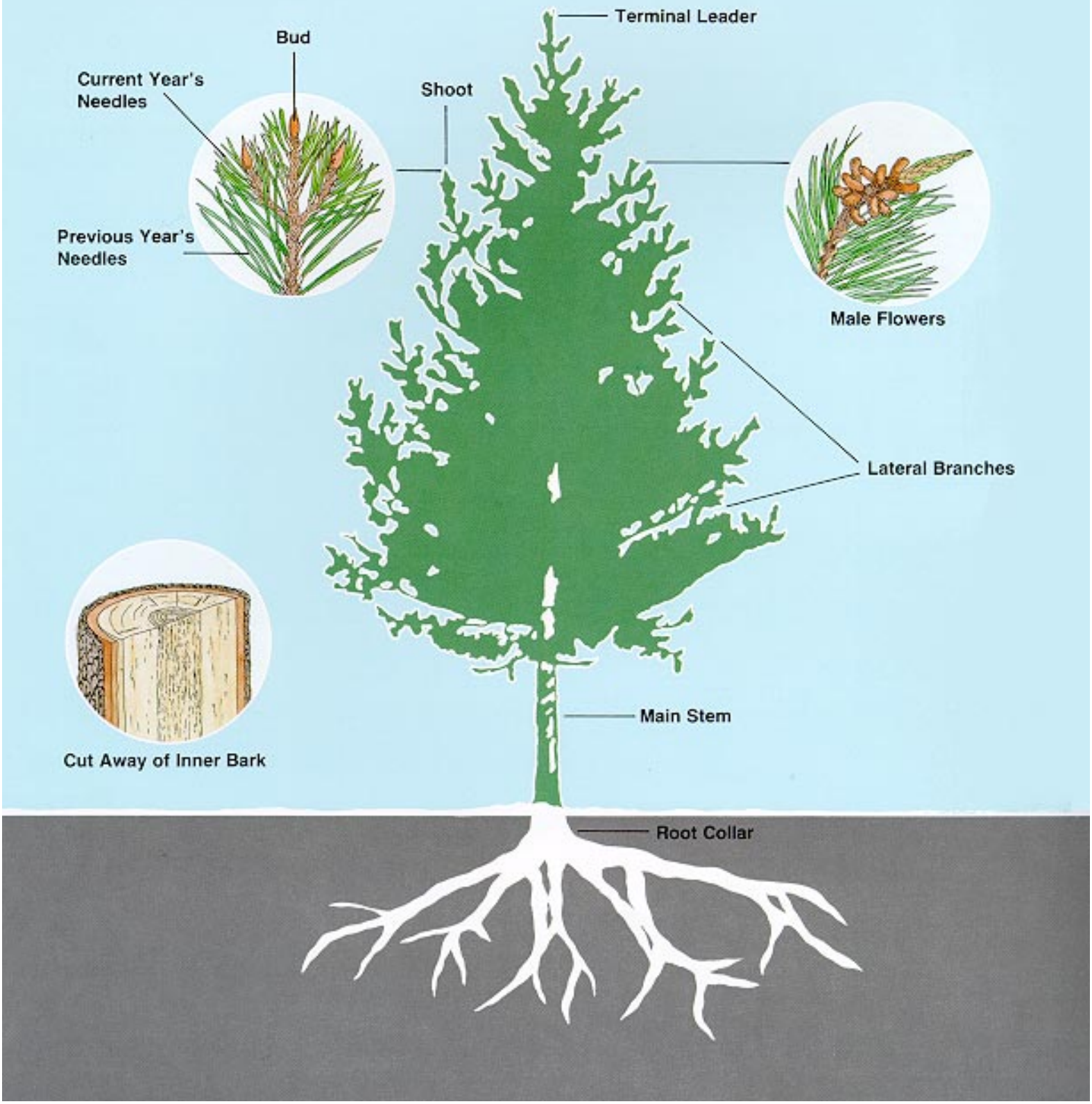
G3428

WISCONSIN WOODLANDS:

Identifying and Managing Pine Pests in Wisconsin

Heather A. Goulding, David J. Hall, Kenneth F. Raffa and A. Jeff Martin

PARTS OF A PINE TREE



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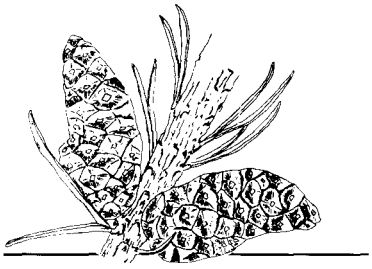
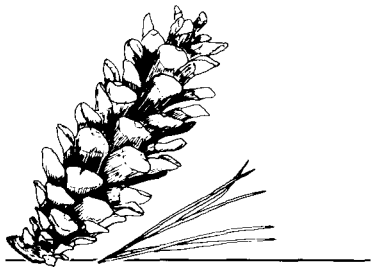
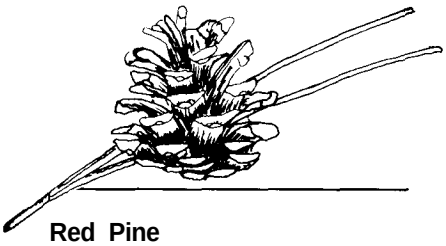
INTRODUCTION



Jack Pine
Needles 3/4 to 1 1/4 inches long
Two needles per bundle



White Pine
Needles 3 to 5 inches long
Five needles per bundle



Red Pine
Needles 5 to 6 inches long
Two needles per bundle

Most private woodland owners have an interest in growing and maintaining a healthy forest. Unfortunately, when dealing with insect and disease pests, they often are faced with a large volume of conflicting information from many sources. This manual provides a single source of practical information for private landowners and professional foresters who need to diagnose and manage pine pests in Wisconsin.

We make no specific pesticide recommendations in this manual. New pesticides enter the market frequently, and others are removed with short notice. Recommendations can also change suddenly as new information becomes available. For specific pesticide recommendations and for pest management information not contained in this manual, contact your local Department of Natural Resources forester, your local DNR pest management specialist, or your county Extension agents.

How to Use this Manual

Before trying to diagnose a pest problem, a first-time user of this manual should read the complete introduction, become familiar with the diagrams inside the front cover and on pages 24 and 25, and glance through the glossary. After you've become familiar with the manual, follow the simple three-step process outlined below.

1. Compare your trees' symptoms with the Signs and Symptoms diagram on pages 24 and 25.
2. Identify the pest by consulting descriptions of each pest listed under your trees' symptoms.
3. Develop a pest management strategy based on the information in the text about your particular pest problem. Choose control alternatives to combat existing pest problems and preventive options to reduce the risk of future problems.

Explanation of Pest Descriptions

Pest's name

Host trees: Tree species and sizes that the pest attacks.

Signs and symptoms: Symptoms that the pest causes and the times of the year that you can expect to find them.

Pests that cause similar symptoms: Other pests that may be causing your problem.

Hazardous conditions: Conditions in which the pest is most likely to occur. In some cases hazard zone or distribution zone maps identify specific areas in Wisconsin which are most likely to host the pest.

Biology: The pest's life cycle.

Loss or damage: Type of damage the pest causes.

Control alternatives: Management options to treat an existing pest problem. Treatment alternatives range from no treatment to very intensive management. Choose one or several of the treatment alternatives. You may choose a passive alternative now and choose a more active alternative later if the pest problem grows. Make your decisions based on the criteria described in the section titled *How to Develop an Integrated Pest Management Strategy.*

Prevention in current and/or future stands: Preventive management options to avoid problems with the pest. Options may be offered for current and/or future stands.

References: Sources of more written information on the pest. Full reference citations are listed at the back of the manual.

How to Develop an Integrated Pest Management Strategy

You own your forest land for one or more reasons: for recreational use, for wildlife production, for timber sales, for increased land values, or for other personal purposes. These reasons establish your objectives for owning your woodland.

You can fulfill these objectives with wise forest management. Planting, thinning and harvesting are all aspects of forest management. Pest control is also an important part of managing your property. Integrated Pest Management (IPM) is a process of evaluating your ownership objectives and your forest's conditions to produce a pest management strategy that is tailored to your needs.

When you encounter a pest problem your first goal is to establish a pest damage "threshold level." A threshold level is the maximum amount of damage you will accept before using pest control.

Consider the following factors when you establish a threshold level:

1. Your ownership objectives.
2. The type of pest and its potential to do damage.
3. The value and condition of your stand.
4. The cost of pest damage versus the cost of pest control.
5. The environmental impact of pest damage and control.

Once you have established a threshold level, determine whether or not pest control is necessary. If you don't expect pest damage to exceed the threshold level, no control is necessary. If the damage or the expected damage exceeds the threshold level, then chose one or more pest control alternatives to reduce the damage to an acceptable level.

IPM involves both long-term and short-term management practices. Long-term pest management prevents or reduces the risk of pest damage in the future, both for current and future stands. Short-term pest management tackles the problem of existing pest problems.

Long-term management practices that reduce pest damage risk:

- Plant the tree species that will be the most successful on your site and time your planting to avoid some pests such as white grubs. Each tree species grows best under specific soil and landscape condition. Furthermore, some sites provide an ideal environment for specific pests. Don't plant susceptible pine species on these sites.
- Promote early crown closure by planting 800 or more trees per acre and protecting seedlings from weed competition and rodent damage. Closed stands are far less susceptible to many pests than open stands.
- Thin and harvest your stand wisely. Maintaining a proper stocking level is important health care for your trees. And healthy trees are more resistant to pests than weak trees.

Short-term pest control alternatives for existing pest problems:

- No control. Accept pest damage if you don't expect it to exceed the threshold level.
- Mechanical control. Physically remove the pest. Mechanical control alternatives range from picking insects off trees to removing alternate hosts to cutting down heavily infested or infected trees.
- Biological control. Allow a pest's natural enemies (parasites, predators, and diseases) to control the pest. Bacterial sprays and viruses are available to control some pests. Most importantly, avoid killing the organisms that naturally control pest problems.
- Chemical control. Apply a chemical pesticide when other control methods cannot reduce pest damage to an acceptable level. The cost of spraying may be impractical when you consider the value of the stand and the pesticide's environmental impact. In addition, pesticides often kill your pest's natural enemies.

This manual provides information about several pine pests and offers management options for each pest. Your integrated pest management strategy depends on your personal judgement and your management needs.

