Why Trees Grow Where They Do?

The Basics of Forest Ecology

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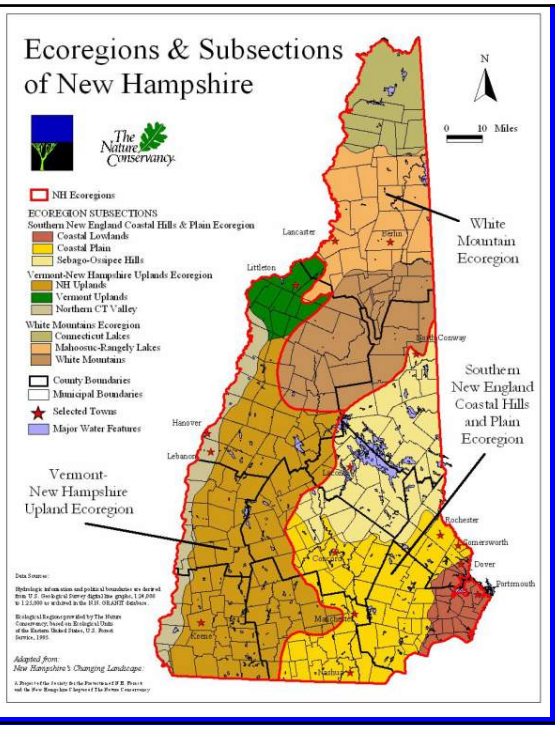
COOPERATIVE EXTENSION

Biome-regional or continental scale ecosystem characterized by distinct vegetation, animals & microbes, developed under specific soil & climactic conditions



Way to look very broadly at the landscape and trees:

Typing based on bedrock, climate, soil, surface water characteristics, disturbance regimes, land use

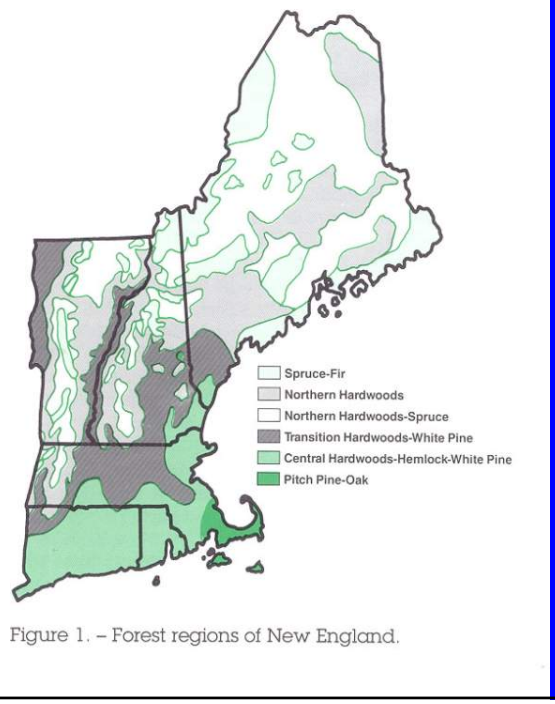
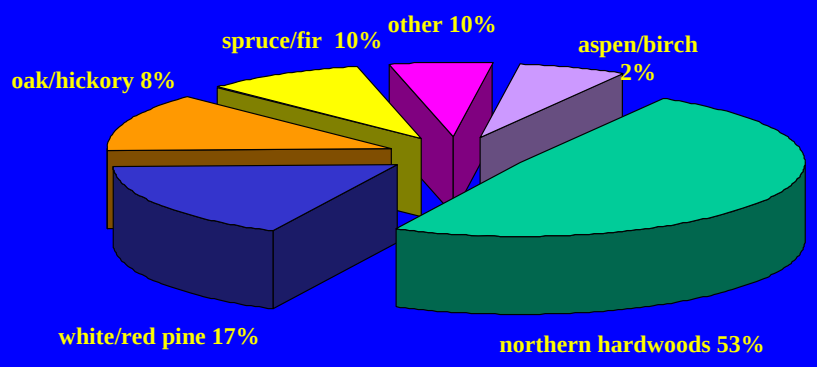


Figure 1. – Forest regions of New England.

