

## Mixed Oak – Hickory History, Silvics, and Stand Dynamics



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Chief Scientist – Station Forester  
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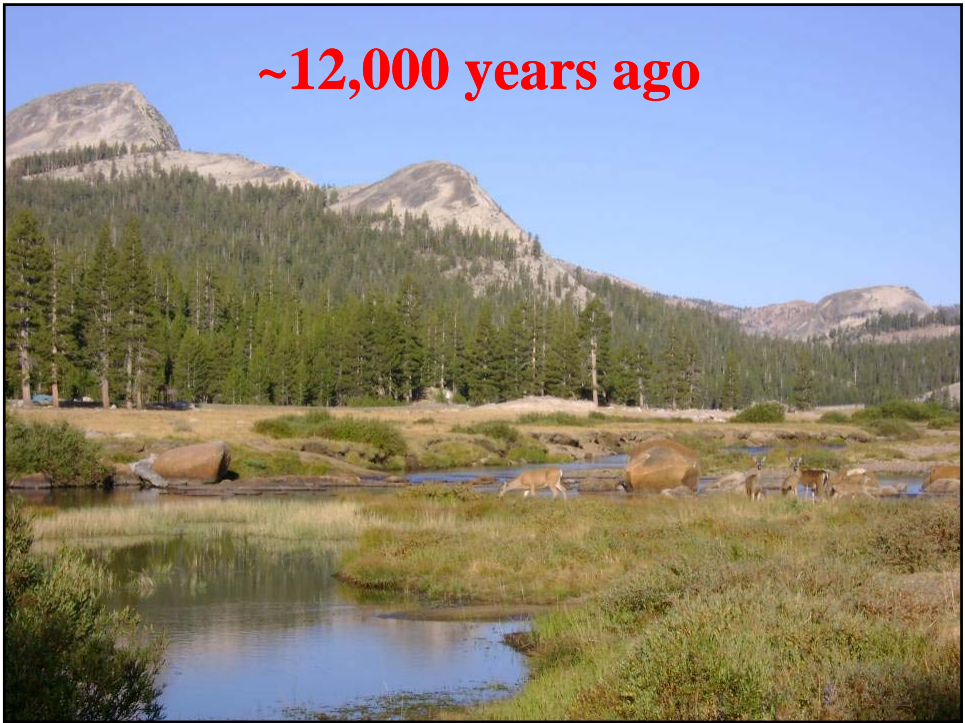


## A short history our forests – Or why so many darn oaks

**Jeffrey S. Ward, Ph.D.**

Chief Scientist – Station Forester

Forestry & Horticulture  
The Connecticut Agricultural  
Experiment Station

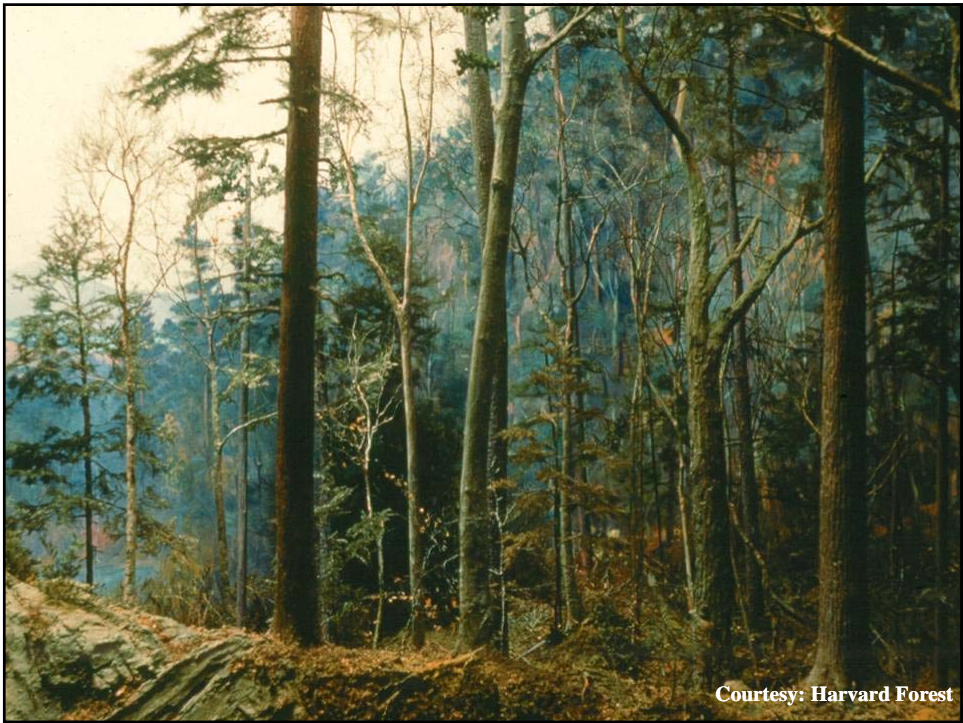




Pleistocene

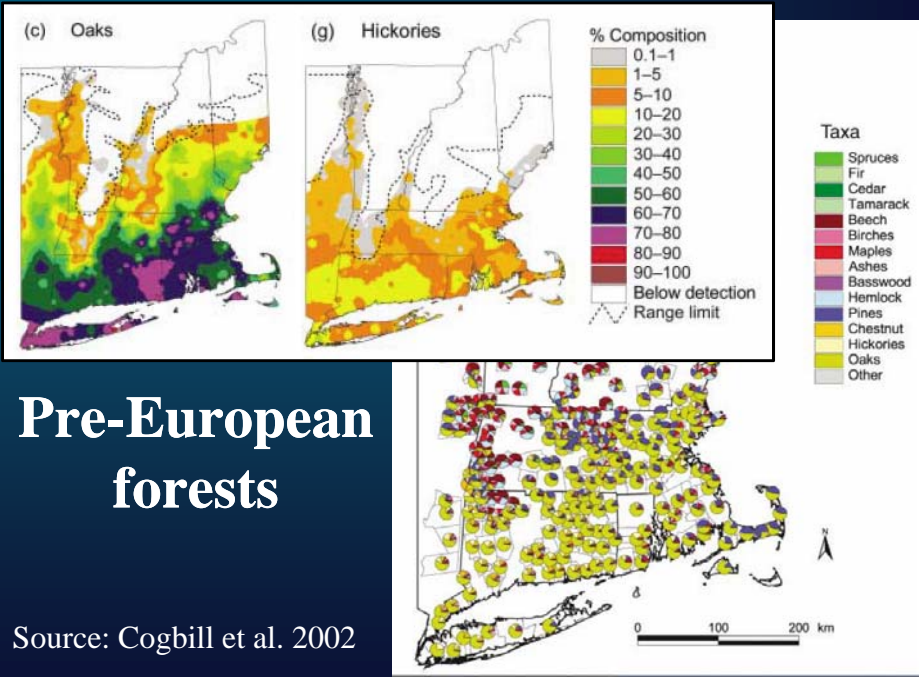


North American Pleistocene Mural, Mammoth detail, copyright by Karen Carr



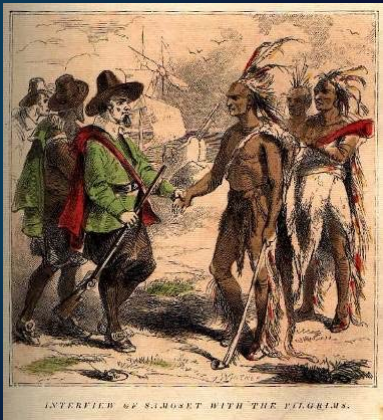
Courtesy: Harvard Forest

# Native Americans





# European arrival



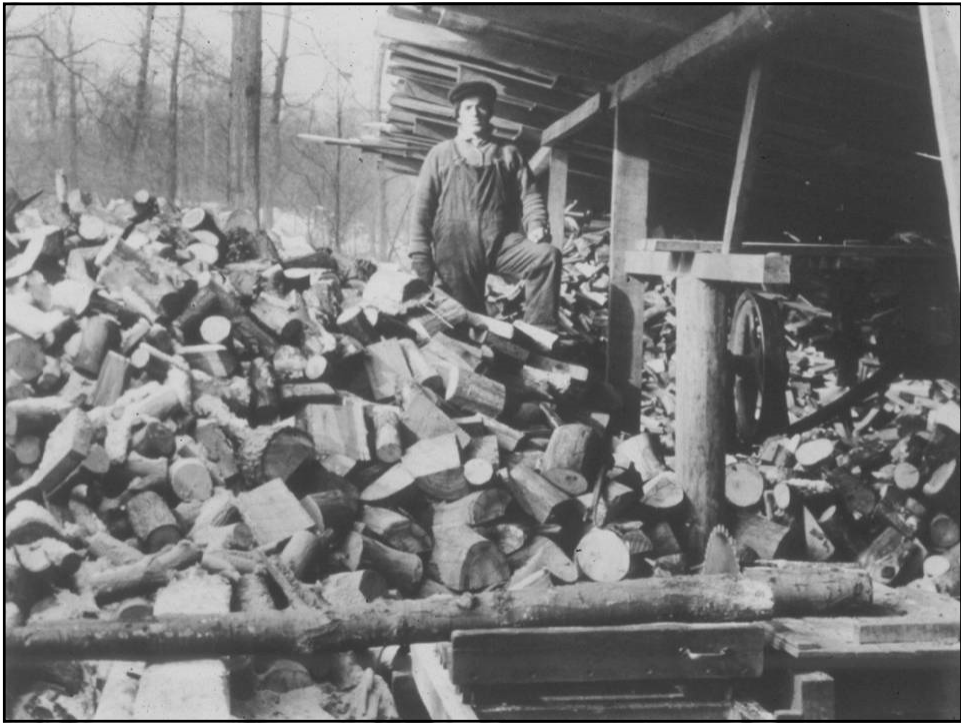
The last virgin stand in Connecticut, located in Colebrook, was harvested in 1912.

