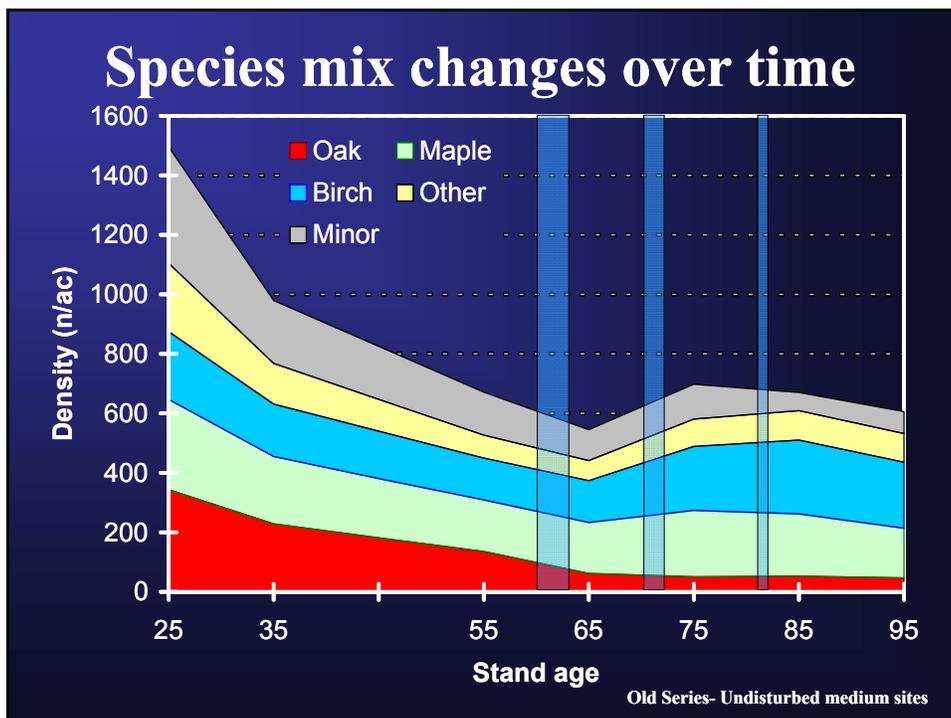
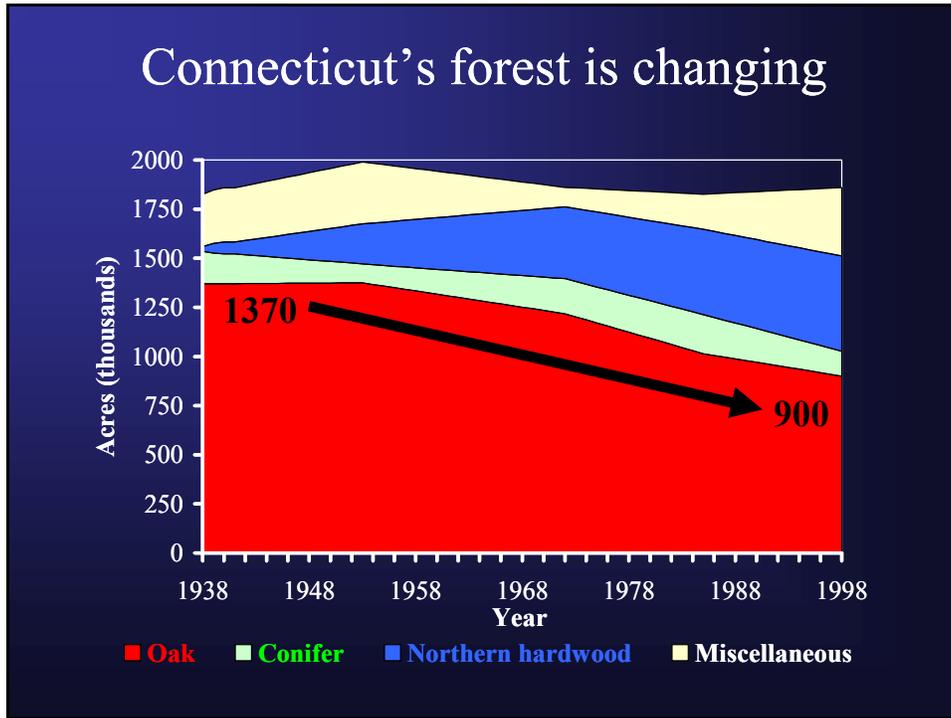


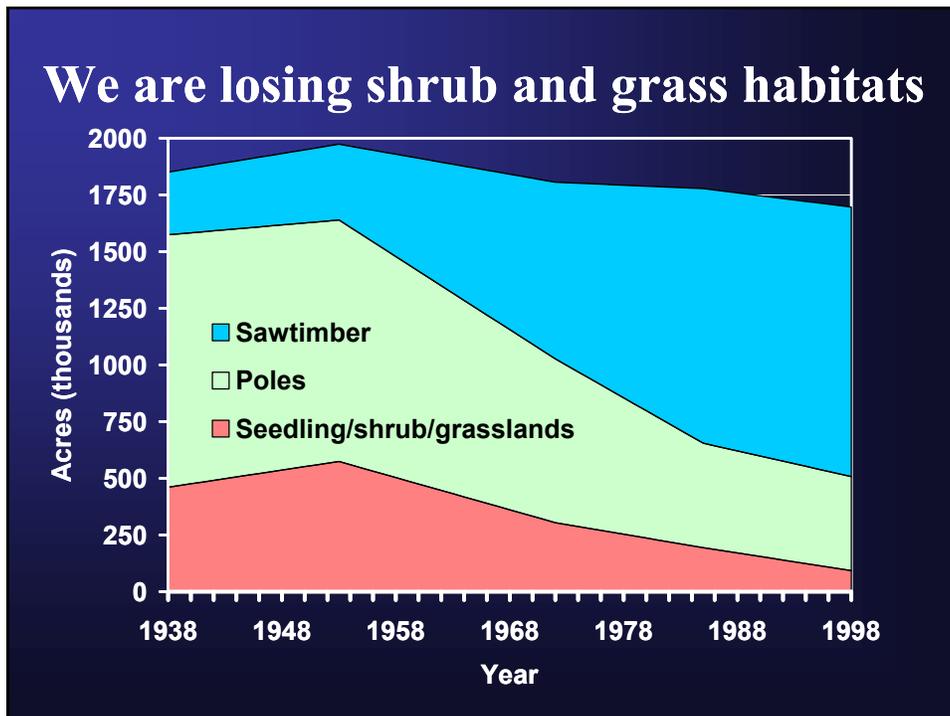
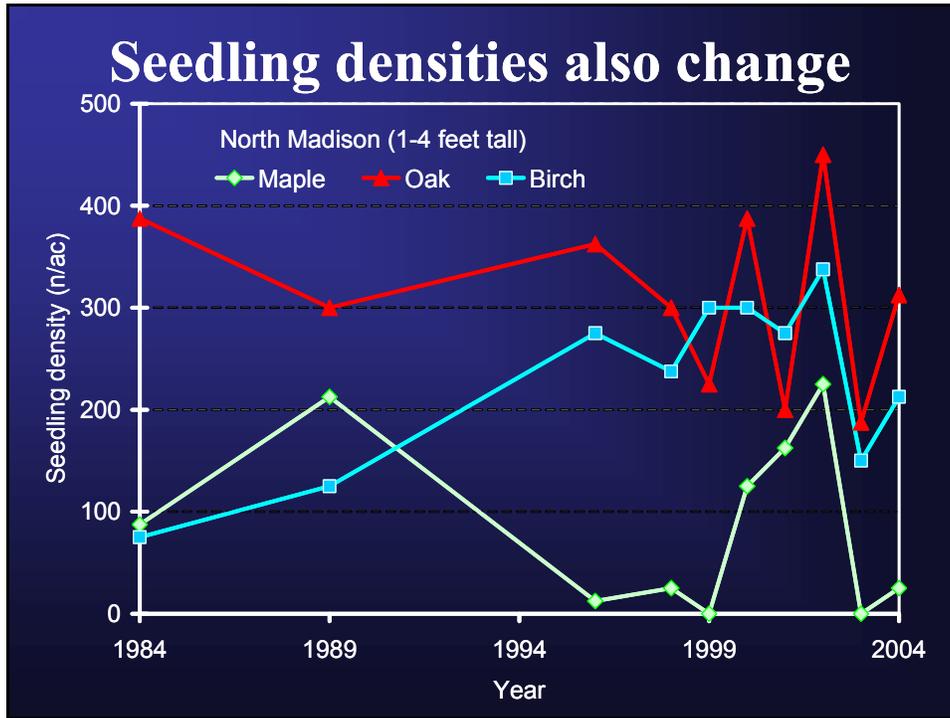
An epic pluvial