Forest Type - a category defining forests based on natural groups of different tree species commonly occurring together over large areas. Named for one or more dominating species (e.g., birch-beech-maple, maple-oak-white pine).

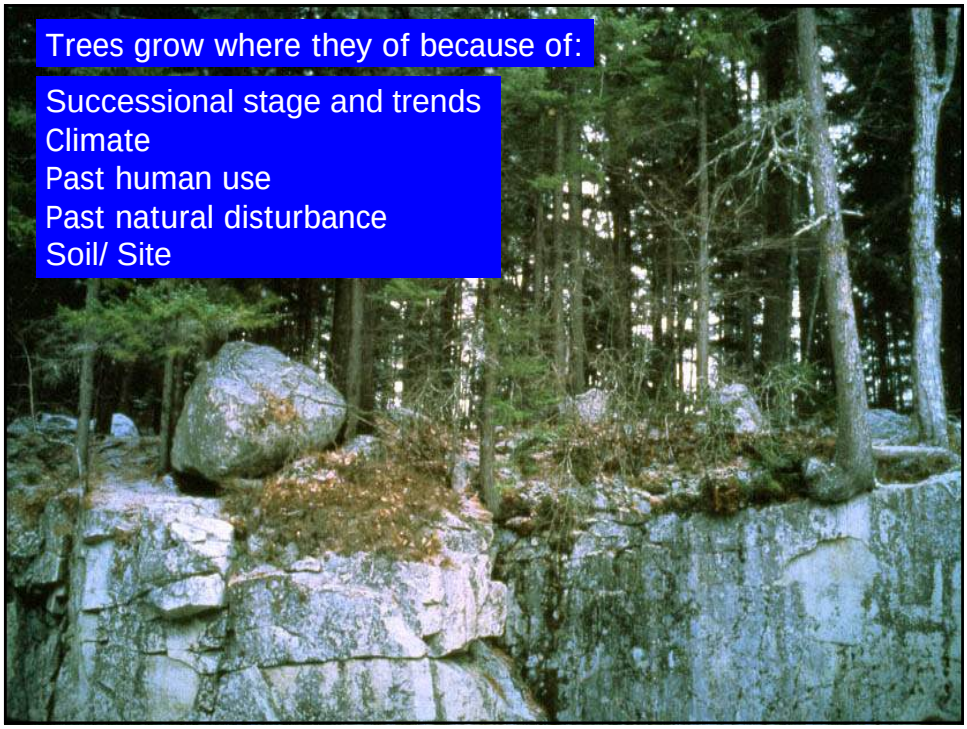
New Hampshire Forest Types, 2002



Source: USDA Forest Service

Why Trees Grow Where They Do?

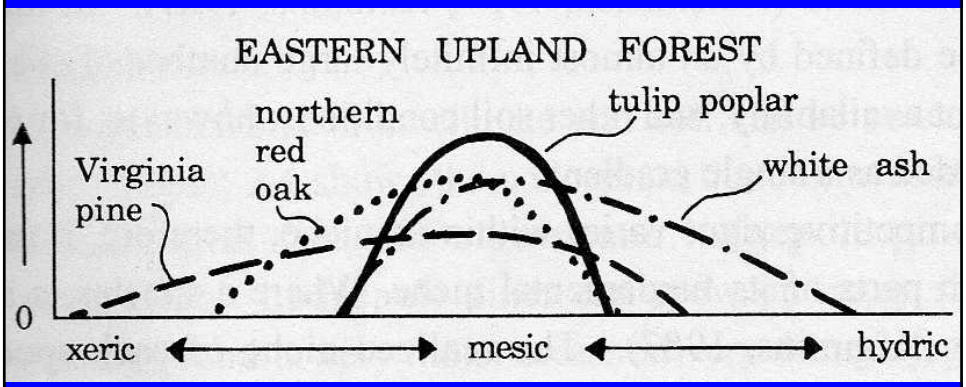
1. Adaptations over time
2. Climate: length of growing season, precipitation
3. Relationship to other trees
   - Succession, seed source/ absence, tolerance
4. Past site history
   - human disturbance
   - natural disturbance
5. Inherent site capability (aka thank the glacier)
   - Soil: water & nutrient levels, productivity
   - topography: slope/ aspect/ elevation (effect climate)