FOLIAGE PESTS

Redheaded Pine Sawfly

Host trees: Red pine and jack pine trees (2 to 20 feet tall)

Signs and symptoms:

Mid-June to mid-July
Rows of up to 35 eggs in slits in needles *(see photo 1).*

July to August
Twigs with dead, straw-like needles *(see photo 2)* and colonies of up to 100 individual larvae. Larvae are yellow-green with rows of black spots, and have red heads *(see photo 3).* Young larvae eat edges of old needles and leave needles' central spines which turn yellow. Older larvae (about 1 inch long) eat whole needles. Also look for completely stripped branches. Larvae prefer previous years' needles; however, they will move to current year's needles after they have eaten all the old needles.

Pests that causes similar symptoms: Red pine sawfly/European pine sawfly *(page 8),* and introduced pine sawfly *(page 7)* on red pine. Pine tussock moth *(page 11)* on jack pine.

Hazardous conditions: Disturbed or eroded soil and soil less than 3 inches deep increase red pine's vulnerability to the redheaded pine sawfly. Red pine stands that are adjacent to northern hardwood stands, especially sugar maple, have an increased chance of infestation. Heavy competition from grass, bracken fern or sweetfern reduces red pine's resistance to the sawfly. Open stands are more susceptible to the redheaded pine sawfly than closed stands. Poor tree survival after planting may produce open stands.

Biology: Fly-like adults emerge in late May in southern Wisconsin to late June in northern Wisconsin. Females lay between 100 and 140 eggs soon after emerging. Larvae hatch from eggs between late June and mid-July and feed on old and then new needles.

1. Rows of sawfly eggs in slits in needles.

2. Straw-like needles left by young sawfly larvae.

FOLIAGE PESTS

Colonies of larvae defoliate whole branches and whole trees during their 5 to 6-week feeding period. The larvae then drop to the ground and spin cocoons in which they overwinter.

Loss or damage: Redheaded pine sawflies periodically defoliate saplings. One heavy defoliation can kill tree tops. When the main stem shoot dies, side branches compete to become the new terminal leader. This process often deforms a straight trunk. Severe defoliation may kill trees.

Control alternatives:

- Accept defoliation and monitor stands for increasing levels of infestation.
- If infestation is light (one or two colonies per tree on 50 or fewer trees), shake or hand pick larvae off trees and destroy them.
- Selectively spot spray infested trees with a chemical insecticide before population develops into a major infestation.
- Wait until a full-blown outbreak develops and then broadcast spray a registered insecticide.

Prevention in future plantations: Avoid planting red pine on disturbed, eroded or shallow soil. Plant red pines at least 50 feet from northern hardwood stands, especially sugar maple. Control weed and grass competition by mowing, tilling or applying an herbicide. Promote early canopy closure by planting 800 or more trees per acre or increasing the survival rate of seedlings and saplings by controlling weed competition and rodent injuries. If survival of initial planting is poor, replace dead trees or replant entire stand if necessary.

References: DNR (1985), Martineau (1984), Rose and Lindquist (1973), USDA (1983).

3. Redheaded pine sawfly larvae.

4. Introduced pine sawfly larva.

Introduced Pine Sawfly

Host trees: White pine and red pine (all sizes)

Signs and symptoms: The introduced pine sawfly's two generations overlap a great deal. You find all stages of the sawfly's life cycle throughout most of the summer.

Mid-May to mid-June
Small pale blue or blue-green eggs in slits in needles. Introduced pine sawfly eggs have a jelly-like coating that distinguishes them from other sawfly eggs.

Late May to early July
Patches of defoliation or sparse needles on branches. Young larvae feed in colonies on previous year's needles; older larvae disperse and feed alone. Therefore, defoliation from this sawfly is often more diffuse than from others. The 1-inch-long larvae have black heads and black bodies with yellow and white spots and two black stripes down their backs *(see photo 4).*

July and August
Brown, 1/4-inch-long cocoons on needles and in ground litter.

August
Second-generation eggs and larvae.

August to September
Second-generation larvae feed on both old and new needles. This generation overwinters in cocoons that are either attached to needles or drop to the ground.

Pests that cause similar symptoms: Red pine sawfly/European pine sawfly *(page 8)* and redheaded pine sawfly *(page 5)* on red pine. White pine sawfly *(page 10)* on white pine.

Hazardous conditions: Open stands are particularly vulnerable to this sawfly. Red pines that are near infested white pines are vulnerable to introduced pine sawfly infestation.

Biology: The first generation adults emerge from their cocoons in late April through June. Females lay eggs in May and June. Larvae hatch in June and July and feed in colonies on the previous year's needles. Older larvae disperse and feed by themselves. The first generation larvae spin cocoons in August; they emerge as second-generation adults. Second-generation eggs and young larvae are present in August, and by late September these larvae spin cocoons in which they overwinter.

Loss or damage: The introduced pine sawfly larvae defoliate white pines during the summer and decrease trees' normal growth. Severe defoliation can kill trees. Occasional heavy outbreaks in white pine frequently lead to the insects defoliating red pines. Severe defoliation of red pines is rare.

Control alternatives:

- Accept some growth loss and the death of some trees.
- Spray larvae with insecticide if defoliation is severe.
- Red pines rarely need to be treated.

Prevention in future plantations: Promote early canopy closure by planting 800 or more trees per acre and increasing survival rate of seedlings and saplings by controlling weed competition and rodent injuries. If survival of the initial planting is poor, replace dead trees or replant the entire stand if necessary.

References: DNR (1985), Wilson (1977), USDA (1983).

Red Pine Sawfly/European Pine Sawfly

Host trees: Red pine (2 to 20 feet tall)

Signs and symptoms:

May to June
Twigs with clusters of dead, straw-like needles and colonies of 80 to 100 green-striped, one-inch-long larvae *(see photo 5).* Young larvae eat the edges of previous year's needles and leave needles' central spines which turn yellow *(see photo 2, page 6).* Larvae feed only on previous year's needles.

One- to 2-inch needle stubs, empty needle sheaths (brown, paper-like tissue at the base of needles), or entirely stripped branches. The eating habits of older larvae of these two sawflies distinguishes them from one another; red pine sawflies leave inch-long needle stubs while European pine sawflies eat entire needles.

September to April
Rows of yellow eggs in slits in needles *(see photo 1, page 5).* The adult female cuts slits in needles to lay rows of about eight eggs.

Pest that cause similar symptoms: Redheaded pine sawfly *(page* 5) and introduced pine sawfly *(page 7).*

Hazardous conditions: Open stands suffer worse outbreaks than closed stands. These sawflies sometimes kill overmature and insect-weakened trees.

Biology: Larvae hatch from eggs in mid-April to early May. Larvae cause the most damage when they feed on old needles in the spring. Colonies defoliate whole branches. After they have stripped an entire tree, colonies move onto another one. Full-grown larvae drop to the ground and spin cocoons in which they pupate. Adults emerge in September. Soon after emerging, females lay their eggs.

Loss or damage: Occasionally, the red pine sawfly and European pine sawfly larvae defoliate saplings during the spring months. Larvae feed early in the season, before new needles develop. Therefore, current year's needles develop normally, leaving the

tree with some, though sparse, foliage. Trees may outgrow the damage and regain their full foliage within 2 or 3 years after feeding ceases. Heavy attacks for several years can decrease annual height and trunk diameter growth by up to 80 percent. Weak, defoliated trees are susceptible to infestation by other insects and diseases. These sawflies rarely kill healthy trees.

Control alternatives:

- Accept defoliation and growth loss.
- If infestation is light (one or two colonies per tree on 50 or fewer trees), shake or hand pick the larvae off trees and destroy them.
- Selectively spray individual infested trees with a chemical insecticide before the population grows into a major infestation.
- Apply a commercial virus insecticide to young European pine sawfly larvae. This treatment is not effective against red pine sawfly.
- Broadcast spray a registered insecticide on all trees.

Prevention in future plantations: Promote early canopy closure by planting 800 or more trees per acre or increasing survival rate of seedlings and saplings by controlling weed competition and rodent injuries. If survival of the initial planting is poor, replace dead trees or replant the entire stand if necessary.

References: DNR (1985), Mahr and Hall (1982), USDA (1983).

5. European pine sawfly larvae.

White Pine Sawfly

Host trees: White pine (2 to 20 feet tall)

Signs and symptoms:

Mid-June to late July
Twigs with clusters of dead straw-like needles *(see photo 2, page 6)* and colonies of pale yellow or white larvae with rows of black spots. Young larvae eat the edges of needles, leaving only the needles' central spines which turn yellow. Older larvae (about 1-inch long) will eat whole needles, first the previous year's and then the current year's.

Mid-August to late September
Second generation larvae hatch with the same appearance and behavior as the first generation.

Pests that cause similar symptoms: Introduced pine sawfly *(page 7).*

Hazardous conditions: Nearly all of Wisconsin's white pine sawfly infestations occur in the southern third of the state. Open stands seem to be more susceptible to white pine sawfly than closed stands.

Biology: Fly-like adults emerge in late May in southern Wisconsin to late June in northern Wisconsin. Females lay between 100 and 140 eggs soon after emerging. Larvae hatch from eggs between late June and mid-July and feed on old and then new needles. Colonies of larvae defoliate whole branches and whole trees during their 5- to 6-week feeding period. The larvae then fall to the ground and spin cocoons in which they overwinter.

Loss or damage: The white pine sawfly causes occasional summer defoliation. Defoliation slows tree growth; severe attacks can kill seedlings and saplings.

Control alternatives:

- Accept some growth loss and the death of some trees.
- If infestation is light (one or two colonies per tree on 50 or fewer trees), shake or hand pick larvae off trees and destroy them.
- Selectively spray individual infested trees with a chemical insecticide before population grows into a major infestation.
- Broadcast spray trees with a registered insecticide.

Prevention in future plantations: Promote early canopy closure by planting 800 or more trees per acre or increasing survival rate of seedlings and saplings by controlling weed competition and rodent injuries. If survival of the initial planting is poor, replace dead trees or replant the entire stand if necessary.

References: DNR (1985), Wilson (1977).

6. Pine tussock moth larva.

Pine Tussock Moth

Host trees: Jack pine and red pine (all sizes). Tussock moths prefer jack pine. During heavy infestations, the moth will also attack red pine stands that are adjacent to infested jack pine stands.

Signs and symptoms:

May
Hairy, 1- to 1 1/2-inch-long caterpillars with four distinct tufts of gray hair on their backs *(see photo 6).* Caterpillars eat previous year's and then current year's needles. The colorful caterpillars leave uneven needle stumps or completely stripped branches. Heavy infestations can completely defoliate and kill trees.

June
Gray-brown cocoons on needles, usually on the underside of twigs.

Late July to early August
White eggs on needles. Female pine tussock moths lay eggs in clusters of two or three rows. Each cluster usually has about 25 eggs.

