

# Heterobasidion root disease and Red Pine Pocket Mortality in Wisconsin Biology and Management



Photos:  
Left: Red pine pocket mortality aerial view  
Upper right: A pocket created by annosum root rot  
Lower right: Annosum fruit bodies



Wisconsin Department of Natural Resources  
Division of Forestry  
Forest Health Protection  
2003, Revised 11/2018



# Heterobasidion Root Disease

**Introduction:** Annosum root rot, recently renamed as Heterobasidion Root disease (HRD), was first identified in Wisconsin in 1993 and is considered among the most important and destructive diseases affecting conifers in the north temperate regions of the world. It is caused by the fungus, *Heterobasidion irregulare* (formally *H. annosum*). Although many woody species have been reported as hosts in the world, HRD has been most commonly observed on red and white pine plantations in Wisconsin.

**Known Locations:** Heterobasidion Root Disease has been observed in 28 counties including Adams, Buffalo, Columbia, Dunn, Grant, Green, Iowa, Jefferson, Juneau, LaCrosse, Marathon, Marinette, Marquette, Monroe, Oconto, Portage, Richland, Sauk, Shawano, Sheboygan, Taylor, Trempealeau, Walworth, Washington, Waukesha, Waupaca, Waushara, and Wood counties. Infection has been observed on overstory red and white pines, and understory balsam fir, jack/red/white pines, white spruce, red cedar, cherry, oak, and buckthorn. Of those, mortality has been observed on jack/red/white pines, balsam fir, and red cedar.



## Symptoms & Signs:

Crown symptoms typically appear 3-8 years after a thinning. Infected trees will have thin crowns, reduced height, diameter, and shoot growth. "Infection centers" develop as the disease progresses and may contain one to many dead trees surrounded by recently dead or dying trees.

Fading and dead trees may have fruit bodies (spore-producing structures) in the root collar area. These are often so low on the tree they are buried among soil and fallen needles. Young fruit bodies appear in mid summer and look like popcorn. By fall, they are bracket-shaped - reddish brown on the top and white on the lower surface. Fruit bodies are perennial yet undergo partial deterioration each year.



Popcorn stage of *Heterobasidion irregulare* fruit body, typically seen in summer.



*H. irregulare* fruit body in the fall



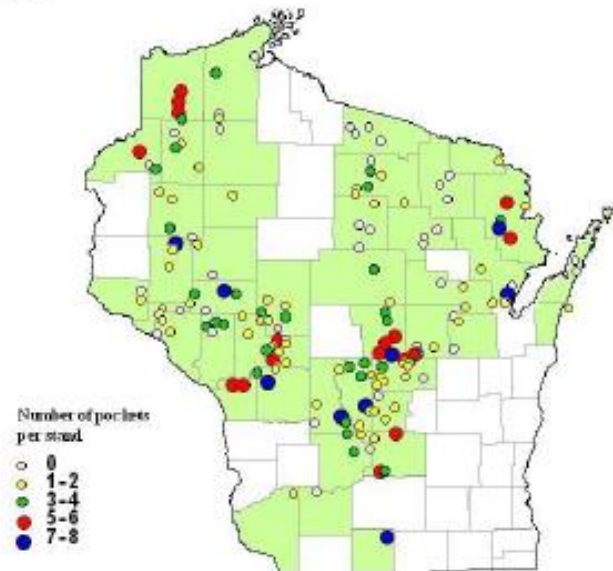
Underside of *H. irregulare* fruit body



# Red Pine Pocket Mortality

**Introduction:** Red pine pocket mortality, caused by a complex of insects and the fungi *Leptographium terrebrantis* and *L. procerum* was first identified in Wisconsin in 1975. National distribution of this syndrome is unknown. Thinned, plantation-grown red pines between the ages of 30-45 are most likely to show symptoms of this syndrome.

**Known Locations:** Red pine pocket mortality was observed in 109 of 157 red pine plantations in a 2002 survey. The number of pockets per plantation varied between 0-8. Red pine is the only species that has shown symptoms of this syndrome.