Adaptations Over Time

- Trees have been adapting to their environment since the beginning. This has set broad, but very definite limits to where they grow.
  - loblolly pine → south
  - red spruce → north
- They adapt to specific sites within their growing region
  - black gum → wetter
  - pitch pine → drier

Adaptations Over Time



Climate

- Not weather- long term weather pattern
- Controls amount of solar energy & water
- Temperature, precipitation, wind
  - Average annual rainfall
  - Snow depth and timing
  - Length of growing season
- Affects soil development
- North-south, high-low elevation
- e.g paper birch/ black birch

Relationship to Other Trees

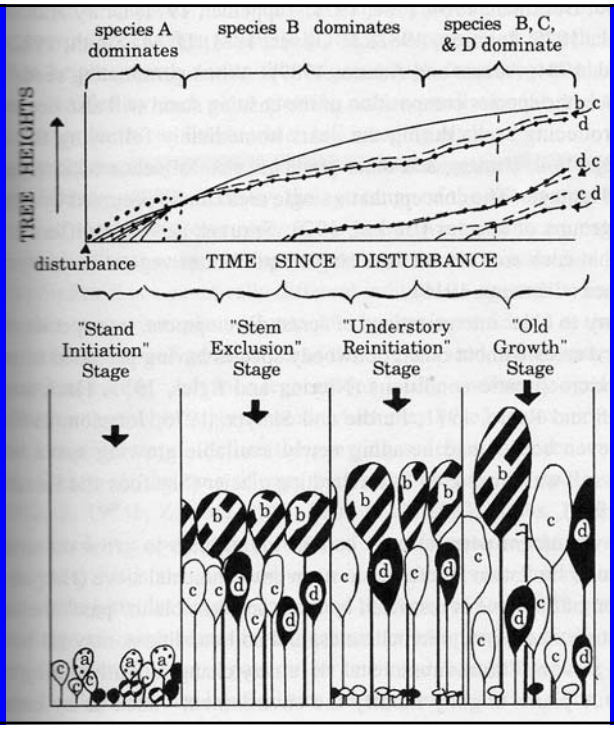
- Amount of light and seed source
- Determines whether or not a tree will regenerate- shade tolerance
  - aspen, willow need direct sun
  - white pine need partial sun
- How much light a tree has determines how fast it grows

Seed

- Source or lack of one determines what might grow
- Not every year a good seed year for everything
- Seeds disseminated by
  - wind, gravity, animals, birds
  - most seed falls within 200 feet of the parent tree

Succession

- The change in plant communities over time
  - as plants inhabit a site they change it making less suitable for selves more suitable for others
- Changing light conditions
- Soil temperature, nutrient moisture regimes
- Not a neat path of succession
  - differs by site
  - humans and natural disturbance
- As forest change food & shelter change and animal populations change



Shade Tolerance

Tolerance is the ability of a tree to grow satisfactorily in the shade of another tree.

Tolerant vs. Intolerant

- Intolerant to shade
  - tends not to reproduce under self
  - “sun-loving”
  - tend to be light seeded, wind-dispersed
  - early successional species
- Tolerant to shade
  - reproduce under self
  - Tend to beheavier seeded moved by gravity, animals
- Intermediate