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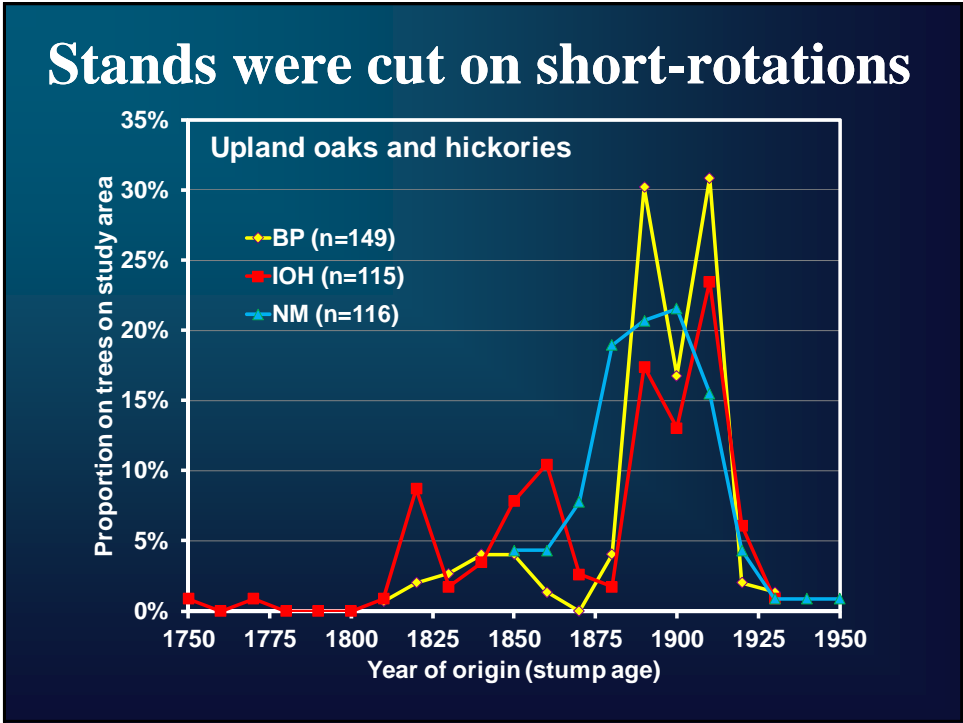








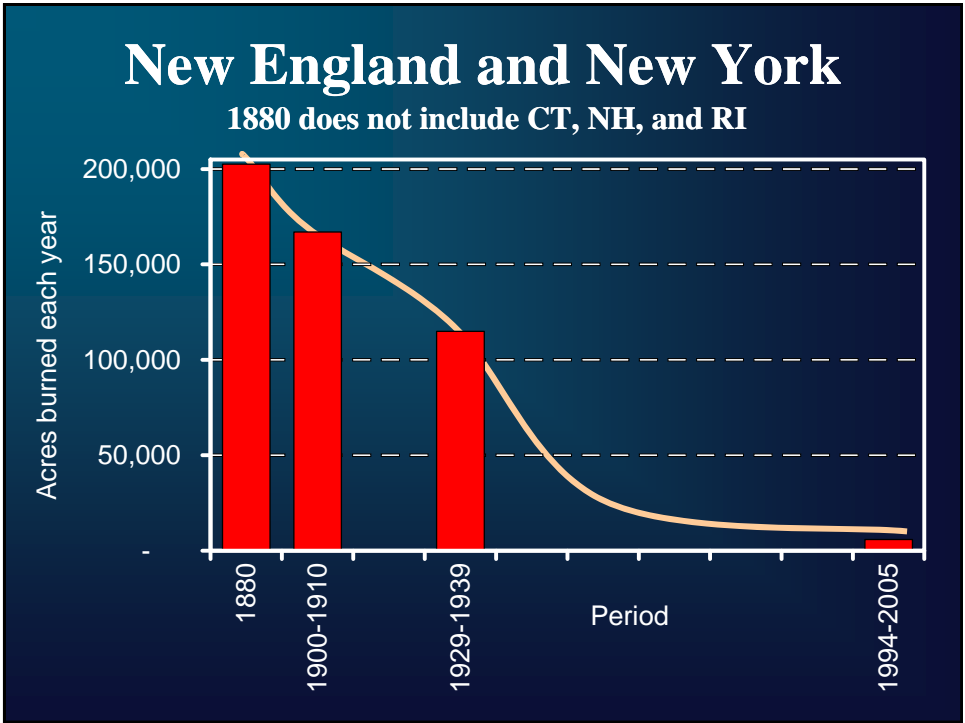
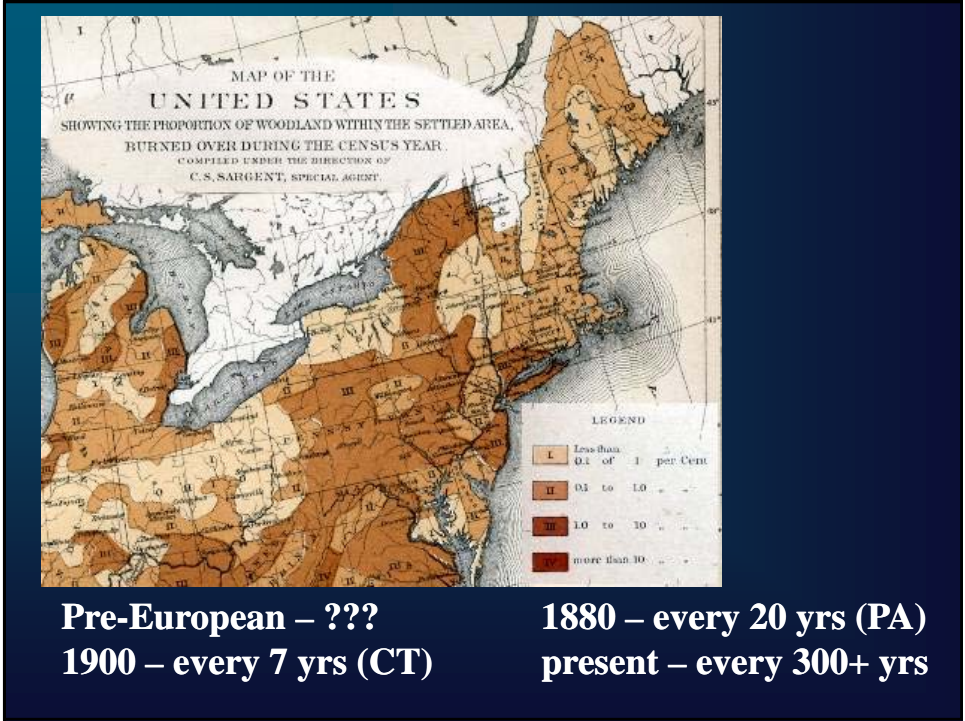


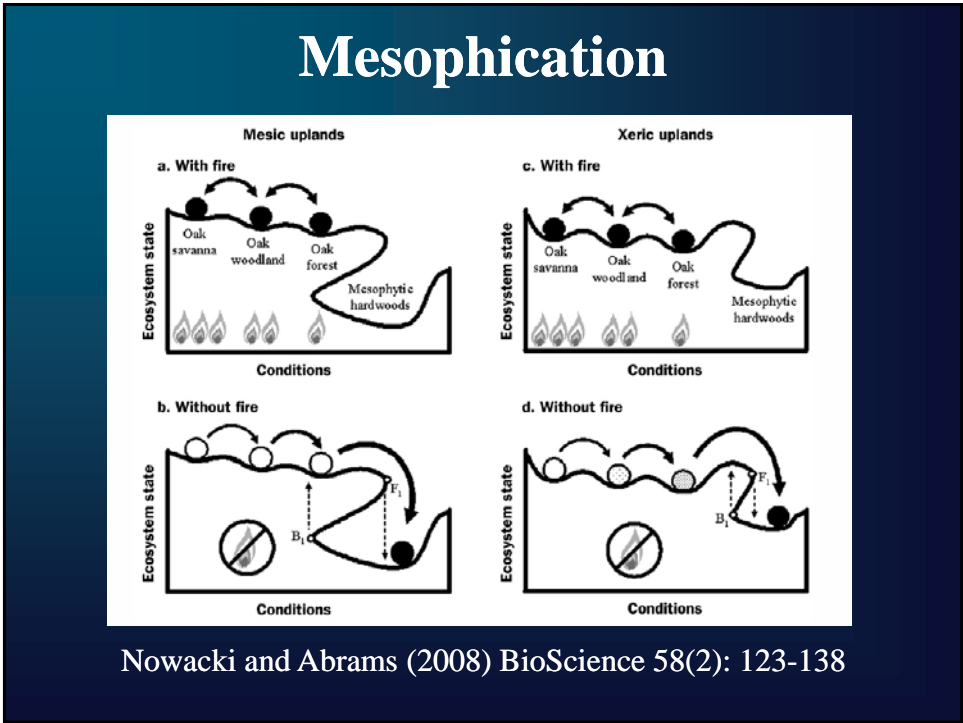
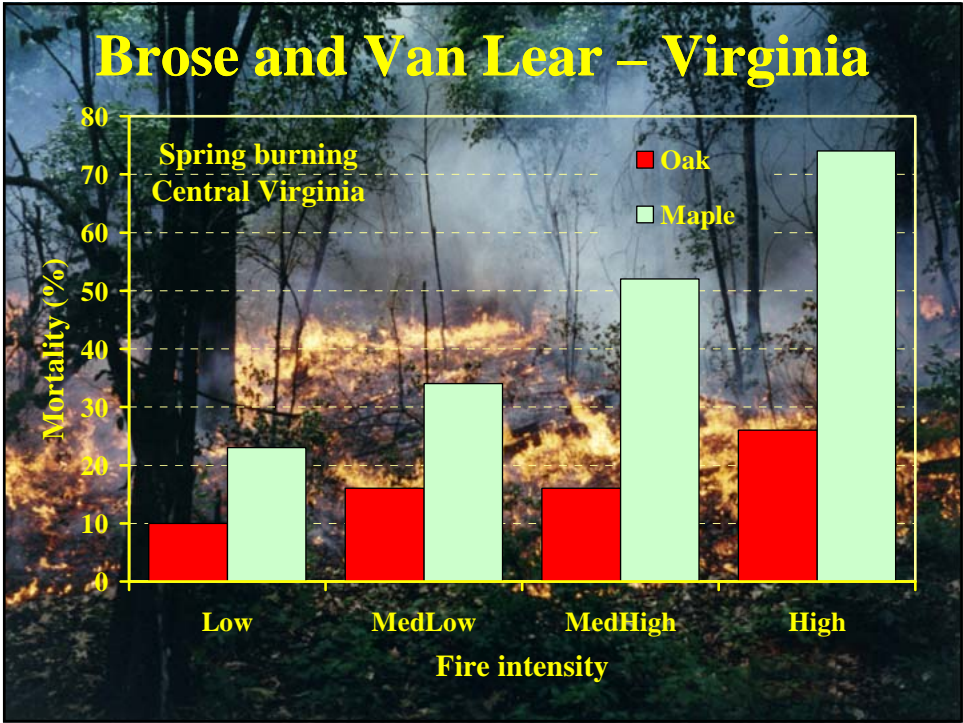




