

Are oak on the decline, or is it just a hiccup?

Stephanie Adams, MS
The Morton Arboretum

Range of Oak Forest Types

Oak forest types in the Eastern United States:
Oak-Hickory and Oak-Pine

Legend:
■ OAK-HICKORY
■ OAK-PINE

Forest Insect & Disease Leaflet 1604.5, Department of Agriculture Forest Service. Oak Decline Philip M. Waigop, David R. Houston, David Scott A. Lankford/USDA

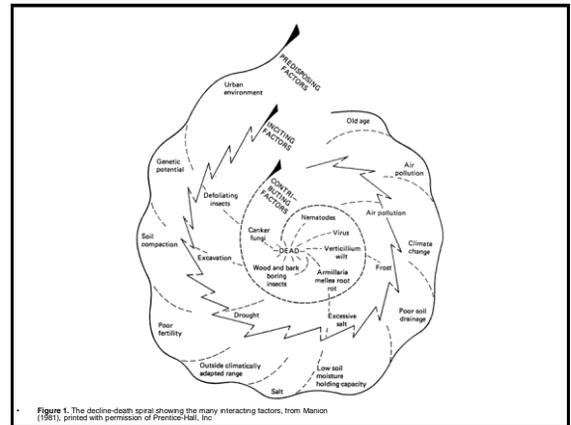
Decline Complex

Three-part complex

Predisposing: Age, climate, soils, genetics, soil fertility, soil moisture, salt, drainage, pollution

Inciting: Defoliation, boring insects, salt, frost

Contributing factors: Two-lined chestnut borer, *Phytophthora cinnamomi*, *Armillaria*, *Biscogniauxia (Hypoxylon)* canker



Diseases and Insect Problems

- Rapid white oak mortality**
 - Ambrosia beetles
 - Armillaria* root rots
 - Biscogniauxia*, formerly *Hypoxylon*, canker
 - Phytophthora cinnamomi*
 - Two-lined chestnut borer
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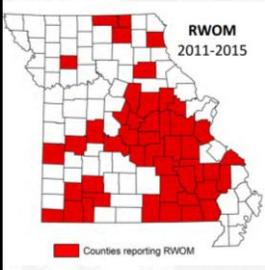
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Rapid White Oak Mortality



- Since 2011
- 2014 in 43 counties
- SE, central, east-central MO and SE Iowa
- 25% of white oaks don't show symptoms
- As of 2014 2.6 million board feet of affected timber salvaged

http://ms.fs.fed.us/pub/howto/rt_oakwilt/identify_prevent_and_control_oak_wilt_print.pdf
10/18/2015

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Rapid White Oak Mortality Factors

- Predisposing factors
 - Seasonal drainage, older trees, species
- Inciting
 - Defoliation
- Contributing factors
 - Ambrosia beetles (*Xyleborinus gracilis*)
 - *Armillaria* root rots
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Rapid White Oak Mortality

- Mortality on high-quality sites
- Tree ring analysis suggests the stresses have been long-term (decades)




Rapid White Oak Mortality

- Most frequent on lower slopes in Missouri
- Upper slope and ridges of Arkansas
- Lower and upper slopes in Iowa, not confirmed in Iowa
- Not found in Illinois



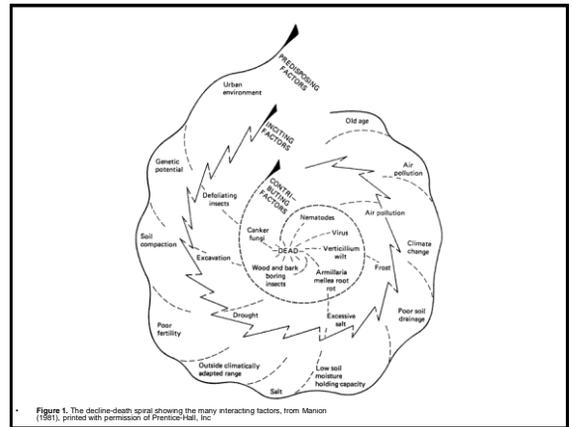
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Oak Decline Occurrence