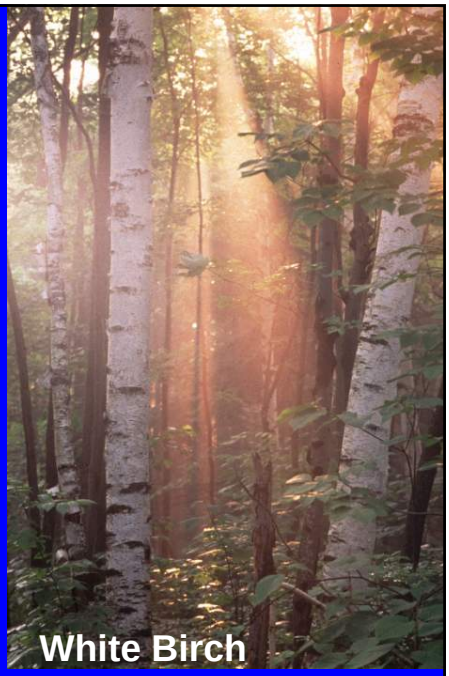
Intolerants

-can't reproduce in shade

-usually short lived

-wind dispersed, light seeded

-early successional or pioneer species



White Birch

Tolerants

-reproduce and survive in shade for long periods

-usually long lived

-late successional or climax species

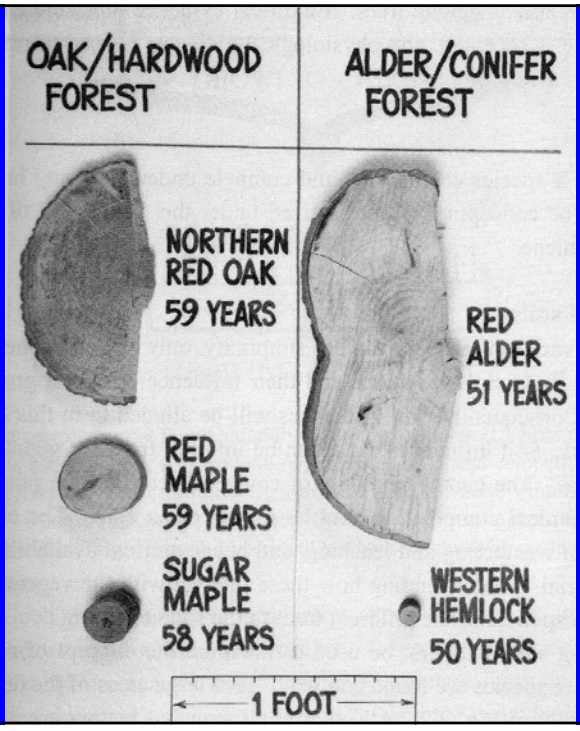
Eastern Hemlock

Intermediates

Softwoods	Hardwoods
Extremely Tolerant	
balsam fir	American beech
eastern hemlock	sugar maple
Tolerant	
red spruce, white spruce, northern white cedar	red maple
Intermediate	
eastern white pine	white ash, red oak, yellow birch
Intolerant	
red pine	paper birch
Extremely Intolerant	
	aspen

Shade Tolerance

Tolerant	Intermediate	Intolerant
Eastern hemlock	White pine	Eastern red cedar
Balsam fir	Yellow birch	Red pine
Atlantic white cedar	Black birch	Pitch pine
Hophornbeam	American chestnut	Butternut
American hornbeam	American elm	Hickories
American beech	Red maple	Paper birch
Sugar maple	Ashes	Larch
Red spruce	Oaks	Willows
Black spruce		Aspens
White spruce		Cottonwood
Northern white cedar		Grey birch
Silver maple		Black locust
basswood		



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Human Disturbance

- Native Americans burned forests for hunting, girdled and cleared forests for agriculture.
  - Coastal and riverine
- From 1700 to the present humans are the number one disturbance factor affecting the structure and composition of our forests.

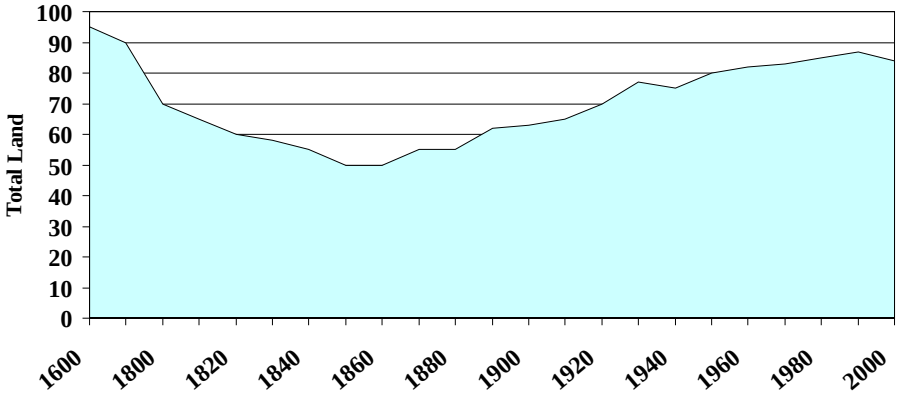
Non-native Insects, Diseases, Plants, Animals