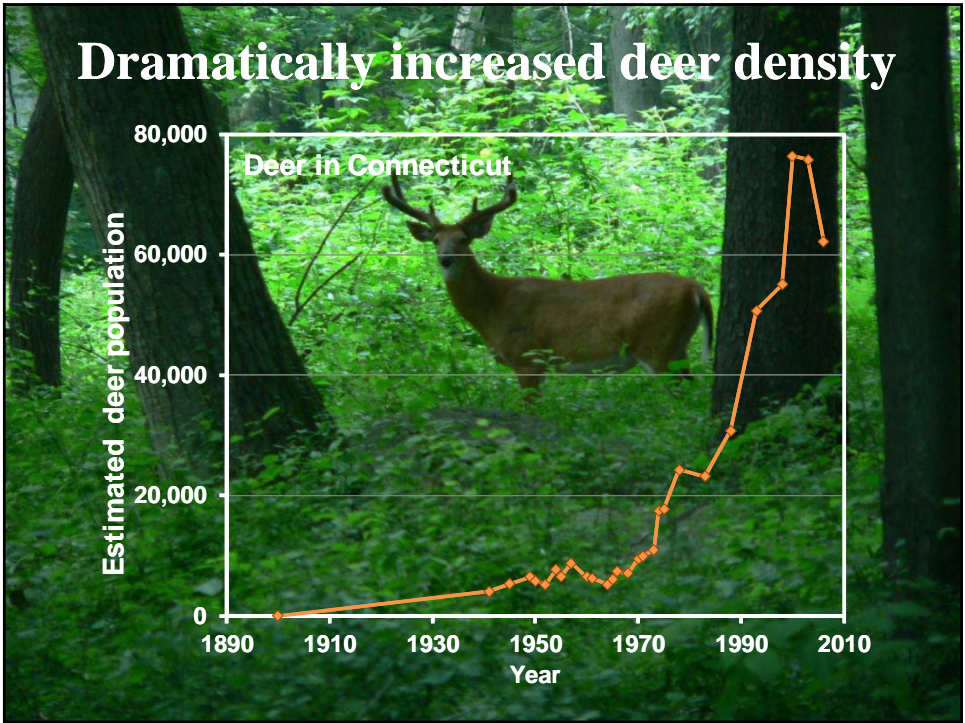
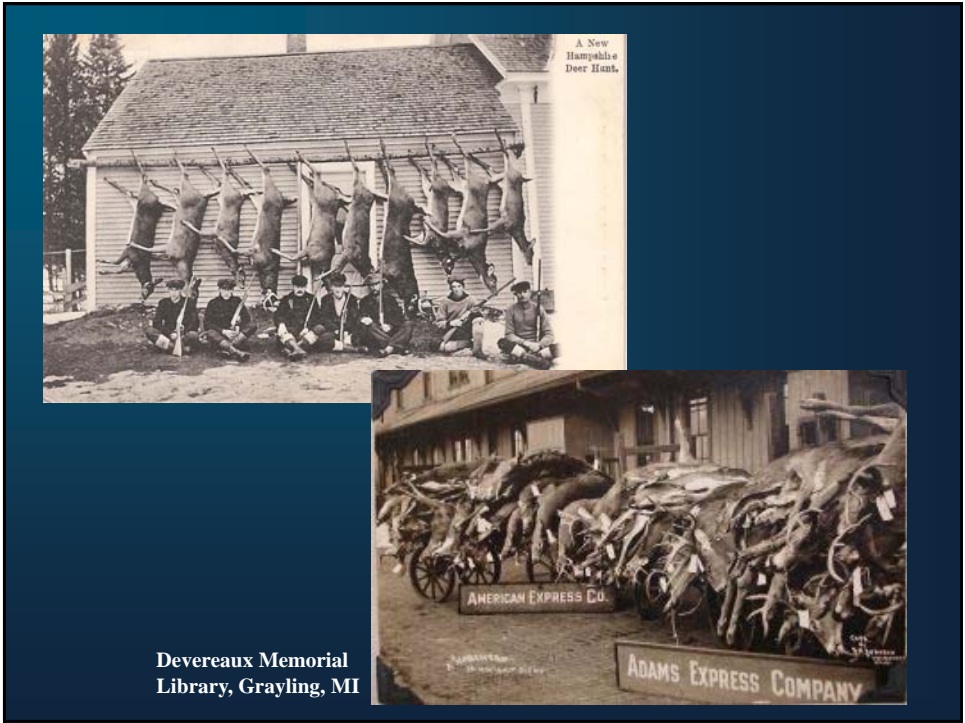
East Hartford 1905







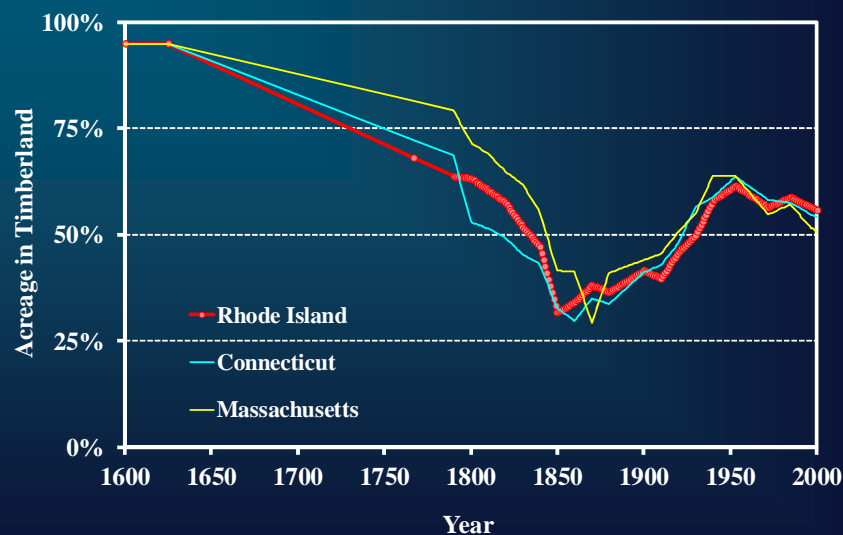




## When our oak forests originated

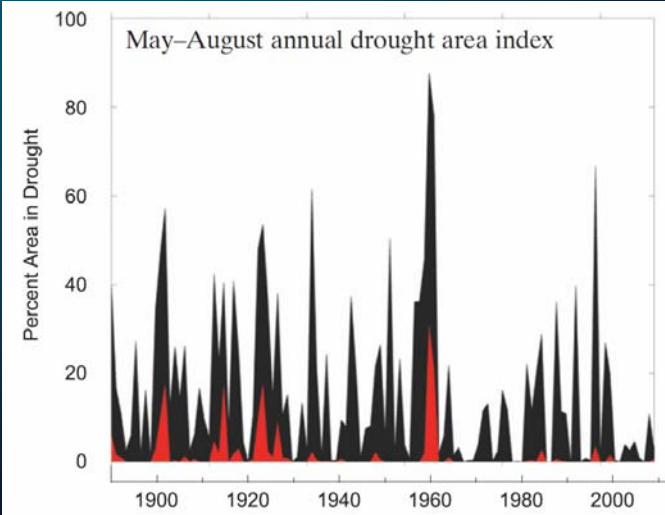
1. Forests were cut more frequently (short-rotation)
2. Forests burned over frequently (and often much hotter)
3. No deer