From Pederson et al. (2013) Journal of Climate







Connecticut's forest is changing

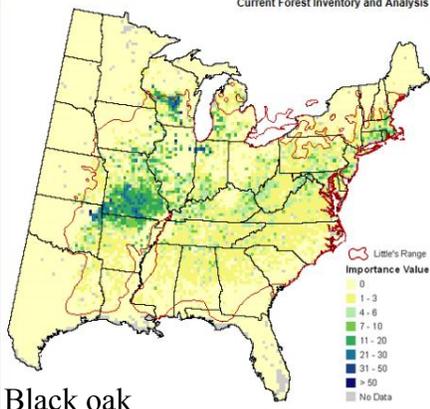
Our oaks are decreasing



Our maples are increasing

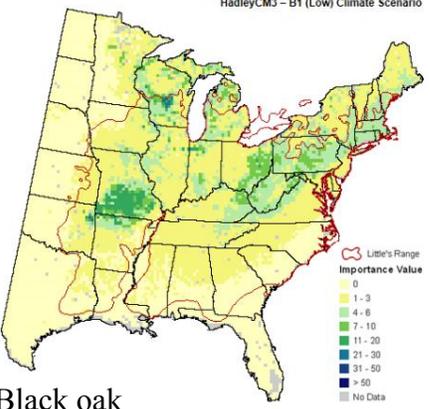
Future changes with climate?

Current Forest Inventory and Analysis



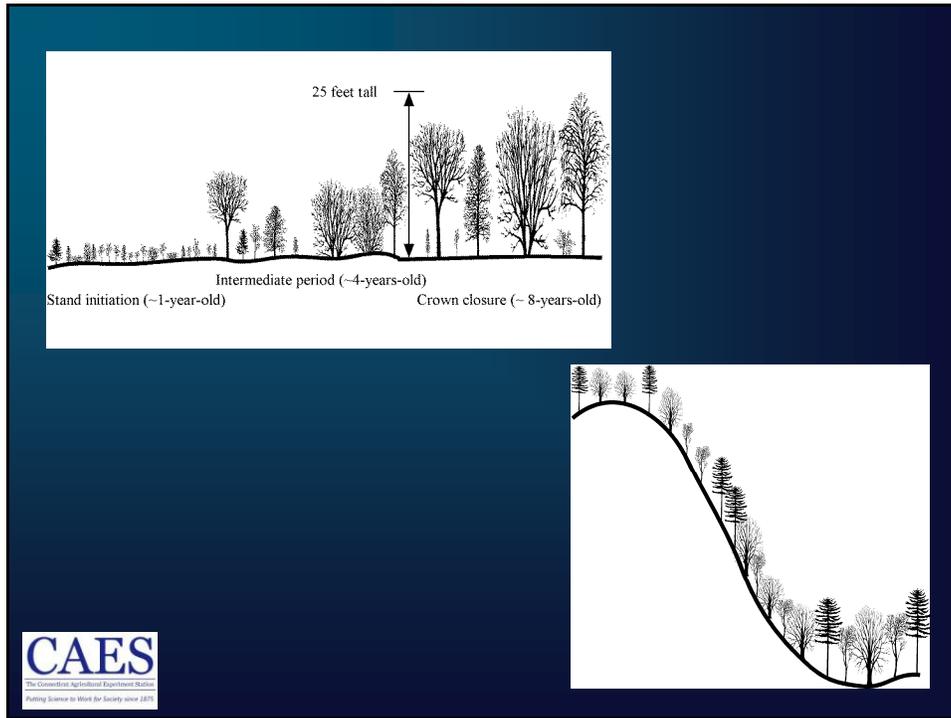
Black oak

HadleyCM3 - B1 (Low) Climate Scenario



Black oak

USDA Forest Service Climate Change Tree Atlas
<https://www.fs.fed.us/nrs/atlas/>



Mixed Oak – Hickory

- **Silvics of selected species**
- **Ecology of regeneration**
- **Stand dynamics**

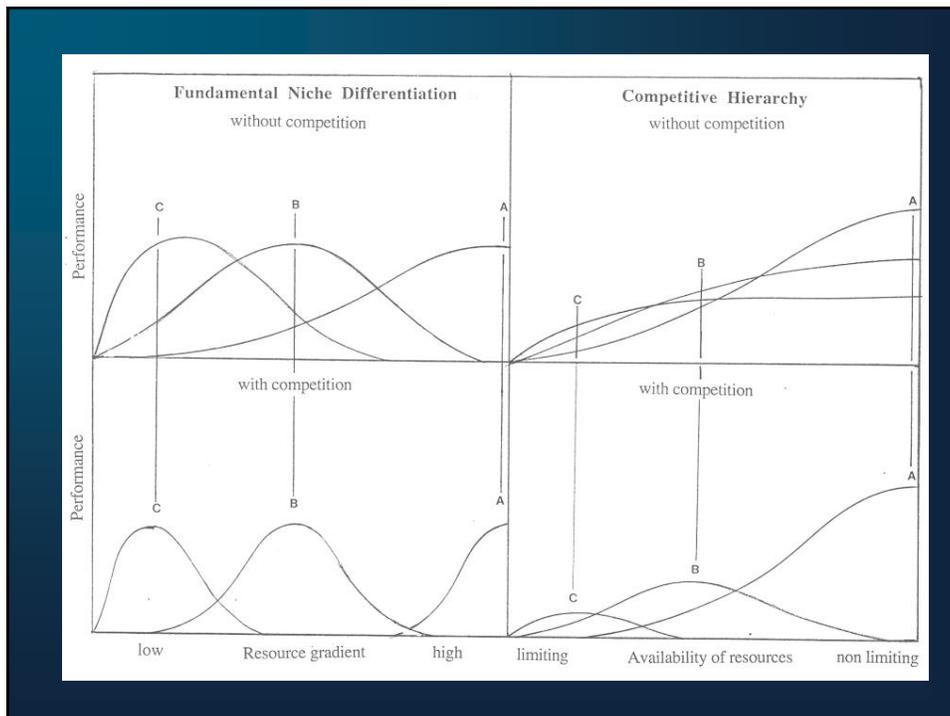
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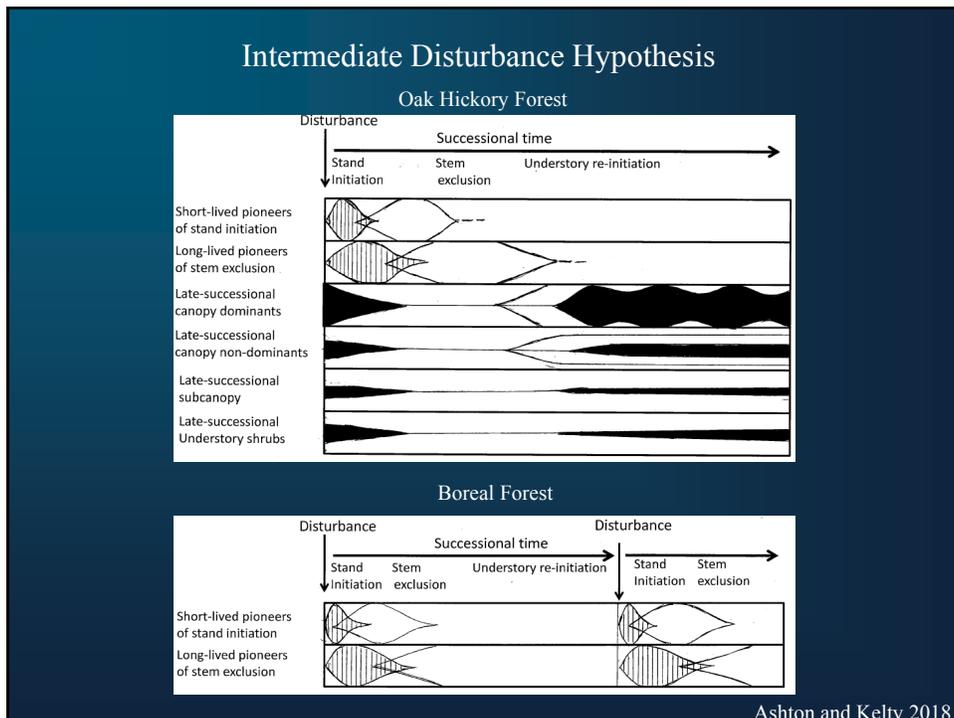
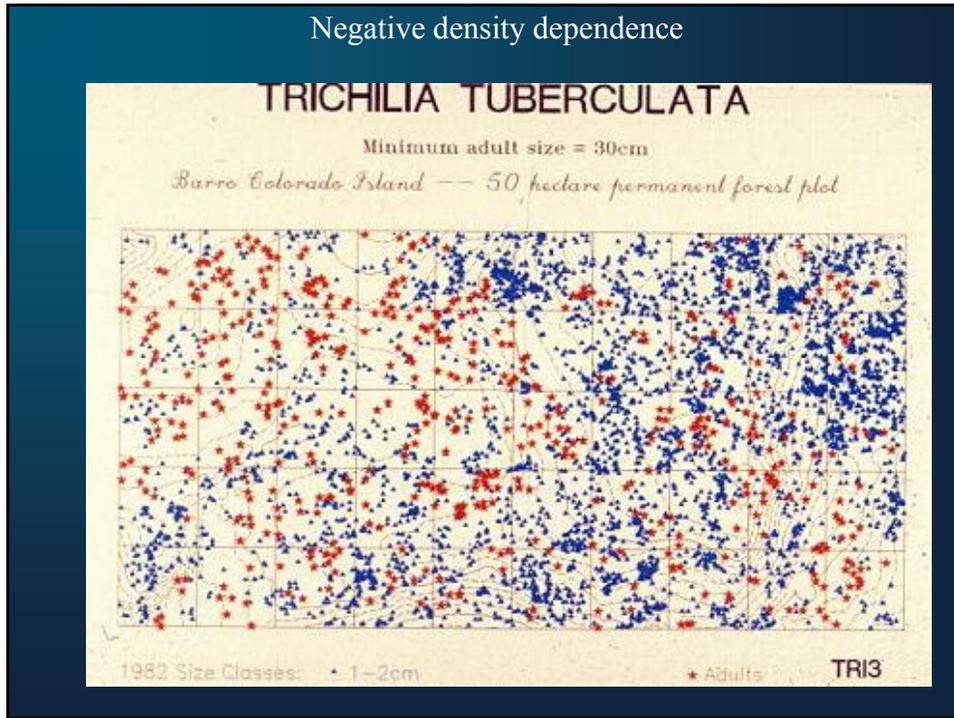
School of Forestry
and Environmental Studies
Yale University