- 1869 gypsy moth to Medford MA
- 1890 beech bark disease in NH
- 1910 white pine blister rust in southern NH
- 1916-1920 chestnut blight does first damage
- 1930 Dutch elm disease outbreak in NH
- 1960's butternut canker first appears
- 2000's hemlock woolly adelgid & ALB

Past Land Use

- Ag & Human activity may have altered the ability of soils to hold minerals
- Eroded & loss of organic matter
- Encouraged regeneration of atypical species
  - by altering the seedbed, encouraged white pine
  - the white pine story

Trend of Forest Land Cover in New Hampshire 1600-2000

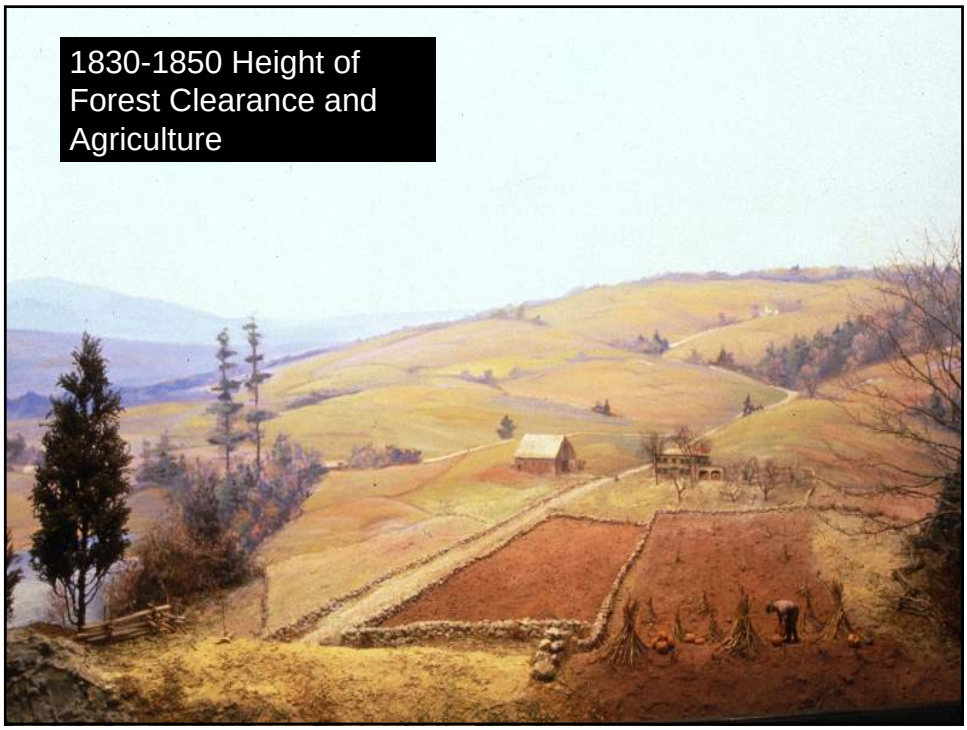


Source: UNH Cooperative Extension

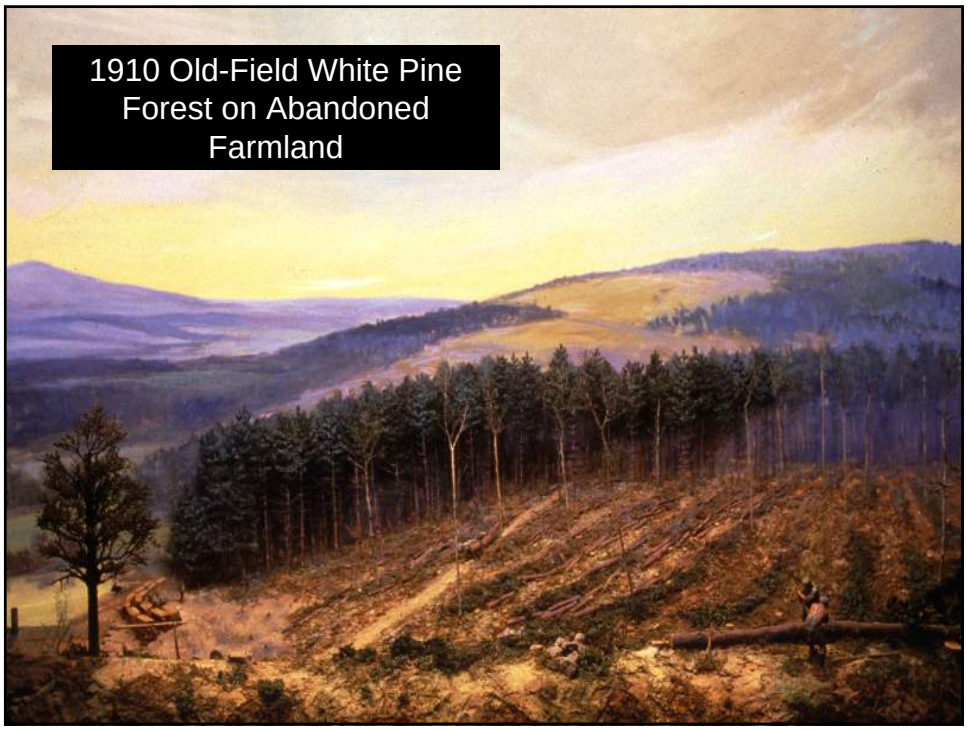
1700 Presettlement Mixed Forest

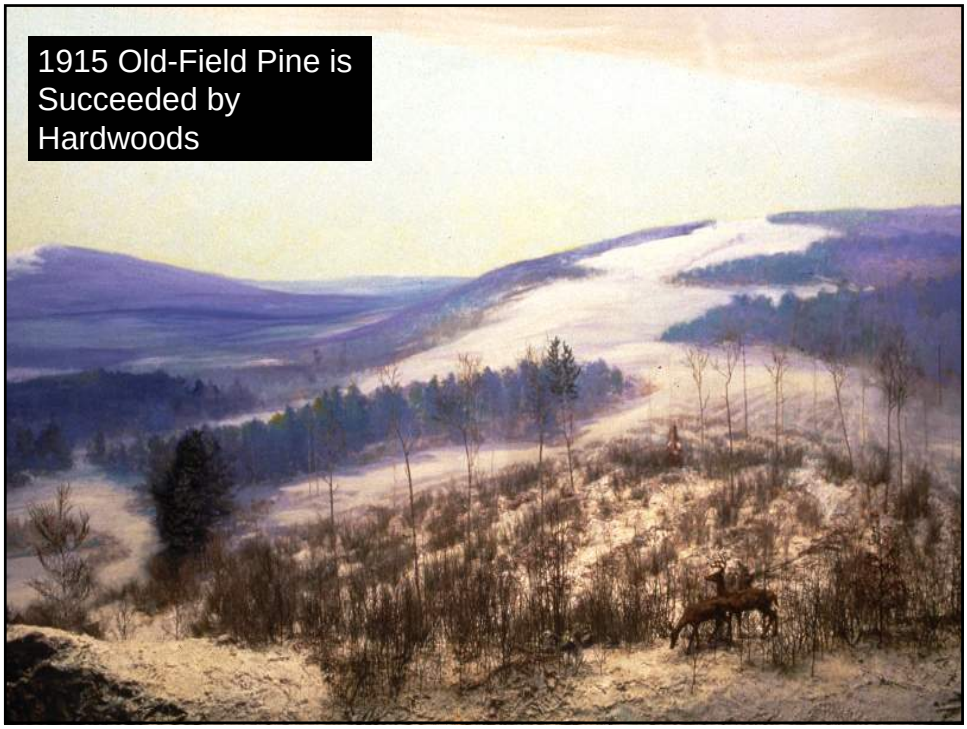