## Symptoms & Signs:

Pockets typically start small with one to a few dead trees surrounded by trees that have reduced shoot growth and thin crowns. Each year, a few trees on the pocket edge may die and the edge of the pocket expands. Over time, pockets can become quite large; 4-acre pockets have been observed.

Pitch tubes, which are signs of attack by the red turpentine beetle, *Dendroctonus valens*, can be present on the lower bole of trees in the pocket margin. The wood in the vicinity of the pitch tubes and in the root collar area may be stained blue-black. Emergence holes of the pine engraver, *Ips pini*, are often evident on the dead trees within the pockets.



Pitch tubes caused by feeding of the red turpentine beetle, *Dendroctonus valens*



Blue-black discoloration caused by *Leptographium* spp.



Emergence holes caused by the pine engraver beetle, *Ips pini*.



# Annosum Root Rot

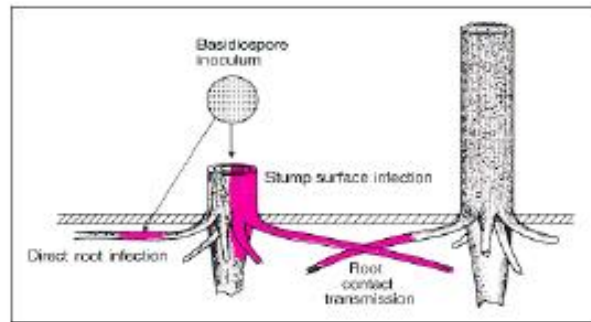
**Biology:** Infection most often occurs when basidiospores, produced by the fruit body, land and germinate on the surface of a freshly cut stump. This infection process creates a strong relationship between annosum root disease and thinned stands.

Basidiospores are most often produced when the temperature is between 41° - 90° F (5° - 32° C). Though most spores are deposited within 90 meters (300 feet), spores can be carried in the wind over many miles.

The fungus colonizes the stump tissue, moves into the root tissue and progresses from tree to tree via root contact at the rate of approximately 3.2- 6.5 feet per year (1-2m/yr). Infection through root and lower stem wounds can also occur. This has been observed in Wisconsin on white pine regeneration in a red pine plantation.

The pathogen degrades both the lignin and the cellulose and causes a stringy yellow decay in the roots and lower stem.

**Impact:** Infected trees will have reduced height, shoot and diameter growth, thin foliage, and eventual mortality. These symptoms typically appear 3-8 years after a thinning. Infection has been observed on overstory red and white pines, and understory balsam fir, jack/red/white pines, red cedar, white spruce, black cherry, oaks, and buckthorn. Of those species, mortality has been observed on jack/red/white pines, balsam fir, and red cedar. The number of infection centers in a stand can vary widely. Infection centers create gaps in the forest canopy where brush and early successional trees can regenerate. Both annosum root rot and red pine pocket mortality can occur in the same stand and even within the same pocket.



Infection occurs through freshly cut stump.  
From: Annosum Root Rot in Eastern Conifers, K. Robbins, 1984. FIDL 76.



Stringy, yellow decay caused by *Heterobasidion*



Infected white pine seedling with several *Heterobasidion annosum* fruit bodies.

**Site Factors/Stand History:** In the southeastern United States, disease development is more common on land formerly used for agriculture and with a pH >6 than on old forest soils. Sandy or sandy loam soils at least 12 inches (30 cm) deep, with good internal drainage and a low seasonal water table are also considered sites favorable for disease development. The influence of site factors on disease progression has not yet been studied in Wisconsin. Annosum root rot is most damaging in plantation-grown conifers where thinnings provide infection courts (fresh stumps) and root grafts provide a pathway for annosum root rot to move from tree to tree.