- Periodic oak decline range since 1900s
 - Oak decline, oak dieback, oak mortality
- Decline starting in the 1960s
- Seen in mid-western states since 1970s
- Ozark highlands in Arkansas and Missouri, southern Ohio, limited in Illinois



Oak Decline Factors

- Predisposing factors
 - Over 70-90 years old
 - Red oak group especially susceptible
 - Scarlet, black, Chinquapin, red, southern red
 - Crowded stands, especially red oak
 - Elevation (hills or valleys)
 - Dry sites, shallow rocky or sandy soils, ridge tops, south and west facing slopes
 - Drought, frost, defoliation, water logging, especially clay soils
 - 2-3 year lag after drought, maybe 10 years



Paul Wray, Iowa State University, Bugwood.org

Oak Decline Hosts

- Inciting
 - Fall webworm
 - Forest tent caterpillar
 - Jumping oak gall
- Contributing factors
 - *Armillaria* root rots
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Oak Decline Symptoms

- Chlorotic, stunted, and sparse leaves, premature fall color, brown foliage remains attached
- Dieback of upper 1/3-1/2 of canopy
- Defoliated trees put on second flush of leaves – dieback following year
- Watersprouts (epicormic shoots) from main stem and structural branches,
- Poor branch growth
- Rootlets in upper 12” of soil die
- Decline over 2-5 years

Forest Insect & Disease Leaflet 1630, U.S. Department of Agriculture Forest Service. Oak Decline
Photo: M. Wargo, David R. Houston, and Leon A. Lombardi



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Oak Decline Outcomes

- Negative: reduced diversity (red oaks more susceptible), decrease in acorns number and quality, other species move in
- Positive: canopy opening, reduce canopy density, stimulate understory, increase diversity of cover types, increase habitat sites

Oak, SW. DA Starkey, JM Dabney, 1989. Oak decline alters habitat in southern upland forests. Proc. Annu. Conf. SEAFWA: 42:491-501.

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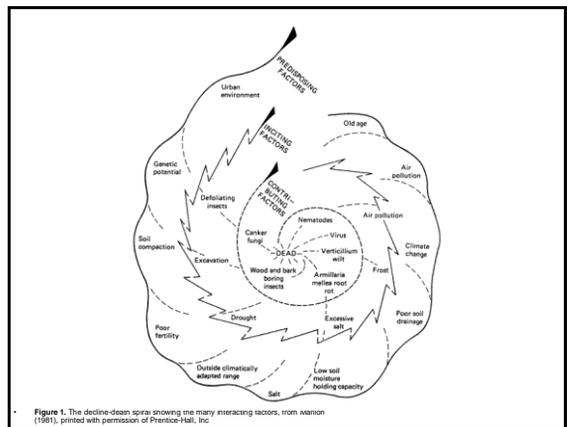
“Oak decline is a normal part of ecosystem processes in aging upland hardwood stands. Dieback and death are expected results when mature oaks come under stress.”

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Defoliators

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Root Rots

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Things that damage the cambium

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Diseases unrelated to COD or RWOM

Anthracnose

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- Fungal foliar infection
- Various host specific fungi

Three different patterns:

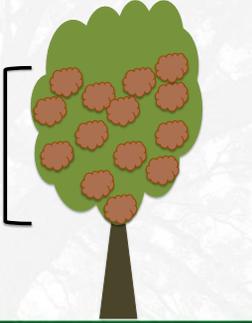
- Early, young leaves brown and shrivel
- Infected later, large irregular dead areas on distorted leaves (delta)
- Late, small necrotic spots on leaves



Anthracnose

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- Foliar symptoms in lower 2/3 of the canopy
- Top 1/3 looks good
- Causes defoliation
- Especially bad in years with cool and wet spring



Armillaria

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- Honey mushroom
- Root rot
- Multiple species
- Normally live as saprophytes
- Opportunistic