Silvics – Diversity Theory

- **Competitive hierarchy**
- **Fundamental niche partitioning**
- **Negative density dependence**
- **Intermediate disturbance hypothesis**

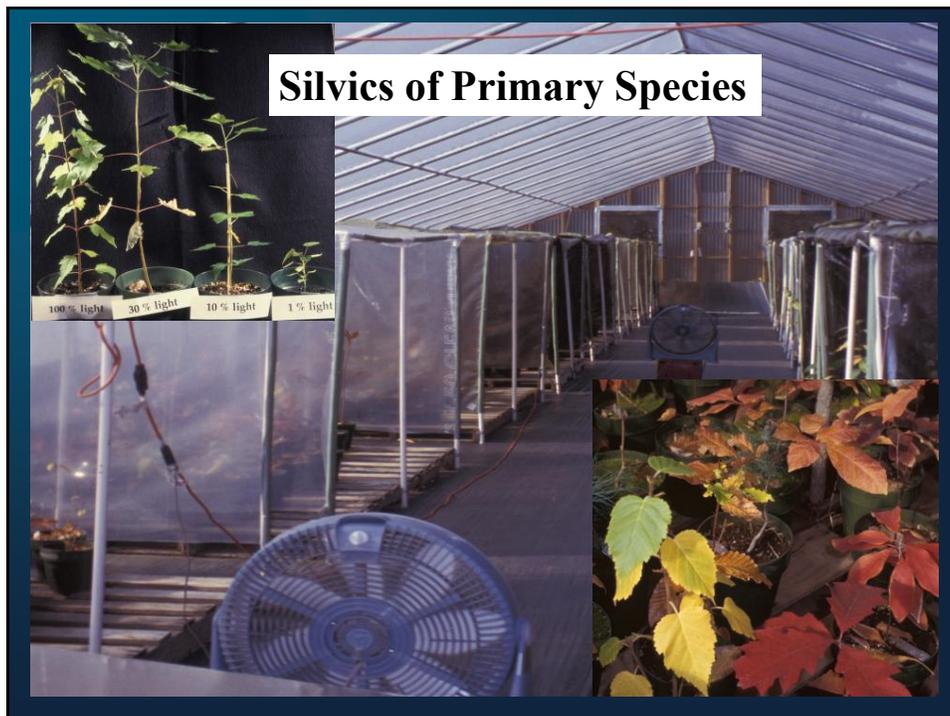


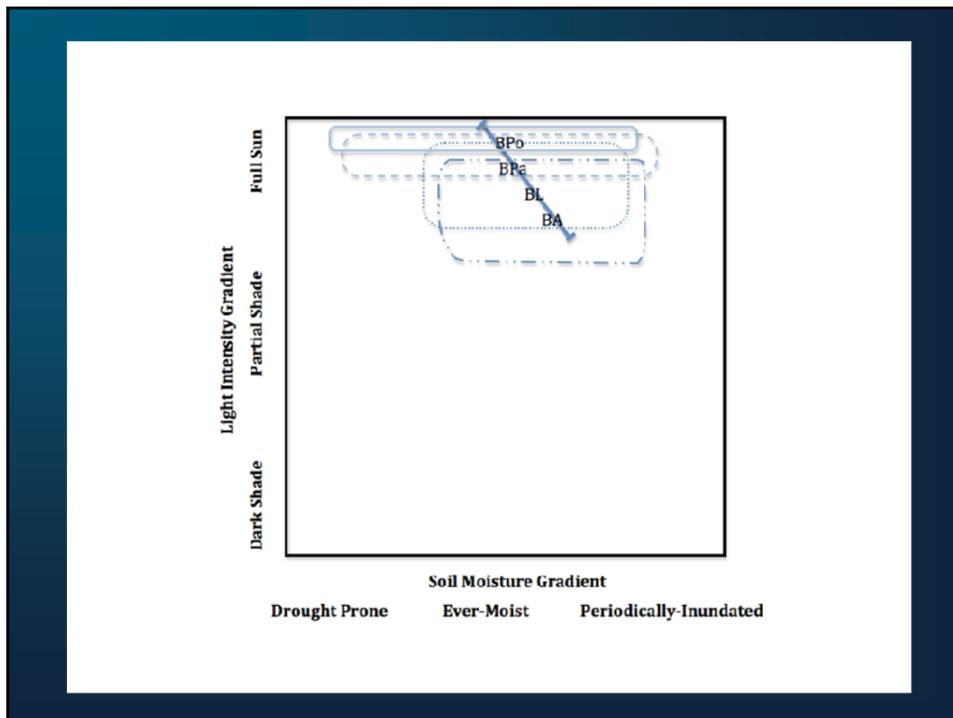
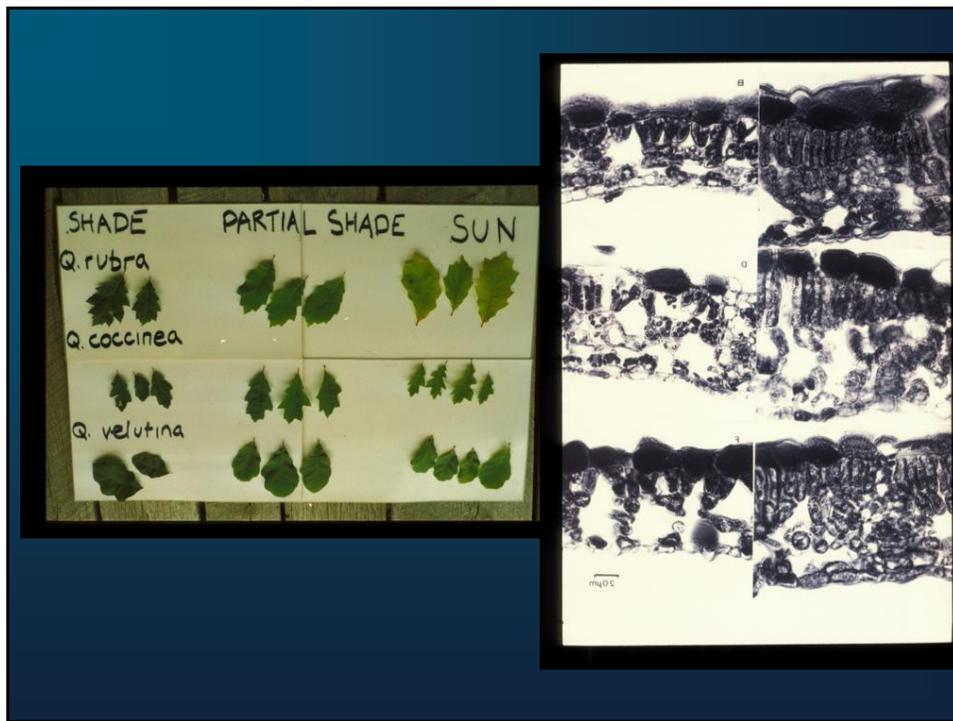