Pests that cause similar symptoms: Redheaded pine sawfly *(page* 5) and red pine sawfly/European pine sawfly *(page 8)* on red pine. Introduced pine sawfly *(page* 7) on white pine.

Hazardous conditions: Within the hazard zone outbreaks occur every 12 to 15 years. Outside the hazard zone outbreaks are rare. Areas where jackpine covers 40% or more of a township-sized area are very vulnerable to this moth. Jack pine in blocks of 600 or more acres may support a tussock moth population that can damage nearby red pine. Blocks of red pine are not usually very vulnerable to the pine tussock moth.

Biology: Adult moths emerge from cocoons and lay eggs in late summer. Young larvae hatch in late August and feed on their egg shells and the current year's needles. The young larvae crawl under bark scales where they overwinter. Larvae feed again the following year between May and July. Larvae cause the most damage during the second year's feeding. In late July, the larvae spin cocoons and pupate for 10 to 14 days.

Loss or damage: Periodic outbreaks of the pine tussock moth cause spring and early summer defoliation. One heavy defoliation can kill a fourth of the trees and kill the tops of another half the trees in a stand. Larvae can completely defoliate and kill pockets of trees within a stand. Two successive years of heavy attacks can often destroy a whole stand. Major outbreaks have begun in pockets of less than 1,000 acres and spread to 40,000 to 60,000 acres within 2 years.

The pine tussock moth hazard zone in Wisconsin

Control alternatives:

- Accept some defoliation and monitor stand for unacceptable levels of damage.
- Treat small, first-year infestations with insecticide to prevent outbreaks from growing

- In jack pine, broadcast spray stands threatened with severe defoliation with a chemical or biological insecticide. Harvest heavily defoliated stands if possible. Clearcut jack pine stands.
- In red pine, remove adjacent infested jack pine stands. Broadcast spray stand with a bacterial or chemical insecticide during spring.

Prevention in current stands: Break up large stands of jack pine by converting to red pine; reduce jack pine to 30% or less of township's vegetation. If site index is 55 or less, harvest trees at age 40 to 45. If site index is 60 or more, harvest when stand age equals site index value minus five.

Prevention in future stands: Avoid establishing jack pine in townships where the ground cover is greater than 40% jack pine. Be aware that others may plant jack pine in the future and increase tussock moth risk. Do not plant stands of jack pine larger than one square mile.

References: DNR (1985), Rose and Lindquist (1973), Sreenivasam et al. (1972), USDA (1983), Wilson (1977).

7. Jack pine budworm larva

Jack Pine Budworm

Host trees: Jack pine (20 years and older); Red pine (all ages). Jack pine is the budworm's preferred host. During heavy infestations, the budworm will also attack red pine stands next to infested jack pine stands.

Signs and symptoms:

May to July
Brown, one-inch-long larvae feeding on needles *(see photo 7).* Shoots may be covered with silk webbing. Mature larvae have distinct rows of white spots on their sides.

Late June to mid-July
Orange-red cast to foliage caused by dead needles hanging on branches.

June to November
Defoliated shoots *(see photo 8)* with partially eaten, reddish-brown needles clinging to silk webbing. Defoliation is usually heaviest in tree tops and at the tips of branches. Budworms defoliate entire trees during heavy infestations.

Mid-June to late July
Brown pupae or pupal skins in webbing.

August
Pale-green eggs on upper-branch needles. Adult female lays eggs in two or three rows that overlap like fish scales.

8. Defoliated jack pine shoots with partially eaten needles clinging to silk webbing.

9. Jack pine staminate cones.

Hazardous conditions: Stands with an abundance of male flowers (see photo 9) may initiate outbreaks. Weak, suppressed and overmature trees and trees in open stands often have an abundance of male flowers. Large areas of trees that are all the same age are vulnerable to severe damage and loss from budworm attacks. Trees on the edge of a stand are very susceptible to attack. Edge trees normally maintain a large budworm population once the stand is infested. Stands planted or cut in shapes with large edge areas may initiate infestations.

Biology: Young larvae overwinter under bark scales. They emerge in May and feed on male flowers and new needles. The larvae continue to feed for about 6 weeks, eating needles and spinning silk webs around shoots, The larvae pupate in webs in late June to mid-July. Moths emerge in about a week and lay eggs in the upper branches of trees. Young larvae hatch and, without feeding, immediately move to bark scales where they overwinter.

Loss or damage: Light infestations reduce trees' yearly growth. The jack pine budworm periodically causes spring and early summer defoliation. One heavy infestation can kill 5% of the trees, and kill the tops of another 10 to 15% of the trees in a stand. Two years of heavy defoliation can kill 20 to 25% of a stand and kill the tops of another 45 to 50% of the trees in a stand.

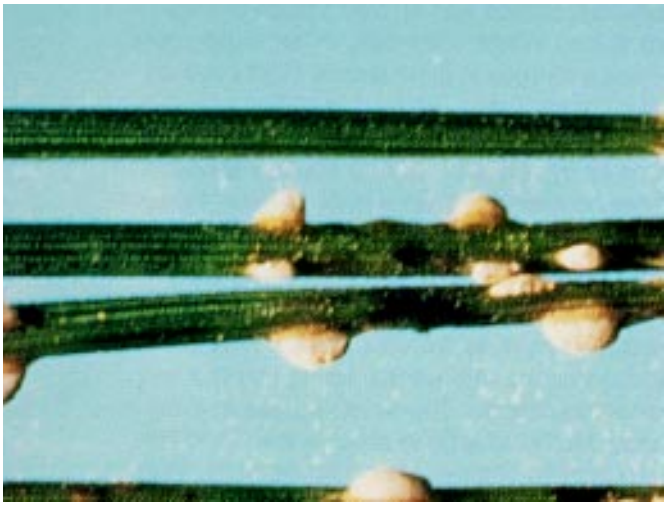
Control alternatives:

- Accept some loss and monitor stand for budworm population build-up.
- Cut stands in shapes that minimize the stands' edge areas.
- Harvest heavily defoliated stands if possible; clearcut jack pine stands.
- Aerial insecticide applications are seldom practical.

Prevention in current stands: Maintain stocking at 70 to 110 square feet per acre. Harvest stands with stocking under 60 square feet per acre to eliminate open stands. Thin or harvest overstocked stands to eliminate suppressed trees. Harvest trees before they are overmature. Maximum harvest age should equal site index value minus five.

Prevention in future stands: Avoid planting strips of jack pine as wind breaks or for aesthetic reasons. Avoid establishing stands that are more than one square mile; establish adjacent stands at 10- to 15-year intervals to eliminate large areas of the same-aged trees. Plant alternate species.

References: DNR (1985), Batzer and Millers (1970).



10. Red pine needle rust droplets on needles.

Red Pine Needle Rust

Host trees: Red pine (up to 15 feet tall)

Signs and symptoms:

April and May
Orange droplets oozing from yellow to reddish-brown patches on lower-branch needles.

May and June
Pale-orange, warty blisters on lower-branch needles *(see photo 10).*

July to September
Look for goldenrod or aster plants with tiny, waxy, orange bumps or orange powdery patches of spores on the underside of their leaves growing near pines.

Hazardous conditions: Goldenrod or aster plants that are near red pine stands create a needle-rust hazard for red pines. Pines growing in moist or humid areas (such as frost pockets, small forest openings, or north-facing slopes) are also particularly susceptible to the fungus.

Biology: Pine needle rust is a fungus that requires both the red pine and an alternate host (either aster or goldenrod) to complete its life cycle. Spores overwinter in pine needles, and cause orange, warty blisters on needles in spring. The blisters break open and disperse wind-borne spores to aster and goldenrod plants. These spores only infect alternate hosts; they cannot infect other pine trees. They develop into orange bumps on the underside of the alternate hosts' leaves. In fall, the fungus produces another wind-borne spore from the orange bumps on the alternate hosts. This type of spore infects pines but cannot infect other alternate hosts. The spores then overwinter in pine needles.

Loss or damage: Occasionally, pine needle rust will defoliate the lower 5 feet of branches during spring. Defoliation may cause some growth loss in young trees. Needle rust seldom causes serious damage to trees.

Control alternatives:

- No direct treatment against this fungus is practical for forest stands.

Prevention in current stands: Mow, cultivate or apply an herbicide to alternate hosts before August when they release wind-borne spores that can infect pines.

Prevention in future stands: Avoid planting red pine stands near areas of large aster or goldenrod populations.

References: DNR (1985), Nicholls and Anderson (1976), USDA (1983).

11. Needle droop's effect on red pine.

Red Pine Needle Droop

Host trees: Red pine (Up to 5 feet tall)

Signs and symptoms:

August to September
Current year's needles droop *(see photo 17).*

September to October
Drooping needles turn brown.

Pests that cause similar symptoms: Red pine needle midge *(page 17)* and red pine shoot blight *(page 26).*

Hazardous conditions: Sandy soils, dense sod and competition for water from other herbaceous plants increase the risk that red pine will get needle droop. Drought years increase the possibility for needle droop. Droop damage may be severe during years of adequate summer moisture followed by dry, fall weather that rapidly depletes a tree's supply of stored water. Needle droop only affects plantations; natural stands apparently aren't affected.

Biology: Needle droop is caused by an inadequate water supply and weather conditions that cause trees to lose water more rapidly than the roots can absorb it. Poor, sandy soils and competition from grasses and other herbaceous plants reduce the amount of water available to red pines when they are young and have poorly developed root systems.

Loss or damage: Needle droop reduces a tree's growth but seldom severely damages or kills trees. Severe cases of needle droop can kill terminal buds or whole terminal shoots.

Control alternatives:

- No direct treatment is necessary for needle droop.

Prevention in current stands: Control weed competition for the first 5 to 10 years after planting red pine stands.

Prevention in future stands: When planting, avoid jamming seedlings into holes that are too small and bending their root tips up to look like J's.

References: DNR (1985), Bergdahl and French (1976).

12. Ozone damage to current year's needles.

Ozone and Atmospheric Pollutants

Host trees: White pine (all sizes)

Signs and symptoms:

July to September
Current year's needles stunted or needle tips uniformly discolored yellow, brown or reddish brown *(see photo 12)* over whole tree. Affected and unaffected trees often stand side by side.

Biology: Sulfur dioxide and ozone are the major pollutants that damage trees. Factors that influence the amount of damage that pollutants cause include: the tree's age, the age of the needles, the weather, the length and concentration of exposure to the pollutant and the individual tree's genetic tolerance for the pollutant. Individual trees differ in their sensitivity to pollution.