Prior to European Settlement- Forests were a patch-like mosaic shaped by: natural and human disturbance history, site conditions, and individual species characteristics.


1740 An Early Settler Clears a Homestead


1830-1850 Height of Forest Clearance and Agriculture


1850 Farm
Abandonment


1910 Old-Field White Pine
Forest on Abandoned
Farmland



Human Disturbance Today an antidote

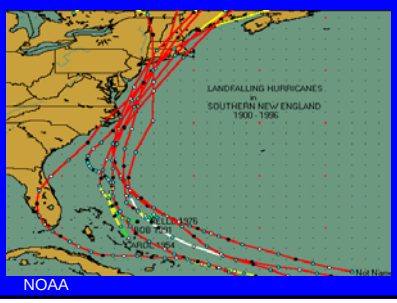
Natural Disturbance

- Hurricanes- 1938, 1954, 1955
- Tornado- 2008
- Wind events
- Ice storms- 1998, 2008
- Fire
  - more control today
  - fire dependant/beneficiaries
    - pitch pine type, ridge top oaks, “scrub” oak, birches, aspens
  - pre-European, some Native American burn river bottomlands for ag and game
- Individual, small group death

Disturbances and Forest Dynamics

1938 Hurricane

Harvard Forest Archives



NOAA

-Greatly influence species composition, age and structure.