## Forest cover plunged, then recovered

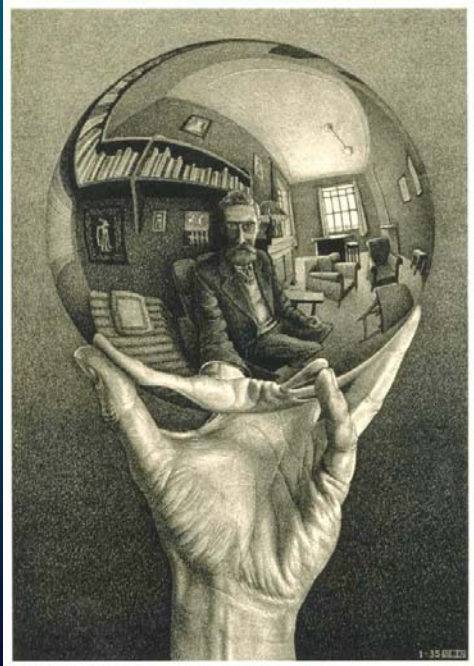




# An epic pluvial




From Pederson et al. (2013) Journal of Climate




# Connecticut's forest is changing

Our oaks are decreasing

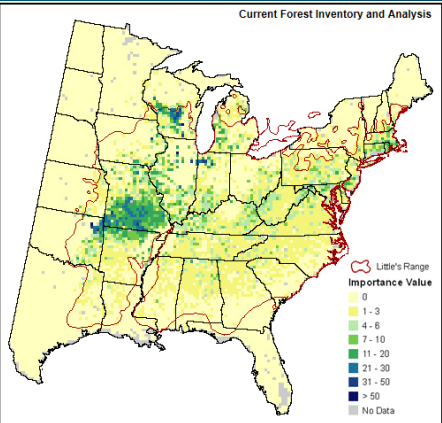


Our maples are increasing

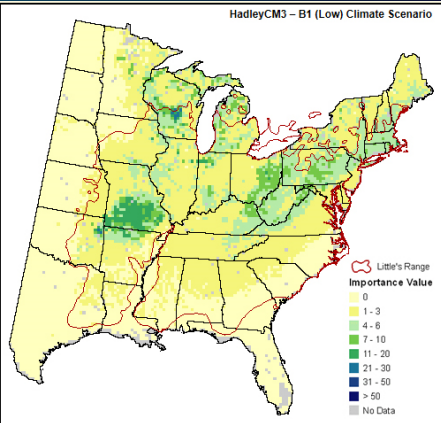


## Future changes with climate?

Current Forest Inventory and Analysis



HadleyCM3 - B1 (Low) Climate Scenario



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**



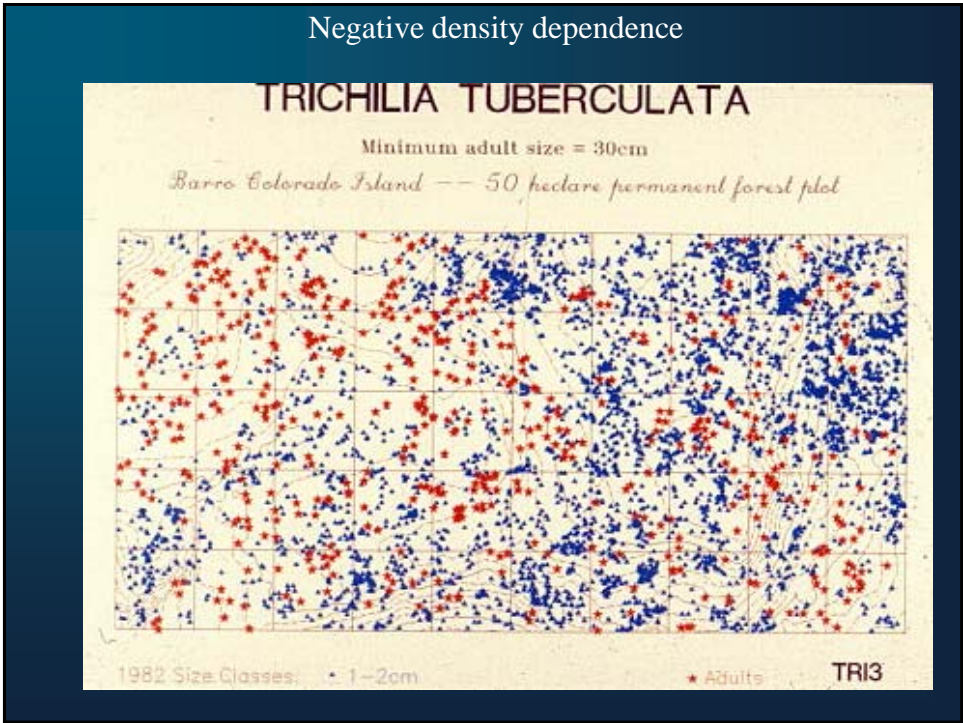
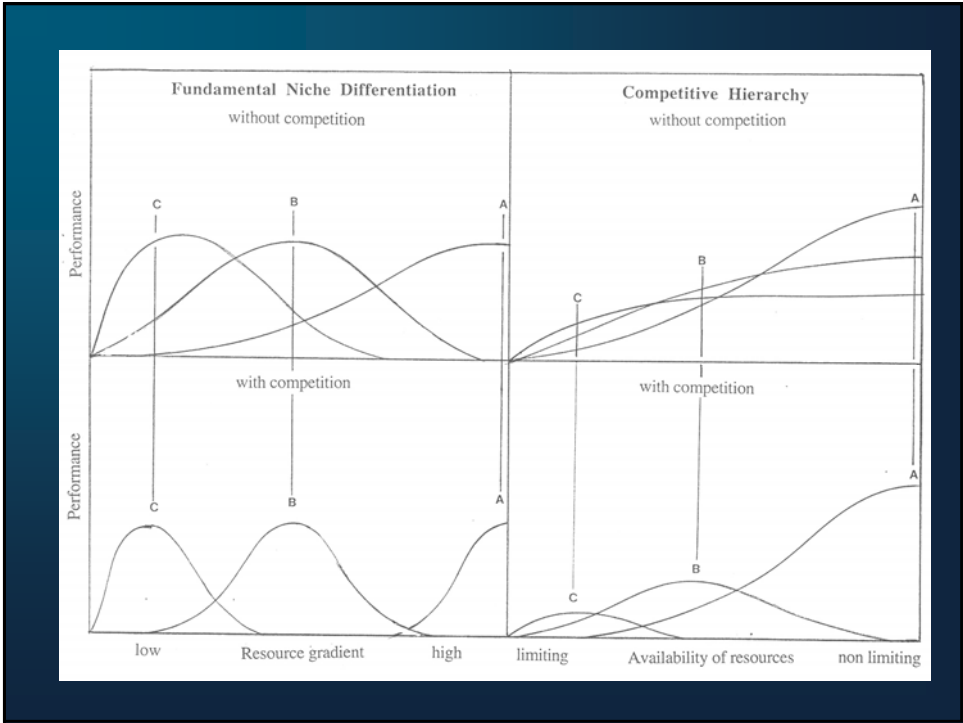
**Mark S. Ashton**

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Ecology

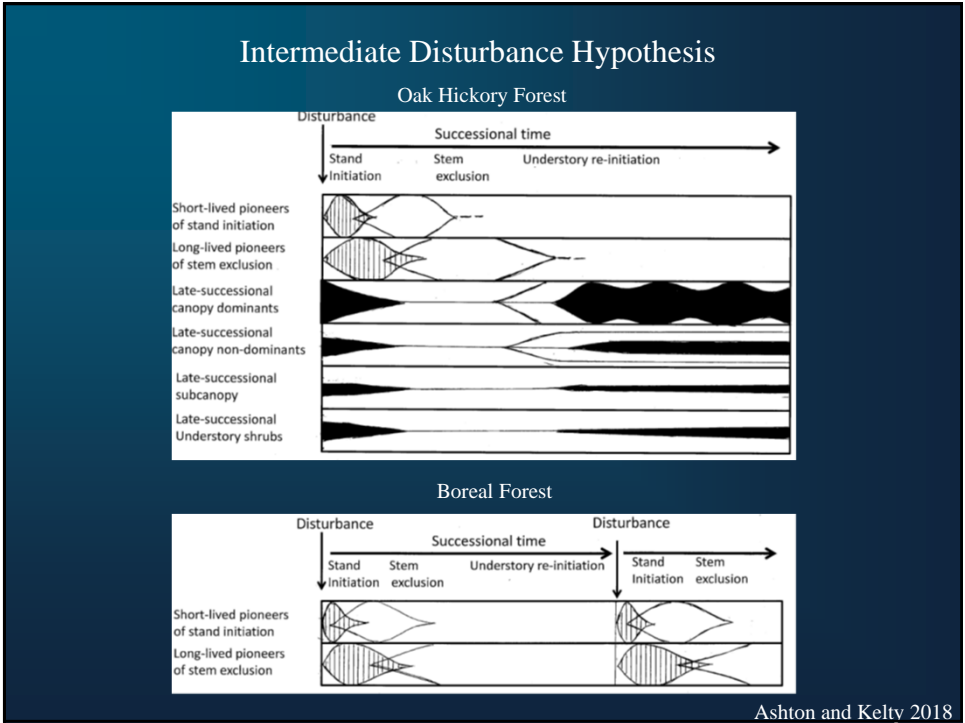
School of Forestry  
and Environmental Studies  
Yale University

## Silvics – Diversity Theory

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

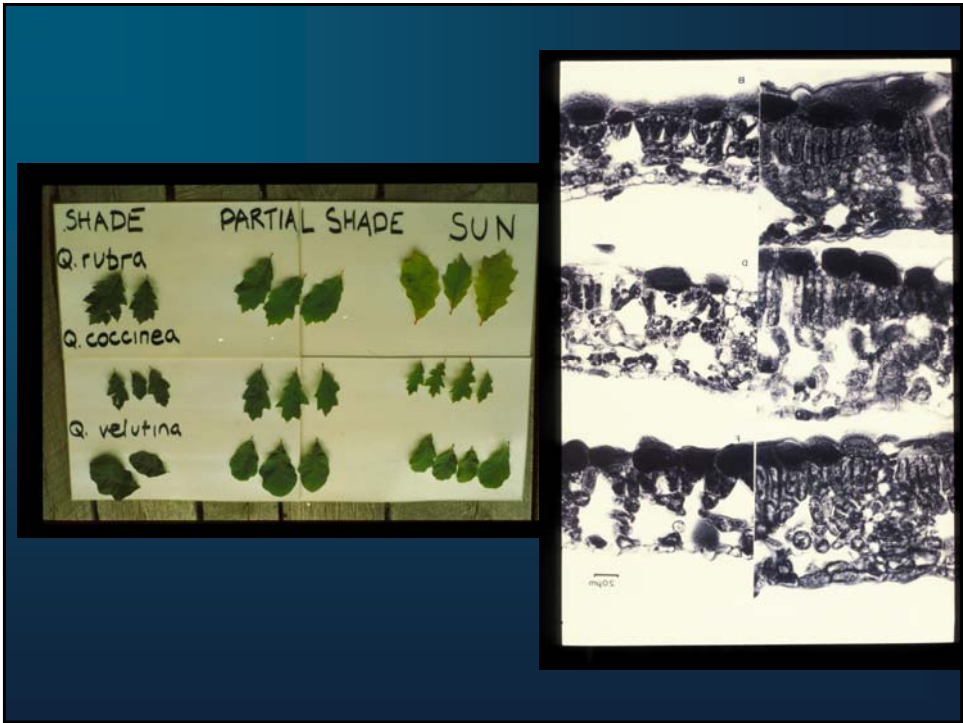
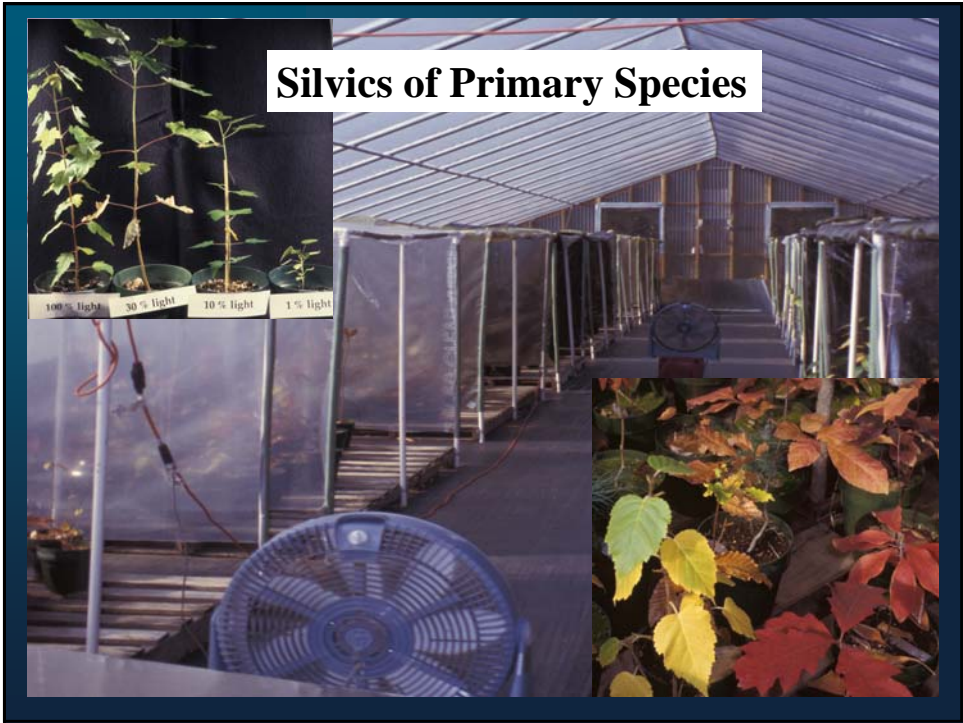