Loss or damage: Air pollution may decrease the vigor and annual growth of sensitive trees if they are exposed to pollutants for several years. Air pollution affects up to 10% of white pines and most of these die before they are 20 years old. Trees that show symptoms only occasionally will survive.

Control alternatives:

- Remove trees when they are young if they show pollution symptoms annually.

Prevention in future stands: Avoid planting white pine in areas frequently exposed to air pollutants and along major highways.

References: DNR (1985), USDA (1983).

12a. Typical Red Pine Needle Midge damage.

Red Pine Needle Midge

Host trees: Red Pine (all sizes, especially those 10 to 20 feet tall)

Signs and symptoms:

October
Yellow or brown needles that are about 40% shorter than normal needles, especially in tree tops *(see photo 12a.).* Orange larvae about 1/8 inch long may be present at the bases of needles.

Mid-winter
Missing or sparse foliage. As much as 75% of the current year's needles may fall off during the winter after a heavy infestation.

Following summer
Dead buds on heavily defoliated branches during the year after a severe infestation.

Pests that cause similar symptoms: Red pine needle droop *(page 15)* and red pine shoot blight *(page 26).*

Biology: Adults emerge from late May through mid-June. Soon after emerging, females lay eggs at the bases of new needles. Larvae hatch within a week and burrow into the developing needles. The larvae leave the needles in October when the needles start to turn brown. Larvae then drop to the ground and overwinter without a cocoon just under the soil surface.

Loss or damage: Occasionally red pine needle midge causes widespread needle browning in stands of poletimber-sized trees. Two to 3 years of heavy infestation in a tree's upper branches may greatly reduce its annual height and trunk diameter growth during those years and may prevent new shoot growth.

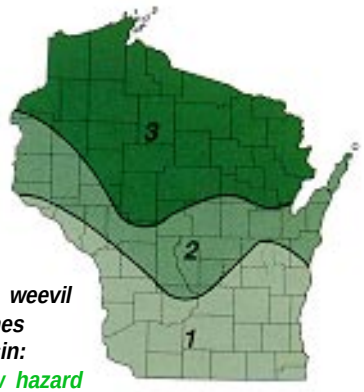
Control alternatives:

- No treatment is available for red pine needle midge.

Prevention: No preventive measures against red pine needle midge are available.

References: DNR (1985), Wilson (1977), Kearby and Benjamin (1964).

13. Terminal leader hooked over and brown after white pine weevil attack.



White pine weevil hazard zones in Wisconsin:
zone 1, low hazard
zone 2, moderate hazard
zone 3, high hazard.

White Pine Weevil

Host trees: All pines (all sizes). White pine weevil rarely attacks red pine.

Signs and symptoms:

All year
Top several branches brown or dead.

Late May to early June
Terminal leaders brown and hooked over *(see photo 13).*

Early May to July
Drops of resin oozing from small holes in previous year's terminal leader growth.

Hazardous conditions: Young stands growing in the open suffer greater damage than stands that grow under a hardwood canopy.

Hazard zone 1:
Low hazard. Weevils attack less than 5% of trees in white and jack pines stands.

Hazard zone 2:
Weevils attack 5 to 10% of trees in young stands growing in the open.

Hazard zone 3:
High hazard. Weevils attack 10 to 30% of trees in young stands growing in the open.

Biology: The adult weevil lays its eggs under the bark of the terminal leader during spring. When the larvae hatch, they bore through the inner bark and destroy the tissue that carries nutrients to the shoot tip *(see photo 14).* The shoot and often some of the top lateral branches die. The larvae pupate in wood-chip cocoons in the shoot. Adult weevils *(see photo 15)* emerge and feed on the shoot's bark until they drop to the ground to overwinter.

Loss or damage: White pine weevils kill the terminal leader, which often forks and deforms a tree's main stem. These weevils cause the greatest damage to saplings and poletimber trees. Heavy infestations may leave a stand with very few trees that are suitable for harvest as saw-timber.

Control alternatives:
Hazard zone 1:

- No control is necessary.

Hazard zone 2:

- Accept stem deformity up to a limit. When only 200 to 300 trees per acre have not been attacked, choose an active treatment alternative.
- Remove infested shoots before adults emerge in mid-July.

14. Bark damage caused by white pine weevil larvae boring through inner bark.

- Prune all but one shoot on forking stems to straighten main-stem growth.
- Remove heavily damaged trees during stand thinning.

Hazard zone 3:

- Practice zone 2 control alternatives. This zone requires a more intensive management approach; damage is more likely to occur in spite of treatment practices.

Prevention in current stands:

Hazard Zone 1:

No preventive practices are necessary.

Hazard zone 2:

Sites that are not shaded:

Maintain dense stocking that will force trees to grow straight until 150 to 300 trees per acre are 20 to 25 feet tall. If trees have straight main stems at this height, they can be harvested as sawtimber later.

Sites that are at least 50% shaded:

Maintain oak stocking at 30 square feet/acre. Maintain combined aspen, birch and maple stocking at 50 square feet/acre. Remove all hardwoods from site when pines are 18 feet tall.

Hazard zone 3:

Practice zone 2 prevention measures. Zone 3 requires a more intensive management approach; damage is likely to occur in spite of preventive practices.

Prevention in future stands:

Hazard zone 1:

No prevention practices are necessary.

Hazard zone 2:

Plant 900 to 1000 seedlings per acre on sites that are not shaded. Plant 800 seedlings per acre on sites that are at least 50% shaded.

Hazard zone 3:

Consider alternative species.

References: DNR (1985), Hastings and Godwin (1971).

15. Adult white pine weevil emerging from wood-chip cocoon.

16. White pine blister rust blisters.

White Pine Blister Rust

Host trees: White pine (all sizes)

Signs and symptoms:

April to May
Orange-yellow blisters breaking through bark on branches or the trunk *(see photo 16).*

June to August
Orange spots or powdery patches of spores on the underside of nearby gooseberry or currant leaves.

July to September
Short, brown, hair-like fungal growth on underside of nearby gooseberry or currant leaves *(see photo 78).*

All year
One or several brown or defoliated branches; slow-growing, yellow branches. Whole trees may be yellow or brown.

Cankers *(see photo 77)* on branches or the trunk, usually within 9 feet of the ground. Cankers may be yellow-orange, especially at margins and slightly swollen. Cankers may also be reddish-brown and sunken. Look for clear, sticky resin oozing from bark near cankers. Resin crystallizes and turns white in a few days.

Hazardous conditions: Small forest openings (with diameters less than height of surrounding trees), the bases of slopes, V-shaped valleys and other topographical depressions are high-risk sites in all hazard zones. These areas frequently experience the conditions that spores require to infect pines. Stands growing in the open are vulnerable to white pine blister rust because they have no overstory to protect them from wind-borne spores.

Biology: White pine blister rust is caused by a fungus that requires white pine and either gooseberry or currant bushes (called alternate hosts) to complete its life cycle. The fungus cannot spread from pine to pine. The fungus has five different spore

17. White pine blister rust canker.

18. Brown hair-like growth on the underside of an alternate host leaf.

White pine blister rust hazard zones in Wisconsin: zone 1, low hazard; zone 2, moderate hazard; zone 3, high hazard; zone 4, very high hazard.

stages in its life cycle, two on white pine and three on an alternate host. The first two spore stages develop on white pine between April and early June. One of these spore stages creates bark blisters that break open and release wind-borne spores. These spores can infect alternate hosts many miles away. Three different spore stages develop on the alternate host's leaves. In fall, the fungus releases another wind-borne spore from the alternate host that infects white pines. The fungus overwinters in white pines. For spores to infect pines, the needles must be wet and the air temperature must remain below 68° F for at least 48 hours.

Loss or damage: The blister fungus forms cankers that girdle and kill branches and trees by destroying the inner bark tissue that carries nutrients through trees. The fungus kills up to 25% of white pine growing in hazard zone 4.

Control alternatives:

- Check your stand for white pine weevil infestations. Blister rust treatment or prevention may not be practical in stands that suffer weevil damage regardless of blister rust control.
- Prune branches that have cankers. Branch cankers closer than 4 inches to the main stem (trunk) may have already infected the main stem.
- Eliminate alternate hosts. This treatment is often very expensive and may not be cost effective in zones 2 and 3. Eliminating alternate hosts in zone 4 is usually ineffective.

Prevention in current and future stands: No preventive measures are necessary zone 1. In other hazard zones, begin pruning 4 to 5 years after planting. Prune branches off the lower half of trees every 3 to 5 years until the lower 9 feet of the trunk is free of all live branches.

Prevention in future stands:

Hazard zone 1:

No preventive measures are necessary in this zone.

Hazard zone 2:

Plant white pines on dry or sandy hilltops, steep slopes, or open fields. Avoid planting in the areas described as hazardous conditions.

Hazard zone 3:

Practice zone 2 preventive management. Plant white pines under solid canopies; canopy trees should be oak, aspen, paper birch or jack pine.

Hazard zone 4:

Practice zone 3 preventive management. Consider alternative tree species.

References: DNR (1985), Nicholls and Anderson (1977), Van Arsdel and Riker (1968).

Saratoga Spittlebug

Host trees: Red pine (2 to 15 feet tall)

Signs and symptoms:

May to June
White, foamy "spittle masses" *(see photo 19)* at the bases of nearby sweet fern, young willow, or berry bushes (called alternate hosts). Look under pine needle litter for spittle masses; they may be difficult to find. Immature spittlebugs are black with scarlet markings and may be present in spittle masses.

19. Saratoga spittlebug spittle mass on alternate host, with black and scarlet nymphs in the spittle mass.

July to September
One or several dead, brown branches (called flagging). Look for adults on needle-bearing shoots *(see photo 20).* Scrape the outer bark off branches of previous 2 years' growth; look for puncture wounds on inner bark that adults cause during feeding *(see photo 21).* Whole trees may be dead.

October to April
Bumps on red pine buds. Adults lay eggs under the small leaf-like scales that cover the bud (bud scales). Eggs cause small bumps that may be easier to feel than see.

20. Saratoga spittlebug adult.

Pests that cause similar symptoms: Red pine shoot moth *(page 29),* European pine shoot moth *(page 30)* and Pales weevil *(page 35).*

Hazardous conditions: Stands on sites where the combination of sweet fern, willow brush and berry bushes cover 20% or more of the ground are very susceptible to spittlebug infestations.