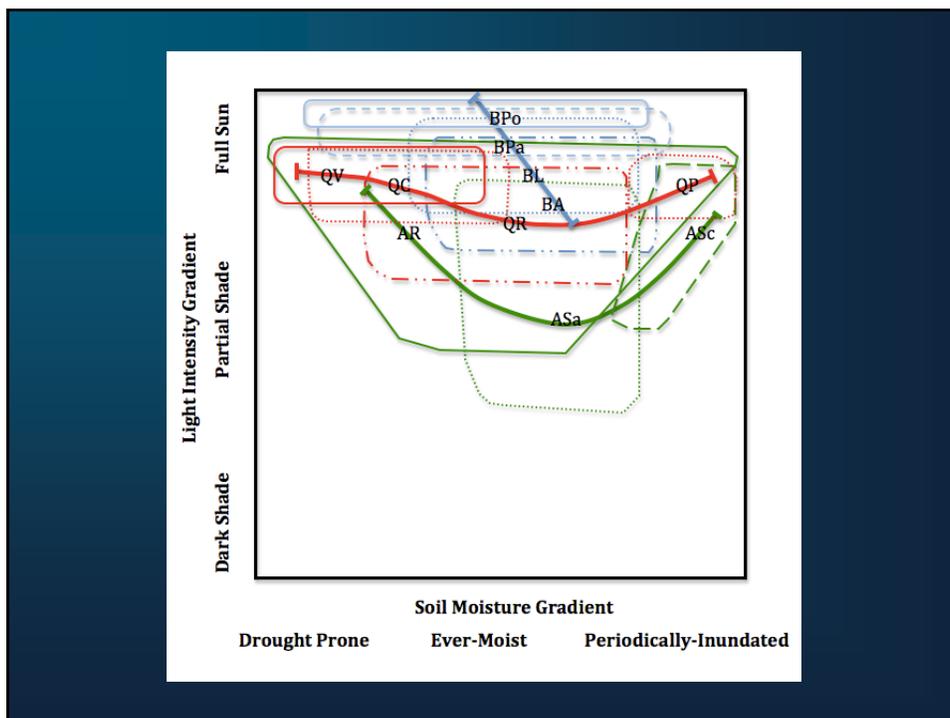
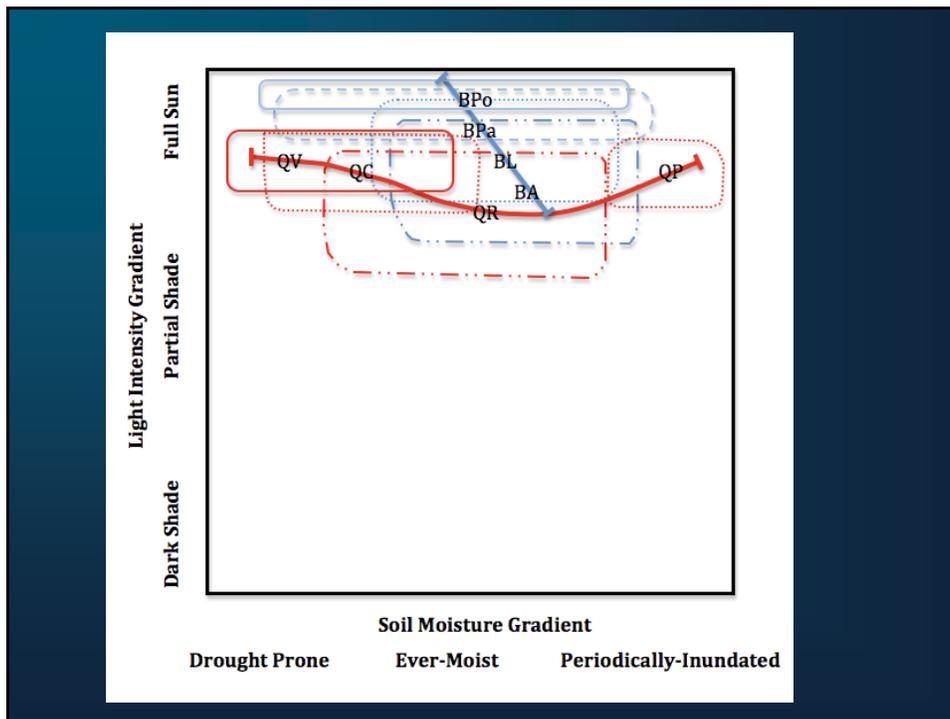
Functional Groups or Guilds of an Oak-Hickory Forest