# Red Pine Pocket Mortality

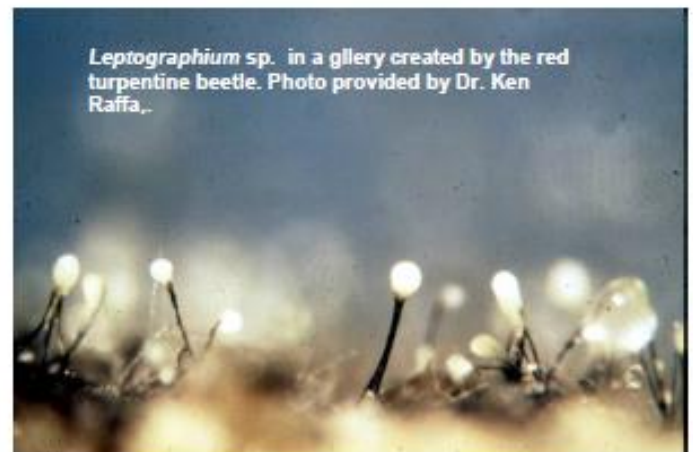
**Biology:** Insect vectors including root collar weevil (*Hylobius radialis*), pales weevil (*H. pales*), red turpentine beetle (*Dendroctonus valens*), pitch-eating weevil (*Pachylobius picivorus*), and *Hylastes porculus*, feed on freshly cut stumps, the lower stem and roots of red pine, transmitting the fungus *Leptographium terebrantis* and *L. procerum* into the lower stem and root system. Once established in the communal root system of a red pine plantation, *Leptographium* spp. spreads to healthy trees via root connections. Trees infected with *Leptographium* are stressed by a decrease in water conduction and a decrease in the production of defensive compounds. These stressed trees continue to attract lower stem feeding beetles, particularly the red turpentine beetles. Bark beetles (*Ips pini* and *I. grandicollis*) are ultimately responsible for tree mortality.

**Impact:** Infected trees will have reduced height and diameter growth. As disease progresses, successful invasion by the pine bark beetles occur. Infestation by the pine bark beetle kills the tree. Red pine pocket mortality has NOT been observed in jack or white pine plantations. White pine regeneration within pockets also appears to be unaffected by this syndrome. The number of infection centers in a stand can vary widely. Infection centers create gaps in the forest canopy where brush and early successional trees can regenerate. Both annosum root rot and red pine pocket mortality can occur in the same stand and even within the same pocket.

**Site Factors/Stand History:** Studies attempting to identify site factors associated with red pine pocket mortality are ongoing. Red pine pocket mortality is a disease of plantation-grown red pine. Red pine pockets are more common in stands that have been thinned than in unthinned stands; root grafts provide a pathway for *Leptographium* to move from tree to tree.



Red Turpentine Beetle, *Dendroctonus valens*. Photo provided by Dr. Ken Raffa.



*Leptographium* sp. in a gallery created by the red turpentine beetle. Photo provided by Dr. Ken Raffa.



White pine regeneration in a red pine pocket.