Biology: The Saratoga spittlebug requires its primary host, red pine, and an alternate host to complete its life cycle. Its most common alternate hosts are sweet ferns, willow brush or berry bushes. In early May, immature spittlebugs (called nymphs) hatch from eggs that have overwintered under red pine bud scales. The nymphs drop to the ground and seek an alternate host. Nymphs feed on an alternate host and form characteristic white, foamy spittle masses around themselves. When populations are high, as

21. Saratoga spittlebug puncture wounds on inner bark.

22. Flagging branches caused by the Saratoga spittlebug.

many as 50 older nymphs may share a large spittle mass. When full grown, a nymph climbs to the top of the alternate host, sheds its last nymphal skin and flies away to a red pine as an adult. The adults feed by sucking sap from the inner bark which destroys the tissues that transport nutrients through the tree. This damage can kill branches or whole trees. Adults lay eggs under the bud scales in late summer.

Loss or damage: Spittlebug infestations kill branches *(see photo 22)* which may reduce tree growth or deform the main stem if the insect attacks the terminal leader. Heavy infestations kill whole trees and, if very severe, can destroy entire stands.

Control alternatives:

- Accept some spittlebug damage.
- Consider applying an herbicide to alternate hosts if the spittlebug population is growing and damage is increasing.
- Treat insects with an insecticide during severe infestations that cause an immediate threat to red pines.

Prevention in current stands: Till or apply herbicide to remove alternate host species when their combined population is 20% or more of the groundcover on your site.

Prevention in future stands: Do not plant red pine on sites where alternate host species are 20% or more of the ground cover.

References: DNR (1985), Wilson (1978).

SIGNS AND SYMPTOMS

1 Dead terminal leader
White pine weevil, p.18

2 Forked stems or branches
White pine weevil, p.18
Red pine shoot moth, p.29

3 Flagging
White pine blister rust, p.20
Saratoga spittlebug, p.22
Diplodia shoot blight, p.27
Scleroderris canker, p.28
Pine root-tip weevil, p.34

4 Scales
Pine tortoise scale, p.31

5 Bark Blisters
White pine blister rust, p.20

6 Cankers
White pine blister rust, p.20
Red pine shoot blight, p.26
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7 Browsed twigs or terminal leaders
Deer, p.42

8 Galls
Eastern gall rust, p.32

9 Resin on bark
White pine blister rust, p.20
Diplodia shoot blight, p.27
Pine root collar weevil, p.33
Pales weevil, p.35

10 Dead shoots
Red pine shoot blight, p.26
Diplodia shoot blight, p.29
Red pine shoot moth, p.29
European pine shoot moth, p.30
Pales weevil, p.35

11 Defoliated branches
All sawflies
Pine tussock moth, p.11
Jack pine budworm, p.12

12 Orange or yellow discolored needles
Red pine needle rust, p.14
Ozone and atmospheric pollutants, p.16
Red pine needle midge, p.17
Red pine shoot blight, p.26

13 Eggs on needles
All sawflies
Pine tussock moth, p.11
Jack pine budworm, p.12

14 Larvae on needles
All sawflies
Pine tussock moth, p.11
Jack pine budworm, p.12

15 Straw-like needles
Redheaded pine sawfly, p.5
Red pine/European pine sawfly, p.8
White pine sawfly, p.10

16 Drooping needles
Red pine needle droop, p.15
Diploidia shoot blight, p.27
Red pine shoot blight, p.26

17 Sawdust or pitch tubes
Pine engraver beetle, p.36
Red turpentine beetle, p.37

18 Bark gnawed off at base
Meadow mouse, p.40

19 Whole dead trees
Eastern gall rust, p.32
Pine root collar weevil, p.33
Pales weevil, p.35
Pine engraver beetle, p.36
Red turpentine beetle, p.37
Shoestring root rot, p.38
Meadow mouse, p.40
Mound ants, p.41

23. Brown, drooping needles on shoot infected with red pine shoot blight.

Red Pine Shoot Blight

(Sirococcus Shoot Blight)

Host trees: Red pine (all sizes)

Signs and symptoms:

June

Current year's shoots dead or drooping; brown, stunted needles *(see photo 23).* A drop of clear, sticky resin may exude from the base of infected needles. Black fruiting bodies that look like black mold may be present at the base of dead needles. Cankers (bark wounds) may develop on infected shoots.

July and later

Fully grown needles that are brown and drooping on current year's shoots. Infected shoots can occur anywhere on saplings and poletimber. On larger trees, the fungus usually infects only lower shoots and branches.

Pests that cause similar symptoms: Red pine needle droop *(page 15),* red pine needle midge *(page 17),* Diplodia shoot blight *(page 27),* Scleroderris canker *(page 28),* and pine root tip weevil *(page 34).*

Hazardous conditions: Red pine stands that grow under older, infected red pines are very likely to be infected by falling spores.

Biology: Red pine shoot blight is caused by a fungus that infects the current year's needles and shoots during the spring months. These needles turn brown and die. The fungus then grows further down into the shoot. The shoot develops cankers, curls over and dies. The fungus overwinters in the dead shoot until the following spring when it forms black fruiting bodies that produce new spores. During wet spring weather, these spores travel in rain-drops and infect other branches or trees.

Loss or damage: Within the distribution zone a single year of infection can kill seedlings and repeated infections can kill saplings. Trees that do not die may be deformed. Lower branches of older trees may die.

Control alternatives:

- No practical treatments for red pine shoot blight are available for forest stands.

Prevention in current stands: Harvest infected trees to reduce or prevent further infection.

Prevention in future stands: Plant new red pines with a buffer zone between new stands and older adjacent stands. Buffer zones should be at least twice as wide as the height of the older trees. Within the distribution zone, avoid establishing new red pine stands underneath old red pine stands.

Red pine shoot blight distribution in Wisconsin.

References: DNR (1985), Nicholls and Robbins (1984).

24. Diplodia-infected tree with several dead shoots.

25. Diplodia fruiting bodies on dead needles.

Diplodia Shoot Blight

Host trees: Red pine (all sizes)

Signs and symptoms:

May to June
Current year's shoots stunted with short, brown needles; dead shoots may be covered with sticky resin. Seedlings with Diplodia often curl over.

July to October
One or more dead, brown branches *(see photo 24).* Small, black fruiting bodies that look like spots of black mold develop on needles, bark and cones *(see photo 25).* Cankers (sunken bark wounds) on branches and the trunk also indicate the presence of Diplodia. Look for resin-soaked wood underneath bark near cankers; in severely infected trees, wood under cankers may be discolored black or gray.

Pests that cause similar symptoms: Red pine shoot blight *(page 26),* Scleroderris canker *(page 28),* and pine root tip weevil *(page 34).*

Hazardous conditions: Open wounds left from insect infestations or pruning operations are entry points for spores to infect trees. Stress caused by frost, drought or a poor site may prompt infection. During drought years, trees on sites that are normally dry are vulnerable to serious infection and death.

Biology: A fungus that infects the current year's shoots during spring causes Diplodia shoot blight. The fungus grows down into the shoots and causes cankers to develop. These cankers eventually kill the shoots. The fungus overwinters in the dead shoots until the following spring when it forms black fruiting bodies that produce new spores. During wet spring weather, these spores travel in raindrops to other branches or trees.

Loss or Damage: Diplodia kills current year's shoots. If the fungus infects trees for several years it can kill major branches and ultimately whole trees by damaging the inner bark that transports nutrients through the tree. Light infections prompted by wounds are normal and cause little damage.

Control alternatives:

- Direct treatment for Diplodia is not practical for woodland owners.

Prevention in current stands: Do not prune trees during wet periods when fruiting bodies release spores. Minimize insect damage that weakens trees and creates entry points for the fungus.

Prevention in future stands: Avoid planting red pine on dry sites or sites that have a history of serious Diplodia infection.

References: DNR (1985), Palmer and Nicholls (1983), Peterson (1981), USDA (1983).

26. Orange discoloration at the base of needles infected with Scleroderris canker.

27. Green discoloration under bark of branch infected with Scleroderris canker.

Scleroderris canker distribution in Wisconsin.

Scleroderris Canker

Host trees: Red pine and jack pine (1 to 10 feet tall)

Signs and symptoms:

May to June
Orange discoloration at base of needles *(see photo 26),* usually on the lower 5 feet of the tree.

July to October
Brown needles. Entire branches may die; needles drop off easily. Twigs may be completely bare after needles drop off. Look for green discoloration under bark on stem where needles have fallen off and where the branch meets the stem *(see photo 27).* Cankers (sunken bark wounds) may appear on branches and stems.

Pests that cause similar symptoms: Red pine shoot blight *(page 26),* Diplodia shoot blight *(page 27),* and pine root tip weevil *(page 34).*

Hazardous conditions: Across northern Wisconsin, frost pockets, which stay cold and moist for long periods of time, provide the most favorable conditions for severe disease development. Trees under 10 feet tall and branches within 5 feet of the ground on taller trees are most susceptible to infection.

Biology: Scleroderris canker is caused by a fungus. The disease spreads from one tree to another by wind-borne fungal spores, mostly during moist weather. Spores infect buds and needles. The fungus then grows down the branch to the main stem (trunk) where it causes cankers that may destroy inner bark tissue and kill the tree.

Loss or damage: Scleroderris kills branches and may kill trees less than 10 feet tall.

Control alternatives:

- No direct treatment for Scleroderris canker is available.

Prevention in current stands: Remove all infected red pine and jack pine in affected areas.

Prevention in future stands: Do not plant infected nursery stock. Avoid planting red pine and jack pine in currently affected areas. Avoid planting in frost pockets, areas of depressed ground where frost conditions or cold air remain late into the day.

References: DNR (1985), Sinclair et al. (1987), Skilling and O'Brien (1972).

26. Dead, brown shoot tips that red pine shoot moth have attacked.

29. Red pine shoot moth larva in hollowed shoot.

Red Pine Shoot Moth

Host trees: Red pine (20 years old and older)

Signs and symptoms:

May to August
Dead, brown shoot tips *(see photo 28).* Larvae eat the inside of shoots, leaving them hollow or filled with gritty frass (insect excrement, *see photo 29).* Break open dead shoots; frass, larvae or pupae may be present. Dead shoots eventually fall off branches.

Pests that cause similar symptoms: Saratoga spittlebug *(page 22),* European pine shoot moth *(page 30),* and Pales weevil *(page 35).*

Hazardous conditions: Trees older than 30 years on dry, sandy soils are most vulnerable to attack.

Biology: Adult moths emerge between mid-July and early September and lay their eggs under bark scales. Young larvae hatch in late summer and overwinter under bark scales. The larvae begin feeding on new shoots in late May and may continue feeding until early August. The gray-brown, inch-long larvae pupate from July to August in silk chambers in dead shoots or cones.