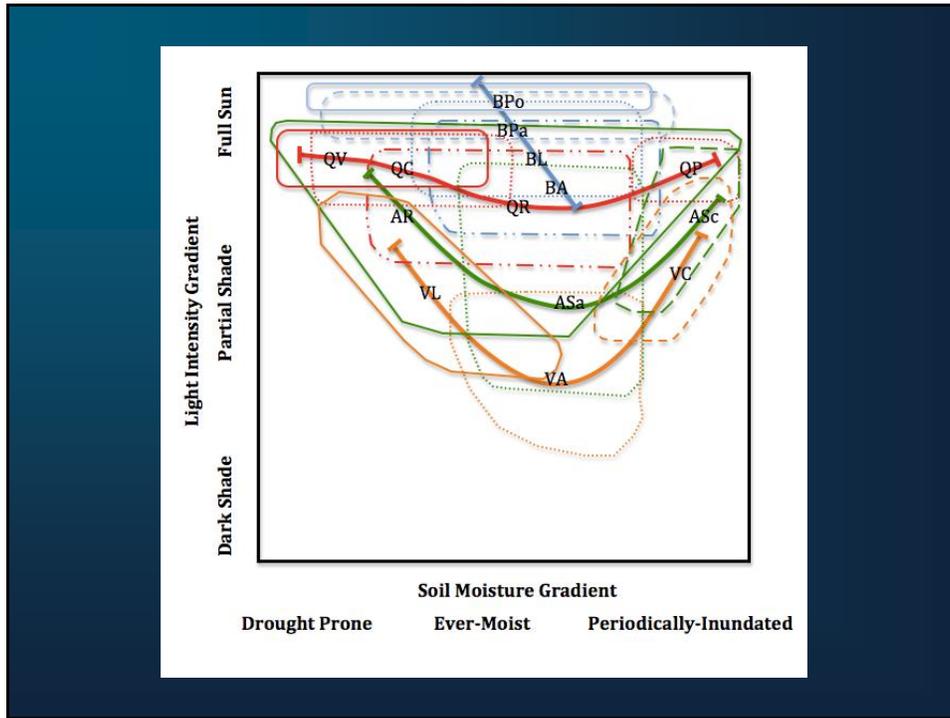
Guild	Developmental stage	Autecology	Examples
Pioneer Short-lived	Initiation (gap phase)	Frequent production of small flowers and seeds, dispersed by wind, water, small birds, bats, very fast-growing – umbrella like; shade intolerant; superficial; use inefficient; mineral soil seed bed; seed bank	<i>Sumac</i> <i>Pin cherry</i>
Pioneer Long-lived	Stem exclusion (building phase)	As above for reproduction....but fast growing, columnar dense-canopied crowns; use-efficient; sequesters of carbon; Vegetative	<i>Black cherry</i> <i>Yellow/ black birch, Red maple</i>
Canopy Dominants	Understory initiation (mature phase)	Frequent but large flowering/fruitlet events, dispersed by gravity, predation escape; shade-tolerant, seedling carpets present before disturbance; relatively resistant to herbivores; crown plasticity – “columnar to cauliflower”; site restricted.	<i>Oaks</i> <i>Sugar maple</i> <i>Hickories</i> <i>Ash</i>
Canopy Non-dominants	as above	Frequent regular flowering/fruitlet, large but relatively fewer flowers and fruits; density dependent; shade tolerant; few seedlings present before disturbance; dispersed by animals; prone to herbivory; crown morphology as above....	<i>Magnolia</i> <i>Persimon</i> <i>Basswood</i>
Sub-canopy	as above	Crowns columnar, greater reliance on vegetative prop.	<i>Sassafras</i> <i>Dogwood, Musciewood</i>
Understory	as above	Crowns planar, low level flowering – rel. inconspicuous, heavy reliance on vegetative prop.	<i>Witchhazel</i> <i>Viburnum</i>

(modified after Ashton et al. 2001)



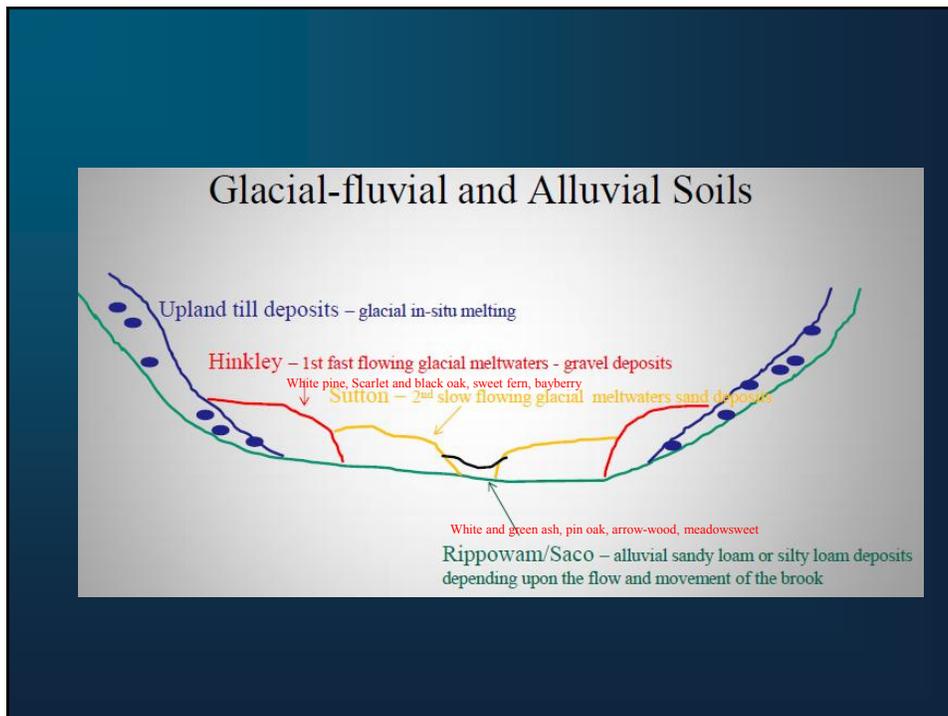
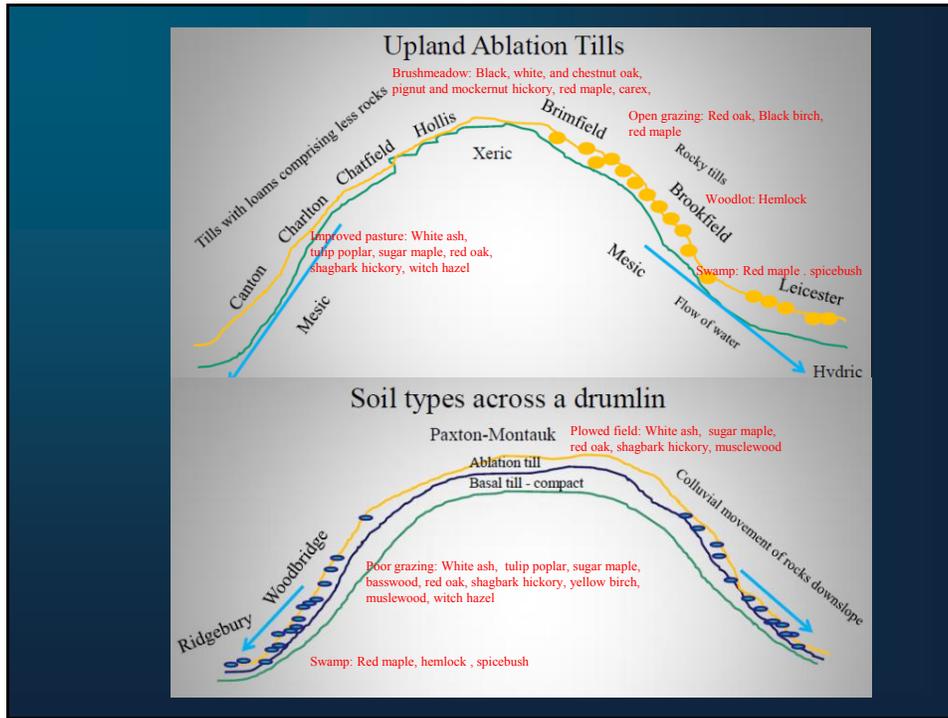






Upland Hardwoods of Southern New England

Species	Relative Shade Tolerance	Relative Drought Tolerance	Site/Successional Status
Eastern Hemlock	VT – very tolerant	II – intermediate intolerance	G/OG SI – stand initiation
American Beech	VT	II	MIS/OG SS – stem exclusion
Sugar Maple	VT	I – intolerant	MFS/OG UI – understory Init
Red Maple	T – tolerant	T – tolerant	G/UI OG – old growth
Eastern White Pine	IT – intermediate tolerant	T	G/OG
American Chestnut	IT	T	G/UI G - generalist
Black Birch	IT	II	G/UI MIS – mesic infertile
Yellow Birch	IT	I	HFS/UI MFS – mesic fertile
Shagbark Hickory	IT	II	MFS/OG HFS – hydric fertile
Northern red oak	II – intermediate intolerant	II	G/OG X - xeric
Swamp white oak	II	VI – very intolerant	HFS/OG
American Elm	II	I – intolerant	MFS/SS
Mockernut Hickory	II	T	X/OG
Pignut Hickory	II	VT	X/OG
Scarlett Oak	I – intolerant	VT – very tolerant	X/UI
Black Oak	I	VT	X/OG
White Oak	I	T	G/OG
Chestnut Oak	I	VT	X/OG
Black Cherry	I	II	MFS/UI
Tulip Poplar	I	I	MFS/OG
Basswood	I	VI	MFS/UI
White Ash	I	I	MFS/OG
Bigtooth Aspen	VI – very intolerant	II	G/SS
Aspen	VI	I	G/SI
Gray Birch	VI	II	G/SI
Paper Birch	VI	II	G/SS
Pin cherry	VI	I	MFS/SI