Armillaria

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- Rhizomorphs under the bark
- White mycelial fans
- Canopy dieback





Armillaria – Oak Decline

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- Indiana
- Minnesota - 30 acres
- Ohio
- Common across Iowa
- 3 *Armillaria* species in Missouri

Bacterial Leaf Scorch

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- *Xylella fastidiosa*
- The bacterium grows in the xylem, which becomes clogged
- Most hardwoods are effected
- Herbaceous plants can harbor the pathogen



Bacterial Leaf Scorch

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- Leafhoppers and spittlebugs
- Can be spread on pruning tools
- Marginal necrosis, sometimes with yellow edge
- Looks like environmental scorch, root damage, flooding
- For a positive ID an ELISA test must be run




Bacterial Leaf Scorch

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Illinois

- 10 counties
- Oak species
 - Bur, red, pin, white, Chinkapin, swamp white, shingle
- Chinese chestnut
- Black walnut
- Sugar maple
- American elm



Bacterial Leaf Scorch

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Management

- No preventative or curative chemical treatments
- Oxytetracycline – injection
 - Masks the symptoms
 - Bacteria is still transmissible
- Remove the infected trees
- Plant non-hosts



Brantton, Dobnick, 2015

Canker

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Dead often discolored sunken area on woody tissue (branches, twigs)



Biscogniauxia (Hypoxylon) canker

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- Air-borne, opportunistic fungi
- Oaks, maple, beech, sycamore, aspen, hickory, pecan, hardwoods
- Stressed or weakened trees more susceptible
 - Drought or injured root systems
 - Forest sites, trees in pastures, recently developed home sites, and established residential areas

Biscogniauxia (Hypoxylon) canker

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- Chronic dieback and wilting
- Smaller leaves, chlorotic or yellowing leaves, and branch tip dieback
- Cankers on main branches or trunk, death is likely to occur
- Canker can grow 3 ft from inoculation site in one season



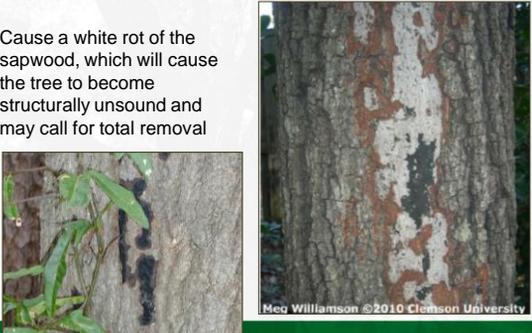
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Biscogniauxia (Hypoxylon) canker

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Cause a white rot of the sapwood, which will cause the tree to become structurally unsound and may call for total removal



Meq Williamson © 2010 Clemson University

Biscogniauxia (Hypoxylon) canker – Oak Decline

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- Indiana
- Ohio
- Missouri



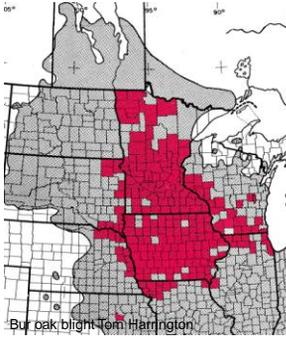
Bur Oak Blight

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- *Quercus macrocarpa* var. *olivaformis*
- Anthracnose-like symptoms
- Trees die in ~20 years