Loss or damage: Red pine shoot moth larvae kill the current year's shoots. When shoots die, the following year's growth may be crooked and deform branches or main stems. The year after a shoot dies, new buds form at the base of the dead section of the shoot. New shoots grow from those buds. When more than one of the new shoots compete for dominance, the branch or stem may become forked. When top shoots die, tree tops often flatten out and become bushy because of increased lateral branch growth.

Control alternatives:

- No direct control for red pine shoot moth is available. Remove deformed trees during thinning operations,

Prevention in future stands: Consider planting alternate species on hazardous sites.

References: DNR (1985), Hainze and Benjamin (1983).

Red Pine shoot moth hazard zone in Wisconsin.

30. Clumps of resin left on shoot by European pine shoot moth.

31. Red pine trunk deformed by European pine shoot moth larva.

European pine shoot moth hazard zone in Wisconsin

European Pine Shoot Moth

Host trees: Red pine (trees with lower branches below snow line)

Signs and symptoms:

May
Dead, brown or stunted shoot tips, usually with short needles.

July to August
Dead, brown needles hanging from shoot tips and clumps of resin on shoots *(see photo 30).* The European pine shoot moth larvae hollow buds and shoots. Check to see if shoot tips are hollow; larvae may be present.

Fall and winter
Larvae under protective "blister" of resin and silk at base of larger buds.

Pests that cause similar symptoms: Saratoga spittlebug *(page 22),* red pine shoot moth *(page 29),* and Pales weevil *(page 35).*

Hazardous conditions: Open stands are more susceptible to the European pine shoot moth than closed stands. Open stands may be caused by poor tree survival after original planting.

Biology: Adults lay their eggs on shoot-tip needles in late June. Larvae hatch in late July and feed on the current year's needles. By mid-August, larvae move to bud clusters where they build webs around two or more buds. Then they hollow out shoots and buds in which they overwinter. Larvae cannot normally survive the winter unless they are protected from the extreme cold in shoots that are beneath the snow line. They complete their development during the following spring when they feed on new buds. Larvae pupate in hollowed buds between May and June.

Loss or damage: Larvae kill buds and new shoots. Branches and stems become crooked *(see photo 31)* or forked when following year's growth tries to replace the dead shoot. Repeated European pine shoot moth attacks can severely deform trees whose lowest branches are below the snow line.

Control alternatives:

- Direct insecticide control is seldom practical in forest stands.

Prevention in current stands: Prune the tree branches that extend below the snowline.

Prevention in future stands: Promote early canopy closure by planting 800 or more trees per acre and increase seedling survival by protecting trees from rodents and weed competition. Avoid planting red pine in hazard zone.

References: DNR (1985), Martineau (1984), Miller et al. (1970).

Pine Tortoise Scale

Host trees: Jack pine (all sizes)

Signs and symptoms:

May to June
Dark-brown to reddish-brown, helmet-shaped scales about a quarter inch in diameter attached to branch or twig bark *(see photo 32).*

July to September
Black sooty mold growing on branches; ants and bees may also be present. The adult female secretes a shiny "honeydew;" if insects don't eat it, a harmless black mold grows on the sticky excretion.

Biology: The pine tortoise scale is a sap-sucking insect. Adult females attach to the bark and secrete a liquid honeydew. In June or July they deposit eggs from which the immature insect, called a crawler, hatches. The young insects move to a feeding spot where they attach themselves and feed on bark sap. Adult males have wings and emerge in late July or August and fly to stationary females to mate. Adult females overwinter on bark under their hardened shells.

Loss or damage: Pine tortoise scale kills branches and sometimes whole seedlings or saplings. One or 2 years of heavy infestations may kill a large percentage of trees.

Control alternatives:

- Insecticide spray is not usually necessary.
- On heavily infested trees, control crawlers in June or July with insecticide.

Prevention in future stands: Promote early canopy closure by planting 800 or more trees per acre or increasing survival rate of seedlings and saplings by controlling weeds and rodents.

References: DNR (1985), Wilson (1977), Wilson (1971).

32. Pine tortoise scales attached to bark.

33. Eastern gall rust gall during spring when it releases orange spores.

Eastern Gall Rust

Host trees: Jack pine (all sizes). Eastern gall rust causes the most damage to seedlings, but the fungus infects older trees as well.

Signs and symptoms:

All year
Swollen, spherical galls on seedling stems or on branches of older trees.

April to early June
Galls covered with cream-colored blisters and produce bright orange spores *(see photo 33).*

June to July
Orange spots or brown, hair-like growth on the underside of nearby oak leaves.

Hazardous conditions: Jack pine trees growing near oaks are susceptible to the eastern gall rust fungus.

Biology: Eastern gall rust is caused by a fungus that requires both pine and oak, an alternate host, to complete its life cycle. The fungus forms spherical galls on jack pine branches and stems. During spring, these galls produce bright orange, wind-borne spores. The spores travel to and infect nearby oak leaves. In June, the undersides of infected oak leaves develop orange spots. In mid-June and July, a brown, hair-like fungal stage develops, also on the underside of oak leaves. These hair-like growths produce another wind-borne spore which infects new pine needles. Galls appear on pines one to two years after initial infection.

Loss or damage: Galls kill seedling stems and kill branches of older trees. Gall injuries leave trees particularly vulnerable to other diseases.

Control alternatives:

- Remove badly infected trees and branches during thinning operations.

Prevention: Preventive measures against Eastern gall rust are impractical in forest stands.

References: DNR (1985), Anderson (1963).

MAIN STEM AND ROOT PESTS

Pine Root Collar Weevil

Host trees: Jack pine and red pine (2 to 20 feet tall)

Signs and symptoms:

May to September
Trunk wounds at or below ground level soaked with clear, sticky resin. Soil near the trunk may also be resin-soaked. Trees may tilt or break off at the root collar. Whole trees die and turn yellow or brown. The adult weevils are dark brown, a half-inch long and have long front snouts that make them look like miniature elephants. Though they are difficult to find, you may see them near the base of the tree.

Pests that cause similar symptoms: Pales weevil *(page 35),* white grubs *(page 39),* meadow mouse *(page 40),* pocket gopher *(page 41),* and mound ants *(page 41).*

Hazardous conditions: Stands planted on nutrient-deficient, sandy soils are vulnerable to root collar weevil attacks. Trees that have more than 3 inches of root collar below the soil surface are vulnerable to this weevil. Jack pine and red pine stands that are within a half mile of heavily infested Scotch pine are vulnerable to weevil infestation. Open stands are more vulnerable to weevil attacks than closed stands.

Biology: Throughout the summer, adults lay eggs under tree bark or in soil. Larvae hatch after about 2 weeks, and bore into the inner bark making "galleries." Gallery digging injures the tree by destroying the inner bark tissues that carry nutrients through the tree. Larvae overwinter in their galleries or in the soil until the next spring when they complete their development. Larvae pupate in soil from mid- to late summer. Adults emerge in fall, but usually lay eggs the next spring. Adults may live for as long as two summers, feeding on the root collar's inner bark.

Loss or damage: Weevils kill seedlings and saplings by girdling their root collars.

Control alternatives:

- Insecticide treatment for root collar weevil is seldom practical in forest stands.

Prevention in current stands: Prune trees' lower branches and scrape ground litter from under trees, leaving mineral soil bare.

Prevention in future stands: Avoid planting red pine and jack pine within 1 mile of infested Scotch pine stands. Plant seedlings with root collar not more than 1 inch deep in sandy soils. Promote early canopy closure by planting 800 or more trees per acre and increasing seedling survival rate by controlling weeds and rodents for 5 years after planting.

References: DNR (1985), Wilson (1975), Wilson (1983).

34. Root in which pine root weevil has tunneled.

Pine Root Tip Weevil

Host trees: Jack pine and red pine (2 to 20 feet tall)

Signs and symptoms:

June to September
One or several dead, brown shoots or whole dead branches. Whole trees may be dead. Look for debarked or hollowed-out roots or roots with tips eaten away *(see photo 34).* Larvae bore into lateral (side) roots, and leave the roots hollow or filled with frass (insect excrement). The adult weevils are difficult to find, but you may see them at the bases of trees; they are dark brown, a half-inch long and have long front snouts that make them look like miniature elephants.

Pests that cause similar symptoms: Red pine shoot blight *(page 26),* Diplodia shoot blight *(page 27),* and Scleroderris canker *(page 28).*

Hazardous conditions: Jack pine or red pine stands that are near Scotch pine are vulnerable to root tip weevil. Trees living on nitrogen-deficient soils are susceptible to pine root tip weevil damage. Closed stands suffer greater weevil damage than open stands, unlike most pest problems.

Biology: Adults lay eggs in small roots during May and June. Larvae hatch and feed on the small roots, making their way toward the larger lateral roots. Larvae feed on roots for two summers and finally pupate in July of the second summer. Adults emerge in late summer and overwinter underground.

Loss or damage: Weevil damage to roots kills branches, tree tops and whole trees. Moderate weevil damage reduces trees' annual growth.

Control alternatives:
- Accept some damage and loss.
- Remove jack pine from infested red pine stands.
- Harvest merchantable trees when branches start to die.

Prevention in future stands: Avoid planting jack pine on nitrogen-deficient soils. Remove jack pine from future red pine sites with poor sandy soils.

References: DNR (1985), Wilson (1977).

35. Pales weevil bark injury covered with white crystallized resin.

36. Pales weevil adult.

Pales Weevil

Host trees: Red pine and white pine (up to 3 feet tall). Pales weevil can cause significant losses to seedlings during the first 3 years after planting. Weevils attack trees as large as 50 feet tall, but seldom cause serious damage.

Signs and symptoms:

May to October
Seedlings with dead stems; older trees with dead branches. Look for patches of stems and twigs where weevils have eaten bark. Bark injuries are often covered with white, crystallized resin *(see photo 35).* Weevils kill seedling stems and young shoots of older trees by removing a complete ring of bark around stems or twigs (called girdling). The adult weevils are dark brown, a half-inch long and have long snouts that make them look like miniature elephants. Though they are hard to find, you may see them near the base of the tree *(see photo 36).*

Pests that cause similar symptoms: Pine root collar weevil *(page 33),* white grubs *(page 39),* meadow mouse *(page 40),* pocket gopher *(page 41),* and mound ants *(page 41)* on seedlings. Saratoga spittlebug *(page 22),* red pine shoot moth *(page 29),* and European pine shoot moth *(page 30)* on larger trees.

Hazardous conditions: Sites with recently cut stumps attract Pales weevils. Weevils are likely to attack seedlings planted near these stumps.

Biology: During the spring, adults lay eggs in small roots of recently cut stumps or in buried wood. Larvae hatch from eggs after about 10 days. They remain underground, boring through and feeding on roots for about 9 weeks. Larvae then pupate in feeding tunnels. Adults emerge from roots and surface to feed on young bark above ground. Adults overwinter in the soil and may live for as long as 2 years.