# Annosum Root Rot

---

## Management:

### 1. If annosum root rot is scattered throughout a stand:

1. Expect tree mortality in pockets and growth loss in trees around the pocket margin.
2. During thinnings or salvage operations, it is recommended that dead trees and the bottom 8 feet of trees that are showing dieback and/or yellowing of the foliage (fader trees) be left on the site to minimize the movement of fruit bodies to uninfected areas of the state.  
Note: Currently, field studies are under way to investigate the frequency of fruit body formation on dead and fader trees that are infected with annosum root rot in southern Wisconsin. Once completed, these studies will provide us with more data to assess the risk of introduction of the disease in a new area through infected wood with fruit bodies.  
The top part of fader trees can be utilized. Minimize felling and skidding wounds.
3. Cutting and burning dead trees and the bottom 8 feet of fader trees on the site will aid in reducing the formation of fruit bodies.
4. Apparently healthy trees outside the pocket, extending  $\frac{1}{2}$  to 1 chain (1 chain = 66 feet) from the perimeter of the last faders may be harvested to utilize the wood before the trees succumb to the disease. At this point, it is believed that the disease spreads approximately 3.5-6.5 feet per year (1-2 m/year), which gives an estimated expansion of  $\frac{1}{2}$  to 1 chain in 10-15 years. This operation will probably not be effective in preventing or delaying the further spread of the disease through root connection.
- 4a. A clear cut of the stand may be considered if the infection is extensive (pockets are coalesced).
5. To limit the formation of new infection centers during thinning, there are two options: 1) Treat all freshly cut stumps with fungicides (see page 9 for information about fungicides). Fungicides will help prevent new infections but will **not stop the movement of annosum root rot through root systems that are already infected.** 2) Provide no treatment to the stumps and expect some additional infection. A native decay fungus, *Phlebiopsis gigantea*, has been known to invade freshly cut stumps and successfully compete against annosum root rot fungus. The percentage of stumps protected naturally by *P. gigantea* is unknown.
6. Start the thinning/harvesting with healthy stands, and then move to infected areas. Cleaning of logging equipment (tires, cutting head, etc) with pressured water prior to leaving the harvest site may be considered to minimize the risk of the spread of annosum root rot to a new location.  
Note: The significance of equipment contamination on the long-distance introduction of this disease is unknown. Spores of the pathogen appear to stay alive in dry soil for one year or longer. Since harvesting equipment inevitably creates wounds on stems and roots, and the fungus could enter through a wound and infect a tree, at this point, washing at least contacting parts of the equipment before entering uninfected areas is believed to be a good cautious approach.
7. After harvest, infected sites may be replanted or naturally regenerated to conifers. In the southeastern United States, regeneration losses have been documented to be a total of approximately 5% with additional disease development following thinnings. This data is not yet available for Wisconsin. Some losses of regeneration are expected for our area as mortality of red and white pine regeneration within annosum pockets has been observed. Some deciduous trees are susceptible but tend to sustain lower mortality; conversion to hardwoods, if appropriate for the site, should be considered.  
Note: Field studies to investigate the survival of regeneration of a variety of native conifer and deciduous tree species are in progress in Wisconsin.

# Red Pine Pocket Mortality

---

## Management options:

The biology of RPPM is not fully understood, and at this point, there is no specific control that is proven to be effective to limit the further spread of this problem. During thinnings, harvesting trees that are showing dieback (fader trees) along the margin of the pocket will help reduce economic losses. Harvesting additional healthy trees along the pocket margin and into the healthy stand will delay the appearance of crown symptoms in the stand. However, it is likely that the dieback and mortality of additional trees will eventually occur. When salvage harvesting is considered, foresters and landowners should choose a practice that would best suit their long-term forest management plan and management objectives. Management options are listed below. Some of the options presented here include practices that have been performed on an experimental basis in a hope of reducing the risk of further spread of the problem, however the effectiveness of these approaches is unknown.

### I. Harvesting options

a) Leave the pocket as a natural opening.

b) Cut dead trees and trees that are showing dieback and/or yellowing of the foliage (fader trees) within and adjacent to the pocket.

This practice will not only capture wood value prior to tree mortality, but help reduce the population build-up of bark beetles in the stand. Bark beetle population increases dramatically during dry summers especially when breeding materials are left on site. Breeding material includes recently cut or killed trees, stressed trees, or logging slash greater than two inches in diameter. If cutting is conducted from March through August, it is recommended that logs and large slash be removed from the site within 3 weeks.

c) Cut dead trees and trees that are showing dieback and/or yellowing of the foliage (fader trees), and also cut a buffer area around the pocket.

Apparently healthy trees outside the pocket, extending ½ to 1 chain (1 chain = 66 feet) from the perimeter of the last fader trees may be harvested to utilize the wood before the trees succumb to the disease. A pocket created by RPPM often expands over time. Based on field observations in Central Wisconsin, it is estimated that a pocket expands approximately ½ chain in 5-7 years, and at least 1 chain in 10-15 years. A clearcut buffer area of ½ chain or 1 chain from the perimeter of the pocket can be created for a pre-salvage purpose. It is unlikely that creating a buffer area around the pocket margin will stop or delay the spread of a pocket created by RPPM. The distance that needs to be clearcut would be adjusted depending on when the next entry is planned and what your land use objectives are. For example, if the next entry isn't planned until 15-20 years later, a larger clearcut buffer area may be preferred to capture wood value. On the contrary, if a landowner's primary land use goal is wildlife habitat or visual quality, clearcutting a buffer area may not be a preferred option or clearcutting a smaller buffer area may be a more attractive option.