-Kill individual trees, patches of trees or stands.

-Hurricanes, ice storms, insects, pathogens, fire, thunderstorms, wildlife, logging, conversion to agriculture.

Prevailing Wind Patterns

Natural Disturbances Create a Diverse Forest

Gaps from individual trees

widespread and scattered throughout the landscape

Large scale disturbances less frequent but larger areas disturbed

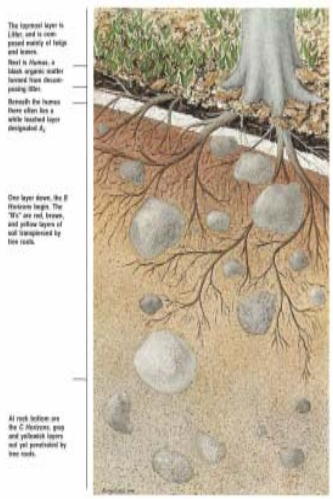
ice storms

wind

Beavers important form of forest disturbance

Inherent Site Capability-Soil

Soil Profile



NH has hundreds of soil types that can be grouped into 9 broad habitat types

Water & nutrient source for the tree

Geology helps determine soil fertility

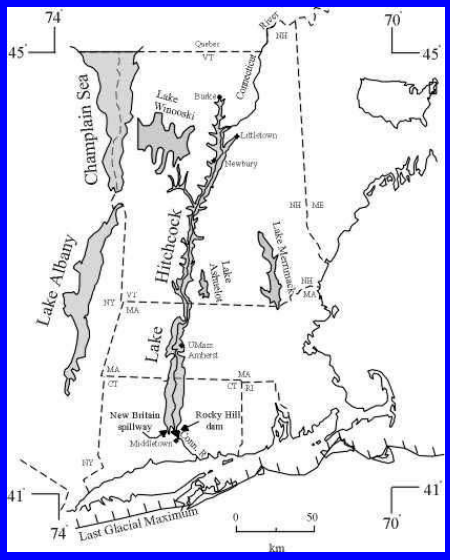
20,000 years ago…

…New England was buried under ice a mile thick.

By 12,000 years ago…

… the glacier had melted.

Glacial Lake Hitchcock



-Formed 15,000 years ago in Ct.

-Lasted for more than 4,000 years.

-At its largest it spanned over 200 miles down the valley.

-Large deposits of clay, sand and gravel.

11,000 years ago Spruce woodlands were the dominant forest.

-Patches of trees interspersed with tundra vegetation.

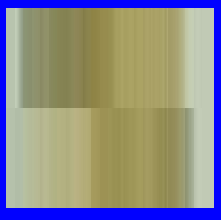
-Coincided with the arrival of the first Native Americans.

How do we know what tree species arrived when?

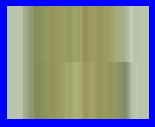
Answer: Tree Pollen!

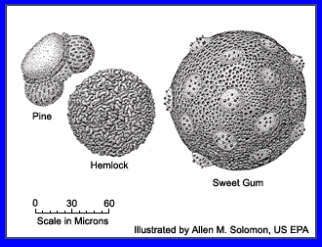
Pollen Core

White Pine



Oak



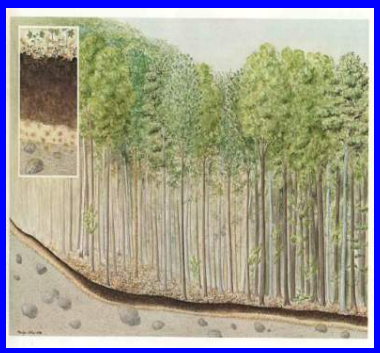


Soils

- Soils have four main ingredients
  - mineral particles
  - organic matter
  - water, and
  - air
- The type of soil in a given area will help determine what types of trees can grow & how well.