Loss or damage: Pales weevils kill first-year seedlings during moderate infestations. Weevils can kill seedings up to 3 years old during heavy infestations. Pales weevils also attack older trees; the insects girdle twigs but cause minimal damage.

Control alternatives:

- Insecticide treatment for Pales weevil during an infestation is seldom practical in forest stands.

Prevention in future stands: Remove freshly cut pine stumps from your site before planting seedlings. Delay planting seedlings for 2 years after harvesting pines. This allows stumps to dry out so that they can no longer support weevils. Treat freshly cut stumps with an insecticide in early spring before weevils lay their eggs. Treat seedlings with an insecticide at planting time if a large population of weevils is present.

References: DNR (1985), Nord et al. (1984).

37. Adult pine engraver beetle in tunnel under bark.

Pine Engraver Beetle *(Bark Beetle)*

Host trees: All pines (12 feet tall and taller)

Signs and symptoms:

April to September
Fine, reddish-brown sawdust on bark and long slender tunnels under bark. Bark may fall off trunk easily. Beetles or larvae may be present in tunnels *(see photo 37).*

July to September
Dead trees with yellow or brown needles. Trunk bark is often covered with small (one-eighth inch) holes.

Pests that cause similar symptoms: Red turpentine beetle *(page 37)* and shoestring root rot *(page 38).*

Hazardous conditions: Diseased, insect-weakened or storm-damaged trees as well as overmature or overstocked stands provide a breeding ground for the beetles. Trees that have been struck by lightning are particularly prone to bark beetle infestations. Summer thinning and logging operations supply the beetles with fresh-cut slash and stems in which to breed.

Biology: Adults emerge from the ground in early spring. The adult male bores into a tree's bark and hollows out a "nuptial chamber" in the inner bark for mating. Several females mate with the male in the chamber. The females then bore 4- to 7-inch long "egg galleries" into the inner bark, where they lay from 30 to 60 eggs. The larvae hatch within about 2 weeks and feed on the inner bark for 10 to 20 days. They pupate at the ends of their tunnels and become adults. They emerge about a week later. Young adults feed on the inner bark and eventually bore holes through the outer bark and emerge either to infest other trees or to overwinter in the soil. As many as three generations of pine engravers may occur within a year.

Loss or damage: The pine engraver kills red pines and jack pines by damaging the inner bark. The beetle kills single, isolated trees or pockets of trees. During years of normal rainfall the beetle causes little damage; during dry summers the beetle can kill pockets of trees as large as several acres. White pines seldom suffer severe damage from the pine engraver.

Control alternatives:

- Accept some bark beetle damage and monitor for unacceptable levels of infestation.
- If the pine engraver severely attacks extremely valuable trees, spray bark with registered insecticide.

Prevention in current stands: Maintain your stands' health by avoiding overstocking and by harvesting stands at maturity. Thin stands between September and March when pine engravers can not take advantage of the damaged bark and logging slash for breeding. Harvest storm-damaged trees or routinely check them for beetle infestations. Consider harvesting stands prematurely if drought or defoliation weakens trees. If summer thinning is necessary, take the following precautions. Remove all branches

and stems larger than 2 inches in diameter from stand site. Leave branches attached to slash to speed up drying. To reduce chance of infestation, remove cut logs and pulpwood from stands within 3 weeks of cutting.

References: DNR (1985), Wilson (1977), Rose and Lindquist (1973), Sartwell et al. (1971).

Red Turpentine Beetle *(Bark Beetle)*

Host trees: Red pine (6 feet tall and taller)

Signs and symptoms:

April to September
White to rust-red pitch tubes (dried pitch around edges of holes in bark) on lower 6 feet of tree. Pull off loose bark and look for narrow tunnels engraved in the inner bark. Tunnels may be filled with frass (insect excrement), 1/3-inch long beetles or larvae. Pine engravers *(page 36)* may also be present.

July to September
Single trees or small group of trees die and turn yellow or brown.

Pest with similar symptoms: Pine engraver beetle *(page 36)* and shoestring root rot *(page 38).*

Hazardous conditions: Weak or injured trees are susceptible to red turpentine beetles, which usually attack trees already under stress or attack by another insect.

Biology: Adult beetles attack dead or weak trees and also infest stumps, freshly cut logs, and exposed, damaged roots. During spring the adults bore through a tree's bark and bore out "galleries" between the bark and the wood. The beetles push resin and frass out of the gallery through their entry holes creating "pitch tubes." The females lay eggs in the gallery and either continue feeding in the same gallery or leave it and attack another tree. Once the larvae hatch, they make galleries of their own. Eventually they pupate in the galleries and emerge as adult beetles. Beetles usually overwinter as adults.

Loss or damage: If trees are weak, the red turpentine beetle can kill trees by destroying the inner bark, which carries nutrients to the rest of the tree.

Control alternatives:
- Direct insecticide treatment is not practical in forest stands.

Prevention in current stands: Remove weakened or damaged trees from stands. Remove stumps or treat them with insecticide after thinning stands.

References: DNR (1985), Smith (1961), Wilson (1977).

36. Sheets of white shoestring root rot fungus at root collar.

Shoestring Root Rot *(Armillaria Root Rot)*

Host trees: All pines (all sizes)

Signs and symptoms:

Summer
Dead or weak trees with yellow or brown needles. Look for sheets of white fungus under the root collar's bark *(see photo 38)* and black shoestring-like strands of fungus on the roots or root collar or growing through the upper layers of soil.

Autumn
Clusters of honey-colored mushrooms may be present at the base of trees or old infected stumps. Mushrooms may only be present for a brief time.

Pests that cause similar symptoms: Pine engraver beetle *(page* 36) and red turpentine beetle *(page 37).*

Hazardous conditions: Red pine and white pine stand sites on which hardwood stands grew previously (especially aspen and oak) have a high risk of root rot infection. Stumps and roots that are heavily infected with the fungus are a source of infection for nearby healthy trees.

Biology: Shoestring root rot is caused by a fungus that feeds on and decays hardwood and conifer stumps. While feeding on dead stumps, the fungus sends "shoestrings" through the soil. These fungal extensions attack live roots they encounter. They often successfully attack the roots of weakened pines. The host trees decline, die and become the food base for further attacks.

Loss or damage: Root rot kills trees by destroying a major portion of the root system or by destroying a complete ring of bark around the root collar. This type of injury, called girdling, destroys the tissues that carry nutrients through the tree. Pine stands that are mixed with dead oak, dead aspen or their stumps can suffer an accumulated tree loss of up to 30% over a 15-year period. Losses are usually less than 10%, however, and are heaviest 5 to 9 years after hardwoods have died or been cut. The fungus may cause damage which does not kill a tree, but which weakens or injures a tree so that other insects or fungi may easily attack and kill it. Bark beetles often attack root-rot-infected trees *(pages 36 and 37).*

Control alternatives:

- No fungicide treatment against shoestring root rot is available.
- Expect tree loss when planting pine near hardwood stumps.
- Harvest infected trees to salvage their timber value, although removing the trees will not prevent the fungus from spreading.

Prevention in future stands: Avoid establishing red pine and white pine stands on or near previous hardwood sites with known root rot infestations. Delay planting pine stands for 7 to 10 years after removing hardwood trees from the site to allow the fungus to die out. Remove infected hardwood stumps and, if practical, remove infected roots from previously infected stands.

References: DNR (1985), Sinclair et al. (1987).

39. White grub larvae.

White Grubs

Host trees: All pines (1 to 3 years old)

Signs and symptoms:

May to September
White, one-inch-long larvae *(see photo 39)* in the top 6 inches of soil. Larvae are C-shape, have a reddish-brown head and six legs.

July to September
Dead trees or trees with brown foliage. Gently pull or dig seedlings out of the ground to see if grubs have eaten small roots and root hairs.

Pests that cause similar symptoms: Pine root collar weevil *(page 33),* Pales weevil *(page 35),* meadow mouse *(page 40),* pocket gopher *(page 41),* and mound ants *(page 41).*

Hazardous conditions: White grub densities that are at or above two grubs per every 10 square feet of soil, may cause heavy seedling losses. Old farmland with heavy grass sod is often infested with white grubs. White grubs cause the heaviest damage in sandy soils.

Biology: Large, brown June-bugs—the white grub adults—emerge between May and June and feed on hardwood foliage. Female adults return to the soil to lay their eggs. Larvae hatch underground and feed on roots for 2 to 5 years, before emerging as adults. Grubs usually feed on grass roots, but also eat pine roots.

Loss or damage: White grubs kill seedlings by eating their roots.

Control alternatives:
- Accept some loss and check stands regularly for unacceptable levels of infestation.
- An insecticide for use at planting time may be available in the future. No insecticides are currently registered for white grubs.

Prevention in future stands: Check grub population the year before spring planting. If grubs are abundant delay planting in infested areas for 2 or 3 years or until the grub population declines.

References: DNR (1985), Rose and Lindquist (1973), USDA (1983).

40. Young trees debarked by mice.

Meadow Mouse (Meadow Vole)

Host trees: Red pine and white pine (1 to 5 feet tall)

Signs and symptoms:

April to August
Bases of main stems debarked and girdled by mice *(see photo 40).* Dead trees.

Pests that cause similar symptoms: Pine root collar weevil *(page 33),* Pales weevil *(page 35),* white grubs *(page 39),* pocket gopher *(page 41),* and mound ants *(page 47).*

Hazardous conditions: Tall grass fields support mouse populations that may cause severe loss to nearby seedling and sapling stands.

Biology: Meadow mice are active all year. The animals feed mostly on grasses and herbaceous plants in grassy fields. Mice may eat thin, young bark when their normal food supply is low, usually during winter. Mice often feed under the snow line which hides the damage until the snow melts. Meadow mice pass through cyclical population changes with peak abundance occurring at roughly 4-year intervals.

Loss or damage: Mice girdle and kill seedlings and saplings during winter, although the damage often isn't visible until the following spring or summer.

Control alternatives:

- Mow or apply an herbicide to grass regularly during the first 5 years after planting.
- Check populations in fall if you are considering using a rodenticide.

Prevention in future stands: Remove grass before planting trees.

References: Craven and Stang (1981), DNR (1985), USDA (1983).

Pocket Gopher

Host trees: Red pine (1 to 6 feet tall)

Signs and symptoms: Dead trees, drooping foliage and gnawed-off roots. Trees may lean because their root support is missing. Look for gopher mounds, 2- or 3-foot-wide piles of soil always fan-shaped and plugged. Do not confuse these with mole holes, which have openings.

