Why Trees Grow Where They Do?
The Basics of Forest Ecology

Steve Roberge, Cheshire County Extension Forester
Karen P. Bennett Extension Forester

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

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).
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)
Trees grow where they of because of:

Successional stage and trends
Climate
Past human use
Past natural disturbance
Soil/ Site

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 be heavier seeded moved by gravity, animals

• Intermediate
**Intolerants**
- can’t reproduce in shade
- usually short lived
- wind dispersed, light seeded
- early successional or pioneer species

**Tolerants**
- reproduce and survive in shade for long periods
- usually long lived
- late successional or climax species
### Softwoods

<table>
<thead>
<tr>
<th>Extremely Tolerant</th>
<th>Tolerant</th>
<th>Intermediate</th>
<th>Intolerant</th>
<th>Extremely Intolerant</th>
</tr>
</thead>
<tbody>
<tr>
<td>balsam fir</td>
<td>red spruce</td>
<td>eastern white pine</td>
<td>red pine</td>
<td>aspen</td>
</tr>
<tr>
<td>eastern hemlock</td>
<td>white spruce</td>
<td>white ash</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>red maple</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>northern white cedar</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Hardwoods

<table>
<thead>
<tr>
<th>Extremely Tolerant</th>
<th>Tolerant</th>
<th>Intermediate</th>
<th>Intolerant</th>
<th>Extremely Intolerant</th>
</tr>
</thead>
<tbody>
<tr>
<td>American beech</td>
<td>sugar maple</td>
<td>white ash</td>
<td>red oak</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>yellow birch</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Shade Tolerance

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

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

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
1915 Old-Field Pine is Succeeded by Hardwoods

Human Disturbance Today an antidote

SOON TO BE BUILT ON THIS SITE

ABSOLUTELY NOTHING

THANKS TO THE PEOPLE OF CANDIA

INSTEAD THESE ACRES WILL CONTINUE TO PROVIDE HABITAT FOR
DEER, MOOSE, FOX, RUFFED GROUSE, SCARLET TANGERS,
AND MANY OTHER WILDLIFE SPECIES

IT WILL PROVIDE COUNTLESS OPPORTUNITIES FOR
CANDIA’S RESIDENTS AND FUTURE GENERATIONS TO ENJOY CANDIA’S RURAL CHARACTER

MANY THANKS TO MARY GIRARD
FOR CHOOSING TO PRESERVE THESE 82 ACRES OF LAND
Natural Disturbance

- 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

- 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

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.

Tundra: NE’s First Natural Community
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

Illustrated by Allen M. Tolinow, US DFW
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

<table>
<thead>
<tr>
<th>Favorable Soil Conditions</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderate well drain &amp; enriched fine texture</td>
<td>white ash, sugar maple</td>
</tr>
<tr>
<td>Sandy tills</td>
<td>beech</td>
</tr>
<tr>
<td>Sandy tills &amp; outwash</td>
<td>red oak</td>
</tr>
<tr>
<td>Outwash &amp; sandy tills</td>
<td>white pine</td>
</tr>
<tr>
<td>Shallow pan, poorly drained, outwash, shallow to bedrock</td>
<td>red spruce, hemlock, balsam fir</td>
</tr>
</tbody>
</table>

### Site Influences What Will Grow

**Tolerate Wet Soils**
- yellow birch
- black gum

**Well-drained Soils**
- red maple
- hemlock
- red oak
- beech
- sugar maple
- ash
Northern Hardwoods

- sugar maple
- white ash

rich soils

Northern Hardwoods

- beech
- yellow birch & red maple
- aspen & white birch

poor soils
wet soils
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
Elevation & Topography Influence Species Composition

Spruce and Fir at High Elevations and Hill Tops

Why Trees Grow Where They Do