Regeneration Ecology

What we know about oak, hickory and other mid-tolerants

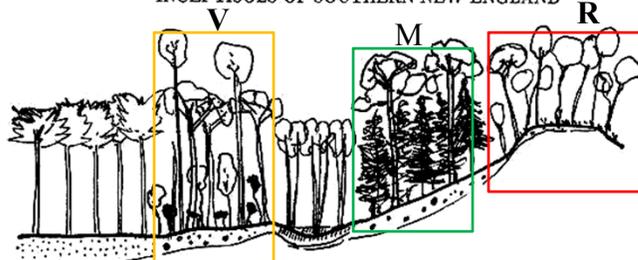
- Masting – infrequent seed crops 3-5 years
- Depend upon advance growth
 - understory seedlings, small saplings
 - adapted to intermediate light conditions (sunflecks)
 - limited upward growth
 - exhibit dieback, root system priority
 - low survival
- Strategy = persistence until canopy disturbance event “releases” them
- Competitive ability depends on presence prior to disturbance to compete with faster growing pioneers (e.g. black birch)
- Masting events help maintain/renew understory population

Research promoting oak – Eastern Forests

- Fire in Central Appalachians (Brose and Van Lear, 1998; Brose, 2008; 2010; Lanham et al., 2002)
- Herbicide in Southern Appalachian mixed hardwood (Loftis, 1983; 1990)
- One-cut shelterwoods in Mississippi bottomlands (Oliver et al., 1990; 2005)

MICRO GRADIENTS

A SOIL GRADIENT ACROSS THE UPLAND
INCEPTISOLS OF SOUTHERN NEW ENGLAND



OUT WASH TILL
deep, excessively
drained sands
flat

white pine

DEEP TILL SWAMP
swale, silty
loam, silt,
inundated,
shallow slope depressed

sugar maple, red maple
yellow poplar,
white ash

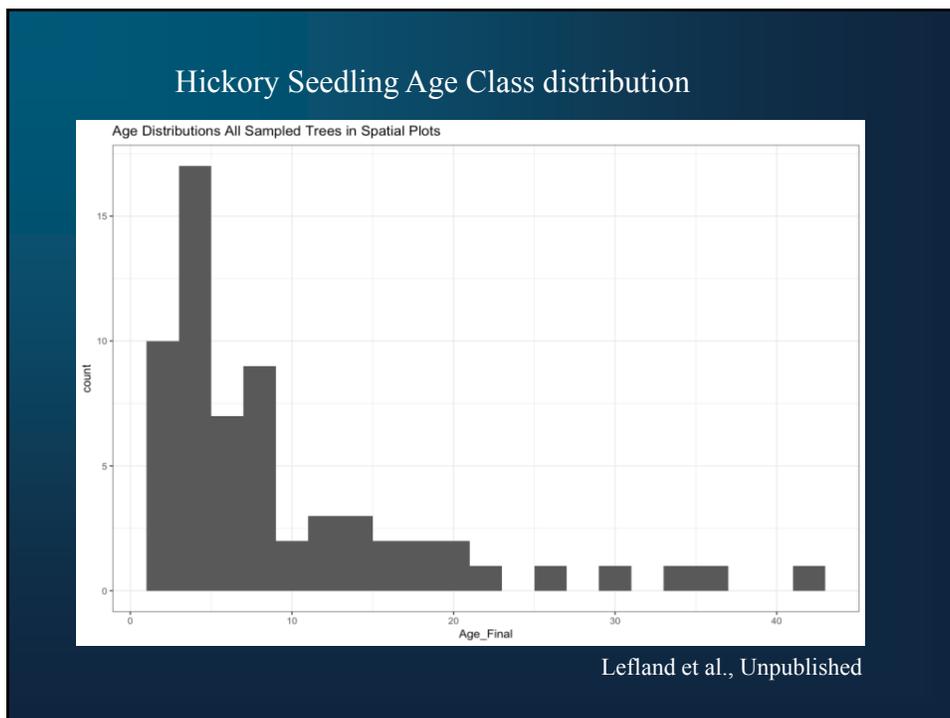
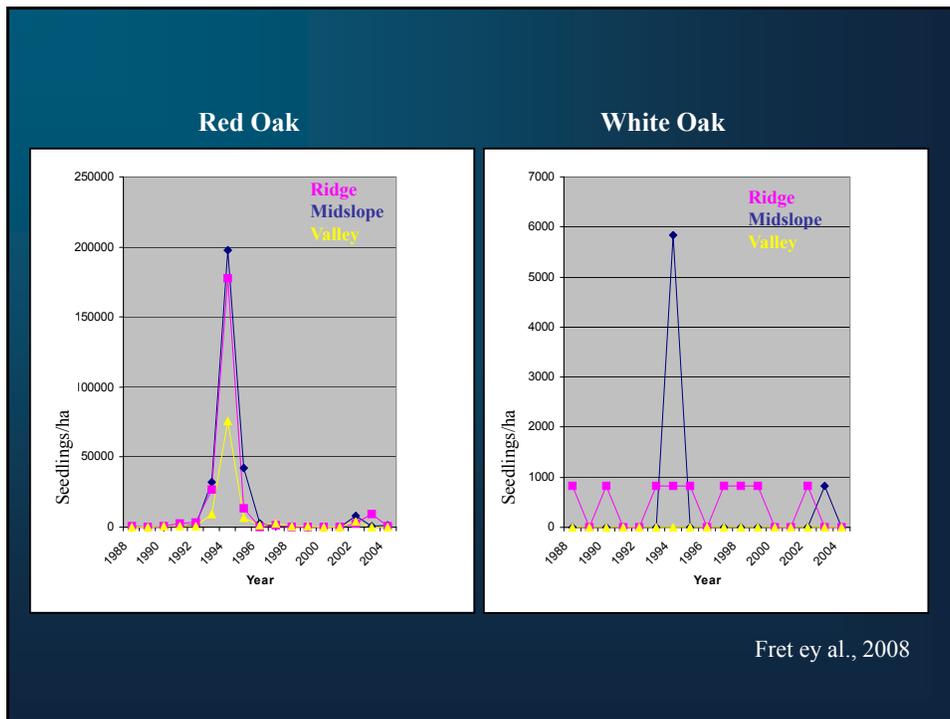
DEEP TILL
silty loam,
moderate
slope