Pests that cause similar symptoms: Pine root collar weevil *(page 33),* Pales weevil *(page 35),* white grubs *(page 39),* meadow mouse *(page 40),* and mound ants *(page 41).*

Hazardous conditions: Significant losses are likely if two or more gopher mounds per acre are present. Sandy soils are most likely to harbor gophers.

Biology: Pocket gophers are small, burrowing rodents. They are 5 to 14 inches long and can vary from light brown to nearly black. Gophers build extensive underground tunnel systems and leave fan-shaped mounds of dirt on the ground surface. The rodents feed on roots they encounter while digging tunnels.

Pocket gopher hazard zone in Wisconsin.

Loss or damage: Gophers kill young trees by eating their roots.

Control alternatives:

- Accept loss of some young trees.
- Eliminate gophers with rodenticide when damage reaches an unacceptable level.

Prevention: Prevention against pocket gophers is not practical in pine stands.

References: Case (1983), DNR (1985). All county UW-Extension offices have copies of the Case (1983) reference.

Mound Ants

Host trees: White pine and jack pine (1 to 10 feet tall)

Signs and symptoms: Dead or dying group of trees. Large ant mounds between trees or in the area of dead trees. Mounds may be as large as 1 to 3 feet high and 2 to 6 feet across. Black or reddish-black, half-inch-long ants that cause blister-like cankers at the base of trees. Look for ants near mounds or on living trees.

Pests that cause similar symptoms: Pine root collar weevil *(page 33),* Pales weevil *(page 35),* white grubs *(page 39),* meadow mouse *(page 40),* and pocket gopher *(page 41).*

Biology: Ants kill trees that shade their mounds by injecting formic acid into the bases of tree trunks. Ants protect aphids and scales (which harm trees) from their natural enemies. However, ants also protect trees by eating pine sawfly and budworm larvae.

Loss or damage: Ants kill seedlings and saplings that shade their mounds.

Control alternatives:

- Accept the loss of some saplings.
- If losses are unacceptable, treat some or all the mounds with a registered insecticide.

Prevention: No preventive measures are known to reduce the risk of ant infestations.

References: DNR (1985), USDA (1983).

White-Tailed Deer

Host trees: All pines (all sizes). Deer prefer white pine.

Signs and symptoms: Browsed twigs (not larger than half-inch diameter) on lower 6 feet of tree. Deer also damage bark by rubbing their antlers against trees. Also look for deer droppings and tracks near trees.

Hazardous conditions: Deer populations are greatest in central and southern Wisconsin and near northern winter deer yards.

Biology: Deer eat exposed pine branches during winter when their food supply is low. Deer also damage trees in fall when they polish their antlers by rubbing them against trees.

Loss or damage: Deer deform trees that are less than 6 feet tall by browsing on branches above the snow line in winter. Browsing causes serious growth loss. Repeated browsing can destroy a plantation. Bucks can debark and kill an occasional tree by rubbing their antlers against tree trunks.

Prevention in current stands: Apply deer repellents to trees. Note that deer repellents are often ineffective. Intensive hunting in the general area may reduce local deer population. You may also consider deer fencing.

Prevention in future stands: Consider planting red pine, which deer favor less than white pine.

References: Craven and Hygnstrom (1986), DNR (1985), USDA (1983).

GLOSSARY

Alternate host— a second plant species that a pest needs to complete its life cycle. Not all pests need alternate hosts.

Broadcast spray— spraying pesticide over all vegetation in the spray area. The opposite of "directed spray," where only target vegetation is sprayed.

Canker— wound in the bark of a branch or stem. Many different types of injuries can cause cankers.

Canopy— the cover of foliage formed when the crowns of adjacent trees in a stand touch.

Canopy closure— the progressive reduction of distance between crowns of adjacent trees until they become a closed stand.

Clearcut— removal of an entire stand in one cutting.

Closed stand— the stage in a stand's growth when the crowns of adjacent trees touch and form a solid canopy.

Crown— the upper part of a tree where most of the foliage grows.

Defoliation— an abnormal loss of leaves or needles caused by factors such as insect feeding or fungal infection.

Diameter at breast height— the diameter of a tree trunk at 4½ feet from the ground on the up-hill side.

Flagging— one or several brown, dead branches on a tree. Dead branches "flag" injuries.

Forking— abnormal growth of lateral (side) branches that deforms branches or main stems. Buds form at the base of the dead portion of an injured shoot. The following year, these buds grow into new shoots. When more than one of the new shoots competes to replace the dead shoot, the branch or stem can become severely deformed.

Frass— insect excrement.

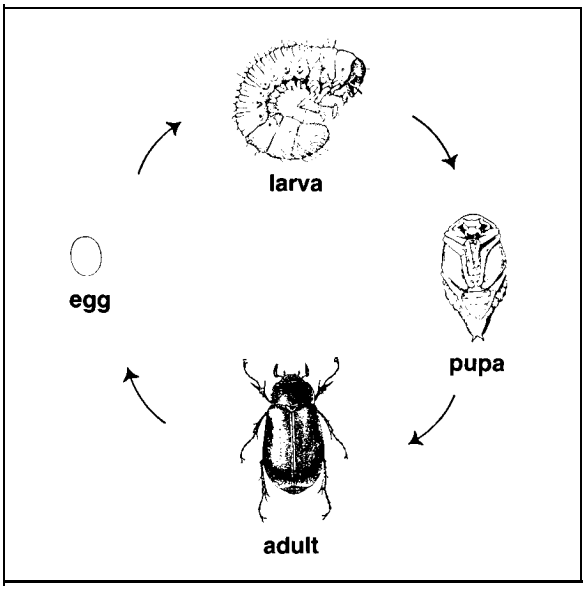
Frost pocket— usually a low area of ground where heavier, cold air settles at night. Frost is often more frequent and more intense in these areas than in surrounding areas. Frost pockets may stay cold and moist for long periods of time.

Fruiting bodies— fungal structures that produces spores.

Girdle— bark wound in a ring around a tree's trunk or branches; girdling kills all parts of the tree above the wound by destroying the tissues that carry nutrients through the tree.

Host— the plant species on which a pest feeds.

Larva (plural, larvae)— the worm-like stage of an insect's life cycle just after hatching from its egg. A basic insect life cycle is illustrated below.



Lateral branch— any branch that grows from the main stem except for the terminal shoot.

Main stem— a tree's trunk or central axis from which branches grow.

Male flowers— pollen cones. Male flowers produce pollen which fertilizes female cones. Pollen cones are about 1 to 2 inches long and are soft in contrast to hard, female seed cones. Trees normally produce abundant pollen cones when they are dying or are under stress.

Needle bundle— a group of needles that are attached to one another at their bases. Needles are attached to twigs in bundles. Red pine and jack pine have two needles per bundle; white pine has five needles per bundle.

Open stands— young stands in which the foliage of adjacent trees does not yet touch. Open stands do not form a closed canopy.

Overmature— the period in a tree's life when it has passed its maturity and its growth has slowed or stopped.

Overstocked— a stocking level at which a stand is too dense for best tree growth (see **Stocking).**

Overstory— a canopy that shades shorter trees.

Poletimber— all trees whose trunk diameter at breast height is between 5 and 9 inches.

Pupa (plural, pupae)— the stage of an insect's life cycle when it changes from a larva into its adult form. Pupae are usually in cocoons or a hard pupal cases that protect the insects.

Root collar— the point at the base of the main stem from which roots begin to grow, usually underground.

Sapling— a tree whose trunk diameter at breast height is between 1 and 5 inches.

Sawtimber— all trees whose trunk diameter at breast height is greater than 9 inches.

Seedling— all trees grown from seed whose trunk diameter is between 0 and 1 inches.

Shoot— the current year's twig growth at the end of a branch.

Site index— the expected height of the trees on a specific site when they are 50 years old. Foresters estimate site indices by measuring a few trees in a stand to determine average age and total height. Foresters can sometimes estimate site index if they know the stand's soil type and location. Contact your county Department of Natural Resources forester to determine your site index.

Slash— the unusable parts of a tree that are left on the ground after a thinning or logging operation.

Stocking— a measure of the number of trees (or the basal area) in a stand as compared to the desirable number (or basal area) needed for best growth and management.

Suppressed trees— weak, relatively small trees with crowns entirely below the general level of the crown canopy. Suppressed trees receive little or no direct sunlight. They are smaller than surrounding trees and develop because of overstocking or chronic poor health.

Terminal leader— a tree's top-most shoot.

Top kill— the death of the top portion of a tree.

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Acknowledgements

This manual was produced as a cooperative effort by the Forest Pest Management Unit of the Wisconsin Department of Natural Resources, the University of Wisconsin-Extension and the U.S. Forest Service, State & Private Forestry.

The Forest Service provided financial support, manuscript reviews, photographs and invaluable advice. From the onset of the project, we freely consulted the Forest Service's Christmas Tree Pest Manual from which we used many format and content ideas.

We thank the following reviewers for their suggestions and comments: Dr. Robert F. Patton, Department of Plant Pathology, and Dr. Scott Craven, Department of Wildlife Ecology, University of Wisconsin-Madison; Dr. Louis F. Wilson, North Central Forest Experiment Station, US. Forest Service; Laura Merrill and Peter A. Rush both of State & Private Forestry, U.S. Forest Service.

We thank George Gallepp and Diane Doering of the Department of Agricultural Journalism, University of Wisconsin-Madison for their advice and help.

A special note of thanks to Allen J. Prey, Supervisor of the Forest Pest Management Unit for administrative and technical advice and to Jane Cummings Carlson, Forest Pathologist, Forest Pest Management Unit, for many comments and suggestions.

The photographs were taken by employees of the U.S. Forest Service or the Wisconsin Department of Natural Resources.

University of Wisconsin-Extension, Cooperative Extension, in cooperation with the U.S. Department of Agriculture and Wisconsin counties, publishes this information to further the purpose of the May 8 and June 30, 1914 Acts of Congress; and provides equal opportunities in employment and programming including Title IX requirements.

Heather A. Goulding was an editor and David J. Hall is a forest entomologist with the Pest Management Unit of the Wisconsin Department of Natural Resources. Kenneth F. Raffa is an assistant professor of forestry, Department of Forestry, School of Natural Resources, College of Agricultural and Life sciences, UW-Madison. Martin also is assistant professor of forestry in the Cooperative Extension Service, University of Wisconsin-Extension.

Produced by the Department of Agricultural Journalism, University of Wisconin-Madison. Design and illustration: Jody Myer.

This publication is available from your Wisconsin county Extension office or from:
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