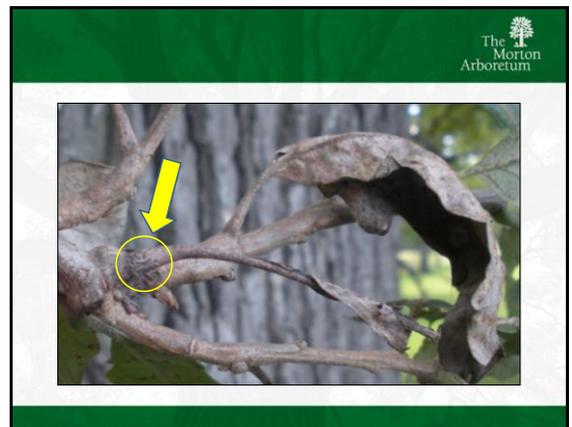


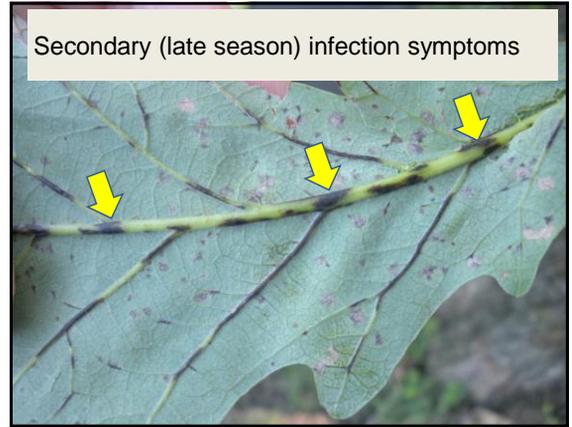
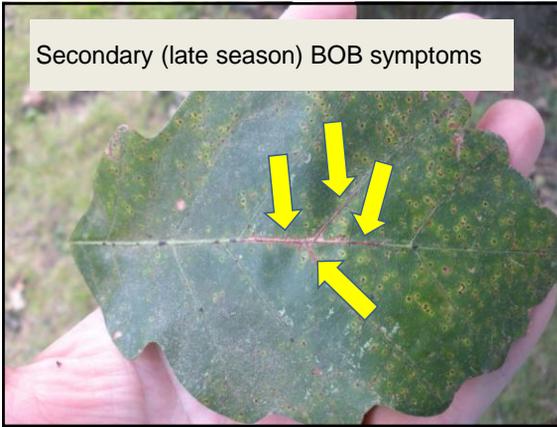
Bur Oak Blight Distribution



- Iowa
 - 2,000 acres
 - 10 years
 - Shift in climate temperature, more frequent rain events, more often associated with grazing and construction, on older trees
- Minnesota
 - 78/87 counties have BOB
 - Symptoms: premature leaf drop, second flush of leaves, water sprouts, dieback
 - Severe symptoms after 5 years infected
- Illinois
 - 2011 – Winnetka
 - 2012 – Lake County
 - 2013-4 – no new reports
 - 2015 – DuPage and Grundy county
- Wisconsin - limited

Bur oak blight: Tom Harrington





Fall Webworm

- White moth about 1 1/2 in.
- Adult appear from May to August
- Deposit egg masses on the lower surface of leaves (~1500 eggs)
- Larvae feed then drop to the ground to spin thin cocoons just beneath the soil surface to overwinter, emerging as adult moths

Two photographs: the top one shows a fuzzy, green caterpillar with white hairs on a leaf; the bottom one shows a white, silken cocoon attached to a leaf.

Photo credit: G. K. Duce, University of Georgia

Fall Webworm

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- Hosts: approximately 120 species of deciduous trees - mulberry, maple, crabapples, birch, chokecherry, walnut, and willow
- Damage occurs in late July and August as the larvae feed

A photograph showing a tree branch heavily covered in white, silken webbing and numerous white cocoons, illustrating the damage caused by Fall Webworm.

Fall Webworm - Oak Decline

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- Wisconsin
 - wide spread, light defoliation
 - 1 site severe
- Missouri

A photograph showing oak leaves that have been severely damaged and defoliated by Fall Webworm, with only bare branches and some remaining webbing visible.