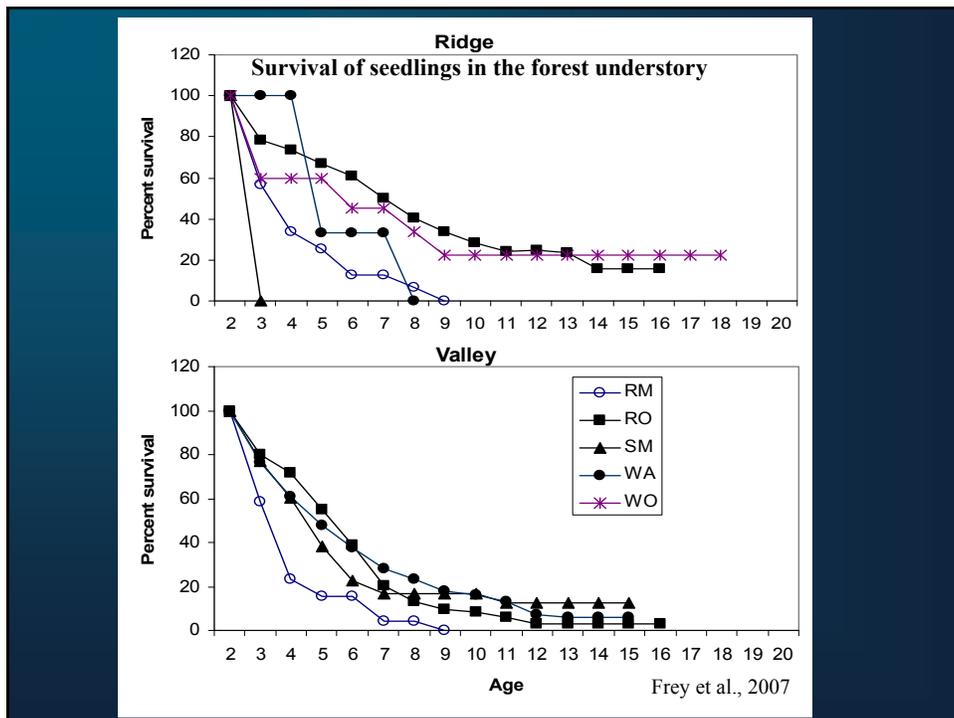
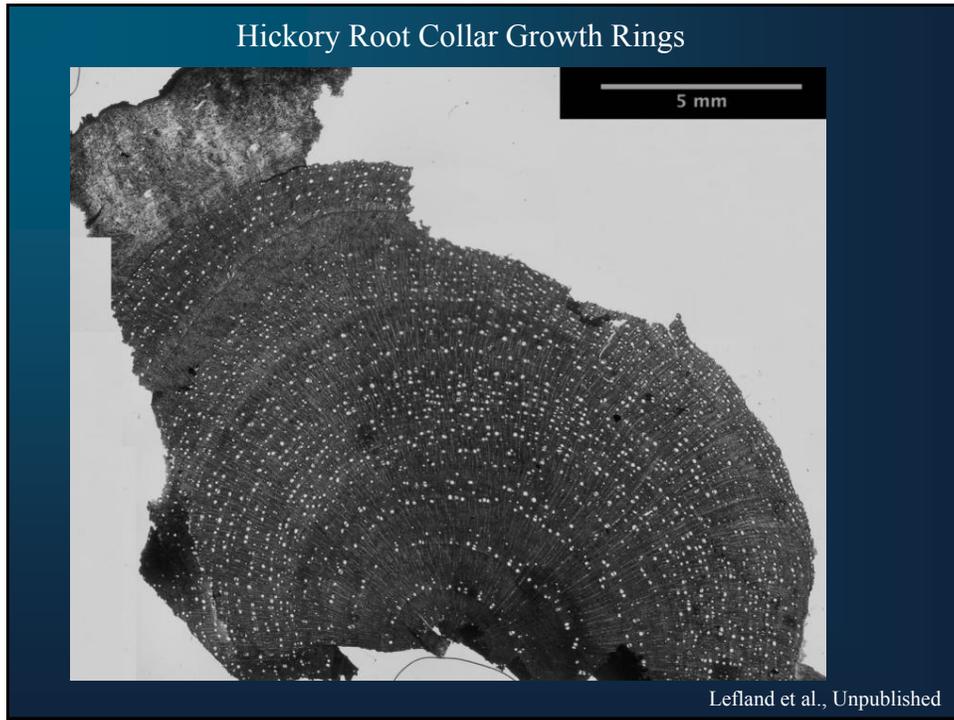
red oak,
hemlock,

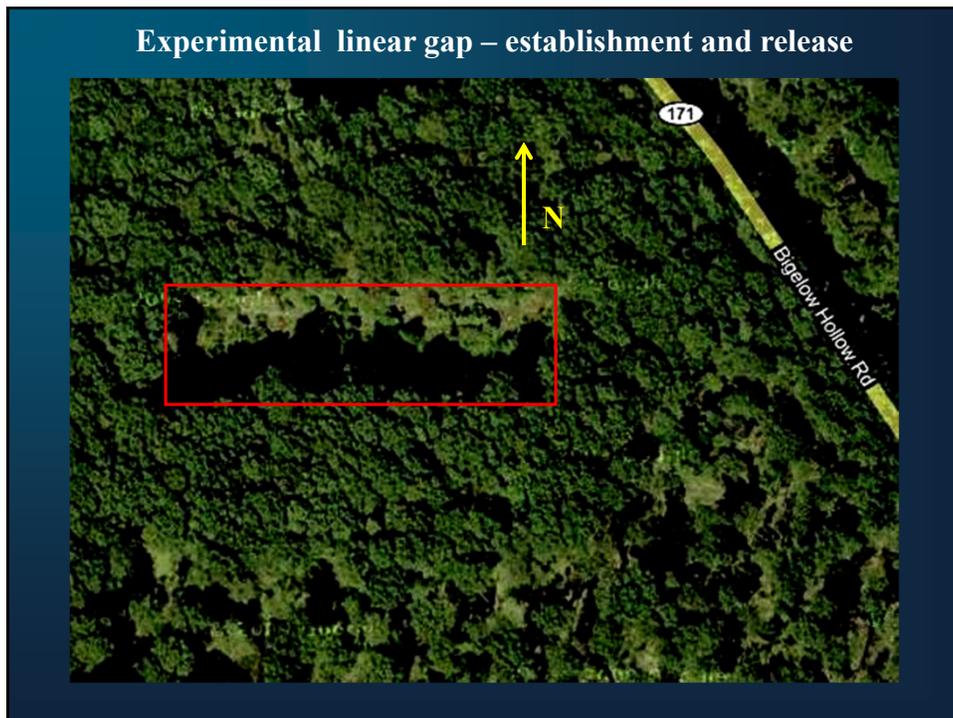
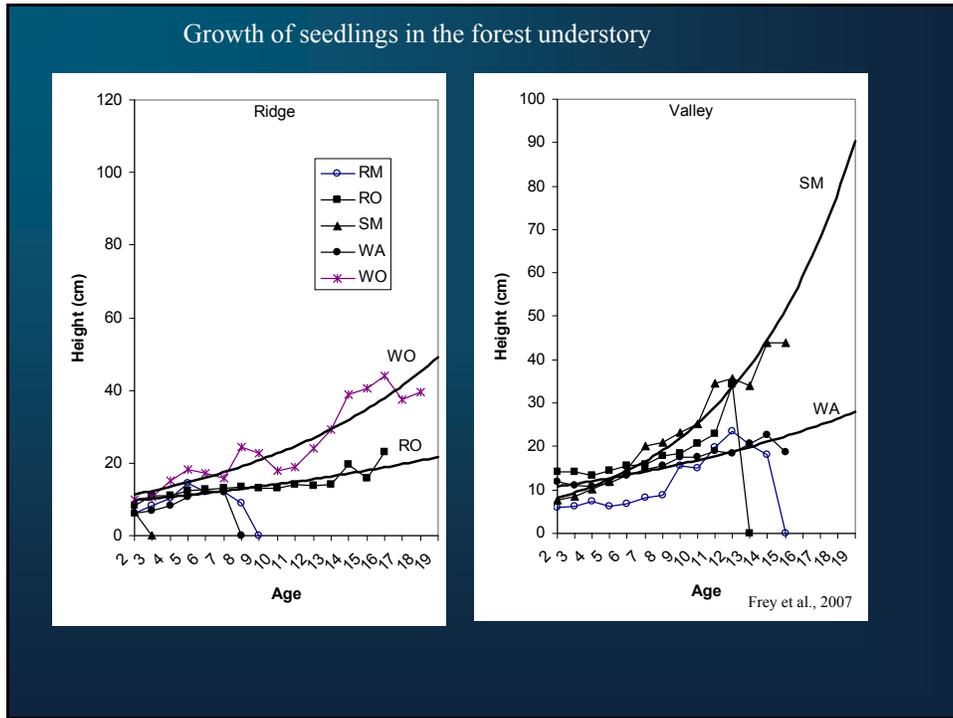
SHALLOW TILL
thin, stony
loam, ridge
bedrock outcrops

