White Pine Blister Rust, Caliciopsis Canker, Foliar Diseases, & White Pine Decline

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William Livingston-University of Maine
Kerik Cox & Sara Villani-Cornell University
Gaston Laflamme & Philippe Tanguay-Canadian Forest Service

Map created by Tom Luther
• White pine represents the greatest portion of growing stock in MA and NH
• 24% growing stock in Massachusetts
• 21% growing stock in New Hampshire
• 9% growing stock in Maine
• Maine is the number one white pine lumber producing state in the nation

Outline

1. WPBR
2. Caliciopsis
3. Foliar Diseases
4. White pine decline
WPBR Disease Cycle

http://www.fs.fed.us/psw/topics/forest_genetics/wpbr/life.shtml
WPBR History in Eastern USA

- 1890s: fungus introduced to NYS on European infected nursery stock
- 1911: disease spreads through Northeast
- 1920: federal quarantine prohibits importation and cultivation of Ribes
- 1930-1950: ~$150 million spent Ribes eradication program including CCC
- 1966: federal quarantine rescinded
- Ribes restrictions in ME, NH, MA
- No Ribes restrictions in VT, CT, and PA

WPBR in NH

- Introduced to NY in 1890, by 1922 up to 50% pine mortality in NH
- Ribes were eradicated 1917-1986 $$$
- In Eastern USA, WPBR no longer a problem for pines when European black currants, R. nigrum (very susceptible, lots of inoculum) removed
- New resistant & immune Ribes in 1990s
- Statewide survey reports 3-7% WPBR incidence by county
- Early 2000s some Ribes allowed
- In 2012, 19 Ribes immune and resistant cultivars were allowed
- These cultivars were selected based on field trials in OR

References:
2. WPBR infection incidence for selected areas in NH by Kyle Lombard and Jennifer Bofinger, 1999.
Objectives

1. Evaluate incidence and severity of white pine blister rust (WPBR) on Ribes cultivars
2. Determine WPBR incidence and severity of neighboring eastern white pine and wild Ribes species
3. Verify presence of WPBR with DNA-based molecular diagnosis techniques
4. Challenge immune Ribes of reliable provenance with NH WPBR isolates
Most sites visited looked like this-private homes.

Note proximity of pines to Ribes
We also visited commercial plantings

Cultivated Ribes

- Surveyed up to 5 plants of each cultivar at each location, for 43 sites
- Determined disease severity for 18 leaves per plant, 255 plants of 19 cultivars total
- Sent samples from each cultivar to Cornell for PCR pathogen diagnosis
- Sent samples from WPBR immune Ribes cultivars to Canada for inoculations
WPBR incidence in cultivated *Ribes*

<table>
<thead>
<tr>
<th>Species</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>R. nigrum (with Cr gene)</td>
<td>B</td>
</tr>
<tr>
<td>R. nigrum (without Cr gene)</td>
<td>AB</td>
</tr>
<tr>
<td>R. odoratum</td>
<td>A</td>
</tr>
<tr>
<td>R. x nidigrolaria</td>
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<tr>
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<td>R. rubrum</td>
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</tbody>
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WPBR severity in cultivated *Ribes*

<table>
<thead>
<tr>
<th>Species</th>
<th>Percentage of diseased leaf area</th>
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<tr>
<td>R. nigrum (with Cr gene)</td>
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White pine sampling

- At each site, sampled 12 pines closest to cultivated *Ribes* within 1000 ft
- 3 pines in each of the 4 cardinal directions
- Recorded DBH, distance from *Ribes*, cardinal direction, presence of aecial scars, presence of other WPBR symptoms
Other WPBR symptoms

WPBR incidence of white pine in relation to presence of infected Ribes

- Pines with aecial scars
- Pines with aecial scars OR other WPBR symptoms

Ribes with Cr gene with WPBR
Ribes without Cr gene with WPBR
Ribes without WPBR

Presence of infected Ribes
Conclusions

- WPBR was found on all cultivars except 1301 (9 plants) and Crusader (8 plants)
- Titania was the most frequently planted cultivar (72 plants, 21 sites)
- Immune Ribes with Cr gene (Consort, Coronet, Titania) are no longer immune
- Pines neighboring infected previously immune Ribes were more likely to be infected
- These cultivars were removed from State approved list
WPBR control

- Pruning lower and infected branches
- Remove infected pine trees
- Remove Ribes
- Resistant eastern white pine varieties are being developed by University of Minnesota and USFS

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Caliciopsis canker

- Reports of damage caused by *Caliciopsis* were common in the 1930s
- Caliciopsis has been found in West Virginia, New England, New York, and Europe
- The fungus attacks thin-barked areas of the bole and branches
- Trees of all age classes are affected