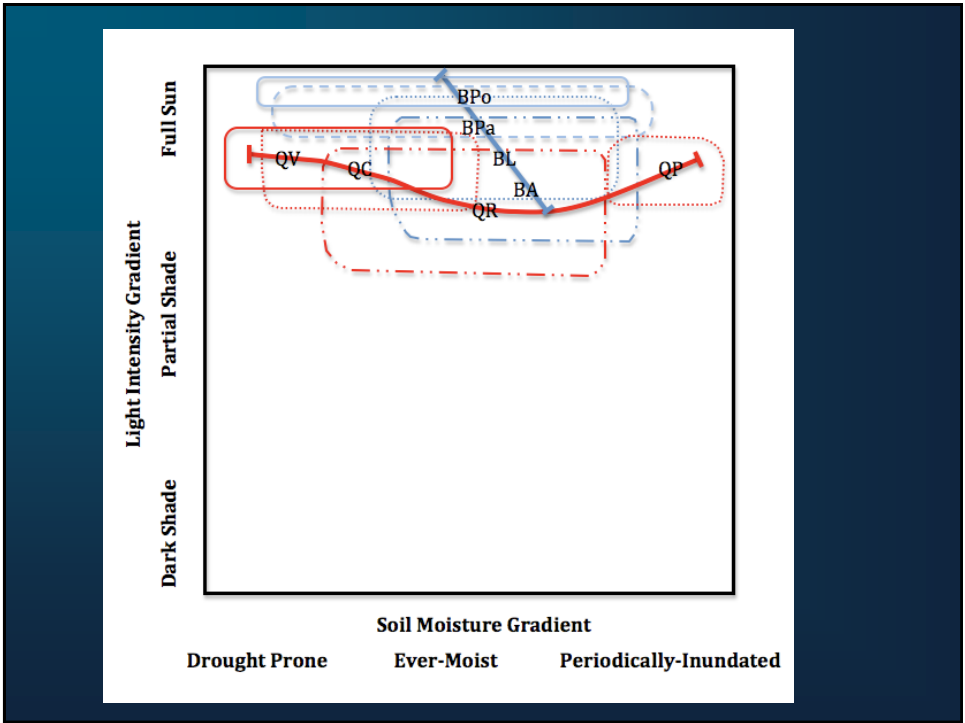
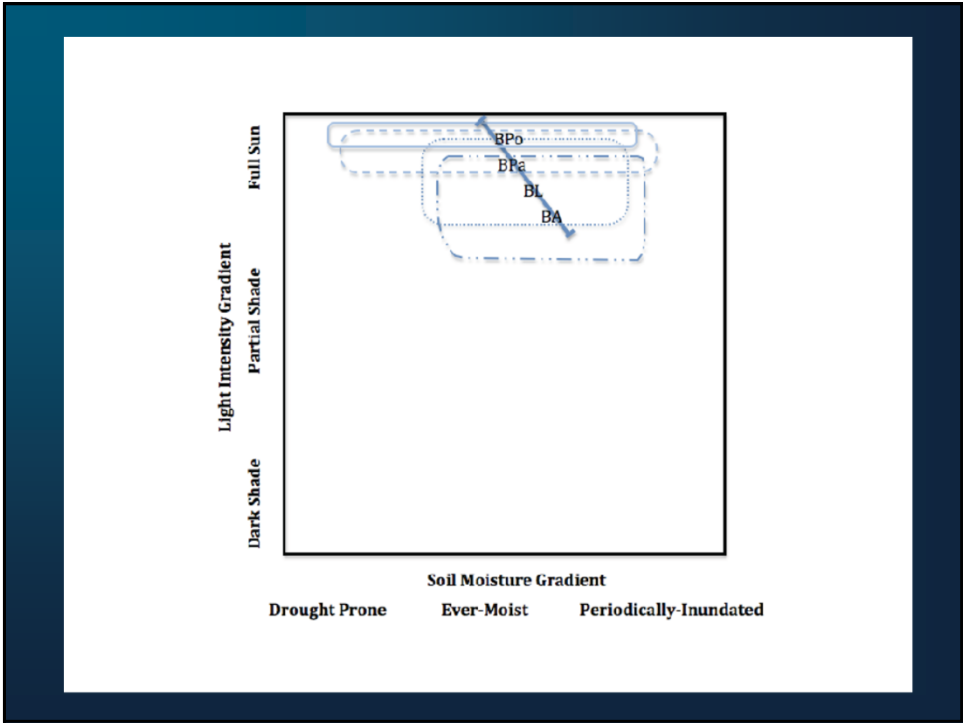




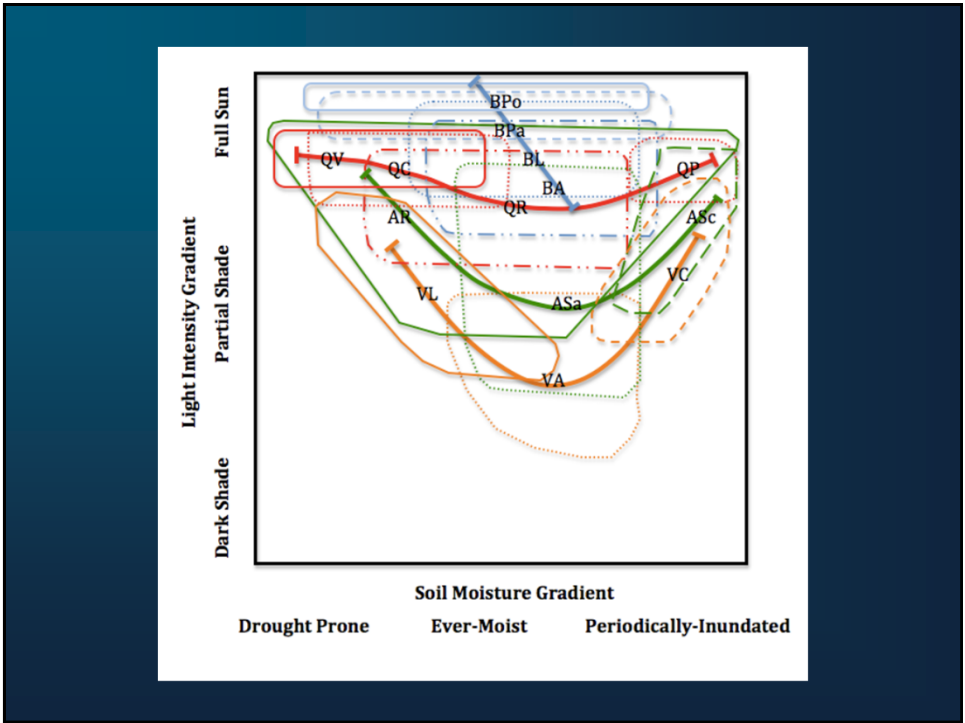
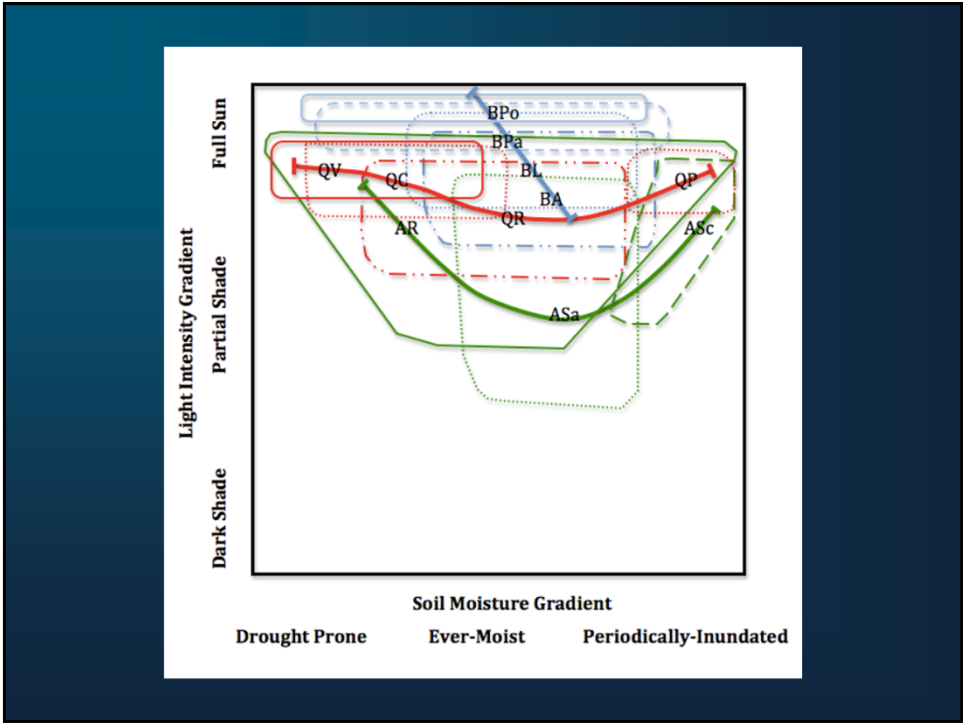
| Functional Groups or Guilds of an Oak-Hickory Forest |   |  |   |
|--|---|--|---|
| Guild  | Developmental stage                     | Autecology   | Examples  |
| Pioneer<br>Short-lived                               | Initiation<br>(gap phase)               | Frequent production of small flowers and seeds, dispersed by wind, water, small birds, bats, very fast-growing – umbrella like; shade intolerant; superficial; use inefficient; mineral soil seed bed; seed bank<br>As above for reproduction....but fast growing, columnar dense-canopied crowns; use-efficient; sequesters of carbon; Vegetative | <i>Sumac</i><br><i>Pin cherry</i>                                   |
| Pioneer<br>Long-lived                                | Stem exclusion<br>(building phase)      |  | <i>Black cherry</i><br><i>Yellow/ black birch, Red maple</i>        |
| Canopy<br>Dominants                                  | Understory initiation<br>(mature phase) | Frequent but large flowering/fruiting 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><br><i>Sugar maple</i><br><i>Hickories</i><br><i>Ash</i> |
| Canopy<br>Non-dominants                              | as above                                | Frequent regular flowering/fruiting, 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><br><i>Persimon</i><br><i>Basswood</i>               |
| Sub-canopy   | as above                                | Crowns columnar, greater reliance on vegetative prop.  | <i>Sassafras</i><br><i>Dogwood, Musclemwood</i>                     |
| Understory   | as above                                | Crowns planar, low level flowering – rel. inconspicuous, heavy reliance on vegetative prop.  | <i>Witchhazel</i><br><i>Viburnum</i>                                |