Cutting fader trees will not only capture wood value prior to tree mortality, but help reduce the population build-up of bark beetles in the stand. Bark beetle population increases dramatically during dry summers especially when breeding materials are left on site. Breeding material includes recently cut or killed trees, stressed trees, or logging slash greater than two inches in diameter. If cutting is conducted from March through August, it is recommended that logs and large slash be removed from the site within 3 weeks.



# Annosum Root Rot

---

## Management (Continued from page 5):

### II. If annosum root rot is rare in a stand (one center) or if centers are widely spaced with large (>40a) blocks of healthy conifers in-between centers:

1. During thinnings or salvage operations, it is recommended that dead trees and the bottom 8 feet of trees that are showing dieback and/or yellowing of the foliage (fader trees) be left on the site to minimize the movement of fruit bodies off site to uninfected areas of the state.  
Note: Currently, field studies are under way to investigate the frequency of fruit body formation on dead trees and fader trees that are infected with annosum root rot in southern Wisconsin. Once completed, these studies will provide us with more data to assess the risk of infected wood on the further spread of the disease.  
The top part of fader trees can be utilized. Minimize felling and skidding wounds.
2. Cutting and burning dead trees and the bottom 8 feet of fader trees on the site will aid in reducing the formation of fruit bodies.
3. Apparently healthy trees outside the pocket, extending  $\frac{1}{2}$  to 1 chain (1 chain = 66 feet) from the perimeter of the last faders may be harvested to utilize the wood before the trees succumb to the disease. At this point, it is believed that the disease spreads approximately 3.2-6.5 feet per year (1-2 m/year), which gives an estimated expansion of  $\frac{1}{2}$  to 1 chain in 10-15 years. This operation will probably not be effective in preventing or delaying the further spread of the disease through root connection.
4. To limit the formation of new infection centers during thinning, it is recommended that all freshly cut stumps be treated with fungicides (see page 9 for information about fungicides). Fungicides will help prevent new infections but will **not stop the movement of annosum root rot through root systems that are already infected.**
5. Start the thinning/harvesting with healthy stands, and then move to infected areas. Cleaning of logging equipment (tires, cutting head, etc) with pressured water prior to leaving the harvest site may be considered to minimize the risk of the spread of annosum root rot to a new location.  
Note: The significance of equipment contamination on the long-distance introduction of this disease is unknown. Spores of the pathogen appear to stay alive in dry soil for one year or longer. Since harvesting equipment inevitably creates wounds on stems and roots, and the fungus could enter through a wound and infect a tree, at this point, washing at least contacting parts of the equipment before entering uninfected areas is believed to be a good cautious approach.
6. After harvest, the site may be planted or naturally regenerated to conifers. In the southeastern United States, regeneration losses have been documented to be a total of approximately 5% with additional disease development following thinnings. Regeneration data are not yet available for Wisconsin. Some losses of regeneration are expected for our area as mortality of red and white pine regeneration within pockets caused by annosum root rot has been observed. Some deciduous trees are susceptible but tend to sustain lower mortality; conversion to hardwoods, if appropriate for the site, should be considered.  
Note: Field studies to investigate the survival of regeneration of a variety of native conifer and deciduous tree species are in progress in Wisconsin.



# Red Pine Pocket Mortality

## Management options (Experimental) (Continued from page 6):

### I. Harvesting options (Continued)

Caution: The following two options (options d and e) are at this point highly experimental. The effectiveness of the following practices has not been proven. Furthermore, there are some scientific articles that point out some negative effects of these practices. Details of the negative effects by pursuing the following practices are explained below. Discussions with a forester and/or a forest health specialist would be recommended before these practices are pursued.