Caliciopsis pinea fruiting bodies
Caliciopsis canker symptoms

Caliciopsis canker
Proposed work

1. Identify areas at greatest risk of *C. pinea* damage
2. Assess effects of thinning in stands infected with *C. pinea*
3. Develop management guidelines for *Caliciopsis* canker
4. Develop DNA tools for pathogen identification
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Picture courtesy of Maine Forest Service
**Objective for 2011**

To determine causal agents of white pine needle damage

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**Methods**

- Samples collected in 4/2011 and 6/2011 from 13 sites in VT, NH, & ME damaged in 2010
- 3-5 trees sampled per site (1 L zip-lock bag per tree)
- All branch tips were examined
- Needles from a representative branch/tree incubated for 24-48 hr at 25°C
- Fruiting bodies examined & photographed
Canavirgella needle cast or Dooks needle blight caused by *Lophophacidium dooksii*

Bifusella needle cast caused by *Bifusella linearis*
Brown spot needle blight caused by *Mycosphaerella dearnessii* or *Lecanosticta acicola*
Conclusions from 2011

- At least 3 pathogenic fungi present at the same site and more than one pathogen on the same tree
- *Mycosphaerella dearnessii* was the most frequently observed & widely distributed pathogen
- *Mycosphaerella dearnessii* most constantly associated with chlorosis and defoliation

Monitoring affected pines

- Pairs of healthy and diseased trees were tagged (State Cooperators) in 8 locations for long term monitoring
- Yearly crown ratings (State Cooperators)
- Tree coring (Dr. William Livingston, University of Maine and Cameron McIntire, Dr. Heidi Asbjornsen, Univ. New Hampshire)
Chlorosis

Average of Yellowing:

- Bethel, ME

Proportion of crown affected

- 2/3
- 1/3 - 2/3
- >1/3

Tree Status:

- Diseased
- Healthy

Defoliation

Average of Defoliation:

- Bethel, ME

Proportion of crown affected

- 2/3
- 1/3 - 2/3
- >1/3

Tree Status:

- Diseased
- Healthy
Fox Forest Basal Area Increment

Cameron McIntire

Crown Defoliation Rating

Cameron McIntire
Disease forecasting

- Kirk Broders & Stephen Wyka-UNH

- 15 data loggers (T and Rh) installed in symptomatic and asymptomatic stands in each of 4 frost hardiness zones (4a-5b)
What is going on?

- Air temperature and precipitation, specially during the growing season have increased (long-term data Hubbard Brook)
- Increase in area forested with white pine: 
- Pathogens were present before but current conditions have resulted in epidemics
Management Recommendations

- These fungi are expected to continue to cause damage during unusually wet springs
- Defoliation has resulted in growth reduction in 1 site & is being monitored in more locations
- Thin damaged trees?

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White Pine Decline in Maine:
Is it a Disease?

- Yellowing and thinning of crown
- Reduced growth
- >50% mortality on isolated sites

Livingston et al. 2005

http://forest.umaine.edu/faculty-staff/directory/william-h-livingston/research/

White Pine Decline in Maine

- Predisposing
  - Dense stands
  - Shallow rooting
- Secondary
  - Bark beetles
  - Armillaria root disease
  - Stem canker fungi
Experimental Treatments
Bill Leak

Massabesic Experimental Forest, Alfred, Maine
http://www.fs.fed.us/ne/durham/4155/massabes.htm

THANK YOU FOR YOUR ATTENTION!!!
Acknowledgements

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- Tom Luther, Rebecca Lilja, and Randy Morin for maps
- Tom Rawinski for wild Ribes ID
- James Bubar and Ribes permit holders for access to their properties
- Needle collection: Wayne Searles, Jim Esden, Tess Greaves, and Jay Lackey
- Foliar pathogen diagnoses: Louise Innes, Kathy Decker, Mary Inman, Sharon Douglas, Nancy Wenner, & Gloria Broders

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Wild & naturalized *Ribes*

- 3 naturalized *R. rubrum* 1 location
  Mean diseased leaf area = 0.1%

- 1 native *R. hirtellum* 1 location
  Mean diseased leaf area = 2%

Inoculations

Titania plants from the Canadian Clonal Genebank were successfully infected with NH samples

Phil Tanguay
Wild & naturalized Ribes

- Ribes present
- Veg P3 Plots (2001-2011)
- White pine absent
- White pine present

P3 plots that are spaced at 1/96,000 acres.

Needle casts

- Newly infected needles remain green until following winter or spring.
- Typical foliage symptoms (reddening and browning) occur in abundance during spring, often more evident on lower branches.
- Spores disseminated by wind and rain to healthy needles in the spring and early summer.
- Green first-year needles at branch tips.
- Brown second-year needles.
- Fungus produces small black fruiting bodies called hysterothecia on dead and dying needle tissues.

Brown spot needle blight