(modified after Ashton et al. 2001)

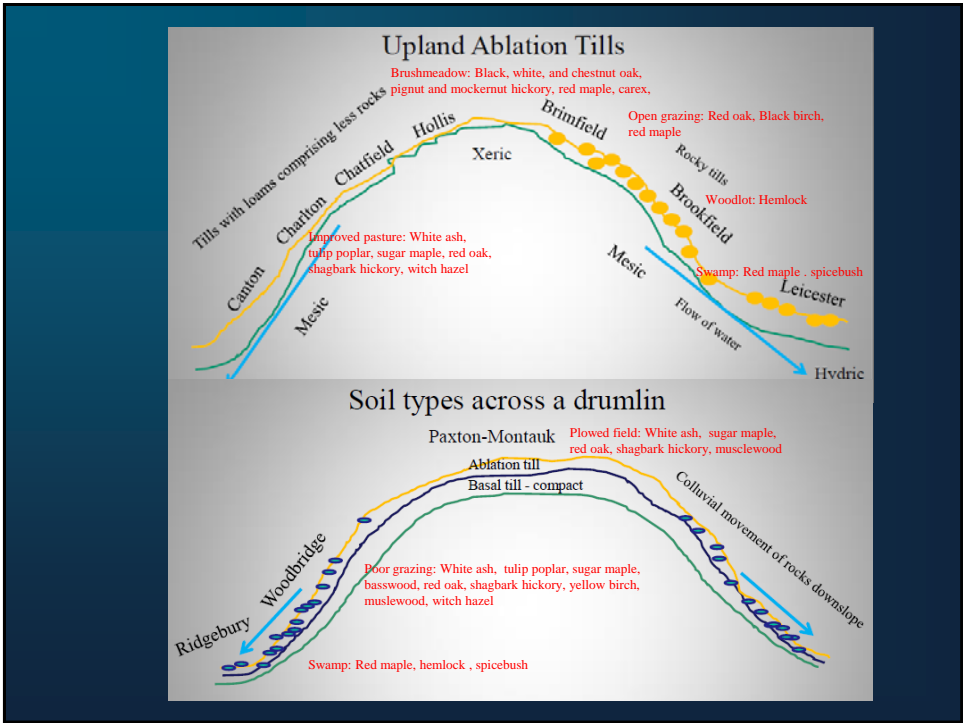


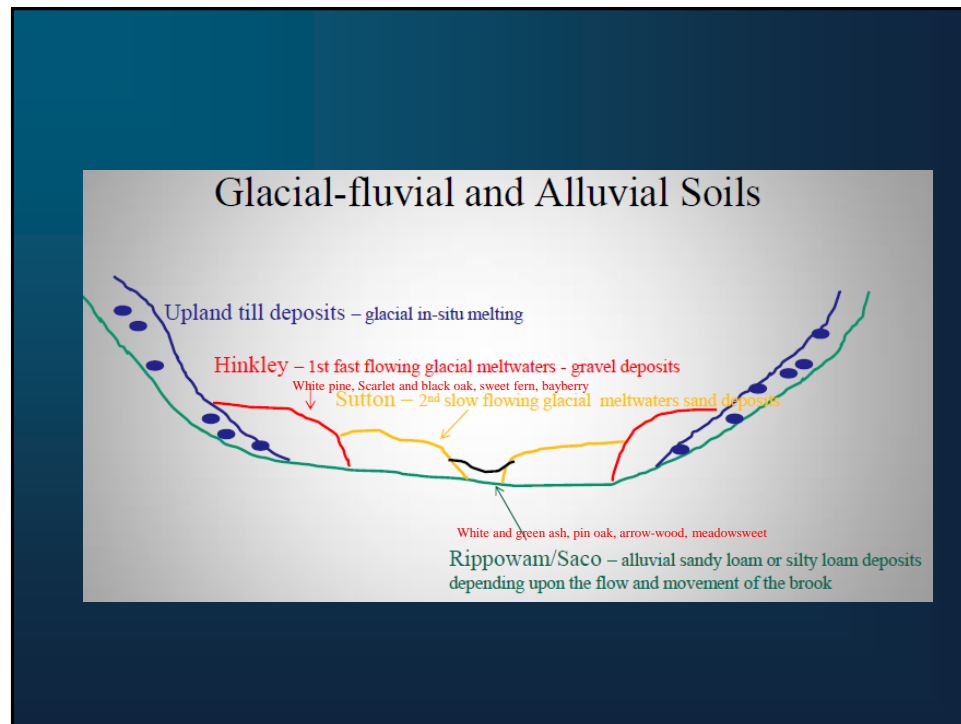






| Upland Hardwoods of Southern New England |                              |                               |                          |                       |
|--|------------------------------|-------------------------------|--------------------------|-----------------------|
| Species                                  | 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

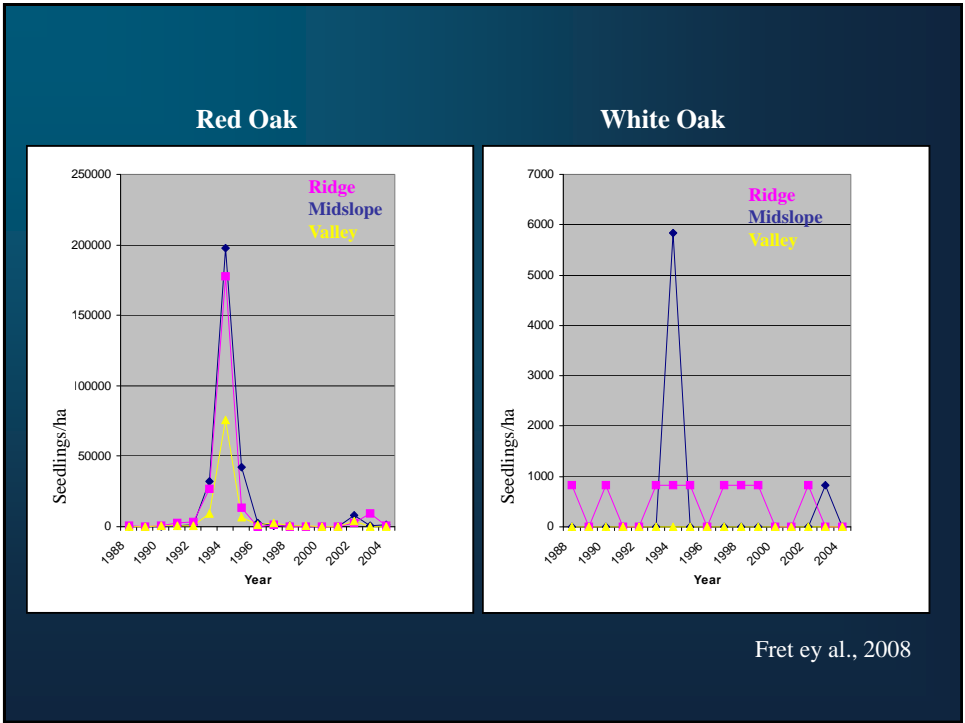
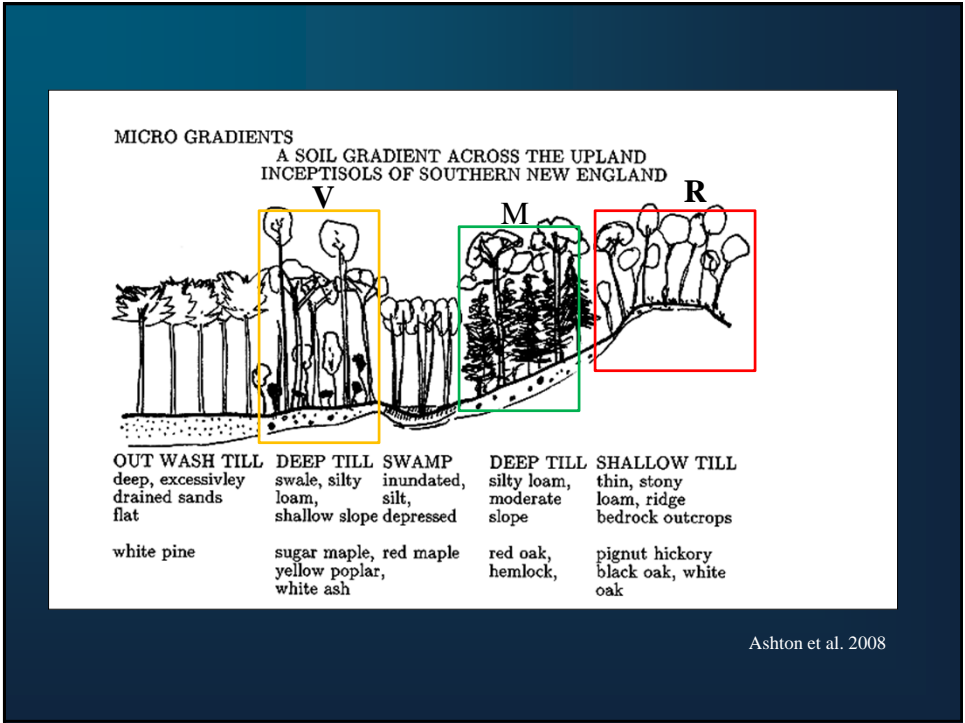
### What we know about oak, hickory and other mid-tolerants