- d) Cut dead trees and trees that are showing dieback and/or yellowing of the foliage (fader trees), cut a buffer area around the pocket, and create root graft barriers around the buffer area by severing the root system. Apparently healthy trees outside the pocket, extending  $\frac{1}{2}$  to 1 chain (1 chain = 66 feet) from the perimeter of the last fader trees may be harvested to utilize the wood before the trees succumb to the disease. A pocket created by RPPM often expands over time. Based on field observations in Central Wisconsin, it is estimated that a pocket expands approximately  $\frac{1}{2}$  chain in 5-7 years and at least 1 chain in 10-15 years. A clearcut buffer area of  $\frac{1}{2}$  chain or 1 chain from the perimeter of the pocket can be created for a pre-salvage purpose. Root severing is conducted using a trencher (ditch witch) or a vibratory plow. A large-scale field study to evaluate the effectiveness of root severing on the control of RPPM was conducted in Wisconsin as a cooperative project between the University of Wisconsin, Department of Entomology and the Wisconsin Department of Natural Resources, and field data collection was completed. The analysis of the data is in progress.

Note: This practice will inevitably create wounds on roots and may provide additional entry courts for annosum root rot if the fungus exists in the site. Thus it is not recommended in or near a stand where annosum root rot is suspected.

Cutting fader trees will help reduce the population build-up of bark beetles in the stand. Bark beetle population increases dramatically during dry summers especially when breeding materials are left on site. Breeding material includes recently cut or killed trees, stressed trees, or logging slash greater than two inches in diameter. If cutting is conducted from March through August, it is recommended that logs and large slash be removed from the site within 3 weeks of cutting.



Roots are severed using a trencher



Right after the site is trenched.



# Heterobasidion Root Disease

## Management (Continued from page 7):

### III. If Heterobasidion root disease is not present in the stand:

Once the disease exists in a stand, it is very difficult to control it. **Prevention of this disease is the best approach.** If you are planning a thinning, consider treating freshly cut stumps with fungicides. Stumps must be treated as soon as possible after cutting and no later than one day after cutting. Fungicides will help prevent new infections, but will not stop the growth of the pathogen if the stump is already infected. There are factors that influence the risk of infection by Heterobasidion root disease. A risk-based fungicide treatment guide is available for landowners and property managers in Wisconsin to determine whether fungicide treatment is warranted in a particular stand. For more information about the guide, visit <http://dnr.wi.gov/> key word "annosum".

Currently the only products that are available in Wisconsin to prevent Heterobasidion root disease are Cellu-Treat (disodium octaborate tetrahydrate) and biological fungicide, Rotstop-C. They are water-soluble and can be applied using a backpack sprayer or an attachment to a harvester.

#### Where to purchase fungicides

**Cellu-Treat:** available in 25-lb bucket or 50-lb bag from Nisus Corporation. As of November 2018, the cost for a 25-lb bucket is \$92.70 plus shipping.

Nisus Corporation - Phone: 1-800-264-0870 Website: [www.nisuscorp.com](http://www.nisuscorp.com)

#### Cellu-Treat Local Distributor:

Crop Production Services, Plainfield

Phone: 715-335-4900

Servco FS, Antigo

Phone: 715-627-4844; 800-807-9900

**Rotstop C:** available in two package sizes – 0.13 oz. package (1 gallon) and 0.67 oz. package (5 gallons)

As of November 2018, the cost for a 0.13 oz. package is \$1.89 and \$9.45 for a 0.67 oz. package.

Contact: [order@bioforest.ca](mailto:order@bioforest.ca), 1-888-236-7378



Cellu-Treat application using a backpack sprayer



A perforated sawbar. Liquid fungicide is sprayed through small holes at the time of felling



# Red Pine Pocket Mortality

---

## Management options (Experimental) (Continued from page 8):

### I. Harvesting options (Continued)

- e) Cut dead trees and trees that are showing dieback and/or yellowing of the foliage (fader trees), cut a buffer area around the pocket as described above, and treat the stumps with a herbicide, such as Garlon 4 (Triclopyr), Tahoe 4E (Triclopyr)<sup>1</sup> or other products that are labeled for cut surface applications.