Forest Tent Caterpillar

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- *Malacosoma disstria*
- United States and Canada - hardwood trees
- Oak, ash, birch, poplar, linden, fruit trees, birch, alder
- Outbreaks can last 3-4 years
- Early season defoliation causes trees to produce second flush of leaves
- Reduced growth and branch dieback

Forest Tent Caterpillar

- Larvae emerge from egg in early to mid-May
- Feed for five to six weeks
- Pupate in the end of June
- Adult moths emerge in mid-July
 - Adults live - five days
 - Egg mass encircles small twigs and can hold 100-350 eggs, overwinter
 - One generation per year




University of Minnesota Extension





Forest Tent Caterpillar

- Minnesota
 - 65,750 acres
 - 30% heavy defoliation
 - Heavy defoliation for the last three years
- Iowa
 - 800 acres
 - Outbreaks every 6 and 16 years

Gypsy Moth

- 100-200 GDD₅₀
- Males undergo 5 instars, females 6
- Females do not fly, males do
- Natural dispersal: hanging from host trees on silken threads and carried by the wind for about 1 mile



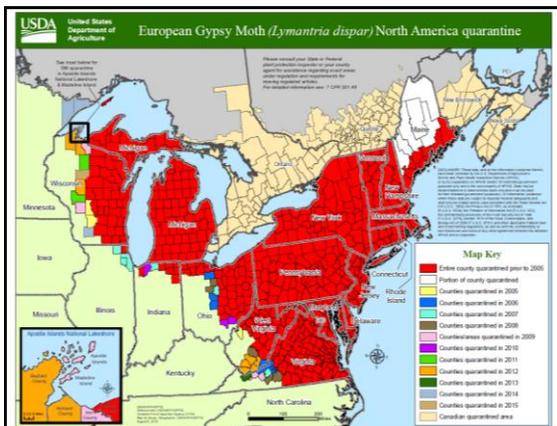





Gypsy Moth

- 450 species of plants
- Oaks are the preferred host
- Also feed on alder, apple, aspen, beech, birch, black gum, cherry, hawthorn, hemlock, hornbeam, larch, linden, maple, sassafras
- Populations fluctuate





Gypsy Moth

- Indiana
 - 28 yrs of surveying
 - 40/92 counties infested
 - Blk - 2,205 acres
 - Pheromone flakes - 11,500 acres
 - No noticeable defoliation
 - Defoliation in 2009 - 70 acres in 2 counties
- Tennessee
 - 7446 traps set
 - 14 male moths caught
- Iowa
 - Controlled by environmental conditions (cold),
 - *Entomophaga*
 - Mating disruption
 - No feeding damage seen
- Ohio
 - Mostly eastern part of the state
 - 51/88 counties under quarantine
 - *Entomophaga*
- Minnesota
 - 2013 = 71,000
 - 2014 = 523
 - 2015 = 1049
- Wisconsin
 - No noticeable defoliation
 - Treating one site
 - *Entomophaga maimaiga* and Nucleopolyhedrovirus (cold),
- Missouri

Jumping Oak Gall

- Caused by a small wasp laying its eggs on the leaves
- Gall falls from its host, the larvae inside causes the gall to jump up to several centimeters off the ground
- Missouri
- Jumping oak gall defoliation 2010



Oak Wilt

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- *Ceratocystis fagacearum*
- Red oak group
- White oak group naturally resistant
- Spread by beetles, root grafts, tools



Oak Wilt

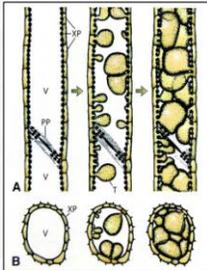
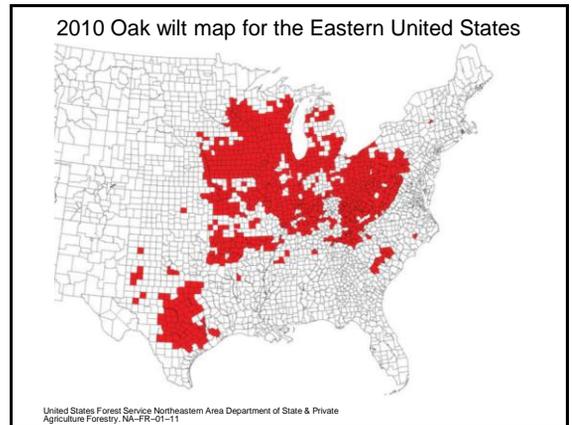
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<h3>Red oak group</h3> <ul style="list-style-type: none"> • Symptoms usually appear in late spring, early summer • Leaves turn bronze and fall off tree in summer • Kills red oaks within 4–6 weeks 	<h3>White oak group</h3> <ul style="list-style-type: none"> • Leaves become straw colored from the leaf tip, but remain attached to branches • Branch dieback occurs • Usually takes several years to tree to die
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Oak Wilt