Soil

Enriched Soils



- Lots of organic matter and fine particles.
- Very productive for hardwoods: sugar maple, white ash

Outwash Soils

-Mostly sand and gravel, left by glacial meltwater.

-Very productive for white pine

Certain Soils “Favor” Certain Species

• white ash, sugar maple	→ • moderate well drain & enriched fine texture
• beech	→ • sandy tills
• red oak	→ • sandy tills & outwash
• white pine	→ • outwash & sandy tills
• red spruce, hemlock, balsam fir	→ • shallow pan, poorly drained, outwash, shallow to bedrock

Site Influences What Will Grow

Tolerate Wet Soils

yellow birch
black gum
red maple
hemlock

Well-drained soils

red oak
beech
sugar maple
ash

Northern Hardwoods

sugar maple

white ash

rich soils

Northern Hardwoods

beech

poor soils

yellow birch &
red maple

wet soils

aspen &
white birch

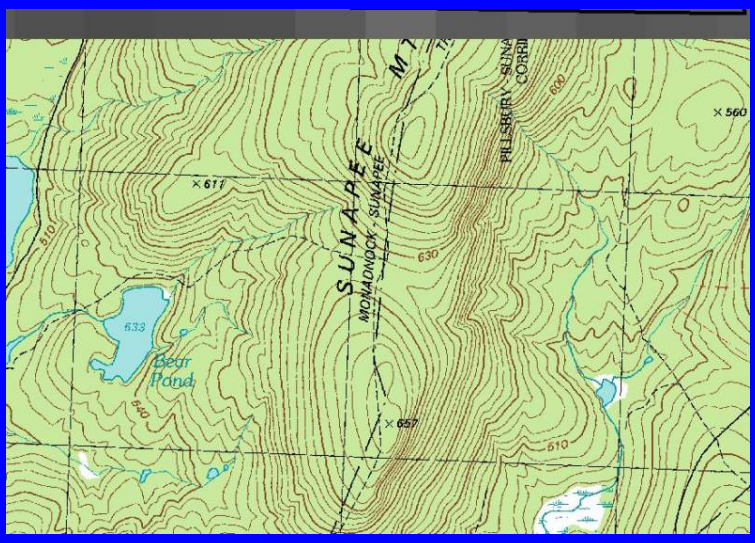
disturbed sites

Topography: Slope/ Aspect/ Elevation

- Soil habitat types related to topography
- Water regime related
  - More water on north facing slopes and at base of slopes than on south facing slopes and on top
- Elevation
  - temperature, soil habitat types, moisture all related

Inherent site capability

Elevation & Topography Influence Species Composition



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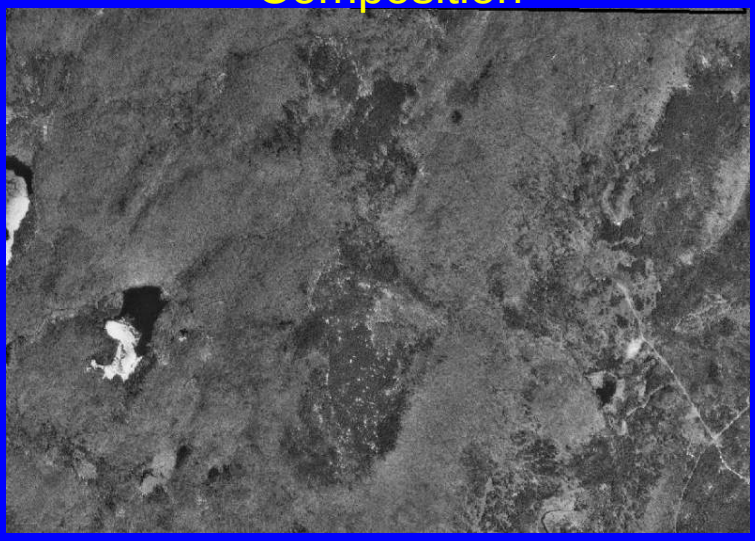

Spruce and Fir at High Elevations and Hill Tops

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http://www.fs.fed.us/na/durham/coopforest/stewardship/text/whytrees.shtml