Apparently healthy trees outside the pocket, extending ½ to 1 chain from the perimeter of the last faders may be harvested to utilize the wood before the trees succumb to the disease. A pocket created by RPPM often expands over time. Based on field observations in Central Wisconsin, it is estimated that a pocket expands approximately ½ chain in 5-7 years, and at least 1 chain in 10-15 years. A clearcut buffer area of ½ chain or 1 chain (1 chain = 66 feet) from the perimeter of the pocket can be created for a pre-salvage purpose. Herbicide treatment of the stumps may promote root death and discourage the spread of the fungus, *Leptographium* spp. The effectiveness of this treatment on the control of RPPM is unknown.

Note: There are some reports that the use of herbicides may increase the risk of introduction and spread of Heterobasidion root disease. This treatment may compromise the management of Heterobasidion root disease, thus it is not recommended in or near a stand where Heterobasidion root disease is suspected.

Cutting fader trees will help reduce the population build-up of bark beetles in the stand. Bark beetle population increases dramatically during dry summers especially when breeding materials are left on site. Breeding material includes recently cut or killed trees, stressed trees, or logging slash greater than two inches in diameter. If cutting is conducted from March through August, it is recommended that logs and large slash be removed from the site within 3 weeks.

- II. Although rarely practical, removing freshly cut stumps will reduce feeding sites for the root collar weevil and the red turpentine beetle. These beetles are considered to be vectors that transmit the root disease.

#### Relationship to Thinning:

Red pine pockets are more common in thinned stands than in unthinned stands. The increased activity of the insects known to vector *Leptographium* spp. and/or the change in microclimate following a thinning, are likely related to the initiation of this syndrome in thinned stands.

Thinning is a necessary management tool used to maintain healthy and vigorous red pine plantations. Overstocked or very dense stands of red pine are more susceptible to attack by bark beetles. Thus, **continue to thin red pine plantations as planned by a professional forester.**

#### Relationship to Mixed Plantings:

RPPM has only been observed affecting red pine. Observations of stands where rows of white pine were mixed with rows of red pine have shown that pocket mortality is limited to red pine, even when growing in close proximity to white pine and other tree species. Consult with a professional forester regarding your options for mixed plantings.

---

<sup>1</sup>You are responsible for using chemicals according to the manufacture's current label directions. Not following label directions is a violation of the federal law. Follow directions exactly to protect the environment and people from chemical exposure.

Reference to a particular product is provided for the reader's information and is not an endorsement of one product over other similar products.



# References

---

- Alexander, S.A., and R.L. Anderson. 1985. How to identify and control annosum root rot in the south. U.S. Department of Agriculture Forest Service, Southern Region, Forestry Bulletin R8-FB/P 19.
- Driver, C.H., and J.H. Ginns, Jr. 1964. Annosus root rot in young southern pine planted on an infested site. Plant Disease Reporter 48: 803-807.
- Klepzig, K., K. Raffa, and E. Smalley. 1991. Association of an insect-fungal complex with red pine decline in Wisconsin. Forest Science, Vol. 37, No. 4: 1119-1139.
- Myren, D.T. 1981. Use of borax and sodium nitrite in an operational thinning of red pine in Ontario to prevent stump infection by *Fomes annosus*. Department of the Environment, Canadian Forestry Service, Great Lakes Forest Research Centre. The Forestry Chronicle, 284-285.
- Robbins, K. 1986. Annosum Root Rot in Eastern Conifers. U.S. Department of Agriculture Forest Service, North Central Region, FIDL No. 76.
- Sinclair, W., H. Lyon, and W. Johnson. 1987. Diseases of trees and shrubs. Comstock Publishers, Cornell University Press. Ithaca, NY. 574 p.
- Woodward, S., H. Stenlid, R. Karjalainen, and A. Huttermann. 1998. *Heterobasidion annosum*, biology, ecology, impact and control. CAB International, University Press, Cambridge, UK.

Aerial survey services provided by the Wisconsin DNR , Aeronautics Services within the Division of Administration and Technology.  
All photos taken by DNR Forest Health Protection Staff unless otherwise indicated.

To order a copy of this publication, contact your DNR zonal forest health specialist or Kyoko Scanlon  
DNR zonal forest health specialist directory – [dnr.wi.gov](http://dnr.wi.gov) (Keyword: Forest Health Staff)