- 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

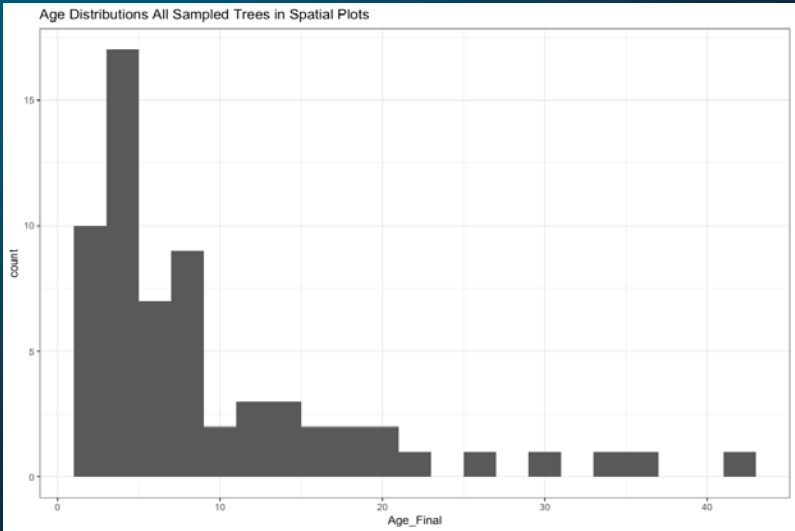
#### Research promoting oak - Eastern Forests

- 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)



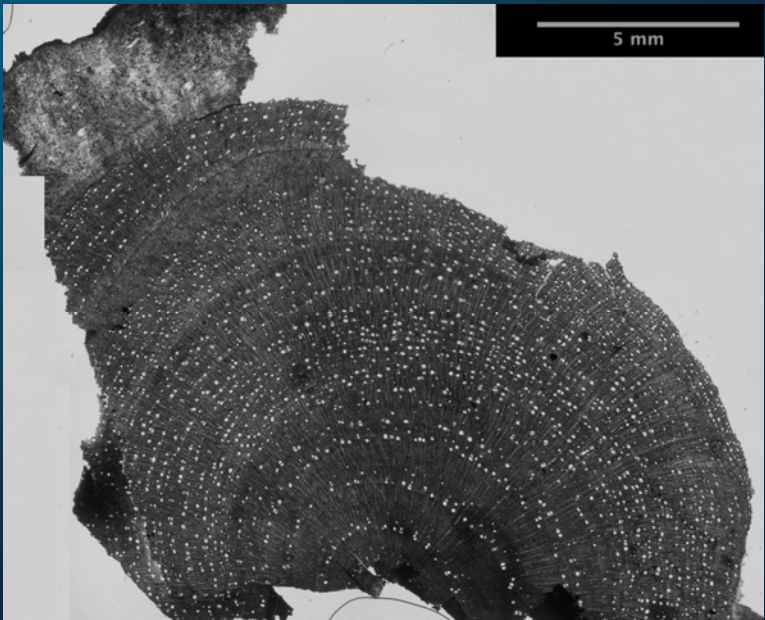


Hickory Seedling Age Class distribution

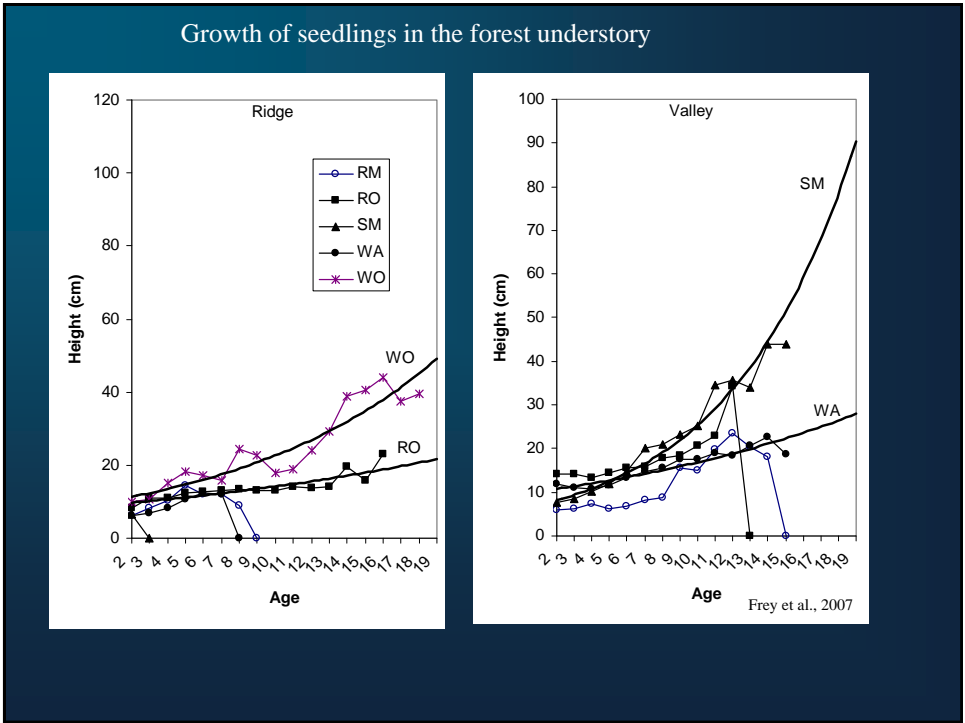
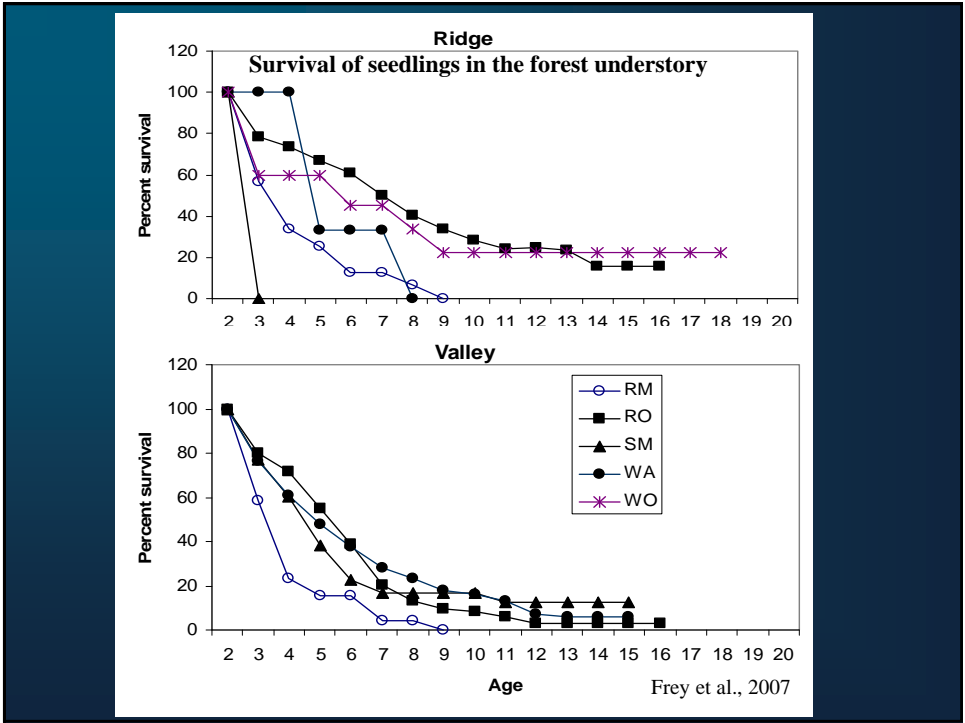