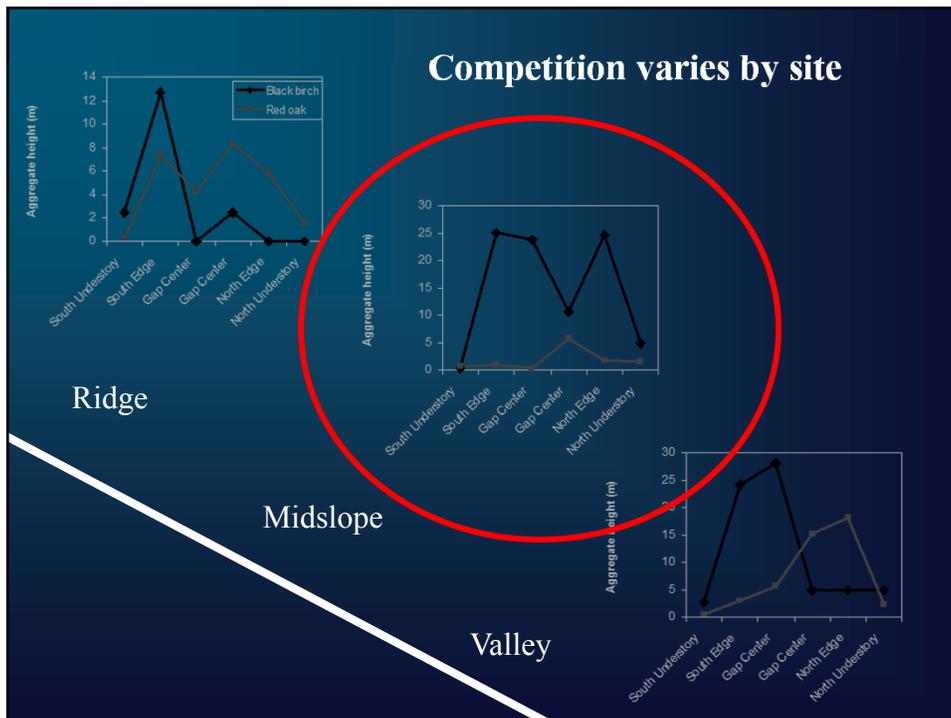
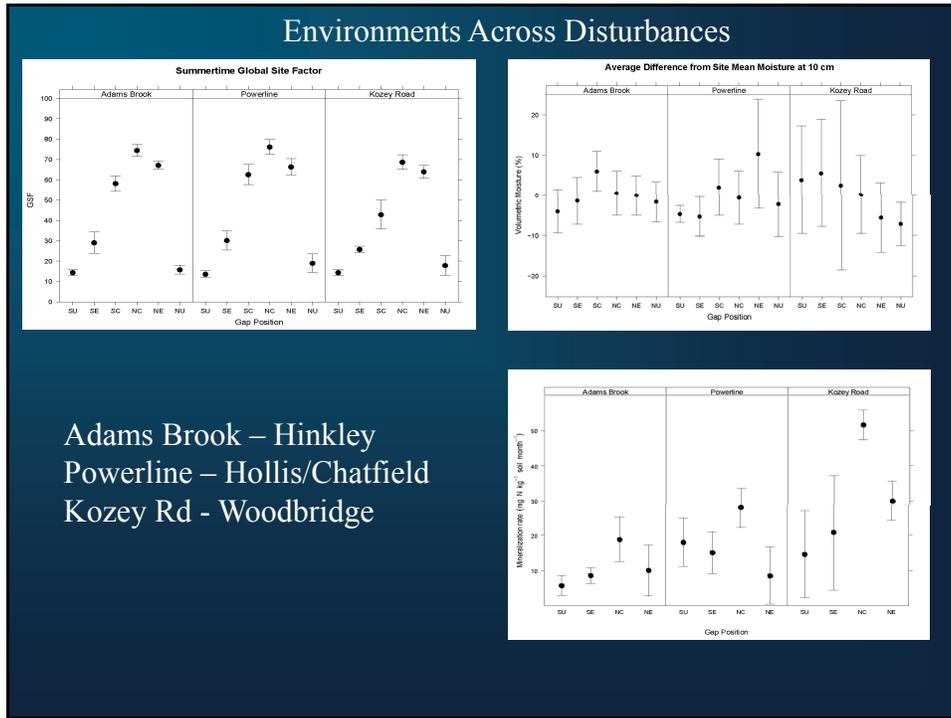
pignut hickory
black oak, white
oak

Ashton et al. 2008







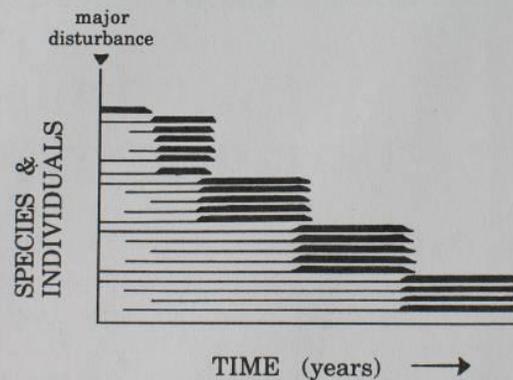


Natures disturbance regime – Hurricanes, Tornadoes and Convectional windstorms

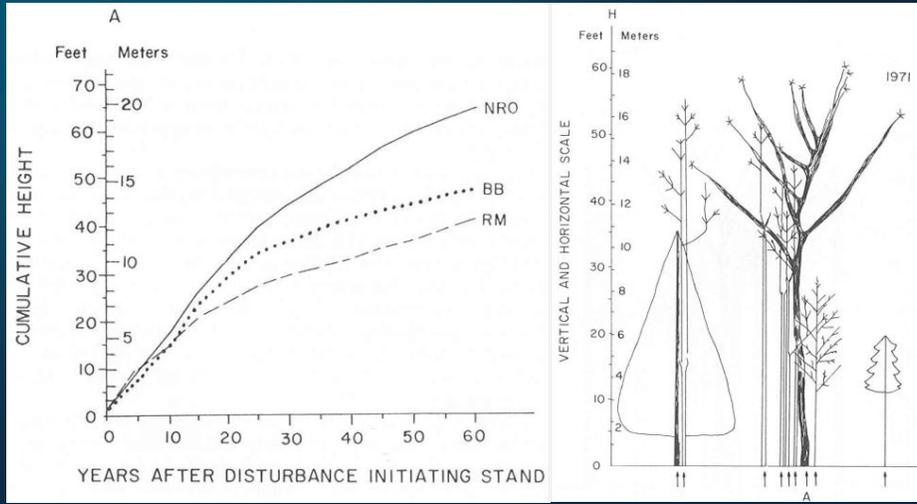


Stand dynamics

B. "INITIAL FLORISTICS"



Second growth forest history and origins: Gradual divergence – Northern red oak – Black birch – Red maple



Oliver (1978)

Second growth forest history and origins: Abrupt divergence – Northern red oak – Hemlock

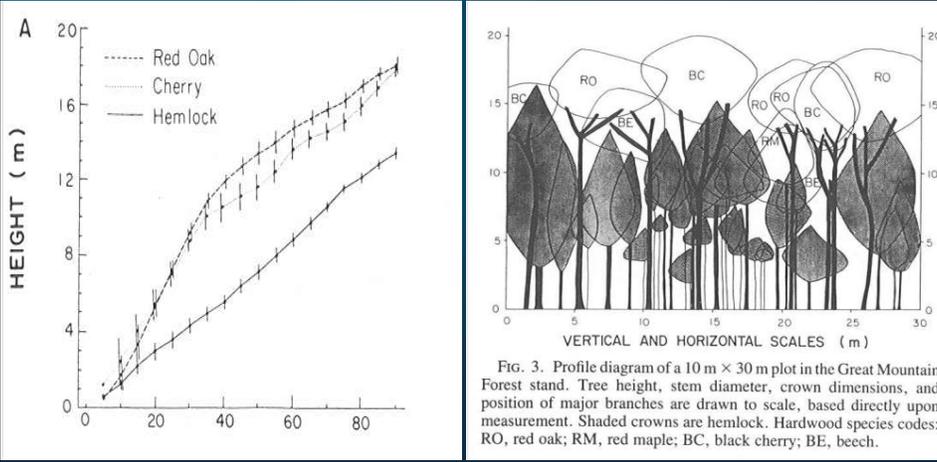


FIG. 3. Profile diagram of a 10 m x 30 m plot in the Great Mountain Forest stand. Tree height, stem diameter, crown dimensions, and position of major branches are drawn to scale, based directly upon measurement. Shaded crowns are hemlock. Hardwood species codes: RO, red oak; RM, red maple; BC, black cherry; BE, beech.

Kelty (1986)