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- Tree wards off fungus by forming tyloses, which plugs xylem
- Streaking under the bark
- Branches wilt

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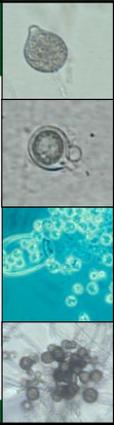
Oak Wilt

- Illinois
 - 2012 increase (drought)
 - 2015 – comparable to other years
- Iowa
 - 3,237 acres in southern half of the state
 - Not spreading
- Wisconsin
 - Southern 2/3 of the state
 - Experimental herbicide to prevent belowground spread
- Minnesota
 - Since 1950
 - 1,145 acres of red oak affected
 - Housing developments, especially bad on forest lines
- Indiana
 - 64 counties

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Phytophthora cinnamomi

- Introduced to the United States
- Woody and herbaceous ornamentals, shade and forest trees, and agronomic crops
- Infection occurs when soil conditions are too moist for healthy host plant growth



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Phytophthora cinnamomi

- Soil and water inhabitants
 - May survive in soil for several years without a host
 - Prefer cool and wet conditions
- Temperatures 15-23C
- Survive for several years in the soil without a host



Fred Brooks, University of Hawaii at Manoa, Bugwood.org

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Phytophthora cinnamomi

- Ohio
- Missouri



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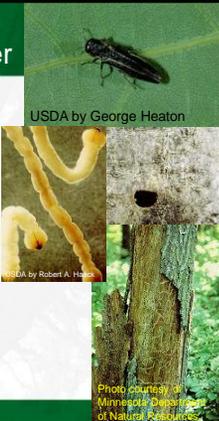
P. cinnamomi Symptoms

- Uniform canopy dieback
- Looks like drought or nutrient deficiency
 - Wilting, yellowing, leaf drop
- Root and lower stem rot
- Twig blights
- Brown or black roots
- Root bark sloughs off




Two-lined Chestnut Borer

- *Agrilus bilineatus*
- Primarily attacks oaks
 - White, red, scarlet, northern pin, black, bur, and chestnut oak.
- Adult beetle is slender, 1/5 to 1/2-inch long, with 2 yellow stripes along its back



USDA by George Heaton

Photo courtesy of Minnesota Department of Natural Resources

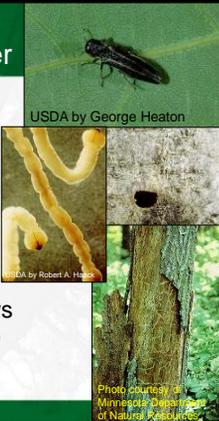


Two-lined Chestnut Borer

- Indiana
- Ohio
- Two-lined chestnut borer – Minnesota - 106 acres
- Missouri

Two-lined Chestnut Borer

- Emerge in late May to June
- Lay eggs in bark
- Eggs hatch in 7 to 14 days
- Larvae burrow through the bark
 - Galleries tightly packed with frass
- Larvae pupate
- Spring the adult beetle chews a D-shaped emergence hole
- One generation per year



USDA by George Heaton

Photo courtesy of Minnesota Department of Natural Resources



Two-lined Chestnut Borer

Attacks begin in the crown and proceed downward in each succeeding year of infestation



USDA; FS, Forest Insect & Disease Leaflet 165



“Oak decline is a normal part of ecosystem processes in aging upland hardwood stands. Dieback and death are expected results when mature oaks come under stress.”

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