Lefland et al., Unpublished

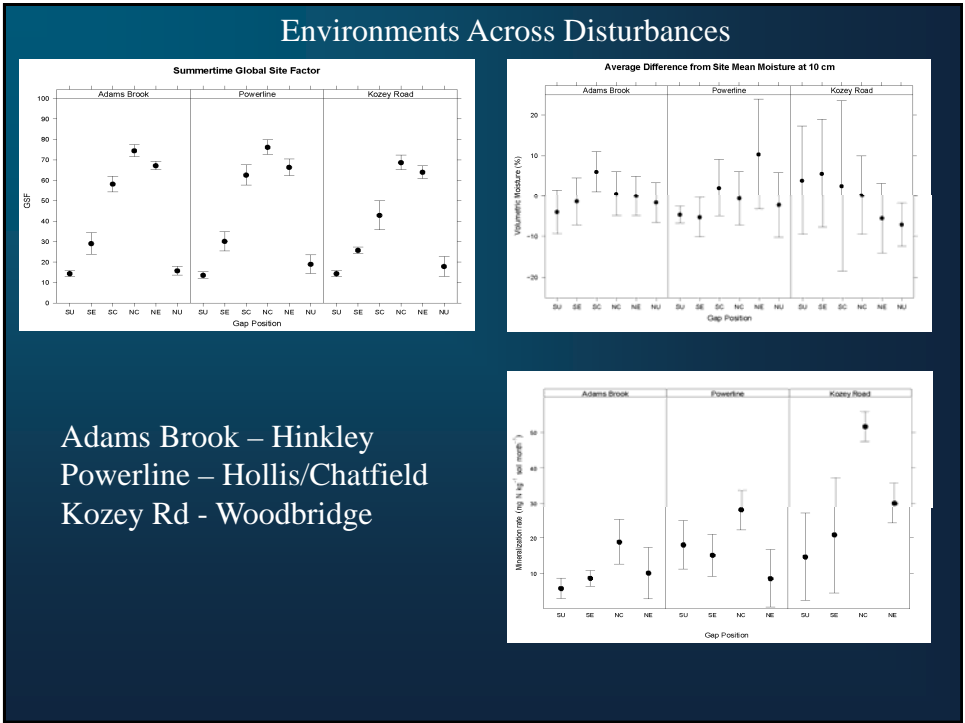
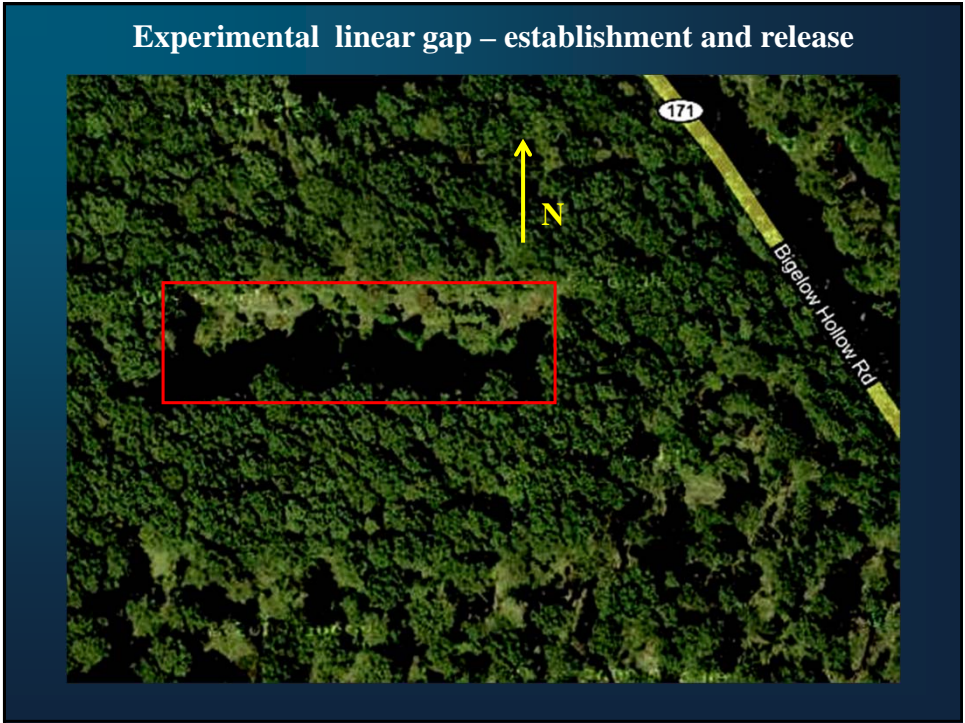
Hickory Root Collar Growth Rings

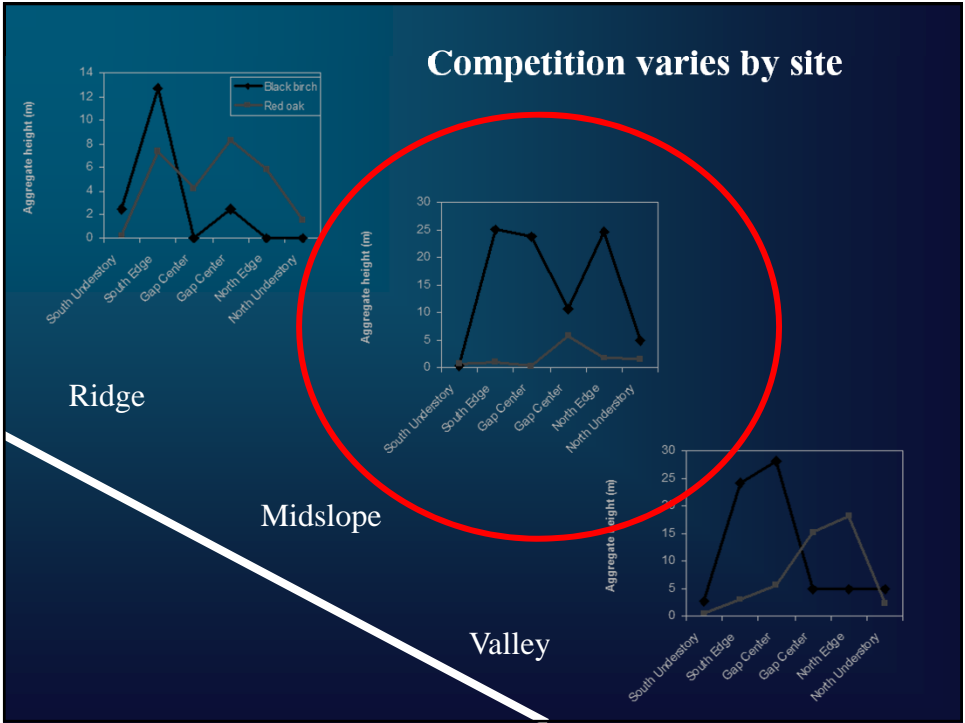


Lefland et al., Unpublished



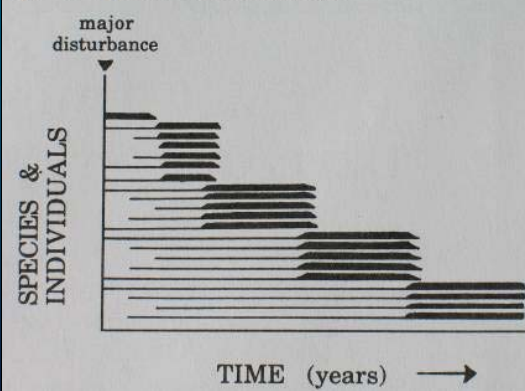




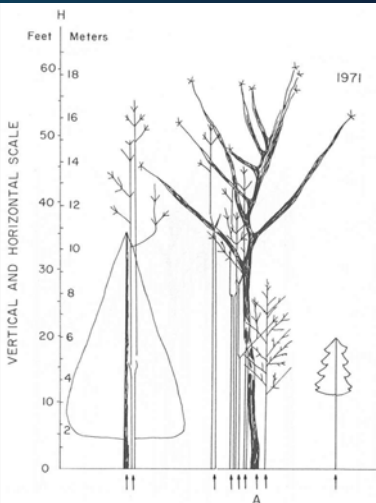
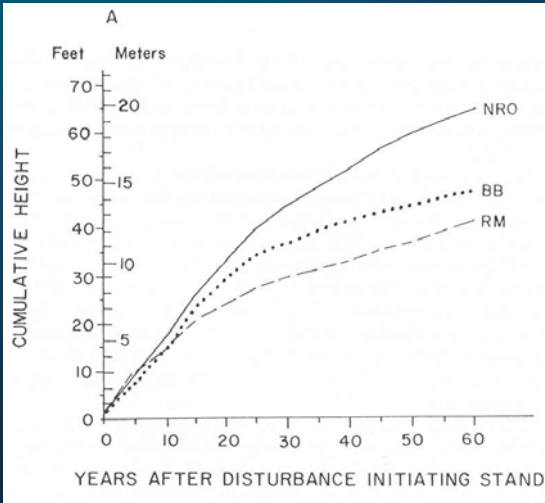


Stand dynamics

B. "INITIAL FLORISTICS"



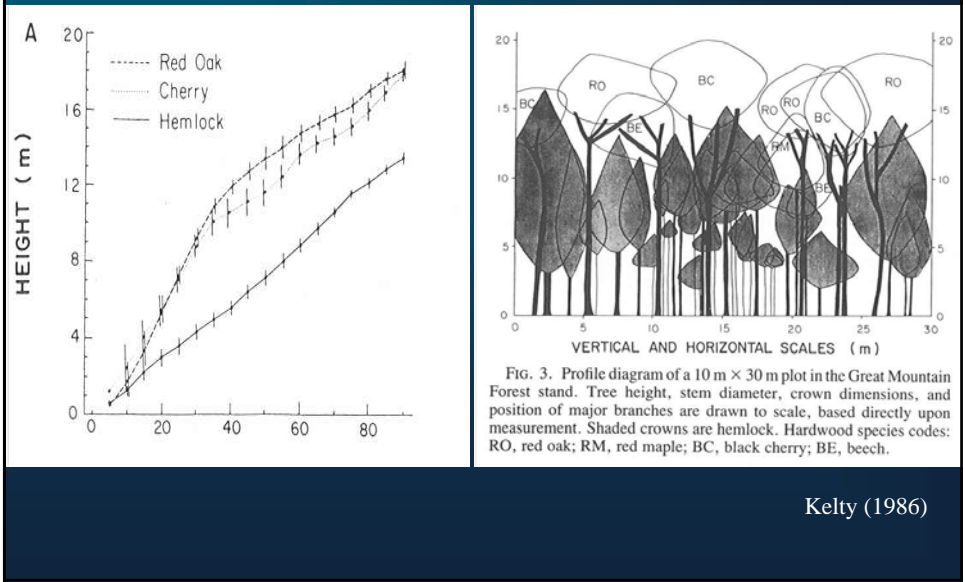
Second growth forest history and origins: Gradual divergence – Northern red oak – Black birch – Red maple



Oliver (1978)



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



Most codominant & intermediate sapling oaks regressed or died

